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Prior knowledge and entrepreneurial innovative success

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Summary. This paper is concerned with the relationship between innovative success of entrepreneurs and their prior knowledge at the stage of firm formation. We distinguish between different kinds of experience an entrepreneur can possess and find evidence that the innovative success subsequent to firm formation is enhanced by entrepreneur's prior technological knowledge but not by prior market and organizational knowledge. Moreover we find that prior technological knowledge gathered through embeddedness within a research community has an additionally positive influence on post start-up innovative success. This is a first hint towards the importance of collective innovation activities.

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1 Introduction

Cohen & Levinthal (1990) argue that there is a knowledge-based barrier to enter new markets where a certain level of knowledge is a prerequisite for being able to recognize and interpret new external information. This is particularly true for technologically dynamic industries and emerging markets. Accordingly, new business formation - and the setting up of a new, innovative firm in particular - is not a widespread and ubiquitous phenomenon, but of rather rare occurrence. It only emerges when specific opportunities for entrepreneurial profits such as market inefficiencies or newly discovered scientific insights meet prior knowledge of potential entrepreneurs, thus triggering opportunity exploitation by means of venture creation. Given that an opportunity for entrepreneurial profits exists, an actor can earn this profit only if he recognizes that the opportunity exists and is of any value (Shane & Venkataraman 2000). According to Austrian economics no two actors share all the same knowledge or information about e.g. a particular scarcity, a new producer or a new method of production (Hayek 1945, Venkataraman 1997). Hence, different people will discover different opportunities because they possess different prior knowledge. The entrepreneur's prior knowledge further influences the relative success of the entrepreneurial outcome. Recent contributions in the literature argue that survival and performance of new firms are fundamentally shaped by prior experience gathered through previous occupational episodes (Carroll et al. 1996, Klepper & Sleeper 2005, Helfat & Lieberman 2002). The technological expertise the entrepreneur alienates into the new firm may in addition determine the new firm's innovative success.

By using patent data statistics and information obtained from the German "Handelsregister" this paper analyses the influence of prior knowledge on entrepreneurial innovative success, measured by the probability that the entrepreneur files a patent subsequent to firm formation. In order to do so the next section reflects upon the literature on entrepreneurial prior knowledge to derive a set of testable hypotheses. The third section introduces the data sources and variables as well as a description of the data used in the analysis. The models and empirical results are presented and discussed in the fourth section. Finally, the paper concludes with remarks on future work that remains to be done.

2 Theoretical background

2.1 Entrepreneurial Opportunity and Prior Knowledge

Following the trail of issues raised by Austrian scholars, entrepreneurship is both alertness to new entrepreneurial opportunities and the sequence of innovative actions following the discovery of an opportunity. Innovative action is based on opportunity discovery, which cannot occur without alertness. Hence, if the entrepreneur is truly alert, he discovers profit opportunities and acts upon them (Koppl & Minniti 2003). By contrast, if a discovered opportunity is not followed by any action, the entrepreneur probably was not able to act, either due to a lack of knowledge, lack of will or lack of vision. Possibly it was not a profit opportunity worth pursuing, at least not for the particular entrepreneur (Koppl & Minniti 2003). Not surprisingly, Shane & Venkataraman (2000) posit that a unique aspect of entrepreneurship research pertains to the questions of why, when and how individuals recognize opportunities for business creation and subsequently act upon them while others do not.

The modern theory of entrepreneurship holds that opportunities are real and independent from entrepreneurs that perceive them (Acs et al. 2005). Entrepreneurial opportunities may appear as imprecisely defined market needs or as un- or underemployed resources or capabilities (Kirzner 1997). Underutilised or unemployed resources as well as new capabilities may offer possibilities to successfully introduce new goods, services and raw materials that can be sold at a profit (Casson 1982, Shane & Venkataraman 2000). But "opportunities rarely present themselves in neat packages. They almost always have to be discovered and packaged." (Venkataraman 1997). In this respect Shane (2000) argues that people possess different information and beliefs, and as a result some actors recognize opportunities that others cannot yet see. Therefore, for entrepreneurship to occur, resource owners must not completely share the particular entrepreneur's beliefs and information, because they would try to capture the entrepreneurial profit by adjusting the price of resources to the point where the entrepreneurial profit would be eliminated (Shane & Venkataraman 2000). Likewise, if other entrepreneurs possessed the same beliefs and information, competition between entrepreneurs would eliminate the entrepreneurial opportunity (Schumpeter 1934).

