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TWEEKERKENSTRAAT 2

B-9000 GENT

Tel. : 32 - (0)9 – 264.34.61
Fax. : 32 - (0)9 – 264.35.92

WORKING PAPER

A Longitudinal Study on the Impact of Venture Capital Firm Heterogeneity on Portfolio Company Growth *

Tom Vanacker †

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† Department of Accounting and Corporate Finance, Kuiperskaai 55E, 9000 GENT, Belgium; TomR.Vanacker@UGent.be

Abstract

Although scholars agree that not all partners are equal, it remains unclear whether companies will particularly benefit from forming relationships with more experienced or more legitimate firms. This study examines the impact of venture capital firm experience and legitimacy on portfolio company growth. For this purpose, I track 94 companies forming initial investment relationships with venture capital firms for up to five years after the initial investment. Linear Mixed Models (LMMs) are used to gain more insight into the non-linear growth trajectories of portfolio companies. Findings indicate that both companies backed by venture capital firms with more industry experience, but not overall experience, and companies backed by more legitimate venture capital firms exhibit higher growth curves.

Introduction

The lack of established working relationships, social approval, tested routines, and the resulting high risk of failure make resource mobilization a key challenge and a process fraught with difficulties within young and small entrepreneurial ventures (Stinchcombe, 1965). Nevertheless, the mobilization of sufficient external resources is critical and ventures which are able to mobilize more strategic resources at startup are likely to develop a competitive advantage over their resource-constrained peers (Lee, Lee and Pennings, 2001). Interorganizational relationships have become an attractive way to obtain resources (Baum, Calabrese and Silverman, 2000). Hence, these relationships are likely to be particularly beneficial to young, resource-constrained ventures (Stuart, Hoang and Hybels, 1999; Stuart, 2000). This study focuses on investment relationships between professional venture capital firms and their portfolio companies as a representative form of interorganizational relationships (Hallen, 2008) and studies the impact of venture capital firm heterogeneity on portfolio company growth.

Although scholars have recognized that certain relationships are more valuable than others, it remains unclear whether it is especially the experience or the legitimacy of the partner which may lead to measurable benefits for young entrepreneurial ventures (Rindova, Williamson, Petkova and Sever, 2005). Some scholars stress the importance of accumulated experience of partners through past actions (Hoang and Rothaermel, 2005; Sorensen, 2007). Firms are likely to learn how to identify and nurture promising ventures through repeated interactions with these ventures (Cohen and Levinthal, 1990) and are likely to develop a repertoire of proven routines (Nelson and Winter, 1982). Others stress the transfer of legitimacy from more established partners to ventures that lack legitimacy in the marketplace (Stuart, Hoang and Hybels, 1999). It is the

information exchange and social influence among actors, which results from affiliating with more legitimate partners, that changes the perception of stakeholders and makes them more likely to transact with the focal venture (Rao, 1994; Pollock and Rindova, 2003). The goal of this study is to examine whether entrepreneurial companies particularly benefit from forming investment relationships with more experienced or more legitimate venture capital firms.

Moreover, empirical work on venture capital firm heterogeneity has almost exclusively put venture capital firms in the foreground by focusing on venture capital fund performance and put portfolio companies in the background (Dimov and Shepherd, 2005; Dimov and De Clercq, 2006; Sorensen, 2007; Hochberg, Ljungqvist and Lu, 2007; Bottazzi, Da Rin and Hellmann, 2007). Nearly all our knowledge on the consequences of venture capital firm heterogeneity comes from the proportion of extreme outcomes, including initial public offerings (IPOs), mergers and acquisitions (M&As) and failures in the portfolios of venture capital funds. It is assumed that IPOs are the most lucrative exit, while M&As are only a second-best option (Berger and Udell, 1998). This raises two concerns. First, for venture capital firms to be able to exit from promising companies through an IPO, an active stock market is required, which is generally not the case in bank-based financial systems, including most Continental European countries (Black and Gilson, 1998). Second, M&As do not distinguish between successful and unsuccessful companies, as it represent a common exit route both for very promising companies and less promising ones (Schwienbacher, 2002; Graebner and Eisenhardt, 2004).

More importantly, studying organizational processes from different perspectives may offer different insights (Van de Ven, 2007). A successful exit from the perspective of the venture capital firm may not always be successful from the perspective of the portfolio company. Exits

by venture capital firms bear risks for entrepreneurs, like losing control and major changes in board composition (Schwienbacher, 2002). While some entrepreneurs may have an active interest in selling their companies others may show strong opposition to an acquisition (Graebner and Eisenhardt, 2004). Additionally, venture capital firms sometimes have perverse incentives and act in their self-interest. Gompers (1996) shows how young venture capital firms bring their portfolio companies to the market prematurely in order to establish legitimacy. Thereby these young venture capital firms do not maximize the value of the IPO from the perspective of their portfolio companies and additionally may put a serious burden on these less mature companies, as the costs of maintaining stock exchange listings are very high (Berger and Udell, 1998). This study departs from extant research on venture capital firm heterogeneity which is generally interested in fund performance and studies the impact of investor heterogeneity from the perspective of the portfolio company thereby focusing on portfolio company growth or its ability to accumulate key resources.

I use a unique longitudinal database, free of survivorship bias, tracking 94 Belgian venture capital backed companies for up to five years after the initial venture capital investment. LMMs are used as an appropriate longitudinal technique to model the dynamic (non-linear) nature of growth. This is an important methodological contribution to organizational growth research that typically measures growth as the difference in size between two points in time, thereby ignoring development in-between these two points (Weinzimmer, Nystrom and Freeman, 1998; Delmar, Davidsson and Gartner, 2003). Results demonstrate how companies which connect with venture capital firms with more industry experience, but not overall experience, and companies which connect with more legitimate venture capital firms exhibit higher growth paths both in employment and total assets. It is unlikely that selection drives these results. A more likely

explanation is that more experienced and legitimate venture capital firms provide superior value-added services to their portfolio companies and provide stronger signals to outside stakeholders which benefits venture growth.

The rest of the paper is organized as follows. I first present a theoretical framework on the impact of venture capital firm experience and legitimacy on portfolio company growth and develop specific hypotheses. Next, I outline the methods, including the sample, measures and method of analysis. Then, I present the main research findings. Finally, I conclude by discussing the results from both a theoretical and practical perspective.

