Discussion Paper No. 13-095

External Capital Access and New Product Launch in Start-Up Firms with Uncertain Intellectual Property Rights

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Non-technical Summary

For innovative start-ups, an effective patent system is a crucial factor for success and survival. The importance of patents for start-ups is based on two features. First, patents grant temporary monopoly rights for the protected invention and thereby help start-up firms to appropriate returns from their R&D investments. Second, patents certify the new venture's quality to outside investors. Attracting investors is essential but at the same time difficult for new ventures because there is uncertainty about their future success.

The desirable positive effects of patents for new ventures are based on the assumption that the patent system works efficiently. The European patent system has experienced the steep increase of patent pendencies in response to a surge in patent applications over the past decades. These delays create uncertainties about the patent grant and scope for patent applicants and investors.

This paper examines the impact of patent pendencies on a start-up company's new product launch and its ability to attract external funds, specifically venture capital and bank financing. Product launch may be postponed if patents are pending because start-ups may be reluctant to engage in necessary follow-up investments for product development before being granted protection of the underlying intellectual property. Regarding external funds, we expect that risk-prone investors with a high involvement in the start-ups company like venture capitalists value pending patents. Cautious investors like banks might be reluctant to invest if a start-up's patent are pending since these patent applications do not provide collateral.

For a large sample of German start-up companies across different industries, we find that patent pendencies significantly lower the likelihood of new product launches indicating that entrepreneurs postpone commercialization if they are confronted with uncertain intellectual property rights. With regards to ventures' access to finance, we find that pending patent applications attract venture capital financing. Bank financing is not influenced by pending patents.

External Capital Access and New Product Launch in Start-Up Firms with Uncertain Intellectual Property Rights[1]

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Abstract

Classical patent literature assumes that patents grant well-defined legal rights to exclude others from practicing an invention. In this scenario, start-up companies benefit from the exclusive right to commercialize patent-protected inventions and the certification effect of patents which signals the ventures' "quality" to investors. If the decision about patent applications is pending at the patent office patent rights become probabilistic and both effects may not realize. We show that start-up companies are reluctant to launch new products if patents are pending. Further, pending patents attract risk-seeking investors (venture capitalists), while more cautious investors (banks) do not react on pending patents.

Keywords: start-ups, patents, probabilistic patents, pending patents, access to finance, new product launch

JEL: L26, O31, O34

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INTRODUCTION

"An effective patent system offers protection for new entrants to the market, who do not have the distribution networks or reputation that can in some ways protect inventions. Their main strategic defense is intellectual property." Intellectual property rights (IPR) are one of the important pre-requisites for successful entrepreneurship as exemplified by Guellec and Sachwald (2008).[1]

The classical patent literature defines IPR, and patents in particular, as devices that grant their owners a well-defined legal right to exclude others from practicing the invention. From this point of perspective, the importance of IPR for new ventures rests upon two features. First, patents grant temporary monopoly rights for protected inventions. Thereby, patents help start-up companies appropriating returns from their R&D investments (Arora and Ceccagnoli, 2006, Cohen et al., 2000, Dechenaux et al., 2008). They do so by safeguarding investments in complementary assets which are required for transferring inventions into marketable products (Teece, 1986) and by facilitating licensing in case the start-up does not aim at commercializing the invention itself (Gans et al., 2008).

Second, patents can certify the start-up company's "quality" to outside investors (Hsu and Ziedonis, 2008). External funds are often essential for new ventures that lack internal means for growth and innovation (Stinchcombe, 1965). At the same time, attracting investors is difficult for new ventures since their "quality" is unknown and their future success is difficult to predict (Stuart et al., 1999). Investors therefore

[1] Guellec and Sachwald (2008) analyze the failure of the Lisbon Agenda which was designed to be the roadmap for Europe to become the most competitive knowledge-based economy.

search for tools to reduce the information gap (Amit et al., 1990). Patents can act as a certification tool by reducing uncertainty with regards to the ventures' technological capabilities and its growth and market potential (Hsu and Ziedonis, 2008, Haeussler et al., 2008). Since patents are only granted for inventions that prove technical feasibility and industrial applicability (Article 52(1) of the European Patent Convention) they represent a major step towards a proof of concept. Due to the monopoly right that patents grant they can further increase the ventures' collateral value for investors.

The predicted positive effects of patents for new ventures are based on the assumption that the patent system works efficiently. If, for instance, a patent system grants patents for marginal inventions - as has been criticized with regards to the U.S. patent system (e.g. Jaffe and Lerner, 2004) - the certification value of patents vanishes. With respect to the European patent system, the steep increase of patent pendencies in response to a surge in patent applications over the past decades raised concerns (Harhoff and Wagner, 2009, Czarnitzki et al., 2011). Such inefficiencies of patent systems render patent rights probabilistic (Lemley and Shapiro, 2005). Against the classical patent literature that defines patents as devices that grant their owners well-defined legal rights allowing the exclusion of third parties from practicing the invention, the view that patents are probabilistic acknowledges that, in practice, the rights afforded to patent holders are highly uncertain.

In this study, we investigate the implications of patent pendencies as one distinctive source of uncertainty surrounding the patenting process. Pending patents induce uncertainties regarding the grant decision, the grant date and the patent scope as well as the strategic value of the invention (Lemley and Shapiro, 2005, Gans et al., 2008). The patent applicant may respond by postponing follow-up investments required for

transferring the technical invention into a marketable product (Cohen et al., 2000, Dechenaux et al., 2008, Teece, 1986) with potentially serious consequences for young ventures' profitability, growth and survival prospect.