However, simply being in possession of valuable information is insufficient for entrepreneurship (Venkataraman 1997). Thus, another central question most notably for our concern is what triggers the search for

and exploitation of opportunities in some actors, but not in others. To give answers Venkataraman (1997) centers the actors' distinctive stocks of information acquired through each individual's own circumstances including occupation, on-the-job routines, social relationships and daily life. No two actors share all the same knowledge or information about e.g. a particular scarcity, an invention or a new method of production (Hayek 1945, Venkataraman 1997). This prior related knowledge confers to the recipient an ability to recognize the value of new knowledge and information, assimilate it and apply it to commercial ends (Cohen & Levinthal 1990, Venkataraman 1997). Shane (2000) as well as Shane & Venkataraman (2000) elucidate that each actor's idiosyncratic prior knowledge creates mental schemata. These provide a frame of reference, the "knowledge corridor" (Ronstadt 1988), which influences the entrepreneur's ability to comprehend, extrapolate, interpret and apply new information in ways that those lacking such prior information cannot replicate. Accordingly, even if information about newly discovered scientific insights and techniques is open to the public, only a subset of actors will possess prior knowledge that is complementary with this new information and, thus, triggers the discovery of a specific entrepreneurial opportunity (Shane & Venkataraman 2000).

2.2 Prior knowledge and experience as pivots of success

All prospective entrepreneurs possess specific knowledge and skills acquired by their past occupational activities and their educational background. As shown, this can be of value in searching for new business opportunities as well as in the day-to-day running of a firm (Shane 2000). Thus, the primary assets of the new business formations are the capabilities and routines embodied in their founders (Hannan & Freeman 1986). The central argument of recent contributions is that survival and success of these new ventures are fundamentally shaped by the prior experience of the entrepreneur (Carroll et al. 1996, Klepper 2001, Helfat & Lieberman 2002). Moreover, it is argued that not the resources and capabilities alone affect the likelihood of new venture success, but it is rather the match between the market entered and the start-up's pre-entry experience and capabilities that matter. Empirical findings suggest that the greater the similarity between pre-entry firm resources and the required resources in an industry, the more likely a firm will enter that particular industry, and the greater the likelihood of firm survival and prosperity (Helfat & Lieberman 2002, Dahl & Reichstein 2005).

Market and organizational pre-entry experience

Reviewing the findings of a study on the farm tractor industries Buenstorf (2006) suggests that the performance of diversifying entrants may not primarily have been caused by technological capabilities. Diversifiers' decisive competitive advantage may have been a close knowledge of customer needs and potential demand for products, because they could draw from almost the same customer base in the new industry. Hence, their pre-entry experience enabled new businesses to introduce commercially successful product innovations. This is in line with conclusions Shepherd & DeTienne (2005) draw from a study that relates the entrepreneur's prior knowledge to entrepreneurial opportunity identification. They assert that those entrepreneurs with more in-depth prior knowledge of customer problems identified more opportunities and opportunities with a higher degree of innovativeness. Having prior knowledge of customer needs, thus, relates to a concerted awareness of market inadequacies and to a superior creative tension (Shane 2000, Shepherd & DeTienne 2005).

Kakati (2003) observed that the development of a new technology or product does not in itself guarantee commercial success of firms operating in emerging markets. Rather, the presence of diversified skills and capabilities in which technological expertise is balanced with organizational skills in areas such as marketing, delegating authorities, and controlling results, are likely to positively affect the new venture's performance. Technological experience is certainly important to obtain innovation, but innovative success also depends on the entrepreneur's capacity to assemble, coordinate, manage and execute resources and processes within and between firms (Bruederl & Preisendoerfer 1998). The entrepreneur may have obtained the necessary managerial ability through previous self-employment episodes (Westhead & Wright 1998). Comparing the performance of experienced and novice entrepreneurs, Westhead & Wright (1998) spot entrepreneurial pre-entry experience to be a crucial determinant for higher chances of business survival and success. The trial-and-error process which took place during prior self-employment may be the best preparation for the current entrepreneurial role (Bruederl & Preisendoerfer 1998). Prior experience of business ownership can therefore be associated with assets like increased expertise, extended networks and an established legitimacy with financiers, customers and suppliers (Westhead et al. 2005). Even the experience of bankruptcy or voluntary firm exit can be deemed to be a special type of business ownership experience. Hence, it might also have a specific effect on the current innovative success of an en-

trepreneur. Concluding the findings in the literature, we suggest the following hypothesis:

Hypothesis 1: The entrepreneur's prior market and organizational knowledge enhances the probability of being successfully innovative subsequent to firm formation.

