

Nascent Entrepreneurs, Innovation and External Finance

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Abstract

This paper examines the relevance of innovation for nascent entrepreneurs' financial decisions. High degrees of uncertainty, insufficient protection of intellectual property and asymmetric information may concern especially innovative start-ups. Innovative nascent entrepreneurs may therefore face the problem of obtaining external finance. We argue that learning amongst entrepreneurs and investors in early stages of a start-up may help to ease problems. Using newly available data on capital seeking nascent entrepreneurs, we investigate the effect of innovation on the probability of being externally financed. In doing so, we distinguish between start-ups in the planning stage and early stage. Our results suggest that being innovative does not affect the probability of having external sources of finance in the planning stage but has a positive effect in the early start-up stage. Early stage start-ups with patents have a significantly higher probability of having equity finance whereas debt finance is not affected. However, this positive affect of a patent is only significant if the start-up has also developed a prototype. This result may indicate that the development of prototypes reduces the uncertainty with respect to innovation success and that patents improve protection of proprietary innovations signaling a high expected value of the start-up to potential investors. Moreover, start-ups with international links and teams are more likely to have equity finance. The most important determinant of debt finance is house ownership.

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1 Introduction

Innovative start-ups face the central problem of obtaining external financial resources when their most important assets are knowledge-based and intangible (Hsu, 2004). There are three crucial problems which impede external finance and which are especially relevant for innovative start-ups.

Firstly, information asymmetries arise if innovative entrepreneurs have better information about the returns of their investment in intangible assets than potential investors/lenders.¹ Moreover, intangible assets are likely to have low collateral value. Hence, "external finance may be expensive, if available at all, because of adverse selection and moral hazard problems." (Carpenter & Petersen, 2002).

Secondly, fundamental uncertainty characterizes the relationship between innovation efforts and their outcomes. Moreover, new knowledge is intrinsically uncertain in its potential economic value (Arrow, 1962). Thus, "the challenge to decision making is ignorance, the fact that nobody really knows anything" (O'Sullivan, 2006). The decisions of innovative entrepreneurs and potential investors may be based on subjective judgements which do not necessarily coincide. This implies that innovative start-ups may have difficulties to finance their innovation efforts.

Thirdly, knowledge exhibits – at least partly – the properties of a public good, i.e. it is non-excludable and non-rival in use. Innovative start-ups may not be able to fully protect their technical knowledge, e.g. protection mechanisms like patents or secrecy are not always effective. If knowledge spills over to other firms, benefits from innovation cannot be fully appropriated by the innovator.

Taken together, uncertainty, knowledge asymmetries, and potential non-exclusive nature of a start-up's investments in intangible assets make it difficult to evaluate the expected value of an innovative firm as compared to non or less innovative firm (Audretsch & Weigand, 2005). One might expect that these

¹ For instance, investors/lenders may find it difficult to evaluate the technical details of an innovation or the ability of the entrepreneur to realize the innovation. Consequently, potential investors may not be able to ascertain whether an innovative start-up is a good risk or a bad risk.

problems are especially relevant in the very early start-up phase of innovative firms.

What does this mean for the financial decision of individuals who are actively involved in starting a new business – so-called nascent entrepreneurs (NEs)? Which factors are relevant for acquiring external finance in the very early stage of an innovative start-up? Which external sources of finance are used by innovative nascent entrepreneurs?

Empirical studies on capital structure are focused on the analysis of the financial decisions of *established* firms. Often these studies lack in the coverage of the smallest and youngest firms, and NEs in particular.² Even studies on venture capital (VC) funding of start-ups are usually based on samples of young firms that have already started their business. Moreover, they are typically restricted to start-ups which received external finance by VCs or had contacted VCs. Obviously, such samples do not allow for investigating start-ups in the planning stage or very early start-up stage which do not have equity finance or any kind of external finance.³

Taken together, financial decisions of nascent entrepreneurs are largely unexplored as yet. This can be explained by the fact that data on the financial decisions of innovative nascent entrepreneurs are barely available. The key issue concerning data is the problem of identifying nascent entrepreneurs. Recently, attempts have been made by scholars to detect NEs through large scale survey, like the Panel Survey of Entrepreneurial Dynamics (PSED). However, as we will explain in our paper such surveys might not be appropriate to analyze the financial decisions of innovative NEs.

Davidsson (2006, pp. 3) points out that the research on NEs is a central development in entrepreneurship research because it aims to "overcome the *selection bias* resulting from including only start-up efforts that actually resulted in up-and-running businesses" and "to overcome the *hindsight bias* and *memory decay* resulting from asking survey questions about the start-up process retrospectively."

² See Harris and Raviv (1991) for a survey of the empirical literature.

³ For an excellent survey of the VC literature, see Gompers and Lerner (2004).

In this study we make use of a new data set which was provided by the Center for Innovative Entrepreneurship (CIE).⁴ This data set contains information that allow for: a) identification of nascent entrepreneurs, which is one of the key issues of the research on nascent entrepreneurs, b) analyzing the financial decisions of nascent entrepreneurs (debt vs. equity finance), c) differentiating between innovative and non- or less innovative entrepreneurs, d) distinguishing between NEs in the planning stage and NEs in an early start-up stage.

We estimate an econometric model of nascent entrepreneurs' choices between debt and equity finance. We present the results of separate estimations for NEs in the planning stage and NEs in an early start-up stage in order to take potential learning effects amongst NEs and potential investors into account.

Our estimation results suggest that being innovative does not affect the probability of having external sources of finance in the planning stage but has a positive effect in the early start-up stage. Early stage start-ups with patents have a significantly higher probability of having equity finance whereas debt finance is not affected. However, this positive affect of a patent is only significant if the start-up has also developed a prototype. Moreover, start-ups with international links and teams are more likely to have equity finance. The most important determinant of debt finance is house ownership.