Pending patents can further impact the venture's access to external finance. The direction of this effect is, however, ambiguous and depends on the type of investor. Patent applications (rather than granted patents) can attract risk-prone investors, like venture capitalists (VCs), because the patent application may serve as proof of concept (Haeussler et al., 2008). Pending patents which correspond to a not yet commercialized invention can increase VCs' returns to investment. VCs might, further, prefer uncertain IPR as they can provide opportunities for expropriation of the ventures' technologies (Ueda, 2004, Dushnitsky and Lenox, 2005). More cautious investors relying on collateralization, like banks, presumably do not attribute value to pending patent applications. They are rather expected to be reluctant to invest in research and development (R&D) intense ventures with pending patents since R&D intense firms are risky investment projects and because R&D and pending patent applications do not provide collateral value.

In this paper, we empirically investigate the impact of patent pendencies on new ventures' ability to attract external funds both from banks and VCs. We focus on these two types of investors because they are located at the opposite ends of the risk-aversion spectrum. We further analyze whether pending patents influence the likelihood of product launches by new ventures. Our results for a large sample of German start-up companies across different industries show that patent pendencies significantly lower the likelihood of new product launches suggesting that entrepreneurs postpone commercialization if they are confronted with uncertain IPR.

With regards to ventures' access to finance, we find that pending patent applications attract venture capital financing. Banks, in contrast, do not value pending patents, but do not show a negative reaction to pending patents either. This suggests that an inefficient patent system holds back commercialization activities by new ventures, but does not necessarily restrict their access to external finance.

Our study contributes to the emerging literature on probabilistic patents and their implications for companies (Lemley and Shapiro, 2005, Gans et al., 2008). Only recently, researchers started relaxing the assumption of patents as well-defined, bulletproof means of intellectual property protection. The literature which is concerned with the implication of a different view on IPR is accordingly still limited, but suggests that the view on patents as probabilistic protection instruments challenges prior stylized findings (Gans et al., 2008, Czarnitzki et al., 2011). Our study contributes to this literature by showing that it is not the well-defined patent that attracts VCs, but that pending patents are of higher value to these risk-loving investors that aim at financial profits as well as on knowledge capture.

This study further contributes to the literature on the importance of patents for access to external financing for new ventures (Baum and Silverman, 2004, Hsu and Ziedonis, 2008, Haeussler et al., 2008). These prior studies often focus exclusively on risk-taking VCs as sources of external funds for new ventures. Our study focuses in addition on banks as a risk-averse source of financing. As expected, the importance of patents and pending patents differs according to the risk attitude of the external investor.

Lastly, our study focuses on the two pillars of the patent system that can support new ventures, its protective function as well as its function as a certification devise. To our

knowledge, prior studies focus on either of them rather than analyzing both dimensions. A joint analysis is interesting from a theoretical as well as a methodological point of perspective because the access to external funding and new product launches are likely to be interdependent for new ventures.

The remainder of the paper is organized as follows. The next section reviews the related literature. Section 3 introduces our data set before and shows descriptive statistics. In section 4, we present our empirical results and the last section concludes.

THEORY

Patents as Intellectual Property Protection Devices

The main function of patent systems is to grant property rights on technical inventions in order to increase incentives to innovate in the economy. Firms tend to under-invest in R&D as their ideas can be subject to expropriation (Arrow, 1962). Like public goods, inventions are non-rival in use in the sense that the result of innovative efforts can be used by more than one party at the same time without restricting the use of the same invention for others. In addition, knowledge is non-excludable so that it is impossible or difficult to exclude third parties from using an invention. Inventions are, hence, costly to develop while they can be copied at relatively low costs (Mansfield et al., 1977). Furthermore, the outcome of innovation projects and the returns to R&D investments are highly uncertain compared to investments in tangible assets. As a consequence, investment into R&D in the private sector is lower than socially desirable. The patent system provides incentives to innovate by helping inventors appropriating the returns to their R&D investment.

Patents occur at an intermediate stage of the innovation process: They are applied for after a research project led to results, but before a new product is developed and introduced into the market. Commercialization requires investments into complementary assets which are substantial and difficult to redeploy (Teece, 1986). Patents help safeguarding follow-up investments since they guarantee that third parties cannot use the respective invention without permission of the patent right holder (Cohen et al., 2000, Dechenaux et al., 2008).

The positive effects of patents as a means to safeguard R&D investments and complementary investments by limiting the threat of imitation can realize if the patent system works as designed in theory. In practice, patent systems are characterized by various types of uncertainty which can affect patent applicants' commercialization decision (Lemley and Shapior, 2005, Gans et al., 2008). Uncertainty about the grant decision is only resolved once the final decision (grant/reject) about the patent application is reached. Patent scope uncertainty stems from the fact that examiners may require the applicant to abandon specific claims or to change the specification of claims in the course of the examination. The final scope of patent protection is only revealed once the patent is granted. Furthermore, uncertainty about the economic and strategic value of the invention exists since the value of the underlying invention may only become apparent to the applicant, competitors, potential investors and licensees once the patent is granted. Lastly, there is pendency uncertainty which corresponds to the duration of the patent examination. Pendency periods vary substantially across technological areas, patent and applicant characteristics (Harhoff and Wagner, 2009, Popp et al., 2004, Regibeau and Rockett, 2007). Only after the pendency time elapsed patent applicants learn about the grant decision, the patent scope and get a better idea

of the strategic value of the patent. While under the assumption of patents as a perfect protection devise, one would expect a strictly positive effect of IPR on commercialization efforts, the notion of probabilistic patents which accounts for uncertainties surrounding IPR leads us to the hypothesis:

Hypothesis 1: Uncertainties about IPR decrease the likelihood of new product launch by start-up firms.