Technological pre-entry experience

Before technological change leads to entrepreneurial innovative success in terms of marketable products, services, processes or organizational forms, entrepreneurs must discover opportunities in which to exploit the invention (Shane 2000). However, new scientific insights that may pave the way for an innovation can be complex, tacit and embodied within the entrepreneur's person (Pavitt 1991, Dasgupta & David 1994). Therefore, some familiarity with the inventor's technological knowledge is a prerequisite to recognize a certain entrepreneurial opportunity inherent in the new technology. Not surprisingly, the individual inventor holding tacit knowledge about his invention should therefore be best suited to conduct the entrepreneurial role (Shane 2004). Shane (2000) underlines the importance of technological prior knowledge for subsequent entrepreneurial innovative success. He shows that individuals from different technological backgrounds, who assess the same technological invention, recognize and then develop different business opportunities.

The significance of technological capabilities in determining competitive advantage of a new firm has been well documented in the literature (Teece 1986, Cohen & Levinthal 1990). A historical example is the U.S. television receiver industry, which was dominated by diversifying radio producers although they were a minority among the entrants (Klepper & Simons 2000). Klepper & Simons (2000), thus, show how technological prior knowledge affects new venture performance. In their examination, entrants from the closely related, matured radio industry possessed technological expertise as well as resources and capabilities that matched with what was needed in the emerging television receiver industry. Therefore, these diversifying entrants benefited due to their ability to leverage their technological skills in the new industry and to gather advantages pertaining to production and product quality. Diversifying entrants survived longer, had higher rates of innovation and finally outperformed other entrants that lacked technological prior

knowledge. Similar evidence was found for the U.S. shipbuilding industries (Thompson 2005) as well as for U.S. census data spanning a broad range of industries (Dunne et al. 1988). Following from the foregone statements, we derive the hypothesis:

Hypothesis 2: The entrepreneur's prior technological knowledge enhances the probability of being successfully innovative subsequent to firm formation.

Network activity and collective innovation experience

According to a sociological perspective of entrepreneurship social capital is considered as a main factor of success for the establishment and growth of young firms (Aldrich & Martinez 2001). Especially the formation of a new innovative firm is to a great extent "peoples' business", as it draws from the entrepreneur's social context that shapes and forms the entrepreneurial outcome (Bruederl & Preisendoerfer 1998, Sorenson 2003, Elfring & Hulsink 2003, Taylor & Morone 2005). Thus, the entrepreneur is not to be seen as an isolated and autonomous actor, but is rather embedded in a network of pre-established social relationships which play a crucial role for venture creation and development (Bruederl & Preisendoerfer 1998, Sorenson 2003, Elfring & Hulsink 2003).

The network literature suggests that economic actors gain access to information through interaction with other actors, who in turn are linked to knowledgeable others. Availability, timing and quality of information accessed depends on network characteristics. Pertinent argumentations are based on Granovetter's (1973) notion of the "strength of weak ties". According to that, weak ties, including casual acquaintance, are more likely to provide unique information than the individual's strong-tie relationships to close friends and family members. Consequently, less cohesive networks may be vital to obtain exclusive knowledge (Burt 1992) which is complementary with the entrepreneur's prior knowledge and, thus, triggers the recognition of a business opportunity in a particular segment or market niche of the economy (Hills et al. 1997). Since new entrants to the entrepreneurial profession often suffer from a lack of financial capital, skilled labor and capabilities to exploit an opportunity, they can leverage their social relationships to gain access to scarce resources (Sorenson 2003).

Beyond the sociological literature (Granovetter 1973), only recently an economic literature dealing with knowledge networks and its impact on the rate of knowledge diffusion (e.g. Cowan & Jonard 1999, Cowan 2004, Morone & Taylor 2004, Cantner & Graf 2006) has emerged. Empirical and simulation analysis of network structures and its influence

on knowledge diffusion show that the rate of diffusion is maximised in networks that exhibit small world properties, i.e. networks with short average path length and high degree of clustering (Watts & Strogatz 1998). The main body of the economic network literature remains at a network level, describing network structure and development. Cantner & Graf (2006) test for the relationship between network embeddedness and individual innovative performance. They find evidence pertaining to a relationship between network position and innovative performance in terms of persistence in an inventor network. Additionally, they find hints for the importance of short term interpersonal linkages in shaping networks of cooperations and even entire local innovation systems (Cantner & Graf 2006).