The paper is arranged as follows: in the next section we will discuss the relationship between finance and innovation. Section 3 describes the data source and the identification of nascent entrepreneurs. Section 4 provides descriptive statistics. Section 5 discusses the econometric model and Section 6 presents the empirical results. Section 7 concludes.

2 Financial decisions of innovative firms

Although the importance of the relationship between finance and innovation appears to be quite obvious researchers from the fields of economics and finance have not united their effort (O'Sullivan, 2006). In the literature on innovation

⁴ See <http://www.vfinance.com/cie/default.asp?page=aboutCIE> for more information.

there has been a lot of emphasis on the role of finance in R&D investments for example Hall (2002), but very few studies have focused the issue other way round, that is, what role does innovation play in determining a certain mix of financial resources. We especially deal with the question, whether being innovative makes NEs behave differently in managing their finances?

Baldwin and Gellatly (2004) use a firm's innovative activity and the industry's knowledge base as determinants of financial structure and also test the other way round. They find that innovation activity and the industry's knowledge base indeed affect a firm's financial structure and specifically the tendency is towards lower debt ratios. Aghion et al. (2004) find that financial behavior of more innovative firms is different than that of less innovative ones. They also find that the use of debt decreases with R&D intensity due to the reason that more innovative firms issue equity in order to meet the investor's participation constraint, even though it would mean sharing ownership. Acs (2002) finds that innovative small firms face binding liquidity constraints and therefore would prefer debt, especially long term. The paper also finds that small firms rely more on retained earnings than larger firms to finance investment. Clearly through these studies it can be seen that innovative firms have a different financial structure and the traditional theories of financial structure have to be tested on innovative firms and the reasons have to be therefore found in order to explain a particular tendency. Amongst the innovative firms again there are differences in financial behavior which vary with firm size, as mentioned in Acs (2002) and other studies.

Financial Constraints and Innovative Nascent Entrepreneurs The problem of information asymmetries may be more severe for nascent entrepreneurs and even more if the firm is innovative from the beginning. Innovative firms have knowledge endowments. An entrepreneur having such knowledge endowments finds it difficult to signal the expected profitability of the start-up to the banks. The banks thus have a problem in selecting the profitable project and therefore as a resort tend to credit rationing (Stiglitz & Weiss, 1981). Since investment

needs of an innovative firm are generally higher, bootstrap finance is also not a solution. The general tendency therefore is to prefer equity. Equity comes at a cost, and that cost is ownership. The probability of an entrepreneur getting equity therefore depends on the willingness to share the ownership. This willingness should be more in the case of nascent entrepreneurs due to high risk nature of the project. Considering that the knowledge endowments are still intangible assets, the reduction of financial constraints needs faster conversion of intangible assets to tangible assets (Hutchinson, 1995). Therefore the stage in which the knowledge based start-up is also important in determining its preference for external finance. In this study we consider nascent entrepreneurs having no previous business earnings. Some entrepreneurs, however, have knowledge endowments (prototypes, patents for example) which are expected to earn profits in future.

The lender's/Investor's problem: First consider the only possibility is to obtain funds from a bank. In this case, as is well known, the problems of adverse selection, moral hazard and consequently costly state verification has to be faced by the banks. Considering also the possibility of credit ratings to decrease rationing, the borrower with knowledge endowments does not have an advantage since the standard credit rating models do not consider knowledge variables in the scaling process (see Dietsch and Petey (2002) and Altman and Sabato (2005) for a new SME credit rating model). This leads to all the firms being treated equally rather than looking at the value maximizing endowments that the firms have. As is known by the credit rationing argument the entrepreneurs either go for low risk projects and the ones who end up getting bank loans are those with the high risk projects. Through the interest rate changes the bank filters these and a benchmark interest rate is set up for lending which is generally high for small firms to afford. The rigid banking procedures and related costs do not allow the banker to scrutinize the value of intangible assets. This is the case of banks not considering all of the borrowers endowments (tangible and intangible) and relying on traditional information set requirements (financial

ratios, asset valuation, collateral etc) which do not actually capture the entire expected profitability of the firm. In this case the firm is expected to invest with the money from family sources, relatives, bootstrap finance and later retained earnings from the business, until it builds up the collateral requirements and then resorts to borrowing from bank. Since these firms are high risk firms, and investment in R&D is huge, chances of failure before the firm satisfies collateral requirements are high.

A most common source of equity for high risk projects is the venture capitalist. The venture capitalists problem in investing in high risk projects is unique. Unlike the bankers, the venture capitalist is interested in future profitability of the firm and is generally well acquainted with the industries to invest in. Similar to portfolio investors, the venture capitalist tends to distribute the overall risk in different projects. Due to the recent burst of bubbles in the new technology areas, the venture capitalists investment becomes more cautious. Therefore the information sets of the VC do not only reflect the industry risk variables but also the information required regarding the entrepreneur's project as well as the entrepreneur. All entrepreneurs do not get VC finance and the rest either have to try to raise outside equity (for which the costs are high and in many cases impossible for a nascent entrepreneur) or rely on their own money or bootstrap. Studies by Auken (January 2005) find the increasing tendency towards bootstrap finance and their difference in usage. However, as said before an innovative start-up may have higher investment needs than other non-innovative businesses, and therefore the amount that could be raised by bootstrap financing may not be enough.

Role of Learning: Given the lenders'/investors' problem we propose the capital structure decision therefore becomes, through different phases of the firm, a function of learning by the investees on the demand side and also by the lenders/investors from the supply side. In this study we focus on the learning on the demand side.