Patents as Certificates for External Capital Providers

It is a well-documented fact that innovative start-up companies often face financial constraints (e.g. Himmelberg and Peterson, 1994, Hall, 2002, Czarnitzki and Hottenrott, 2011, Schneider and Veugelers, 2010). For start-up companies, internal financing is important, but often not sufficient for financing innovation because new ventures do not possess a portfolio of sales generating products which can be used for financing innovation activities and new product development. The acquisition of external funds is difficult for young innovative companies as well (Leland and Pyle, 1977, Bhattacharya and Ritter, 1983, Himmelberg and Petersen, 1994, Hall, 2002, Harhoff, 1998). This is because the "quality" of start-up firms is not directly observable for external investors. The relationship between investors and young ventures is characterized by a substantial degree of asymmetric information (Spence, 1973). Investors search for information that reduces uncertainty about the quality of new ventures (Amit et al., 1990, Hall and Hofer, 1993). Quality revealing information can come from different sources like the characteristics of the entrepreneur herself such as her educational background and working track record (Eisenhardt and Schoonhoven 1990, Burton et al. 2002, Shane and Stuart 2002, Dick et al., 2013) and

the ventures' inter-organizational networks (Stuart et al., 1999). In case of R&D intensive start-ups, quality assessment is especially difficult because R&D incorporates technological uncertainty and market risk in addition to the typical risks surrounding start-up companies (Hall, 2002, 2005, Arrow, 1962, Lessat et al., 1999). The uncertainty associated with R&D translates into highly skewed returns on investments (Cassar, 2004, Moore, 1994). Patents may serve as quality certification for the ventures' technologies and technological capabilities (Hsu and Ziedonies, 2008, Haeussler et al., 2008).

In light of patents as well-defined, unchallengeable protection devices, previous literature has shown that patents are an important criterion for VCs. Baum and Silverman (2004) investigate the screening process of VCs in the U.S. and show that patents have a positive impact on the amount of venture capital it receives. Hsu and Ziedonis (2008) find a positive effect of patents on investors' perception of the company's value for a sample of venture capital financed U.S. semiconductor start-ups. Ventures holding patents, further, attract more prominent VCs (Hsu and Ziedonis, 2008).

Baum and Silverman (2004) and Haeussler et al. (2008) distinguish between the patent application and the patent grant as signals for VC investors. Baum and Silverman (2004) find a strong effect of patent applications and a weaker effect of patent grants for their U.S. sample. Focusing on a sample of German and U.K. start-ups and their European patent records, Haeussler et al. (2008) find that firms with patent applications attract venture capital funding earlier than others. They find no additional effect of the patent grant decision for the timing of venture capital

investment.[2] In line with the definition of patents as probabilistic intellectual property protection devices, prior findings suggest that risk-loving investors value patent applications more strongly than granted patents.

Previous studies only consider the certification effect of patents for VCs. Different types of investors, however, have heterogeneous risk preferences. Theoretical literature predicts that start-ups with a relatively small collateral value (Holmstrom and Tirole, 1997, Ueda, 2004), high growth (Ueda, 2004, De Bettignies, 2008), high risk (Berger and Udell, 1998, Ueda, 2004) and potentially high profitability (Ueda, 2004) have a higher probability to receive venture capital than funds from more cautious capital suppliers like banks. These theoretical predictions are supported by empirical evidence (e.g. Storey, 1993, Audretsch and Lehman, 2004) which suggests that small and innovative firms are more likely to be financed by VCs than by banks (Hellmann and Puri, 2000, Audretsch and Lehman, 2004, for the U.S.). Given the characteristics of high-tech ventures, cautious investors like banks are in general more reluctant to provide funding. If the start-up is successful and generates high profits their return is bounded to the fixed interest rate, while they bear the full risk in case of failure (Carpenter and Petersen, 2002). Banks require regular interest payments and collateral value. During the very early stages, start-ups do usually not generate enough returns to be able to pay regular interests (Hall, 2002, Gompers, 1995) and cannot provide sufficient collateral for banks (Berger and Udell, 1998, Carpenter and Petersen, 2002).

[2] It is noteworthy that Haeussler et al. (2008) find evidence that other milestones in the patent application process at the EPO seem to reduce uncertainty for external VCs. Patent oppositions, for instance, lead to earlier VC financing for new ventures.

VCs, in contrast, are specialized in financing risky and potentially highly rewarded opportunities purchasing an equity stake and providing management support (see e.g. Sahlman, 1990). In contrast to banks, they provide monitoring, managerial and technical support for the ventures in addition to financial means (Gompers and Lerner, 1998, Hellmann and Puri, 2000). As they learn more about the firm in the course of their involvement and active guidance the ventures' technologies described in patent applications may be of value for VCs, but not for banks. This is not at least because VCs are not entirely motivated by financial returns, but also by knowledge capture (Dushnitsky and Lenox, 2005). The technical expertise of VCs and their possibility to behave opportunistically, hence, creates a double-moral hazard problem in the sense that not only the venture's effort is needed to attain successful outcomes, but also the VC's support and loyalty. Furthermore, in contrast to banks, VCs can credibly commit to take over the venture (Landier, 2001, Ueda, 2004, De Bettignies and Brander, 2007). In fact, VCs often replace the founders of new ventures by a new management team, even if the founders are performing well (Wasserman, 2003, Heger and Tykvova, 2009).

The involvement of VCs and their knowledge capture motivation create a special role for IPR in the relationship between VC and venture. IPR protect ventures against expropriation by VCs (Ueda, 2004), but probabilistic IPR can encourage VCs to invest in ventures if they aim at learning and expropriation (Dushnitsky and Lenox, 2005).

The discussion above leads us to hypothesize:

Hypothesis 2a: Uncertain IPR attracts VCs.

Hypothesis 2b: Uncertain IPRs discourage banks to invest in new ventures.

Prior Studies on Uncertain IPRs

Previous literature shows that uncertainty about IPR can have significant implications. For the U.S., Gans et al. (2008) show that patent pendencies reduce licensing activities of new ventures. They find that the likelihood of a cooperative licensing agreement for an invention increases significantly after a patent has been granted. Without formal intellectual property protection for their inventions new ventures fear expropriation and limit information disclosure. For a German firm sample that is not limited to start-up companies, Czarnitzki et al. (2011) show that patent pendencies reduce firms' R&D collaborations with competitors. Vertical collaboration activities are not affected though. We contribute to the empirical literature on patent pendencies by investigating their effects on new product launch and the access to external capital for start-up companies.