The entrepreneur's social network might therefore function as a channel for knowledge transfer while enabling connections to e.g. a research community (Burt 1992). Today's inventive and innovative activities more often than not show the systemic character of "collective invention" (Allen 1983). More commonly, it is the formal and informal collaboration of the entrepreneur with different actors that makes successful innovation more likely (e.g. Cantner & Graf 2004). In this respect, dense social networks often prove useful because they foster the flow of information between individuals as they imply reciprocal obligations, mutual understanding and trust (Coleman 1990). Coleman (1990) further points out that close interactions with other actors are valuable in terms of information quality provided. Based on this the following hypothesis applies:

Hypothesis 3: Entrepreneurs with prior knowledge gathered through formal and informal exchange are more likely to be successfully innovative after firm formation than others.

3 Data base

3.1 Data sources and variables

In order to test the hypotheses suggested above, we resort to two data sources. First, the database of the "Handelsregister" provides information about German firm formations of the years 1990 till 2004. The name of the firm, information about firm founders, their residence and age are as well available as data concerning firm status and firm development. The second data source is the "Deutsches Patentblatt", a database containing all patents applied for at the German Patent Office

or at the European Patent Office for Germany. Patent data provides information about the names and addresses of the inventors who applied for a certain patent. Following Balconi et al. (2004), we assume that multiple inventors that are listed on a patent application know each other and have had contact during the research project that resulted in the patented intellectual property. We use patents applied for between 1997 and 2004. As we are interested in the inventors' technological prior knowledge and their collective innovation experience, the subsequent decision whether the patent is granted or not is not of interest for our purpose.

Additionally, we are interested in determinants of the innovative success of recently founded firms. We therefore use patents as an indicator of innovative success. One of the major drawbacks of using simple patent counts as a measure of innovative output is that not all patents are of a similar quality and importance. Patents, like publications, can vary greatly in their commercial impact and technological influence. Nevertheless, and even more important for our concern, Griliches (1990) as well as Acs et al. (2002) have shown that patents provide a fairly reliable measure of innovative success. This reliability may, however, be restricted to technological innovations and has some shortcomings in regression fitness (e.g. Encaoua et al. 2006).

An entrepreneur is deemed as successfully innovative if either he or his newly founded firm file a patent in the period after firm formation.

3.2 Descriptive data

The hypotheses are tested on a sample of entrepreneurs who founded a firm in the region of Jena in 2000 or 2001. During this period a total of 80 firms were established by 85 founders. In the following analysis, data of these 85 firm founders is used to test our hypotheses.

As mentioned above the innovative success (*INNO – SUC*) of firms newly founded in t is measured by patents applied for in $t + 1$. In our analysis, t represents the period 2000-2001 and the period $t + 1$ comprises the years 2002-2004. Table 2 shows that during these years, 16 of the 85 founders examined filed for a patent as inventor or applicant or their firms were labeled as an applicant on a patent. So nearly 19% of the new firms can be considered as successfully innovative.

The information provided by patent data is further used to indicate the prior technological knowledge (*TECH – EXP*) the firm founder holds at the stage of firm formation and which has been acquired before in

$t - 1$.⁴

In our sample patent applications in the pre-formation period from 1997 to 1999 indicate the entrepreneur's technological prior knowledge. As table 2 shows, 21 of the sampled firm founders are identified either as an inventor or as an applicant on a patent in 1997-1999. A further kind of knowledge which is beneficial to a newly founded firm comprises the market and organizational experience the entrepreneur already possesses. We assume that all observed entrepreneurs who founded another firm before 2000 have already gathered this experience. The binary variable *MARKET - EXP* takes a value of 1 in that instance and 0 otherwise. In our sample 12 entrepreneurs have already gathered prior market experience (table 2).