Theory and Hypotheses

Relationships with venture capital firms are one of the earliest and most critical relationships formed, especially within growth-oriented entrepreneurial ventures requiring quick access to a variety of resources (Katila, Rosenberger and Eisenhardt, 2008). Venture capital firms not only contribute well-needed financial resources to their portfolio companies, but generally also contribute knowledge-based resources like advice, referrals for executive hires and industry connections (Sapienza, Manigart and Vermeir, 1996). Most prior research has treated venture capital firm participation as a dummy variable (Hsu, 2004), thereby assuming that all venture capital firms have equal capacity to source high quality companies and equal ability to nurture companies through active involvement (Megginson and Weiss, 1991; Kortum and Lerner, 2000; Hellmann and Puri, 2002; Davila, Foster and Gupta, 2003; Baum and Silverman, 2004).

Nevertheless, venture capital firms exhibit significant heterogeneity both in their selection behavior (Muzyka, Birley and Leleux, 1996) and post-investment assistance to their portfolio companies (Elango, Fried, Hisrich and Polonchek, 1995). Venture capital firm experience and legitimacy constitute two kinds of intangible resources which play a central role in the venture capital industry potentially leading to measurable benefits for portfolio companies. Below I discuss the role of venture capital firm experience and legitimacy on the growth path of their portfolio companies in more detail.

Venture Capital Firm Experience and Portfolio Company Growth

Learning theory indicates that firms learn how to manage relationships through repeated engagements with other ventures. Firms are likely to absorb and accumulate knowledge through prior relationship formation (Cohen and Levinthal, 1990). Firms are also likely to develop routines based on past experiences (Nelson and Winter, 1982). The routines that become part of an organization's repertoire are those that previously produced favorable outcomes (Levinthal and March, 1993). Moreover, the application of routines increases their efficiency and the likelihood of a desirable outcome (Levitt and March, 1988).

As venture capital firms gain experience they may become more capable at selecting the best ventures. The decision accuracy of venture capitalists increases with experience, although too much experience is not necessarily beneficial as experienced decision-makers may get trapped in their current modes of thought (Shepherd, Zacharakis and Baron, 2003). Despite the potential downside of having too much experience for decision-making accuracy, Sorensen (2007) demonstrates the existence of a monotonically increasing relationship between overall venture

capital firm experience and the probability of portfolio companies going public[1]. The main driver behind the results is investor selection; more experienced venture capital firms invest in better companies (Sorensen, 2007).

The accumulated experience may not only influence venture capital firms' ability to select more promising ventures, but may also contribute to the quality of the extra-financial, knowledge-based resources they offer to their portfolio companies (Baum and Silverman, 2004). Venture capital firms typically play an important role in monitoring the management and progress of their portfolio companies (Lerner, 1995; Fried, Bruton and Hisrich, 1998) and often help their portfolio companies with professionalizing, for example, by influencing the structure and experience of the management team (Hellmann and Puri, 2002). The effectiveness of post-investment management is likely to be dependent upon venture capital firm ability (Dimov and De Clercq, 2006). Overall, both the expected ability of more experienced venture capital firms to source high quality companies and their ability to nurture companies through active involvement lead to the following hypothesis:

Hypothesis 1A: Companies backed by venture capital firms with high overall experience will exhibit steeper growth curves compared to companies backed by venture capital firms with low overall experience.

[1] It should be noted that the precise shape of the relationship between experience and company growth -that is, whether it is monotonically increasing or an inverted U-shape- is a separate empirical issue. A priori, I would expect the monotonically increasing relationship to materialize in our research setting, as the Belgian venture capital industry although developed is still significantly less mature than its U.S. and U.K. equivalents. Hence, it is unlikely that Belgian venture capital firms already moved down to the flatter part of the learning curve (see more on this issue later).

Not all experience is the same, however, and learning performance is expected to be the greatest when the object of learning is related to what is already known (Cohen and Levinthal, 1990). Scholars have argued that it is difficult to learn from experience when performing heterogeneous tasks (Zollo and Winter, 2002). Extending this idea, it may be difficult for venture capital firms to learn from prior experience if they form investment relationships with very different types of companies. Alternatively, venture capital firms investing in a more homogenous group of companies may maximally benefit from learning curve effects through the accumulation of superior knowledge. An important specialization strategy for venture capital firms is to invest in only one or a few industries (Norton and Tenenbaum, 1993).

There are several ways through which specialized industry expertise held by venture capital firms may positively influence portfolio company growth. First, specialized industry expertise may allow for a better understanding of the intricacies associated with investing in particular industries. This may facilitate the selection of more promising ventures, as it is not because venture capital firms are good in selecting companies with high potential in for example the wholesale industry, that they will be equally able to do so in the biotechnology industry. Second, increased industry expertise may also benefit specialized venture capital firms in performing their governance role and value adding activities (Sapienza, Manigart and Vermeir, 1996). Venture capital firms with high industry deal experience may be better connected, for example, drawing on a greater number of contacts with relevant suppliers, customers, investors and managers for their portfolio companies (Hochberg, Ljungqvist and Lu, 2007). This leads to the following hypothesis:

Hypothesis 1B: Companies backed by venture capital firms with high industry experience will exhibit steeper growth curves compared to companies backed by venture capital firms with low industry experience.

Venture Capital Firm Legitimacy and Portfolio Company Growth

Signaling theory indicates that company stakeholders, like customers, suppliers, employees and investors -especially those that are risk averse- will be more likely to transact with entrepreneurial ventures after they have been endorsed by established firms (Stuart, Hoang and Hybels, 1999). Davila, Foster, and Gupta (2003) illustrate that venture capital firms as a group signal company quality to the labor market and thereby influences the ease with which companies attract key employees. Janney and Folta (2003) show how in a sample of publicly quoted technology companies, private equity placements send positive signals to the market and increase company value. This effect more pronounced when these quoted companies raise finance from more established investors (Janney and Folta, 2006). It indicates that the decision to offer finance by venture capital investors informs stakeholders about company quality and this manifests itself in increased growth.

Not all venture capital firms are likely to provide credible signals as many venture capital firms still need to establish legitimacy in the marketplace themselves (Gompers, 1996). When entrepreneurial companies connect with partners that lack legitimacy it is unlikely that this will change the perception of outsiders in any significant way. However, the legitimacy of more established venture capital firms is likely to transfer to their portfolio companies that lack legitimacy in the marketplace (Stuart, Hoang and Hybels, 1999; Stuart, 2000). This should allow

these portfolio companies to mobilize more resources from key stakeholders across time which should contribute to company growth. Accordingly, I put forth the following hypothesis:

Hypothesis 2: Companies backed by more legitimate venture capital firms will exhibit steeper growth curves compared to companies backed by less legitimate venture capital firms.