In different phases of the firm growth, the firms that did not get financed

may learn from the ones which get, in terms of their strategy (business plans, building prototypes, other innovative efforts etc..) and also build up their endowments in an attempt to 'imitate' the successful firm. If the firms are in the planning phase, which means that they are at a very early stage of learning, financing decisions tend to be indecisive and once they start growing and developing their knowledge endowments, their financing decision tends towards equity for the reasons said above. This reasoning could explain for example, the findings of Audretsch and Lehmann (2004), Carpenter and Petersen (2002) and Rossi (2005) that high technology firms and firms having patents had equity as the source of finance and the role of venture capital is important while being less finance constrained. Furthermore this could be a reason why firms with less financial constraints also tend to keep a sustained patenting profile over time as shown in (Scellato, 2007). This may be due to the reason that the financing decision of the entrepreneur depends on whether the source considers the knowledge endowments of the borrower into its information requirement sets. Moreover, investor might learn from successful start-ups in the market. This would make the investor to look for the matching conditions for her next investment, basing on a successfully firm's characteristics. Appropriability problems might also be relevant. On the one hand, potential investors tend to refuse to invest in innovative start-ups that are not able to protect their proprietary innovations. On the other hand, start-ups that fear the involuntary leakage of business relevant knowledge to the investor might refuse equity finance in the early stage. They may do so because the investor could behave opportunistically and further transfer the knowledge to other firms or threaten the start-up with the transfer in order to increase the share in the start-up. The upshot of our theoretical consideration are the following hypotheses:

- Hypothesis 1: NEs which can protect their proprietary innovation have a higher probability of getting external finance
- Hypothesis 2: NEs which can signal reduced uncertainty with respect to innovation outcome have a higher probability of getting external finance

3 Data

3.1 The CIE survey

The data set used in this paper is based on a survey conducted by the Center for Innovative Entrepreneurship in May and June 2005 in the context of a research project that was funded by the Ewing Marion Kauffman Foundation. The aim of that project was to investigate whether the web site of a venture capital directory can be used as a research tool. For this purpose CIE surveyed visitors of the web site www.vfinance.com, which is a location for entrepreneurs seeking capital to find the names of potential angel investors or venture capital firms. CIE did this in two ways: emails were sent inviting visitors who had come to the web site previously to participate in the survey; and visitors to the web site were intercepted at random and asked to participate in the survey. The basis of our analysis is a data set that comprises the responses of 4122 entrepreneurs, investors and others.

An obvious objection which can be raised against this sampling method is its potential selectivity bias. Only those nascent entrepreneurs can be surveyed who are seeking external finance, who are using the internet for doing this and who visit the web site of a specific venture capital directory. One might therefore ask whether the sample is representative. However, the counter question is: representative of what?

The well-known PSED (Panel Study of Entrepreneurial Dynamics), for instance, is a representative sample of American adults and it was initiated to "provide systematic, reliable and generalizable data on important features of the entrepreneurial or start-up process." (Reynolds, Carter, Gartner, & Greene, 2006). While the sampling mechanism used in PSED is appropriate to generate a sample that is nationally representative with respect to population characteristics, like age or education, it might not be ideal to analyze innovative nascent entrepreneurs' sources of external finance.

As pointed out by Davidsson (2006, p. 55) the downside of such a 'representative' sample "is that the sample will be very heterogenous and dominated

by imitative, low-potential ventures.” He therefore suggests to ”use other sampling mechanisms than probability sampling in order to get sufficient numbers of high-tech firms, for instance” (Davidsson, 2006, p.56). In this respect, the CIE survey is a valuable source of information about nascent entrepreneurs *seeking capital*. Moreover, the descriptive statistics that will be presented in Section 4 show that the fraction of innovative entrepreneurs is quite high in our sample.

3.2 Defining and identifying nascent entrepreneurs

In this study we identify nascent entrepreneurs in similar way as it is done in the PSED, i.e. we use similar criteria that a respondent has to meet in order to be considered as a nascent entrepreneur. The “three criteria nascent entrepreneur” in the PSED is an individual who is 1) “now trying to start a new business”, 2) “currently active in a startup effort” and ”anticipates full or part ownership of the new business” and 3) “had NOT yet attained positive monthly cash flow that covered expenses and the owner-manager salaries for more than three months” (Reynolds et al., 2006, p. 268).

In our study a respondent had to meet the following criteria to be considered as a nascent entrepreneur:

- entrepreneur seeking capital to start a new business,
- actively involved in running the business,
- owner or part owner of the business,
- business has not generated revenues in 2004 and 2005

We excluded the cases where a respondent said that ownership is 0 percent and where any positive revenues are reported. The survey questions are listed in the Appendix.

Furthermore, we differentiate between two groups of nascent entrepreneurs: a group of entrepreneurs who are in a planning stage and the group of entrepreneurs who are engaged in a start-up which is in a very early stage. To be considered as a member of the former group the following criteria had to be met

- planning a new business,
- start-up is *not in operation, products/services are not launched*,

and we identify a respondent as a member of the latter group if following criteria are met

- Start-up; not generating revenue,
- at least a concept is developed

Moreover, we excluded those respondents from the first group of nascent entrepreneurs (planning stage) who reported that they started their business before 2005 and/or that the number of employees – not counting the owners – exceeds one. We excluded respondents from the second group of nascent entrepreneurs (very early start-ups) who reported that they started their business before 2003 and/or that the number of employees exceeds ten. We use these admittedly demanding criteria to guard as far as possible against flawed data.

External source of finance: The data set contains information about the sources of business financing. Entrepreneurs reported whether they used the following external financing sources to establish their business: 1) bank loans to the business, 2) home equity loan in an owner's name, 3) other bank loans in an owner's name, 4) venture funds in exchange for stock/ownership in company and 5) individual investors or companies in exchange for stock/ownership in company. While the first three sources are indicators for debt, the last two sources represent indicators for equity.

Again, we checked the consistency of the responses. First, we excluded those cases from the sample where respondents reported equity finance and 100 percent ownership. Entrepreneurs reported what percent of their business they own. Second, we excluded the cases where a respondent declares to own 0 percent of the business and at the same time reports to have equity as a source of business financing.