DATA, VARIABLES' DEFINITIONS AND DESCRIPTIVE STATISTICS

Data

The empirical analysis is based on the KfW/ZEW Start-up Panel (SuP), a large sample of start-up firms located in Germany. This data set provides comprehensive information on German entrepreneurial firms. Started in 2008, the SuP is a joint project of the Centre for European Economic Research (ZEW) in Mannheim, the "Kreditanstalt für Wiederaufbau" (KfW) Bankengruppe, Germany's largest state-owned promotional bank, and Creditreform, the largest credit rating agency in

Germany, and was initiated in 2008. The SuP focuses on legally independent firms excluding de-mergers and subsidiaries. The survey is conducted using computer-assisted telephone interviews.

The aim of the SuP is to provide a complete track record for entrepreneurial start-ups with respect to specific firm characteristics (e.g. sales, number of employees), strategic decisions (e.g. composition of the management team, product market entry strategy) and financial sources. Firms drop out of the sample if they reach an age of eight years.[3] The assigned foundation year corresponds to the year in which a firm starts its regular business activities.

The SuP is a stratified random sample. The population is taken from the database of Creditreform which provides the most comprehensive database for German firms.[4] Stratification criteria are the year of firm foundation, industry sector[5] and promotion of the venture by the KfW Bankengruppe. Stratification according to industry is based on ten industry clusters, four of which are high-technology industries. Altogether, technology-oriented firms represent half of the surveyed firms. Since the annual number of new firm formations in high-technology manufacturing is rather small (Metzger et al., 2008) each year's random draw includes entrepreneurial firms which have been founded within the last three years. For a more detailed description of the sample design we refer to Fryges et al. (2009).

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[3] In other international surveys on start-up firms, the maximum firm age varies between two and eight years depending inter alia on the technology intensity of the respective industries (Van Praag, 2003, Brüderl et al., 2007, Agarwal and Audretsch, 2001, Prantl, 2001).

[4] Information on the firm's name, address, legal form, industry classification and information regarding insolvency procedures is included (see Almus et al., 2000, for a detailed description).

[5] The industry sectors agriculture, mining and quarrying, electricity, gas and water supply, health care, and the public sector are excluded from the sample.

In order to identify pending patents we linked the SuP to the data base of the German Patent and Trademark Office (GPTO) using a computer-based matching algorithm.[6] The link between both databases was conducted based on firms' and founders' names and addresses in the SuP and the names and addresses of patent applicants as listed in the patent records of the GPTO. Each match suggested by the algorithm was checked manually. It is important to note that we do not only match patent applications to company applicants, i.e. the ventures, but also to the entrepreneurs. This is important because ventures may be established only after a technical invention by the founder has been granted patent protection. In our sample, 91% of the patents are owned by the founder and not by the venture.

Our sample includes ventures that have been founded in the period 2005-2009 in Germany and have been surveyed in the period 2008-2009. For our analysis, we only focus on new ventures in manufacturing and technology related services as we suppose that patenting activities are more pronounced in those sectors. In total, our sample includes 2,092 venture year observations.

Variables' Definition and Descriptive Statistics

This section defines and describes the variables used in the empirical analysis. Table 1 shows the descriptive statistics for our variables, Table 2 the correlation matrix.

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[6] We use the patent database of the GPTO rather than the database of the European Patent Office (EPO) because there is a significant overlap of the GPTO database and the database of the EPO. After a patent has been applied for at the GPTO patent applicants have a period of twelve months to take the application to the EPO (or other patent offices). In particular young and small firms first apply for patent protection at the German national patent office before filing a (more costly) patent application at the EPO. Some do not search protection at the European level at all. Furthermore, the GPTO provides us with a comprehensive record of the whole patent examination process. We use this information to distinguish pending patents from patent applications with a final grant decision.

Dependent Variables

We define three different dependent variables. The first variable indicates whether a new product has been launched which allows us to test whether new product introductions are influenced by patent pendencies. Almost half of the observations indicate a new product launch within the last two years (about 43%).

In order to test whether pending patents impact the access to external financing we focus on VCs and banks as potential suppliers of external funds. We define two dummy variables indicating whether the venture had access to funds from these sources. Most observations in our sample rely on internal financing of their activities as is suggested by the previous literature (e.g. Himmelberg and Petersen, 1994): Only 3% received venture capital and only 12% received funding from banks.

Table 1 about here

Table 2 about here

Pending Patents

With respect to the patenting activities of our sampled ventures we find a small numbers of ventures with patent applications. Although 31% of the venture observations report that they conduct R&D in-house the number of patent applications per firm and founders is quite small with an average patent application stock of 0.02 per employee per venture observation. The most active venture in terms of patenting has a patent stock of three patent applications per employee.

We make use of the GPTO information in order to identify the ventures' pending patent applications. Pending applications are defined as filings that are still under review at the GPTO in the year of interest. We normalize the number of pending

patents by the venture's patent application stock. For our ventures, on average, 2% of their patent application stock is still pending. For some ventures, all patent applications are still awaiting a decision. Note that the patent variables are lagged by one year in order to avoid endogeneity issues.

Control Variables

In addition to the variables of main interest, we use a number of control variables. We control for firm size in terms of employment since size is likely to be correlated with the innovation capabilities of the venture. External investors may use this information as an indication for high market potential. We use the logarithm of the number of employees in order to account for the skewness of the venture size distribution. In order to control for venture performance, we use the empirical price cost margin which is on average 6%. This variable further indicates whether a firm already sells products in the markets so that it generates returns. In this sense, it also captures the availability of internal funds. Another variable that proxies the availability of funds is whether the firm is a company with limited liabilities. Companies with limited liabilities are more risk-prone and conduct more R&D than others (Czarnitzki and Kraft, 2000) so that they might be able to attract VCs more easily whereas they may have more difficulties in persuading banks to provide them with funds.