Data and Method

Sample

This study partially builds on a database provided by the Belgian Venture Capital and Private Equity Association linking venture capital backed companies to their lead investors. I track 94 companies that received initial venture capital finance between 1999 and 2003. Deals are only selected until 2003 in order to have at least three-year financial figures for the companies selected at the end of this timeframe, as the last financial figures available at the time of data collection were those of 2006.

For each portfolio company I collected detailed yearly financial statement data for up to five years after the initial venture capital investment. This was possible as all Belgian limited liability companies, irrespective of their size, are required to file financial statements with the National Bank. It offered 487 firm year observations. The average age of the portfolio companies at baseline (i.e. the year of the initial venture capital firm investment) equals 3.46 years, with a minimum of zero and maximum of 15 years. At baseline, the average company employs 9.78 people and has 3,905,500 euro of assets. Some 60% of the companies in the sample are active in

four sectors, namely computer and related activities (24%), biotechnology (12%), manufacturing (11%) and wholesale (11%).

In order to collect data on the lead venture capital firm providing initial venture capital, I combined multiple sources including the Zephyr database (a database of private equity deals with a special focus on pan-European transactions), the Belgian Venture Capital and Private Equity Association database and trade directories. The lead venture capital firms providing initial finance range from small venture capital firms with only six million euro of assets under management to venture capital firms with more than one billion euro of assets under management. The majority of lead investors offering initial finance to Belgian companies are domestic investors. Only two companies raised initial finance from international venture capital funds.

Measures

Dependent variable. Organizational scholars argue that growth studies should be longitudinal because of the dynamic nature of growth (Weinzimmer, Nystrom and Freeman, 1998). I study the temporal growth pattern of venture capital backed companies from the year of investment relationship formation up to five years after the initial investment. This is important as the typical lifespan of venture capital investments is around three to five years (Zarutskie, 2007). Furthermore, a five-year period has been the time frame most widely used in prior organizational growth studies (Weinzimmer, Nystrom and Freeman, 1998).

Growth is multidimensional in nature and hence the classification of a company as a high growth company depends on the growth concept and growth formula used (Delmar, Davidsson and Gartner, 2003). I take into account the multidimensional nature of growth by using two different growth indicators. Venture capital investors typically invest in companies which require large investments in employment and total assets but without immediate sale prospects, even in low tech industries (Puri and Zarutskie, 2008). This explains my choice to study *growth in employment* (in full time equivalents) and *growth in total assets*. I decided to focus on absolute changes in employment and total assets. Relative measures are not as suitable in the current research setting, since many variables may have a value equal or close to zero during the initial stage of venture capital firm involvement (Baum, Calabrese and Silverman, 2000).

Independent variables. The key independent variables are correlates of experience and legitimacy of the lead venture capital firm measured at baseline. Overall experience, is operationalized as the total number of investments made by the venture capital firm prior to the focal investment (Gompers, Kovner, Lerner and Scharfstein, 2008; Sorensen, 2007). It includes both the number of investments prior to the focal investment within the timeframe of this study (i.e., 1999-2003) and the number of investments made by the venture capital firm before this timeframe. Overall deal experience ranges from 1 to 90 investments with a median value of 9 investments. Industry experience, is constructed similarly to overall experience, but only examines investments in the same industry (2-digit industry code) as the focal company (Gompers, Kovner, Lerner and Scharfstein, 2008; Sorenson and Stuart, 2001). Industry deal experience ranges from 1 to 26 investments with a median value of 2 investments. The natural logarithm of overall and industry experience was used in subsequent analysis because doing so captured the decreasing marginal returns that experiential learning is subject to (Pennings,

Barkema and Douma, 1994; Hoang and Rothaermel, 2005). Similar results were obtained using the non-transformed measures.

As a proxy for venture capital firm legitimacy I construct a dummy variable which equals one when a venture capital firm is older than seven years (median value) and zero otherwise[2]. Older venture capital firms are like to be more legitimate compared to younger venture capital firms for at least two reasons. First, when venture capital firms invest it takes several years before the first results of the initial investments can be observed by outsiders (Zarutskie, 2007). Contrary to older venture capital firms with rich historical backgrounds, younger venture capital firms typically lack a track record of past performance. Second, many venture capital firms periodically raise follow-on funds to remain active in venture capital financing and firms generally have two or three overlapping funds each starting three to six years after the previous fund (Gompers and Lerner, 1996). Hence, older venture capital firms are likely to have demonstrated they conform to the generally accepted industry norms and practices, which should increase their legitimacy in the marketplace (Oliver, 1997).

While venture capital firm age might also proxy for accumulated experience, the correlations between overall deal experience and venture capital firm age (0.49) and especially industry deal experience and venture capital firm age (0.31) are rather low. In order to alleviate the concern that venture capital firm age reflects accumulated experience rather than legitimacy, I also ran models that control for venture capital firm experience in order to pick up any residual effects of this potential confound. Additionally, as an alternative proxy for venture capital firm legitimacy,

[2] Following Gompers (1996), I prefer to use a dummy variable in order to address potential nonlinearities. Nevertheless, similar results were obtained when using a continuous venture capital firm age variable instead of a dummy variable.

I looked up the number of times venture capital firms were cited in Belgian financial newspapers over the period 1995 until the year of initial investment. The media presents stakeholders with information that affects impression formation and legitimization of companies (Pollock and Rindova, 2003).

Control variables. Prior studies have advanced important company and venture capital firm characteristics associated with growth. It is well-established that age effects may cause differences in growth patterns (Jovanovic, 1982). *Company age* at baseline is measured as the difference between the year of initial investment and company founding year. Similarly, high tech companies may exhibit a different growth path compared to low tech companies (Harhoff, Stahl and Woywode, 1998). A *high tech* dummy variable is equal to one when the company is active in a high tech sector and zero otherwise. The classification of an industry as a high tech industry is based on a classification scheme provided by the Belgian government and is based on two digit industry codes. It includes industries, such as biotechnology, computer and related activities.

Companies investing in *intangible assets* typically do this to generate future growth (Titman and Wessels, 1988). Rather than the absolute level of intangible assets, scholars mainly emphasize the importance of intangible assets relative to tangible assets as one of the main drivers of the sustainability of performance (Villalonga, 2004). The ratio of intangible assets on total assets is used as a proxy for growth potential. I also control for the *amount of equity finance* received by the portfolio company at baseline. It is calculated based on financial accounts as the net increase in outside equity in the year of venture capital firm participation.

It is also necessary to control for size differences between venture capital firms, as there are multiple reasons why larger venture capital firms may have fast growing companies in their portfolio besides experience and legitimacy (Sorenson and Stuart, 2001). Larger venture capital firms, for example, have more possibilities to offer large amounts of follow-on finance compared to smaller venture capital firms. *Venture capital firm size* at baseline is measured as the natural logarithm of capital under management. Finally, I include year and industry dummy variables in the analysis to control for potential time (year of initial investment) and industry effects.