Innovation: In the survey entrepreneurs were asked the following question "Does your business own or have you applied for a patent that is essential to the business?" A nascent entrepreneur is considered to be innovative or at least to be engaged in a knowledge-based start-up if the answer is YES. Alternatively, the development of a prototype can be viewed as an indicator of innovation. The dataset provides information about this and we will discuss this in Section 6.

Business relevant information: The data set contains additional information about the start-up. whether a business plan was written, whether the business has international links, whether the respondent is a serial entrepreneur, whether the business was started by a single person or a team of people and whether the respondents owns a house that can be used as collateral (see Appendix for the questions asked).

4 External source of finance and start-up characteristics

Table 1 reports on the descriptive statistics. As can be seen from the table, 12 percent of the nascent entrepreneurs in the planning stage use debt as an external source of finance whereas 19 nascent entrepreneurs in a very early stage of the start-up. With respect to equity finance the difference between both groups of entrepreneurs is even larger. While only 6 percent of nascent entrepreneurs in the planning stage have equity finance, more than 20 percent of the nascent entrepreneurs in the early start-stage have equity finance. These differences are statistically significant at the 1 percent level. Nascent entrepreneurs in the planning stage choose either debt (25) or equity (50), whereas only one entrepreneur of this group relies on both, debt and equity. In the early start-up stage 19 entrepreneurs rely on both sources of external finance while 73 choose only equity and 79 choose only debt.

The fraction of innovative entrepreneurs – patent application or ownership of a business related patent – increases from 15.5 percent in the planning stage to more than 20 percent in the early start-up stage. An even stronger increase

can be observed for fraction of entrepreneurs who report to have developed prototypes. It is 6.1 percent in the planning stage and 25.2 percent in the early start-up stage. In the group of entrepreneurs in the planning stage 66 applied for patent or own one and 32 percent of these have also developed a prototype. In the early start-up stage 155 start-ups have patents or applied for patents and 47 percent of these innovative start-ups have also developed a prototype. Although we do not know whether the patents are related to the prototype, it is likely that at least some of the nascent entrepreneurs try to protect their business relevant innovation (prototype) through patents.

[insert table 1 about here]

As can be seen from the table, already 63 percent of the nascent entrepreneurs in the planning stage have developed a concept while 30 percent of them are still in the process of developing a concept. As can be expected, the fraction of entrepreneurs that have merely developed a concept is significantly smaller for the group of entrepreneurs in an early start-up stage. Most of them report 'start-up operation' but only 4.6 percent have already launched a product or services. However, this is not surprising since these are start-ups that have not generated revenues as yet.

There are also significant differences between both groups with respect to the fraction of those entrepreneurs who have written a business plan, who have established links with international partners and who have started a business before. In the early start-up stage group these fractions are larger. Moreover, there are more serial entrepreneurs in this group and more team start-ups. The large fraction of teams (50 percent) is in line with the numbers based on the PSED.

[insert table 2 about here]

Table 2 reports on the number and the percentage of entrepreneurs that have chosen debt and/or equity finance where the numbers are presented separately for start-ups with a patent and without a patent. In the planning stage the fraction of innovative firms without external finance (14.6 percent) corresponds with their fraction in the total sample (15.5). With respect to debt and equity

they are slightly over-represented in this stage. In the early start-up stage, however, they are under-represented in the category 'no external finance' and they are over-represented with respect to equity finance. This points to a remarkable change in the capital structure between these early stages of a start-up.

One obvious explanation for the significant differences between entrepreneurs in the planning stage and entrepreneurs in the early startup stage is that at least some of the start-up characteristics may affect the probability of making a transition from the a nascent entrepreneur in the planning stage to a nascent entrepreneur in the early start-up stage. Consequently, the fraction of start-ups with these characteristics would be higher in later stages of the start-up. Parker and Belghitar (2006) investigated the decision of nascent entrepreneurs to quit, to remain a nascent entrepreneur or to start a firm. They found, for instance, that preparing business plans and experience in business ownership do not influence nascent entrepreneurs decision whereas team ventures are less likely to realize their start-ups. Another explanation is, that many nascent entrepreneurs may begin to write business plans, intensify their innovation efforts or try to establish links to international partners once they have taken the decision to realize the start-up.

In summary, the descriptive statistics suggest that the division of the sample into two groups is reasonable since both groups differ with respect to relevant business characteristics. In the econometric analysis we will therefore investigate both groups separately.

5 Econometric Model

Suppose that a nascent entrepreneur i can choose between sources of finance j which differ with respect to the expected profit, i.e. each of them is associated with certain costs. A profit-maximizing entrepreneur will opt for the alternative (denoted π_{ij}) which yields the maximum profit among the four financing alternatives (no external finance, debt, equity and debt & equity).

$$\pi_{ij} = \text{Max}(\pi_{i0}, \pi_{i1}, \pi_{i2}, \pi_{i3}) \quad (1)$$

The profit associated with each of these sources of finance is assumed to be determined by business-specific factors x ,

$$\pi_{ij} = x_{ij}\beta + u_{ij}, \quad i = 1, \dots, N \quad j = 0, \dots, 3. \quad (2)$$

where β is a parameter vector, u_{ij} is an error term and i denotes the nascent entrepreneur. The profit associated with each financial decision is an unobservable latent variable. What can be observed, however, are the entrepreneurs' choices of financial sources. If source j is chosen, we assume that this decision is the most profitable one ($\text{Prob}(\pi_{ij})$).

The business-specific factors x might be, for instance, patents, developed products, a business plan, international links or collaterals. These factors may have different effects on the costs of each alternative and may consequently influence the relative profits. A venture capitalist, for instance, will usually call for a sound business plan. For a nascent entrepreneur without such a business plan, it might be very costly to elaborate and write it and therefore other sources of finance might be preferred. As explained in the Section, endowments of a start-up are only given in the short run.