While *TECH - EXP* indicates whether the firm founder possesses technological prior knowledge or not, a further assumption is made on inventor's embeddedness in a research community as the source of such kind of knowledge. Embeddedness into the research community is measured on the basis of an innovator and inventor network built up from the information provided by patent data. To test the impact of connections to other researchers in the pre-founding phase on innovative success after firm founding, we include the normalised degree centrality⁵ to indicate the embeddedness of each inventor (one vertex) within the innovator-inventor network. Naturally, the influence of embeddedness can only be measured for those inventors who have been active within a network, meaning those who gathered technological experience prior firm formation. As a result, only 21 inventors with prior technological knowledge can be considered. As table 2 shows, among these, one inventor applied for a patent as a single inventor (*PRE - NET* value of 0), while all other inventors applied for a patent together with at least one co-inventor.

To control for the sector the firm is founded in and the respective intensity of patenting, we use the binary variable *PATENT - INT* which takes the value of 1 if the firm belongs to a sector with patent intensity above the median sector and 0 otherwise.

⁴ Patents applied for in t are excluded here because the invention cannot be categorised into the pre- or post-formation phase. In order to make a clear cut between the two stages we left out the years 2000 and 2001

⁵ The number of vertices adjacent to a given vertex in a symmetric graph is the degree of that vertex. The normalised degree centrality is the degree divided by the maximum possible degree expressed as a percentage (Borgatti et al. 2002)

Table 1. Content of the used variables

Variable	Description
INNO-SUC	Patent application with newly founded firm as applicant or entrepreneur named as inventor. Value 1 if patent applied for in 2002 to 2004, 0 otherwise.
MARKET-EXP	Individual experience of the firm founder with "how-to-found-a-firm". Takes the value 1 if the entrepreneur has founded an other firm before 2000, 0 otherwise.
TECH-EXP	Indicates whether the entrepreneur possess technological knowledge at the stage of firm formation. Takes the value 1 if the entrepreneur is named as inventor in the period before firm formation (1997-99), 0 otherwise.
PRE-NET	Indicates the embeddedness of the entrepreneur within a research community. Only firm founders with prior technological knowledge are observed. This value is the normalised Freeman degree which is the sum of the direct connections of an actor divided by the sum of all potential connections, yielding a measure between 0 and 1.
PATENT-INT	Indicates whether the firm has been founded in a patent intensive sector. Takes the value 1 if the sum of all patents applied for this sector is above the value of the median sector, 0 otherwise.

In a first descriptive analysis the bilateral relationship between each of these variables are observed. Table 3 shows the respective covariance

Table 2. observed variables

	obs.	cases	Mean	Median	Max.	Min.	Std. Dev.
INNO-SUC	85	16	0.188	0.000	1.000	0.000	0.393
MARKET-EXP	85	12	0.141	0.000	1.000	0.000	0.350
TECH-EXP	85	21	0.247	0.000	1.000	0.000	0.434
PATENT-INT	85	40	0.471	0.000	1.000	0.000	0.502
PRE-NET	21	20	0.749	0.589	3.028	0.000	0.731

matrix. This measure is used because of the binary nature of four of the variables. It simply indicates whether both variables are independent from each other (value close to zero). The value of the covariance itself, however, cannot be interpreted. In general we find rather low values except the relation between *INNO – SUC* and *PRE – NET*. The covariance between *MARKET – EXP* and *INNO – SUC* is most closely to zero. The covariance between *TECH – EXP* and *PRE – NET* is zero by definition.

Table 3. Covariance Matrix

	INNO- SUC	MARKET- EXP	PATENT- INT	TECH- EXP	PRE-NET
INNO-SUC	0.153				
MARKET-EXP	-0.003	0.121			
PATENT-INT	0.064	0.028	0.249		
TECH-EXP	0.083	0.024	0.025	0.186	
PRE-NET	0.200	-0.030	0.013	0.000	0.509

3.3 Network results

Beside these description of our data, we make use of Social Network Analysis (SNA) to investigate the issue of embeddedness in cooperative research and to find differences among firm founders who possess technological experience at the stage of firm formation. For those entrepreneurs we distinguish two groups, a first one with firm founders who are successfully innovative (*INNO – SUC* = 1; no.=16) and a second one with founders who show no further innovative success (*INNO – SUC* = 0; no.=69).

The ego net⁶ for each actor of the second group is displayed in figure 1. Except for one, all inventors of this group are embedded within so called cliques prior to firm formation. A clique is defined as a set of actors who are all connected to each other. This finding is explained by the fact that inventors in a particular clique are stated as multiple inventors of one and the same patent. Only one actor filed a patent as single inventor.