Analysis

Linear Mixed Models (LMMs) for repeated measures are used to study change in employment and total assets (Weiss, 2005; Fitzmaurice, Laird and Ware, 2004). It is the mix of fixed and random effects in the same model that is the basis of the name Linear Mixed Model. Scholars have often used General Multivariate Regressions Models. This requires longitudinal data where all companies have the same number of repeated measures, taken at time points, which are also the same for all companies (Fitzmaurice, Laird and Ware, 2004). These strict assumptions are rarely fulfilled in longitudinal (growth) studies and are not required when using the procedure MIXED in SAS to model LMMs.

It is conceptually convenient to depict LMMs as multilevel models (Fitzmaurice, Laird and Ware, 2004). The multilevel perspective is most useful if one assumes that companies randomly vary in terms of their initial size and growth trajectory. This assumption seems reasonable for many applications in organizational studies. Individual profile plots (not presented) confirm significant

heterogeneity in initial company size and how companies evolve over time. For this purpose, I discuss two levels of equations.

The first-level in the hierarchy is the individual-level model, which specifies the nature of change for each individual company. The simplest model of individual company change is the straight-line (linear) growth model:

$$Y_{ij} = \beta_{1i} + \beta_{2i}\, t_{ij} + e_{ij} \qquad (1)$$

where Y_{ij} is the ith company's employment or total assets at the jth time point. t_{ij} is the linear time coding used to fit a linear trend to the ith company's data across time. β_{1i} and β_{2i} are the company specific intercept and linear coefficient, respectively. The values of the βs can vary among the companies. The e_{ij} are the residuals. Equation (1) illustrates the flexibility of LMMs. Companies can have different number of time points, they may be measured at different times and each company can have a different trajectory (Fitzmaurice, Laird and Ware, 2004). LMMs can also accommodate non-linear change. The simplest non-linear model is a quadratic model, which is specified by adding $\beta_{3i}\, t_{ij}^2$ to equation (1)[3]:

$$Y_{ij} = \beta_{1i} + \beta_{2i}\, t_{ij} + \beta_{3i}\, t_{ij}^2 + e_{ij} \qquad (2)$$

The second-level in the hierarchy are the group-level models. Though individual regression equations are informative, researchers are usually interested in group effects. Conceptually, the random change parameters from the individual-level model (e.g. β_{1i}, β_{2i} and β_{3i} or company specific intercept, linear coefficient and quadratic coefficient respectively) are treated as response

[3] A point of confusion is that LMMs can be used to model non-linear change across time. The term linear in Linear Mixed Model refers to the linearity of the parameters and does not refer to the type of change that is modeled.

variables in a second set of models. Considering the equation (2) quadratic individual change model, the group level equations are:

$$\beta_{1i} = \beta_1 + b_{1i} \qquad (3)$$

$$\beta_{2i} = \beta_2 + b_{2i} \qquad (4)$$

$$\beta_{3i} = \beta_3 + b_{3i} \qquad (5)$$

β_1, β_2 and β_3 are the fixed intercepts in the level 2 equations and thus the averages of the individual-level parameters. β_1, β_2 and β_3 indicate the nature of change for the group as a whole, where β_1 is the group mean intercept or mean initial size, β_2 is the group mean linear change and β_3 is the group mean quadratic change. These βs are known as fixed effects, because they do not vary among companies. b_{1i}, b_{2i} and b_{3i} are the level 2 residual terms reflecting individual company differences from the fixed effects.

An extension of the unconditional model discussed above is to incorporate one or more static covariates. A static covariate of change is a predictor of change that does not vary over the course of the study. The key covariates in this paper are overall deal experience, industry deal experience and venture capital firm age measured at baseline. That is, I examine whether the individual change parameters (e.g. β_{1i}, β_{2i} and β_{3i}) vary as a function of the experience and legitimacy of the investor backing the company. Overall deal experience, industry deal experience and age of the lead investor are measured at baseline and consequently do not vary across time. Hence, they are incorporated in the group-level equations. Consider the individual-level quadratic change model (2) above. The group level equations studying change conditional on overall deal experience, for example, then become:

$$\beta_{1i} = \beta_1 + \beta_4 \, ode_i + b_{1i} \qquad (6)$$

$$\beta_{2i} = \beta_2 + \beta_5 \, ode_i + b_{2i} \qquad (7)$$

$$\beta_{3i} = \beta_3 + \beta_6 \, ode_i + b_{3i} \qquad (8)$$

where ode_i is the value of overall deal experience of the lead investor measured at baseline for the ith company. β_4 is the relationship between overall deal experience and intercept (initial size), β_5 is the relationship between overall deal experience and linear change and β_6 is the relationship between overall deal experience and quadratic change. β_4 is also known as the deal experience by intercept interaction, as it indicates how the mean initial size (or intercept) of companies is dependent on overall investor experience. β_5 is known as the overall experience by linear trend interaction, as it indicates how the mean linear trend is dependent on investor overall experience. Similarly, β_6 is the overall deal experience by quadratic trend interaction.

Results

Table 1 shows descriptive information on employment and total assets. It reports unconditional means across time. The bottom of Table 1 shows the sample sizes at each time point. The study does not suffer from survivorship bias, as failing companies are included in the analysis. This information is typically unavailable to other researchers (see Cassar (2004) for a discussion on survivorship bias when examining startup financing). The sample size decreases at the end of the time frame for two main reasons. First, some companies are too young to have four or five-year observations. Second, due to M&As some companies stop to exist as independent entities. The companies are included in the analysis for the years before the M&A, but excluded as the companies stop to exist as separate entities after the M&A.

The LMM methodology assumes that the response variable is normally distributed. I check the conditional and unconditional distributions of the raw employment and total assets values using longitudinal box plots (Weiss, 2005). These show that employment and total assets are positively skewed (not presented). Therefore, the natural logarithm of employment and the natural logarithm of total assets are used as normalizing transformations for all subsequent analyses.

Modeling Unconditional Change in Venture Capital Backed Companies

I first develop models for unconditional change in employment and total assets. Unconditional models do not have static covariates of change. Therefore, unconditional models focus on mean change in the entire group of venture capital backed companies. Thereby, more insight is gained in the temporal pattern of growth within venture capital backed companies, which is a critical step in order to be able to start answering questions about what the effects are of particular covariates, such as venture capital firm experience and legitimacy, on this growth pattern (Weiss, 2005).