If the J disturbances of equation (2) are independent and identically distributed with type I extreme distribution, then the multinomial logit model of cooperation choice can be written as follows ⁵

$$P_{ij} = \text{Prob}(\pi_{ij} = 1 \mid x_i) = \frac{e^{\beta_j' x_i}}{1 + \sum_{k=0}^3 e^{\beta_k' x_i}} \quad \text{for } j = 0, \dots, 3, \beta_0 = 0. \quad (3)$$

where one of the coefficient vectors is normalized to zero in order to achieve identification. The multinomial logit model implies that the log ratio of the probabilities for any two financial decisions j and k is given by

$$\ln \left[\frac{P_{ij}}{P_{ik}} \right] = x_i'(\beta_j - \beta_k) = x_i' \beta_j \quad \text{with } \beta_k = 0. \quad (4)$$

This means that the estimates of β_j reflect the marginal effect of a change in an explanatory variable x_i on the log-odds ratio of the cooperation strategy j and the baseline category k . Note, that sign and magnitude of this coefficient are not

⁵ See Greene, 2003, pp.720-723.

necessarily identical with the marginal effect of a change in x_i on probability P_{ij} . The latter can be calculated as follows

$$\frac{\partial P_j}{\partial x_i} = P_j \left[\beta_j - \sum_{k=0}^3 P_k \beta_k \right] = P_j [\beta_j - \bar{\beta}]. \quad (5)$$

In order to analyze the determinants of nascent entrepreneur's choice between debt, equity or no external finance at all we estimate a multinomial logit model (MNL). Estimates of the marginal effects of changes in explanatory variables on probabilities of each financial decision will be presented in section 6.1.

6 Results

6.1 Estimation Results

In this section we will present estimates which are obtained from separate estimations of the MNL model for nascent entrepreneurs in the planning stage and nascent entrepreneurs in the early start-up stage. We did not differentiate between nascent entrepreneurs who rely only on equity finance and those who rely on both, equity and debt. Instead, we estimated the MNL model with the three categories 'no external finance', 'debt finance' and 'both sources of external finance'.⁶

A basic assumption of the MNL model is that irrelevant alternatives are stochastically independent from each other (Independence from Irrelevant Alternatives (IIA)-assumption), i.e. the odds ratios of any two cooperation strategies are independent of the probabilities of other cooperation strategies (Greene, 2003, p.724). Intuitively, the IIA assumption is not very plausible if nascent entrepreneurs view two alternatives as similar rather than independent. Therefore, we tested for the validity of this assumption. We performed a Hausman-test and the test results suggest that the null hypothesis of IIA cannot be rejected for

⁶ For the group of entrepreneurs in the planning stage this distinction would be since only one entrepreneur has both, debt and equity. For the other group a Wald test of whether the two categories 'only equity finance' and 'both sources of finance' can be combined suggest that this is the case. Further Wald tests reject the Null hypothesis that these categories can be further collapsed indicating that significant differences between the determinants of external sources of finance exist. Test results are available from the authors upon request.

both groups (planning stage, early start-up stage).⁷

The *marginal effects* of the explanatory variables on the probabilities of each category are reported for the group of nascent entrepreneurs in the planning stage and for the group of nascent entrepreneurs in an early start-up stage in Table 3. As can be seen from this table, nascent entrepreneurs in the planning stage who have a business plan, who have started a business before and who (or family members) own a house have a lower probability of having no external sources of finance. The probability of having debt finance is positively affected by the existence of a business plan and by house ownership. Obviously, the existence of collateral is very relevant for bank loans – as expected. In contrast, a business plan and a developed concept have a positive impact on getting equity. Moreover, being a team start-up reduces the probability of debt finance whereas it is positive for equity.

Results are different for the early start-up stage. Here, the probability of having no external sources of finance decreases if a start-up owns a patent or has applied for patent, has developed a prototype, has launched products/services or has established international links. Again, serial entrepreneurs and team start-ups have a higher probability of choosing external finance. The probability of debt finance is higher if a start-up has launched product/services and as in the planning stage team start-ups have a lower probability of debt finance and existence of collateral increases this probability. The probability of equity finance is higher for start-ups that have developed a prototype and that have contracted with companies or individuals outside the United States for goods or services. As in the planning stage, team start-ups and start-ups with a business plan are more likely to choose equity.

[insert table 3 about here]

[insert table 4 about here]

The statistically insignificant effect of patents for equity finance might be explained by the fact that many start-ups with a prototype do also report

⁷ This test compares the estimated coefficients of a model using all three categories and a subset where one of the categories is excluded. If the IIA assumption holds, then the estimation of the restricted and the unrestricted model should provide similar estimates.

that they have applied for a patent or own a patent. Therefore, we performed additional estimations which take this into account by differentiating between start-ups that report only a patent, start-ups that have a prototype but no patent and start-ups that have both. The estimation results are reported in Table 3. For the group of entrepreneurs in the planning stage the estimations results are hardly affected. For the group of entrepreneurs in an early start-up stage, however, results do now show that especially start-ups that report both, patents and prototypes, have a higher probability of being externally financed and in particular the probability of equity finance is positively affected. However, results also show that start-ups with a prototype but no patent have a higher probability of equity finance while this is not the case for start-ups with patents but no prototype.