A variable that controls for the innovation capacity but also for the riskiness of the venture is a dummy variable that equals one if the venture conducts R&D in-house. We further control for the share of high skilled employees, those with a university degree, as opposed to the share of workers without training. The share of high skilled

workers is low with about 1%. In contrast, more than 40% of the ventures' employees had no training.

Moreover, we account for the presence of a corporate investor. Ventures with the financial and non-financial backing of a corporation have been found to be more success in terms of radical innovation than a control group of independent ventures (Czarnitzki et al., 2010). The presence of a corporate investor can impact the likelihood to receive funding from other sources as well as the likelihood to introduce a new product to the market because, similar to VCs, corporate investors often supply managerial guidance in addition to the financial investment.

We further control for a number of characteristics of the founder or the founding team. First of all, 36% of the ventures have been founded by a team. With respect to the educational background and experience of the founders, it turns out that almost half of the observations have at least one founder holding a university degree. 28% of the observations correspond to ventures founded by at least one person with a business background, while 50% of the observations are founded by a team or an individual entrepreneur with a technical background. At least one of the founders of 74% of the observations has experience in managing a firm. The most experienced team member has worked, on average, for 14 years within the same industry. We use the logarithm of this variable to account for the skewness of its distribution. Lastly, it should be noted that a relatively large share of the venture observations (42%) has been founded by a re-starter. Re-starters might, on the one hand, have advantages for managing the new venture due to their past experience. Moreover, they might be discriminated by banks and VCs because of their past failure. The educational, employment and self-employment experience of the founder can act as a signal to

potential investors (Eisenhardt and Schoonhoven 1990, Burton et al. 2002, Shane and Stuart 2002).

We further use control variables for the stratification criteria used to create the firm sample: industry dummies, year of firm foundation and KfW involvement. Finally, we include a dummy for the year of observation to control for possible differences in cyclical patterns. These variables are included in all regressions, but not reported.

ESTIMATION APPROACH AND EMPIRICAL FINDINGS

We hypothesize that pending patents affect a firm's decision to launch new products and their access to external financing. Since the access to external funds is likely to impact new product launches we are interested in estimating the following equations:

$$bank\ financing_i = \alpha\, pending\ patents_i + \delta X_i + u_i \quad (1)$$

$$VC\ financing_i = \alpha\, pending\ patents_i + \delta X_i + v_i \quad (2)$$

$$product\ launch_i = \alpha\, pending\ patents_i + \beta\, bank\ financing_i + \gamma\, VC\ financing_i + \delta X_i + w_i \quad (3)$$

where X depict our control variables for venture i and u, v and w the error terms respectively.

Recursive Model

The system of equations presented above can be interpreted as a hierarchical recursive model (Maddala 1983, Greene 1998, 2003) because the financing variables enter the equation for new product launch as regressors. This renders the sources of external finance potentially endogenous regressors in the product launch equation. We apply a

multivariate probit model to estimate the equation system above allowing for correlated error terms. This equation system is identified as long as there is enough variation in the exogenous regressors (Wilde, 2000). The results are presented in Table 3. The correlations between the equations turn out to be not significantly different from zero. This suggests that although plausible from a theoretical point of view we do not face an endogeneity problem with regards to the financing sources for our sample so that we can apply standard probit estimation to the individual equations.

Table 3 about here

Probit Models

The results of the ordinary probit models are presented in Table 4, the marginal effects in Table 5. We first discuss the results for the financing equations. Table 5 shows that there is a significant positive effect of pending patent applications on the probability of receiving venture capital funds. Hence, hypothesis 2a receives support. A one unit change of pending patent applications over the patent application stock increases the likelihood to receive venture capital by 4%. Although significant in a statistical sense, the economic impact of the certification effect of pending patents on the venture capital markets is rather small for ventures in Germany. This might be due to the fact that the German venture capital market is rather small. The effect of the patent application stock is of similar size indicating that pending patents are twice as attractive as the total patent application stock. The result is in line with the findings by Haeussler et al. (2008) about the timing of venture capital investment. They find venture capital investment to happen after the patent application date rather than after the patent grant date.

With respect to bank financing there is no significant effect of the patent variables. These results suggest that banks do not rely on patent applications, pending or not, as quality indicators for ventures. Banks also do not discriminate innovative ventures because they are presumably riskier which good news for these ventures is. Hypothesis 2b, hence, does not receive support. Overall, the results suggest that risk-taking VCs prefer to invest in start-ups which already have a proof of concept and are passing on to the product development and market launch stage, while banks as more cautious investors do not attribute value to patent applications, but not discriminate against them either.

With respect to the control variables, we find that VCs have a preference for team foundations and capital companies. The latter effect can be explained by the fact that companies with limited liability are more prone to innovation (Czarnitzki and Kraft, 2000). Ventures with technically educated founders are discriminated against the benchmark of having neither a business nor a technical education. Also, founders with industry experience are less likely to receive venture capital. This may indicate that VCs seek greater influence on technological or commercialization decisions. Banks, in contrast, seem to invest in the better risks which are large ventures and they are less interested in funding re-starters.

Focusing on the product launch equation, it appears that pending patents have a negative impact indicating that with uncertain IPR ventures are reluctant to commercialize technologies. This supports hypothesis 1. The likelihood that the ventures introduce a new product decreases by 22% if the pending patents variable increases by one unit. This is a significant economic effect.

With regards to the control variables, new product launches are more likely to occur for large ventures, for ventures that conduct R&D and for venture capital backed companies. The latter result suggests that VCs supply non-monetary support in addition to capital. The price cost margin shows a negative effect suggesting that ventures with a better performance figure and those that already launched at least on product tend to be less prone to new product launch. This finding is expected for our sample of young and rather small ventures. After their first market launch ventures may concentrate on developing and improving the market positioning and features of this product and its production. At this stage, the ventures most likely lack the capacity to develop and launch further products.