The results of the unconditional analysis appear in Table 2. I start by testing an elaborate model including a linear, quadratic and cubic term. Models higher than third order are rarely used in social sciences. Following Peixoto (1987), testing involves backward elimination, starting with the highest order polynomial, in order to avoid bias. If the highest order term is significant, all lower order terms are left in the model regardless of their significance, because only the highest order term is interpretable, in the sense that it does not change when the time metric is arbitrarily changed (Peixoto, 1987). The unconditional model for $\log_e$ employment has a linear, quadratic and cubic term. The omnibus null hypothesis of no time effects is rejected, $F(3,79) = 14.32$,

$p<0.001$. As for the specific tests, the linear, quadratic and cubic term are significant. Figure 1 plots the observed and predicted means of the unconditional models for $\log_e$ employment and demonstrates how $\log_e$ employment first increases, then exhibits a drop off, before increasing again across time. Moreover, it indicates good model fit between observed and predicted means.

For $\log_e$ total assets, the cubic term is not significant in the highest order polynomial tested. However, the omnibus null hypothesis of no time effects is rejected, $F(3,86) = 3.25$, $p<0.05$. Given that the cubic term is not significant it is dropped from the model and the second order term is tested. The specific test of the quadratic term is significant. The positive linear and negative quadratic term indicate the means increased over time, before decreasing towards the initial level. This drop is mainly explained by companies that fail in the period three to five years after the initial investment[4]. Figure 1 plots the observed and predicted means of the unconditional models for $\log_e$ total assets.

Modeling Conditional Change in Venture Capital Backed Companies

In the previous section unconditional change was modeled allowing us to gain insight in the temporal pattern of change within venture capital backed companies *as a group*. In this section, conditional LMMs are estimated, which allow us to study the impact of venture capital firm experience and legitimacy on the growth path of venture capital backed companies, controlling for a-priori covariates, such as company age, initial investment size and venture capital firm size amongst other controls.

[4] Excluding failed companies from the analyses does not change the main conclusions of this study. However, it introduces a bias in that the total assets growth profile of the mean company exhibits a monotonically increasing trend. Given that 10% of the companies in the sample fail this entails an important decrease in asset accumulation within venture capital backed companies. Hence, excluding failed companies from the analyses gives an unrealistic image of the growth profile of the average venture capital backed company.

The results of the conditional analyses are reported in Table 3. Separate models for growth in employment (E) and total assets (TA) are reported. I start with reporting LMMs conditional on the main independent variables separately: overall deal experience (E1 and TA1), industry deal experience (E2 and TA2) and venture capital firm age dummy (E3 and TA3). Next, I report nested models, including both overall deal experience and venture capital firm age dummy (E4 and TA4) and industry deal experience and venture capital firm age dummy (E5 and TA5).

In models E1 and TA1 the overall deal experience by intercept interaction was not significant. This indicates that there were no differences in initial size (employment and total assets) between companies backed by investors with high or low overall deal experience. In model E1 the overall deal experience by linear trend interaction is significant. It provides evidence that companies backed by investors with high overall deal experience show a significantly steeper growth curve in employment compared to companies backed by less experienced investors. However, these results are not confirmed for growth in total assets (TA1).

In models E2 and TA2 the industry deal experience by intercept interaction was not significant. Companies backed by investors with high or low industry deal experience did not differ in size at baseline. Both in model E2 and TA2 the industry deal experience by linear trend interaction is positive and significant. It indicates that companies backed by investors with higher industry deal experience exhibit higher growth rates across time. Figure 2 plots the predicted means from the unconditional model and the predicted means for companies backed by investors with high industry deal experience versus investors with low industry deal experience (based on a median

split). It confirms that companies backed by investors with higher industry deal experience exhibit steeper growth curves both in employment and total assets[5].

In models E3 and TA3 the effect of venture capital firm legitimacy is tested by using the venture capital firm age dummy. The venture capital firm age dummy variable had both an effect on the linear and quadratic growth trend[6]. The significant venture capital firm age dummy variable by intercept term indicates that companies backed by older venture capital firms are larger in term of total assets at baseline (TA3). The venture capital firm age by quadratic term interaction is positive and significant both in the employment and total assets model. Figure 3 plots the predicted means from the unconditional model and the predicted means for companies backed by old versus young venture capital firms (based on a median split). It shows considerable differences in the growth path of companies backed by old versus young venture capital firms, where the growth path of companies backed by older more legitimate venture capital firms lies consistently above that of companies backed by younger less legitimate venture capital firms.

Models E4 and TA4 include both overall deal experience and venture capital firm age (dummy). In both models the overall deal experience by linear trend interaction is not significant. The effect of venture capital firm age however remains stable. Models E5 and TA5 include both industry deal experience and venture capital firm age. In these models the statistically significant industry deal experience by linear trend interactions indicate companies backed by investors with higher industry deal experience exhibit a steeper growth curve. The effect of venture capital firm age again remains stable. These results indicate that companies particularly benefit from relationship

[5] As a robustness check, I tested for the existence of an inverted U-shape relationship between experience and company growth. Results did not confirm such a relationship.

[6] Note that in polynomial models only the highest order term is interpretable (Peixoto, 1987). The sign of the linear term may be informative about the shape of the growth curve but only when considered with the higher order terms.

formation with partners that have high industry deal experience rather than overall deal experience. Furthermore, the stable results of venture capital firm age in the nested models alleviates the potential concern that venture capital firm age proxies for accumulated experience rather than legitimacy. Both investors with high industry deal experience and legitimacy positively influence the growth path of their portfolio companies[7]. Interestingly, the nested models also indicate that older more legitimate venture capital firms invest in companies that are larger in terms of employment and total assets at baseline.

As a robustness check, I also ran additional models testing the impact of the natural logarithm of the number of citations to the respective venture capital firms on portfolio company growth (Not presented in Table 3, but available from the author upon simple request). Companies backed by investors that appear more frequently in the financial press exhibit a steeper growth curve in employment. The same holds for growth in total assets, but results are not statistically significant. Overall, findings demonstrate the robustness of the positive relationship between venture capital firm legitimacy and company growth reported above and this especially for growth in employment.

Finally, some of the results of the control variables also merit attention. Company age by intercept interactions indicate that older companies are larger at baseline (E1-E5 and TA1-TA5). The high tech dummy by intercept interactions are only significant in the employment models. Companies active in high technology industries employ more people at baseline (E1-E5). However, companies with more intangible assets are smaller in term of number of employees at

[7] I also ran models including an interaction between the centered values of industry deal experience and venture capital firm age. Results did not confirm any significant interaction effect.

baseline (E1-E5) and smaller in term of total assets (TA1-TA5). Companies receiving a larger equity investment at baseline are larger in terms of employment (E1-E5) and total assets (TA1-TA5). Larger venture capital firms have a tendency to invest in larger companies (E1-E2 and TA1-TA5). Finally, in the employment models, the negative and significant company age by linear trend interactions indicate that older companies have a lower linear growth rate (E1-E5).