Although not reported here, we have also conducted estimations where we controlled for industry effects as well as personal characteristics of the NEs, like education, age or gender. The basic results with respect to the relevance of patents and prototype are, however, not affected.⁸

6.2 Discussion of estimation results

Our estimation results suggest that innovative start-ups – with patents and prototype – are more likely to be externally financed, especially by business angels and venture capitalists. It seems that technical knowledge per se does not have a positive influence. A significant effect does only appear if patents are combined with the development of a prototype. One explanation for this result is that the development of a prototype reduces information asymmetries and resolves the problem of uncertainty associated with the outcome of innovation efforts. Hence, the expected value of an innovative start-up may be better predictable. The finding that prototype in combination with patent has a higher marginal and statistically more significant effect on the probability of equity finance as compared to the development of a prototype without having a patent may be explained by the fact that a start-up can better appropriate the benefits from

⁸ The estimation results are available from the authors upon request

its innovation if the latter is protected by patents. On the one hand, innovation cannot be easily imitated by competitors. On the other hand, opportunistic behavior of the investor is also less likely which may make the NE more willing to accept equity, i.e. a close relationship and share of ownership with the investor.

Our results extend the findings of empirical studies by looking at the stage-wise preference for finance. Studies like Audretsch and Lehmann (2004), Thornhill (2004), Carpenter and Petersen (2002), Mueller and Zimmermann (2006), Baldwin and Gellatly (2004) put forward that small, young and innovative firms find it difficult to get external finance and their general preference would be towards new equity since debt is unavailable and in some cases not enough to carry on future innovation efforts. We argue that even though this may be true, the preference or for that matter the combinations that the entrepreneurs confront may change depending on the stage of the start-up. Acs (2002) finds that small innovative firms have a tendency towards debt, which we view depends on the stage of the firm. These firms may rely on higher risky source of finance until they build up their retained earnings, since internal finance is found to be crucial for further R&D (Himmelberg & Petersen, 1994), and then the next option would be debt, since the collateral requirements in terms of fixed assets, cash position, may be met. This would point out to a proposition that the *pecking order* financing (Myers & Majluf, 1984) may change not in its usual order of retained earnings, debt, inside equity and outside equity, right from the stage 1 of firm growth, but rather this ordering may change in very early stages. We suspect that the ordering hierarchies keep changing until the firm grows enough to build its retained earnings and fixed assets and then the usual pecking order could be followed. What follows therefore is that in the very early stages the start-ups may have to accept the risk in return of survival. The other interesting finding is that probability of getting financed externally and the tendency towards equity increases with the knowledge endowments the start-up has, may prove the point that financing depends on the growth of knowledge endowments and this growth may be an investee induced growth or investor encouraged growth, which we term as learning effects on financing strategy.

7 Conclusion

In this paper we analyze the relationship between innovation activities of nascent entrepreneurs and their financial decisions. It can be argued that especially *innovative* nascent entrepreneurs may face the problem of obtaining external finance because of uncertainty, appropriability problems and information asymmetries.

We developed two hypotheses in this paper: First, NEs which can protect their proprietary innovation have a higher probability of getting external finance and second - NEs which can signal reduced uncertainty with respect to innovation outcome have a higher probability of getting external finance. Our estimation results provide evidence in support of both hypotheses. In particular, our results indicate that innovative nascent entrepreneurs have a higher probability of getting equity than non-innovative entrepreneurs. In contrast, the probability of debt finance is not affected by innovation. However, the positive effect on equity does only occur if NEs have successfully developed a prototype and do at the same time own a patent or have applied for a patent. One explanation for this result is that the development of a prototype reduces information asymmetries and resolves the problem of uncertainty associated with the outcome of innovation efforts. While prototypes may signal less risk, patents may signal that the start-up can appropriate the returns from its investment in intangible assets. Moreover, the fraction of innovative start-ups increases remarkably between the planning stage of a start-up and the early start-up stage. Other business related characteristics, like international orientation, team start-up or the existence of a business plan do also affect the probability of getting external finance.

To the authors' best knowledge financial decisions of innovative NEs have not been analyzed as yet. Previous studies in the fields of economics and finance focused primarily on firm characteristics, industry characteristics or macroeconomic effects. Rarely studies had considered the presence of knowledge in NE start-ups and what happens to such firms driven by knowledge in terms of getting funds. Hence, this paper contributes to the existing literature.

Future theoretical research could formalize the learning process of innovative nascent entrepreneurs and investors. Empirical studies should analyze the financial decisions of innovative NEs by using panel data. This would allow for studying the impact of financial decision on start-up survival, for instance.

A Questions

Defining and identifying nascent entrepreneurs

- Which category best describes you? (Answer: Entrepreneur seeking capital to start a new business, Entrepreneur seeking capital for an operating business; Entrepreneur interested in business planning services or seminars; Visitor searching for general information about raising capital; Investor interested in investment opportunities; vFinance Investments Client; vFinance Employee or Associate.)
- Are you actively involved in running this business? (Answer: YES/NO)
- What percent of this business do you own? (Answer: 0, 1 - 25, 26 - 50, 51 - 75, 76 - 99, 100)
- Did your business generate revenue in the first quarter of 2005 (January 2005 through March 2005)? (Answer: YES/NO)
- 2004 revenue. In U.S. dollars? (Answer: Over 10 million, 5 million to 10 million, 1 million to 5 million, 500,000 to 999,999, 250,000 to 499,999, 150,000 to 249,999, 100,000 to 149,999, 75,000 to 99,999, 50,000 to 74,999, 25,000 to 49,999, 1 to 24,999, No revenue in 2004.)

Distinguishing between planning stage and early start-up stage

- Which of these best describes you? (Answer: I currently own and operate a business; I am planning to start a new business; I am interested in private investments in businesses; None of the above.),
- Where is your business in the start-up process? (Answer: concept in development, concept developed, prototype developed, start-up operation or product/service launched.)

External sources of finance

- What sources of business financing have you already used to establish this business? (Answer: bank loans to the business, home equity loan in an owner's name, other bank loans in an owner's name, venture funds in exchange for stock/ownership in company, individual investors or companies in exchange for stock/ownership in company.)