Table 4 about here

Table 5 about here

Robustness Check: Instrumental Variables

Although the results from the multivariate probit model indicate that there is no endogeneity issue with regards to the funding sources in the product launch equation, we test whether this result is supported if we use an alternative methodology. A second way of dealing with endogenous regressors in our context is to apply instrumental variables techniques. Bank financing and venture capital financing are treated as potentially endogenous regressors in the product launch equation.

As instrument for venture capital financing we use the share of venture capital backed ventures on the NUTS 3 regional level.[7] The availability of venture capital in a specific region should be indicative for the likelihood of receiving venture capital funding for the individual venture in our sample while the regional venture capital supply should not impact the likelihood that the individual venture launches a new product.

As an instrument for bank financing we use a measure for the concentration of public banks on the NUTS 3 regional level. We define the market shares of public banks in the region and calculate a Herfindahl concentration index. The measure takes values between zero and one and reaches it maximum if a region is dominated by a particular bank. We focus on public banks for several reasons. First, entrepreneurs typically first approach their house bank for a credit before moving to alternative banks and most people in Germany have their private bank accounts with public banks. Second, public banks fulfill a public mandate to foster small businesses and regional development. Finally, public banks do not have return on investment targets so that they may be more involved in the support of entrepreneurs. The concentration measure depicts the degree of dominance of public banks in a region. If there is a strong concentration of public banks in a region the individual ventures' likelihood to receive bank financing should higher because the bank can be assumed to have a balanced risk portfolio. The concentration measure is not expected to influence new product launches by the venture.

[7] NUTS stands for Nomenclature of Territorial Units for Statistics and is a geocode standard for classifying regions. The NUTS 3 level corresponds to the German county ("Kreis") level.

In the first step, we test whether the proposed instruments are relevant, i.e. the instrumental variables have to show a high partial correlation with the potentially endogenous variable. We run ordinary least squares (OLS) regressions for equations (1) and (2) and include the respective instrumental variable as an additional regressor. According to Staiger and Stock (1997) and Stock et al. (2002), a partial F-statistic for the instrumental variable which exceeds a critical value of 8.96 for our case indicates that the instruments are relevant. Our instruments for both equations turn out to be relevant. The share of venture capital backed ventures show an F-statistic of 20.41 in the venture capital financing equation and the Herfindahl index for public banks shows an F-statistic of 9.87 in the bank financing equation.

Having shown that our instruments are relevant, we test in the next step whether venture capital and bank financing are endogenous regressors in the product launch equation. This could be for instance the case if both venture capital financing and the likelihood of a product launch would be correlated with the unobserved quality of the venture. We apply Smith and Blundell (1986) tests and find that the test statistic does not reject exogeneity for both potentially endogenous variables.[8] This confirms our result from the multivariate model by indicating that endogeneity is not a concern for our application. Hence, our ordinary probit results presented in the previous subsection display unbiased results.

[8] In order to do so, we run OLS regressions for equations (1) and (2) and include the respective instrumental variable as an additional regressor and obtain the residuals from these regressions. We estimate the probit model for the product launch equation, but now also include the residuals obtained in step 1. The standard t-statistic of the coefficient of the included residuals is a valid test on endogeneity of the financing variables.

Endogeneity of Pending Patents

A remaining issue is the potential endogeneity of pending patents. Patent applicants at the GPTO have the possibility to ask for examination of their patent application for up to seven years after the application date. Henkel and Jell (2010) document that more than 50% of the patent applications at the GPTO experience an applicant-induced examination delay. The reasons for these delays are that applicants aim at creating uncertainty for competitors and that they want to gain time for evaluation (Henkel and Jell, 2010). This could render the pending patents variable endogenous in our regressions. Our analysis so far dealt with the potential endogeneity of pending patents by using all patent variables with a one-year lag. Although we suspect that strategic delays are not useful for start-up companies that, in contrast to industry incumbents, benefit from the certification effect of patents, we test whether pending patents are subject to endogeneity in the product launch equation. We use the average pendency time for our start-up companies at the industry level as instrument. This measure depicts whether ventures induce strategic delays at the patent office due to industry specificities. It is, hence, likely to correlate with the patent strategy of individual ventures in the same industry, but unlikely to correlate with the likelihood of the individual start-up's product launch. The instrument passes the Staiger and Stock (1997) test for relevance with a partial F-statistic of 13.96. A Smith and Blundell (1986) test does not reject the null hypothesis of exogeneity of pending patents. This is in line with our expectation that young ventures do not strategically delay the patenting progress because they can substantially benefit from the certification effect of patents.

DISCUSSION

Patents can have two important features for young ventures. On the one hand, they grant patent holders temporary monopoly rights on inventions safeguarding complementary investments needed to develop an idea into a marketable product (Teece, 1986). As such, patents should facilitate the market launch of new products. On the other hand, patents can act as a "quality" certificate for potential external investors (Hsu and Ziedonis, 2008, Haeussler et al., 2008).

The predicted positive effects of patents for new ventures are based on the assumption that the patent system works efficiently. In practice, the rights afforded to patent holders are however highly uncertain. In this study, we focus on the effect of patent pendencies as one source of uncertainty surrounding the patent application process. We posit that if patents are pending at the patent office the desirable effects of patents for new ventures may not realize.

Our results for a sample of German ventures support our hypotheses. We show that ventures are reluctant to launch new products when patent applications are pending. With regards to access to external funds, we find that patent pendencies increase the likelihood to receive venture capital financing. Pending patents are more attractive to VCs than patent grants. This is in line with the notion that VCs are risk-taking, seeking for high returns on innovation as well as in knowledge capture. In particular the latter point can render ventures with pending patents attractive. Our results further show that neither granted patents nor pending patent applications have an impact on bank financing. The (prospect of the) monopoly right for the invention and the possibility that the IPR can be traded apparently bears no collateral value for banks.

The good news is that there is no evidence for banks discriminating innovative ventures.