Alternative Explanations for the Hypothesized Relationships: Investor Selection versus Value Adding

Two distinct processes may explain the findings in this paper. One explanation is that more experienced and legitimate venture capital firms have access to companies with different characteristics and that venture capital firms will select companies with higher growth potential. An alternative explanation is that more experienced venture capital firms and legitimate venture capital firms add more value post investment. More experienced venture capital firms, for example, may be better business advisors and have a larger network, while more legitimate venture capitals firms may convey a stronger signal to outside stakeholders.

Amit, Brander and Zott (1998) argue that although venture capital firms exist because of their capacity to reduce informational asymmetry, venture capital firms will still prefer to select those companies where selection costs are relatively low. In other words, venture capital firms will prefer to invest in those companies where the cost of informational asymmetry is less severe. Information problems are thought to be particularly severe in young, small and technology-based companies (Berger and Udell, 1998; Carpenter and Petersen, 2002). It should be easier for venture capital firms to select promising companies when these are characterized by lower

informational asymmetry (Lerner, 1999). Following this line of reasoning, if selection drives the results one would expect more experienced and legitimate venture capital firms to select older, larger and low tech companies.

Moreover, selection entails that more experienced and legitimate venture capital firms identify and invest in those companies that have more growth opportunities already present in the company prior to the investment or alternatively that companies with high growth potential prefer to raise finance from more experienced venture capital firms (Sorensen, 2007; Hsu, 2004). Companies invest in intangible assets to generate future growth and hence, if selection drives the results, one might expect that more experienced and legitimate venture capital firms will match with those companies that have higher intangible assets on total assets ratios.

Non-parametric Mann-Whitney Tests indicate few differences in initial characteristics between the companies backed by investors with high industry deal experience versus those backed by investors with low industry deal experience (based on median split). Both groups of companies do not differ in terms of age, total assets, employment and intangible assets ratio[8]. However, venture capital firms with high industry deal experience are more likely to invest in biotechnology ventures ($p<0.01$). The biotechnology industry is one of the riskiest and most uncertain industries in our modern knowledge-based economy.

I also compared the companies backed by young versus old venture capital firms (based on median split). Both groups of companies do not differ in terms of age, total assets, employment

[8] Multivariate logit models confirm the reported results. Company characteristics, such as size and intangible assets ratio, which may be influenced by the financing received are measured in the year *prior* to the investment (when possible) in order to avoid problems of reverse causality.

and industry focus. Young, less legitimate venture capital firms select companies with higher growth opportunities as proxied by the intangible asset on total asset ratio ($p<0.05$)[9]. If the portfolio companies of older, more legitimate venture capital firms exhibit higher growth curves because of investor selection, one would expect older venture capital firms to select those companies with the highest growth potential which is the opposite from what is reported here.

Why would young venture capital firms be more likely to select companies with high growth potential compared to their older counterparts? Young venture capital firms have incentives to grandstand or take actions that signal their ability to their own potential investors (Gompers, 1996). This is important as previous research indicates that past performance influences fundraising ability (Lakonishok, Shleifer, Thaler, and Vishny, 1991). Hence, younger venture capital firms have an incentive to bring companies public earlier than older venture capital firms, this in order to establish legitimacy in the marketplace and successfully raise capital for new funds (Gompers, 1996). Extending this line of reasoning, young venture capital firms may have a large incentive to invest in companies with high growth potential that can be brought public quickly.

Discussion and Conclusion

Most prior research treated venture capital firms as a homogenous group, thereby obscuring experience and legitimacy differences between venture capital firms (Hsu, 2004). It remains

[9] Entrepreneurial ventures may also use patents to signal their value and commercial potential to outside stakeholders, including venture capital investors (Hsu & Ziedonis, 2007). As a robustness check, I looked up whether companies in the sample were granted patents up until one year after the initial investment using the European Patent Office database. I find that younger, less legitimate venture capital firms are more likely to select companies that successfully applied for patents ($p<0.05$). It indicates that younger less legitimate venture capital firms select ventures with higher growth potential. This adds to the robustness of the reported results.

unclear whether it is particularly the experience or legitimacy of the venture capital firm which will benefit venture development. Moreover, recent studies explicitly incorporating venture capital firm heterogeneity almost exclusively focus on explaining fund performance. In this study, I take the perspective of the portfolio company and examine the impact of venture capital firm heterogeneity on the growth pattern of venture capital backed companies.

Using learning and signaling theory, I provide testable hypotheses on the impact of venture capital firm experience and legitimacy on portfolio company growth. I use a unique longitudinal database tracking employment and total assets within 94 companies for up to five years after the initial investment. Results indicate that both investor experience and legitimacy significantly influence the (non-linear) growth path of venture capital backed companies. However, not all experience matters. Companies backed by investors with more overall deal experience do not exhibit different growth curves compared to companies backed by investors with limited overall deal experience. Hence, I find no support for hypothesis 1A once models control for venture capital firm legitimacy. Nevertheless, companies backed by investors with high industry experience exhibit steeper growth curves both in employment and total assets, thereby offering support for hypothesis 1B. Furthermore, companies backed more legitimate venture capital firms exhibit higher growth curves compared to companies backed by venture capital firms that lack legitimacy in the marketplace thereby offering support for hypothesis 2.

Academic Contributions

From a theoretical standpoint this study contributes in at least three ways. First, prior research has demonstrated a tension between economists and institutional theorists on who the most valuable

partners are for young resource-constrained ventures (Rindova, Williamson, Petkova and Sever, 2005). It remains unclear whether entrepreneurial ventures will particularly benefit from connecting with partners that are good or known in the marketplace? Economists stress the role of experienced firms which are likely to provide higher quality tangible and knowledge-based resources through learning based on past actions. Institutional theorists stress the role of partner legitimacy which is transferred to entrepreneurial ventures, thereby influencing stakeholder perceptions making the latter more likely to transact with the venture. This study demonstrates the artificial nature of this tension, as the development of entrepreneurial ventures benefits both from connecting with more experienced and legitimate partners. Hence, both experience and legitimacy plays a complementary role and entrepreneurial ventures are likely to benefit both from forming relationships with good and well-known partners.