Business characteristics

- Does your business own or have you applied for a patent that is essential to the business? (Answer: YES/NO)
- Has your business contracted with any companies or individuals outside the United States for goods or services? (Answer: YES/NO)
- Do you have a written business plan for your business? (Answer: YES/NO)
- Have you started another business before this business? (Answer: YES/NO)
- Do you or anyone in your household own your residence? (Answer: YES/NO)
- Which of the following best describes how your business was started? (Answer: A new business created by a single person; A new business created by a team of people; A business inherited from someone else; Purchase of an existing business; Purchase of a franchise)

References

- Acs, Z. (2002). *Innovation and the growth of cities*. Edward Elgar.
- Aghion, P., Bond, S., Klemm, A., & Marinescu, I. (2004, 04/05). Technology and financial structure: Are innovative firms different? *Journal of the European Economic Association*, 2(2-3), 277-288.
- Altman, E. I., & Sabato, G. (2005). Modeling Credit Risk for SMEs: Evidence from the US Market [Working Paper Series]. *SSRN eLibrary*.
- Arrow, K. J. (1962). Economic welfare and the allocation of resources for invention. In R. R. Nelson (Ed.), *The rate and direction of inventive activity: Economic and social factors* (Vol. 13, p. 609-625). Princeton: Princeton University Press.
- Audretsch, D. B., & Lehmann, E. E. (2004, May). *Financing high-tech growth: The role of debt or equity* (Discussion Papers on Entrepreneurship, Growth and Public Policy No. 2004-19). Max Planck Institute of Economics, Group for Entrepreneurship, Growth and Public Policy.
- Audretsch, D. B., & Weigand, J. (2005, June). Do knowledge conditions make a difference?: Investment, finance and ownership in german industries. *Research Policy*, 34(5), 595-613.
- Auken, H. V. (January 2005). Differences in the usage of bootstrap financing among technology-based versus nontechnology-based firms. *Journal of Small Business Management*, 43.
- Baldwin, J., & Gellatly, G. (2004). *Innovation strategies and performance in small firms*. Edward Elgar.
- Carpenter, R. E., & Petersen, B. C. (2002, February). Capital market imperfections, high-tech investment, and new equity financing. *Economic Journal*, 112(477), F54-F72.
- Davidsson, P. (2006). Nascent entrepreneurship: Empirical studies and developments. *Foundations and Trends in Entrepreneurship*, 2(1), 1 – 76.
- Dietsch, M., & Petey, J. (2002, March). The credit risk in sme loans portfolios: Modeling issues, pricing, and capital requirements. *Journal of Banking & Finance*, 26(2-3), 303-322.
- Gompers, P., & Lerner, J. (2004). *The venture capital cycle* (2 ed.). MIT.
- Greene, W. (2003). *Econometric analysis* (5 ed.). Prentice Hall.
- Harris, M., & Raviv, A. (1991, March). The theory of capital structure. *Journal of Finance*, 46(1), 297-355.
- Himmelberg, C. P., & Petersen, B. C. (1994, February). R&d and internal finance: A panel study of small firms in high-tech industries. *The Review of Economics and Statistics*, 76(1), 38-51.
- Hsu, D. (2004). What do entrepreneurs pay for venture capital affiliation? *Journal of Finance*, 59(4), 1805 – 1844.
- Hutchinson, R. W. (1995, June). The capital structure and investment decisions of the small owner-managed firm: Some exploratory issues. *Small Business Economics*, 7(3), 231-39.
- Mueller, E., & Zimmermann, V. (2006, February). *The importance of equity finance for r&d activity are there differences between young and old companies?* (Discussion Papers No. 111). SFB/TR 15 Governance and

- the Efficiency of Economic Systems, Free University of Berlin, Humboldt University of Berlin, University of Bonn, University.
- Myers, S., & Majluf, N. S. (1984). Corporate financing and investment decisions when firms have information that investors do not have. *Journal of Financial Economics*, *13*, 187-221.
- O'Sullivan, M. (2006). Finance and innovation. In J. Fagerber, D. Mowery, & R. Nelson (Eds.), *The oxford handbook of innovation* (p. 240-265). Oxford: Oxford University Press.
- Parker, S. C., & Belghitar, Y. (2006, August). What happens to nascent entrepreneurs? an econometric analysis of the psed. *Small Business Economics*, *27*(1), 81-101.
- Reynolds, P., Carter, N., Gartner, W., & Greene, P. (2006). The prevalence of nascent entrepreneurs in the united states: Evidence from the panel study of entrepreneurial dynamics. *Small Business Economics*, *23*, 263 – 284.
- Rossi, S. (2005). Patents, Capital Structure and the Demand for Corporate Securities [Working Paper Series]. *SSRN eLibrary*.
- Scellato, G. (2007). Patents, firm size and financial constraints: an empirical analysis for a panel of Italian manufacturing firms. *Camb. J. Econ.*, *31*(1), 55-76.
- Stiglitz, J. E., & Weiss, A. (1981, June). Credit rationing in markets with imperfect information. *American Economic Review*, *71*(3), 393-410.
- Thornhill, S. (2004). Growth history, knowledge intensity and capital structure in small firms. *Venture Capital: An International Journal of Entrepreneurial Finance*, *6*, 73-89(17).

Tab. 1: Descriptive statistics

Variable	planning stage		early start-up stage		Z-test
	Mean	Std. Dev.	Mean	Std. Dev.	
Debt	0.120	0.325	0.192	0.394	3.0*
Equity	0.061	0.240	0.204	0.404	6.3*
Patents	0.155	0.362	0.323	0.468	5.9*
Concept in development	0.296	0.457	N.A.	N.A.	N.A.
Concept developed	0.636	0.482	0.304	0.461	-10.0*
Prototype developed	0.068	0.252	0.260	0.439	7.7*
Start-up operation	N.A.	N.A.	0.390	0.488	N.A.
Product/service	N.A.	N.A.	0.046	0.209	N.A.
Business plan	0.601	0.490	0.835	0.371	7.9*
Serial entrepreneur	0.467	0.500	0.600	0.490	4.0*
International links	0.110	0.314	0.215	0.411	4.2*
Team	0.340	0.474	0.479	0.500	4.2*
House	0.587	0.493	0.625	0.485	1.2

Notes: All variables are dummy variables that take on the values one or zero. N.A. means not applicable. Z-test for the equality between two proportions: * denotes significant at the 1 percent level.