Our study contributes to the emerging literature on probabilistic patents and the implications of the probabilistic nature of patents (Lemley and Shapiro, 2005, Gans et al., 2008). Prior literature has shown that once patents are viewed as probabilistic legal rights prior results can be challenged. Accounting for the probabilistic nature of patents, for instance, mitigates earlier positive findings on the importance of patents for licensing agreements (Gans et al., 2008) and R&D collaboration (Czarnitzki et al., 2011). We contribute to this growing literature by illustrating that it is not the granted patent right that attracts VCs, but that pending patents are of higher value to these risk-loving investors which aim at financial profits as well as on knowledge capture.

Our results have important policy implications as well. The predominant role of the patent system is to provide incentives to innovate by granting temporarily exclusive rights that encourage the commercialization of the patented invention. We show that uncertainties created by patent pendencies have negative effects on the commercialization of promising ideas. In particular with respect to start-up firms, an efficient patent system helps to spur innovation and new product introductions. If new ventures hold back the market launch of new products waiting for a patent grant decision this can have detrimental consequences for profitability, growth and survival.

Some caveats have to be taken into account when interpreting our results. First, our ventures are very young and exist for a maximum of three years. It would be interesting to investigate whether the effects of pending patents sustain for more mature ventures. Further, it would be interesting to investigate the selection process

into venture capital and bank financing from the ventures' perspective in more detail and the selection process of ventures by the VCs respectively.

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TABLES

Table 1: Descriptive Statistics

variable	mean	standard deviation
product launch	0.43	0.50
VC financing	0.03	0.17
bank financing	0.12	0.33
pending patents/patent stock	0.02	0.13
patent stock/employment	0.02	0.15
R&D	0.31	0.46
Log(employment)	1.15	0.64
team foundation	0.36	0.48
university degree	0.49	0.50
business education	0.28	0.45
technical education	0.50	0.50
leadership experience	0.74	0.44
log(work experience in the same field)	2.65	0.66
restarter	0.42	0.49
capital company	0.46	0.50
price cost margin	0.06	0.27
corporate investor	0.04	0.19
% employees with university degree	0.01	0.03
% employees without training	0.42	0.86

Table 2: Correlation Table

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	product launch	1																	
2	VC financing	0.09	1																
3	bank financing	0.02	0.03	1															
4	pending patents/patent stock	0.00	0.19	0.02	1														
5	patent stock/employment	0.02	0.18	-0.02	0.56	1													
6	R&D	0.30	0.12	-0.01	0.10	0.14	1												
7	Log(employment)	0.12	0.11	0.12	0.06	-0.02	0.12	1											
8	team foundation	0.05	0.13	-0.01	0.10	0.08	0.16	0.13	1										
9	university degree	0.12	0.07	-0.08	0.08	0.07	0.23	0.02	0.27	1									
10	business education	0.04	0.05	-0.01	-0.01	0.00	0.01	0.06	0.23	0.12	1								
11	technical education	-0.01	-0.01	0.03	0.05	0.01	0.08	0.01	0.13	0.19	-0.25	1							
12	leadership experience	0.11	0.06	0.00	0.06	0.06	0.18	0.16	0.25	0.24	0.08	0.09	1						
13	log(work experience in the same field)	-0.03	-0.04	0.03	0.00	0.02	0.01	0.05	0.08	0.00	-0.13	0.14	0.22	1					
14	Restarter	0.10	0.05	-0.09	0.06	0.09	0.23	0.07	0.29	0.19	0.08	0.02	0.50	0.06	1				
15	capital company	0.15	0.15	-0.02	0.13	0.10	0.29	0.28	0.39	0.33	0.15	0.06	0.31	0.09	0.28	1			
16	price cost margin	-0.09	-0.08	-0.05	-0.11	-0.07	-0.11	-0.10	-0.11	-0.07	-0.04	0.02	-0.02	0.05	-0.03	-0.21	1		
17	corporate investor	0.08	0.12	0.00	0.03	0.03	0.10	0.09	0.18	0.09	0.12	-0.01	0.08	-0.01	0.08	0.16	-0.08	1	
18	% employees with university degree	0.11	0.22	-0.01	0.05	0.03	0.24	0.34	0.16	0.27	0.05	0.06	0.13	0.01	0.11	0.29	-0.04	0.16	1
19	% employees without training	-0.07	-0.05	-0.01	-0.03	-0.00	-0.09	-0.20	-0.07	-0.12	-0.06	-0.03	-0.09	-0.08	-0.04	-0.14	-0.04	-0.04	-0.16

Table 3: Multivariate Probit Model (#2092)

	VC financing	Bank financing	Product launch
	coef.	coef.	coef.
	(s.e.)	(s.e.)	(s.e.)
pending patents/patent stock	0.75**	0.30	-0.63**
	(0.33)	(0.36)	(0.29)
patent stock/employment	0.53*	-0.57	0.01
	(0.27)	(0.57)	(0.24)
R&D	0.15	0.04	0.67***
	(0.15)	(0.09)	(0.07)
Log(employment)	0.15	0.25***	0.17***
	(0.12)	(0.06)	(0.05)
team foundation	0.47***	0.01	-0.10
	(0.16)	(0.09)	(0.07)
university degree	-0.20	-0.16*	0.15**
	(0.16)	(0.09)	(0.07)
business education	-0.03	0.08	0.04
	(0.15)	(0.10)	(0.07)
technical education	-0.29*	0.15*	-0.08
	(0.15)	(0.08)	(0.07)
leadership experience	0.20	0.12	0.14*
	(0.23)	(0.10)	(0.08)
log(work experience in the same field)	-0.26**	0.06	-0.07
	(0.11)	(0.06)	(0.05)
restart	-0.22	-0.26***	0.01
	(0.16)	(0.09)	(0.07)
capital company	0.53**	-0.08	0.01
	(0.21)	(0.09)	(0.07)
price cost margin	-0.42*	-0.17	-0.24**
	(0.24)	(0.14)	(0.11)
price cost margin missing	0.29**	-0.07	-0.12*
	(0.14)	(0.08)	(0.06)
founded in 2005	0.03	-0.19	-0.29***
	(0.22)	(0.13)	(0.09)
founded in 2006	-0.08	-0.08	-0.21**
	(0.22)	(0.12)	(0.09)
corporate investor	0.29	0.13	0.26*
	(0.23)	(0.20)	(0.16)
% employees with university degree	4.56***	-0.87	-0.73
	(1.64)	(1.58)	(1.23)
% employees without training	-0.17	0.00	-0.02
	(0.15)	(0.05)	(0.04)
VC financing			0.46**
			(0.23)
bank financing			-0.11
			(0.17)
constant	-2.46***	-1.41***	-0.15
	(0.49)	(0.24)	(0.19)
$\rho_{2,1}$ = 0.11 (s.e. = 0.07)	$\rho_{3,1}$ = -0.01 (s.e. = 0.07)		$\rho_{3,2}$ = 0.08 (s.e. = 0.08)
LL	-2189.65		
Wald Chi2	487.34		