Second, prior research unambiguously demonstrated that more experienced and legitimate firms perform better (Pollock and Rindova, 2003; Hoang and Rothaermel, 2005; Sorensen, 2007). More experienced and legitimate firms are, for example, able to ask a higher premium from entrepreneurial ventures that are willing to connect with them (Hsu, 2004). Given the cost of affiliating with more experienced and legitimate partners, it is important to consider how relationships with these partners affect the development of entrepreneurial companies. This study demonstrates how entrepreneurial ventures connecting with more experienced and legitimate partners are able to accumulate more human resources and total assets. Hence, as growth in employment is a good proxy for the value of private entrepreneurial companies (Davila, Foster and Gupta, 2003), the premium required by more experienced and legitimate investors may be worthwhile.

Third, this study also starts to disentangle the processes underlying the higher growth of entrepreneurial ventures backed by more experienced and legitimate partners. Experienced and legitimate partners may be able to both select more promising ventures and contribute better intangible knowledge-based resources. It is unlikely that selection drives our results. The companies getting finance from more experienced and legitimate investors do not differ systematically in age and size prior to the initial investment. Results do suggest that venture capital firms with high industry deal experience are more likely to invest in the biotechnology industry, which is one of the riskiest industries in our modern economy. Furthermore, results suggest that companies getting finance from more legitimate venture capital firms may have lower growth opportunities prior to the investment. In sum, this indicates that more experienced and legitimate investors do not necessarily select more promising companies before the investment, but contribute superior knowledge-based resources after the investment and convey stronger signals to outside stakeholders.

From an empirical standpoint this study addresses two related shortcomings in organizational growth studies. First, growth studies often look only at first and last year sizes and ignore development in between these two time points (Delmar, Davidsson and Gartner, 2003; Weinzimmer, Nystrom and Freeman 1998). Second, researchers typically make highly simplistic (and often implicit) assumptions about the temporal growth pattern across time. It is common for researchers to assume that growth occurs as a quantum size leap at one particular point in time or that growth is a linear process (See Davidsson and Wiklund, 2006 for a literature overview and critical comment). While nearly all organizational scholars agree that growth is a dynamic non-linear process, few scholars explicitly incorporate this idea in theory building and empirical testing.

This study explicitly models the dynamic nature of growth and demonstrates how LMMs can be used for that purpose. LMMs allow modeling non-linear change trajectories and account for individual differences between companies as well as similarities among groups of companies (Weiss, 2005; Fitzmaurice, Laird and Ware, 2004). Despite major advances in statistical methods for longitudinal analysis in recent years, the methods have not been widely used (Fitzmaurice, Laird and Ware, 2004).

Implications for Practice

Entrepreneurs typically have to balance the pressure of running out of cash and the time needed to search for desirable investors. This study indicates that the decision from which investor to raise finance may have a long-term impact, besides the provision of cash at the time of the investment. Hence, raising initial finance from desirable venture capital firms may be worth the higher cost (Hsu, 2004). Moreover, a complaint often heard from entrepreneurs is that experienced and legitimate venture capital firms are especially wary to offer finance to young and small entrepreneurial companies. I did not find evidence, however, that more experienced and legitimate venture capital firms select older or larger entrepreneurial companies. Overall, my findings are encouraging for entrepreneurs as they suggest that even young and small entrepreneurial ventures have the potential for receiving investments from desirable investors.

Results may also be informative for government officials. All over the world programs are implemented to increase the supply of venture capital, especially to young, innovative and growth-oriented entrepreneurial companies, which are considered to be the motor of any modern

economy. Policy makers should take into account that not only to supply of financial capital as a commodity good is important. Policy measures targeting experienced and legitimate investors may have disproportionally positive effects on employment generation and asset accumulation within an economy.

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TABLE 1
Descriptive Statistics for Employment and Total Assets [a]

Measure	Time					
	Baseline	1	2	3	4	5
Sample means (*s.d.*)						
Employment	9.78 (14.81)	12.76 (18.59)	14.82 (24.22)	16.88 (29.40)	19.79 (36.04)	22.47 (45.52)
Total Assets	3,905 (6,678)	4,561 (7,287)	4,780 (7,165)	6,096 (10,574)	7,742 (16,074)	6,087 (10,299)
N (% Missing)						
Employment	83 (5.68)	91 (3.19)	92 (0.01)	86 (0.01)	72 (0.00)	53 (0.00)
Total Assets	88 (0.00)	94 (0.00)	93 (0.00)	87 (0.00)	72 (0.00)	53 (0.00)

[a] Employment is in full time equivalents and total assets (excluding cash and cash equivalents) in 1,000EUR.

Note: *s.d.* = standard deviation

TABLE 2
Unconditional Analysis for Employment and Total Assets

Response	Omnibus Test	Intercept	Linear Trend	Quadratic Trend	Cubic Trend
$\log_e$ employment	$F(3, 79) = 14.32^{***}$	1.6325^{***}	0.4911^{***}	-0.1590^{***}	0.0169^{**}
$\log_e$ total assets	$F(3, 86) = 3.29^{**}$	6.9132^{***}	0.3962^{**}	-0.1637 †	0.0174
$\log_e$ total assets		6.9657^{***}	0.1647	-0.0361 †	---

† $p < .10$
* $p < .05$
** $p < .01$
*** $p < .001$
Two-tailed tests.

TABLE 3
Conditional Analysis for Employment and Total Assets [a]