Tab. 2: Descriptive statistics: patents and sources of finance
planning stage

	no external	debt	equity	both	Total
no patents	299 (85.4)	40 (80.0)	20 (80.0)	1 (100.0)	360 (84.5)
patents	51 (14.6)	10 (20.0)	5 (20.0)	0 (0.0)	66 (15.5)
	350 (100)	50 (100)	25 (100)	1 (100)	426 (100)
early start-up stage					
no patents	229 (74.1)	49 (67.1)	34 (43.0)	13 (68.4)	325 (67.7)
patents	80 (25.9)	24 (32.3)	45 (56.7)	6 (31.6)	155 (32.3)
	309 (100)	73 (100)	79 (100)	19 (100)	480 (100)

Notes: Percentage in parentheses.

Tab. 3: Determinants of nascent entrepreneurs' external sources of finance

Variable	planning stage			early start-up stage		
	No	Debt	Both	No	Debt	Both
Patents	-0.019 (0.048)	0.028 (0.045)	-0.009 (0.017)	-0.105** (0.052)	0.041 (0.041)	0.064 (0.039)
Prototype devel.	-0.139 (0.13)	-0.021 (0.048)	0.160 (0.14)	-0.122* (0.065)	-0.0335 (0.044)	0.155*** (0.058)
Concept devel.	0.0192 (0.039)	-0.0547 (0.034)	0.036* (0.020)	N.A.	N.A.	N.A.
Start-up oper.	N.A.	N.A.	N.A.	-0.037 (0.055)	0.036 (0.042)	0.001 (0.043)
Product/service	N.A.	N.A.	N.A.	-0.211* (0.12)	0.211* (0.12)	-0.001 (0.093)
Business plan	-0.095*** (0.031)	0.0558** (0.027)	0.0394** (0.018)	-0.0178 (0.059)	-0.056 (0.049)	0.074* (0.040)
Serial entrep.	-0.053* (0.031)	0.0323 (0.028)	0.0202 (0.016)	-0.106** (0.044)	0.060* (0.033)	0.046 (0.035)
Internat.links	-0.079 (0.059)	0.0346 (0.050)	0.0445 (0.036)	-0.116** (0.058)	0.0094 (0.043)	0.107** (0.047)
Team	0.024 (0.033)	-0.0615** (0.026)	0.0373* (0.021)	-0.135*** (0.046)	-0.0616* (0.034)	0.197*** (0.037)
House	-0.094*** (0.032)	0.115*** (0.028)	-0.0215 (0.016)	-0.132*** (0.043)	0.114*** (0.032)	0.0178 (0.035)
χ^2 -statistic	60.48			109.9		
Pseudo R ²	0.122			0.128		
Actual Frequ.	350	50	26	309	73	98
Pred. Frequ.	373	39	14	334	71	75

Notes: Multinomial Logit Estimation results. The standard errors are reported in parentheses.

The asterisks *, ** and *** denote significant at the 10, 5 and 1 percent level respectively.

The estimates reflect the marginal effects of a change of the respective dummy variables from 0 to 1.

Tab. 4: Determinants of nascent entrepreneurs' external sources of finance

Variable	planning stage			early start-up stage		
	No	Debt	Both	No	Debt	Both
Patents/protot.	-0.140 (0.13)	-0.005 (0.057)	0.145 (0.13)	-0.272*** (0.080)	0.009 (0.057)	0.263*** (0.081)
Only prototype	-0.121 (0.17)	0.0162 (0.11)	0.105 (0.15)	-0.0929 (0.089)	-0.067 (0.047)	0.160* (0.087)
Only patents	-0.020 (0.052)	0.035 (0.050)	-0.015 (0.017)	-0.077 (0.065)	0.016 (0.048)	0.061 (0.054)
Concept devel.	0.019 (0.039)	-0.055 (0.034)	0.036* (0.020)	N.A.	N.A.	N.A.
Start-up oper.	N.A.	N.A.	N.A.	-0.036 (0.054)	0.035 (0.042)	0.001 (0.043)
Product/service	N.A.	N.A.	N.A.	-0.215* (0.12)	0.216* (0.12)	-0.001 (0.094)
Business plan	-0.094*** (0.031)	0.055** (0.027)	0.039** (0.018)	-0.021 (0.059)	-0.053 (0.049)	0.074* (0.040)
Serial entrep.	-0.052* (0.031)	0.032 (0.028)	0.020 (0.016)	-0.107** (0.044)	0.061* (0.033)	0.047 (0.035)
Internat.links	-0.080 (0.059)	0.035 (0.050)	0.045 (0.036)	-0.116** (0.058)	0.010 (0.043)	0.107** (0.047)
Team	0.025 (0.033)	-0.063** (0.026)	0.038* (0.021)	-0.137*** (0.046)	-0.060* (0.034)	0.197*** (0.038)
House	-0.094*** (0.032)	0.115*** (0.028)	-0.021 (0.016)	-0.135*** (0.044)	0.117*** (0.032)	0.019 (0.035)
χ^2 -statistic	60.58			111.1		
Pseudo R ²	0.122			0.129		
Actual Frequ.	350	50	26	309	73	98
Pred. Frequ.	373	39	14	334	71	75

Notes: Multinomial Logit Estimation results. The standard errors are reported in parentheses.

The asterisks *, ** and *** denote significant at the 10, 5 and 1 percent level respectively.

The estimates reflect the marginal effects of a change of the respective dummy variables from 0 to 1.