***,**,* indicate statistical significance at the 1%, 5%, 10% level.
5 industry dummies, 1 year dummy and 1 stratification dummy are included but not reported.

Table 4: Probit Model (#2092)

	VC financing	Bank financing	Product launch
	coef. (s.e.)	coef. (s.e.)	coef. (s.e.)
pending patents/patent stock	0.75**	0.30	-0.62**
	(0.35)	(0.41)	(0.32)
patent stock/employment	0.53**	-0.57	0.03
	(0.27)	(0.53)	(0.23)
R&D	0.15	0.05	0.68***
	(0.14)	(0.09)	(0.07)
Log(employment)	0.16	0.25***	0.16***
	(0.13)	(0.07)	(0.05)
team foundation	0.47***	0.01	-0.10
	(0.16)	(0.10)	(0.07)
university degree	-0.20	-0.16*	0.15**
	(0.16)	(0.10)	(0.07)
business education	0.02	0.08	0.03
	(0.15)	(0.10)	(0.08)
technical education	-0.30**	0.15*	-0.08
	(0.14)	(0.09)	(0.07)
leadership experience	0.19	0.11	0.13
	(0.21)	(0.11)	(0.09)
log(work experience in the same field)	-0.25**	0.06	-0.07
	(0.10)	(0.06)	(0.05)
restart	-0.22	-0.26***	0.02
	(0.16)	(0.10)	(0.07)
capital company	0.53***	-0.07	0.01
	(0.19)	(0.10)	(0.08)
price cost margin	-0.41*	-0.17	-0.23**
	(0.25)	(0.15)	(0.12)
price cost margin missing	0.28**	-0.08	-0.12*
	(0.12)	(0.08)	(0.06)
founded in 2005	0.03	-0.19	-0.29***
	(0.21)	(0.13)	(0.10)
founded in 2006	-0.06	-0.08	-0.20**
	(0.21)	(0.13)	(0.09)
corporate investor	0.29	0.13	0.26
	(0.23)	(0.20)	(0.17)
% employees with university degree	4.51**	-0.90	-0.69
	(1.81)	(1.95)	(1.22)
% employees without training	-0.18	0.00	-0.02
	(0.13)	(0.05)	(0.04)
VC financing			0.43**
			(0.20)
bank financing			0.05
			(0.09)
constant	-2.48***	-1.41***	-0.17
	(0.46)	(0.25)	(0.19)
LL	-196.94	-705.72	-1288.92
Pseudo-R2	0.27	0.08	0.10

***,**,* indicate statistical significance at the 1%, 5%, 10% level.
5 industry dummies, 1 year dummy and 1 stratification dummy are included but not

Table 5: Marginal Effects

	VC financing	Bank financing	Product launch
	coef. (s.e.)	coef. (s.e.)	coef. (s.e.)
pending patents/patent stock	0.04**	0.05	-0.22**
	(0.02)	(0.07)	(0.11)
patent stock/employment	0.03**	-0.11	0.01
	(0.01)	(0.10)	(0.08)
R&D	0.01	0.01	0.24***
	(0.01)	(0.02)	(0.02)
Log(employment)	0.01	0.05***	0.06***
	(0.01)	(0.01)	(0.02)
team foundation	0.02***	0.00	-0.03
	(0.01)	(0.02)	(0.03)
university degree	-0.01	-0.03*	0.05**
	(0.01)	(0.02)	(0.03)
business education	0.00	0.01	0.01
	(0.01)	(0.02)	(0.03)
technical education	-0.01**	0.03*	-0.03
	(0.01)	(0.02)	(0.02)
leadership experience	0.01	0.02	0.05
	(0.01)	(0.02)	(0.03)
log(work experience in the same field)	-0.01**	0.01	-0.03
	(0.01)	(0.01)	(0.02)
restart	-0.01	-0.05***	0.01
	(0.01)	(0.02)	(0.03)
capital company	0.03***	-0.01	0.00
	(0.01)	(0.02)	(0.03)
price cost margin	-0.02*	-0.03	-0.08**
	(0.01)	(0.03)	(0.04)
price cost margin missing	0.01**	-0.02	-0.04*
	(0.01)	(0.01)	(0.02)
founded in 2005	0.00	-0.03	-0.10***
	(0.01)	(0.02)	(0.03)
founded in 2006	-0.00	-0.01	-0.07**
	(0.01)	(0.02)	(0.03)
corporate investor	0.01	0.02	0.09
	(0.01)	(0.04)	(0.06)
% employees with university degree	0.22**	-0.17	-0.24
	(0.09)	(0.36)	(0.43)
% employees without training	-0.01	0.00	-0.01
	(0.01)	(0.01)	(0.01)
VC financing			0.15**
			(0.07)
bank financing			0.02
			(0.03)

***,**,* indicate statistical significance at the 1%, 5%, 10% level.
5 industry dummies, 1 year dummy and 1 stratification dummy are included but not reported.