	Employment					Total Assets				
	E1	**E2**	**E3**	**E4**	**E5**	**TA1**	**TA2**	**TA3**	**TA4**	**TA5**
INTERCEPT	-0.7983	-0.7819	-0.9008	-0.9047	-0.8600	1.2516	1.2937	1.1032	1.2383	1.2656
Overall Deal Experience	**-0.0877**			**-0.1514**		**0.0139**			**-0.1424**	**-0.4045**
Industry Deal Experience		**-0.1946**			**-0.2135** †		**-0.3069**			
VCF Age (Dummy)			**0.3460**	**0.4405** †	**0.3834** †			**0.4356** †	**0.5330** †	**0.5189** *
Company Age	0.1075 ***	0.1052 ***	0.1113 ***	0.1109 ***	0.1088 ***	0.0555 †	0.0500 †	0.0600 *	0.0587 †	0.0545 †
High Tech (Dummy)	0.3662 †	0.3964 *	0.3699 *	0.4067 *	0.4263 *	-0.2726	-0.2044	-0.2313	-0.2120	-0.1396
Intangible Assets Ratio	-0.0081 *	-0.0080 *	-0.0077 *	-0.0071 †	-0.0072 *	-0.0136 **	-0.0129 **	-0.0124 **	-0.0120 **	-0.0114 **
Initial Investment Size	0.1144 †	0.1147 †	0.1267 †	0.1217 †	0.1243 †	0.5812 ***	0.5747 ***	0.5949 ***	0.5932 ***	0.5948 ***
VCF Size	0.1459 †	0.1456 †	0.1109	0.1390	0.1268	0.2024 †	0.2355 *	0.1848 †	0.1972 †	0.2043 *
LINEAR TREND	0.4038 ***	0.4273 ***	0.6425 ***	0.5341 ***	0.5445 ***	0.0361	-0.1027	0.3576 *	0.1317	0.0792
Overall Deal Experience*Linear Trend	**0.0664** †			**0.0597**		**0.0603**			**0.1176**	
Industry Deal Experience*Linear Trend		**0.1079** *			**0.0940** †		**0.2338** *			**0.2539** *
VCF Age (Dummy)*Linear Trend			**-0.1778** †	**-0.2211** *	**-0.1936** *			**-0.3777** †	**-0.4581** *	**-0.4198** *
Company Age*Linear Trend	-0.0133 *	-0.0120 *	-0.0141 *	-0.0139 *	-0.0127 *	0.0002	0.0050	0.0002	0.0010	0.0041
QUADRATIC TREND	-0.1674 ***	-0.1678 ***	-0.1896 ***	-0.1921 ***	-0.1921 ***	-0.0384 †	-0.0380 †	-0.0724 *	-0.0705 *	-0.0702 *
VCF Age (Dummy)*Quadratic Trend			**0.0423** **	**0.0424** **	**0.0418** **			**0.0710** †	**0.0700** †	**0.0695** †
CUBIC TREND	0.0184 **	0.0184 **	0.0185 **	0.0191 ***	0.0191 ***	---	---	---	---	---
Null Model Likelihood Ratio Test Chi-Square	717.79 ***	717.87 ***	720.63 ***	723.20 ***	723.40 ***	451.00 ***	448.25 ***	455.17 ***	455.85 ***	452.63 ***
N	477	477	477	477	477	487	487	487	487	487

† p < .10
* p < .05
** p < .01
*** p < .001
Conservative two-tailed tests.

FIGURE 1
Unconditional Models: Observed and Predicted Means

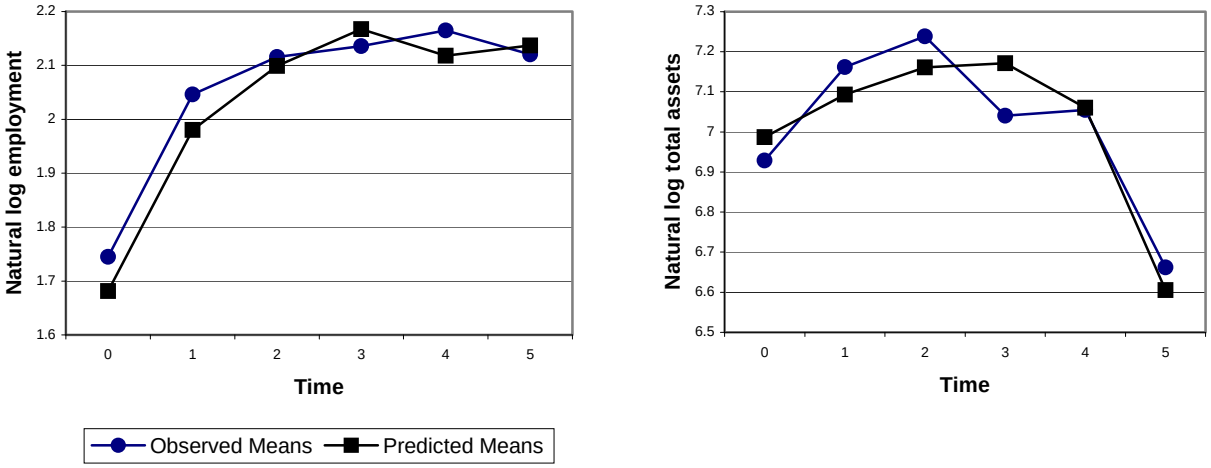

FIGURE 2

Conditional Models: Predicted Means for Companies Backed by Investors with High Industry Deal Experience versus Low Industry Deal Experience

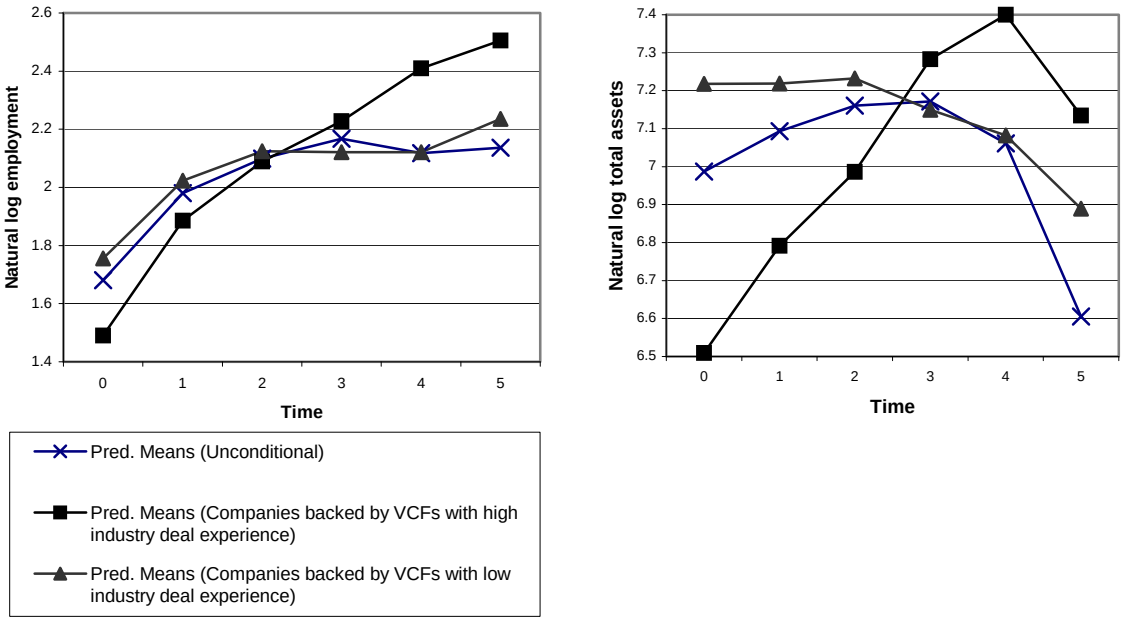

FIGURE 3

Conditional Models: Predicted Means for Companies Backed by Old versus Young Venture capital firms