⁶ "The egocentric network (or ego net) of vertex v in graph G is defined as $G[v[N(v)]]$ (i.e., the subgraph of G induced by v and its neighborhood)." (Butts 2006, p.40)

Figure 2 shows the ego nets of the second group, inventors who applied for patents prior also after founding a firm.

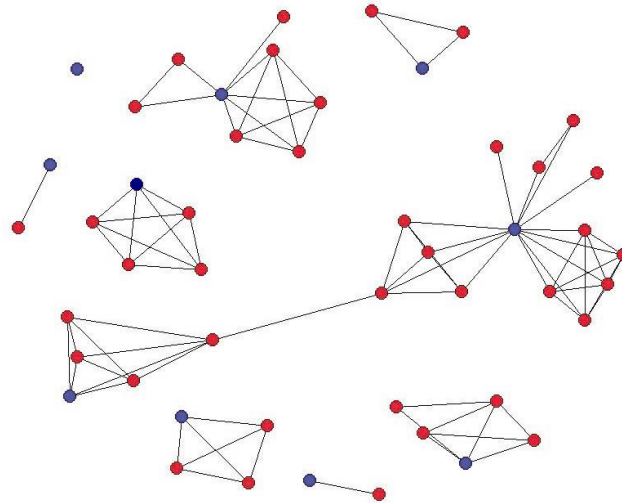


Fig. 1. Group of technologically experienced entrepreneurs without innovative success after firm formation

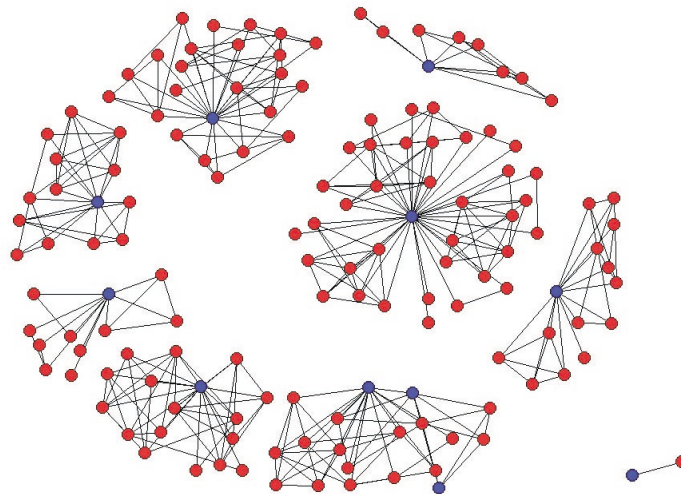


Fig. 2. Group of technologically experienced entrepreneurs with innovative success after firm formation

It is obvious that almost each member of this group has more connections to other researchers than the members of the first group. Additionally we find no clique structure as we did for the first group in figure 1. This outcome can be explained by two facts. First, inventors with innovation success after firm formation hold more patent applications in the pre-entry-phase (on the average 3.5 patents for group 2 compared to 1.4 for group 1). Second, these patents show a higher number of co-applications and co-inventions than the patents of group 1 inventors.

After this descriptive analysis of the determinants influencing the innovative behavior of newly founded firms, we test the assumed relations in a more formal way.

4 Models and Regression results

4.1 Estimation methodology

To test the hypotheses related to the innovative success of the newly founded firms, we apply a binary Logit model. This is due to the binary dependent variable *INNO-SUC* which takes a value of 1 if the newly founded firm has applied for a patent in the period after firm formation or if the entrepreneur is named as an inventor in this period.

The hypotheses to be tested refer to the influence of entrepreneurial knowledge assets of the firm founder at the stage of firm formation on further innovative success. In order to test for hypothesis 1 we start with Model 1 analyzing the impact of market experience (*MARKET-EXP*) on the innovative success.

$$P_{(INNO-SUC=1)} = \beta_0 + \beta_3 * MARKET - EXP + \beta_4 * PATENT - INT \quad (1)$$

In a second step (Model 2) we include the variable *TECH-EXP* which indicates whether firm founders possess technological experience in terms of patent application in the period before business formation:

$$P_{(INNO-SUC=1)} = \beta_0 + \beta_1 * TECH - EXP + \beta_3 * MARKET - EXP + \beta_4 * PATENT - INT$$

As mentioned above, the embeddedness within a research community is represented by a connectivity indicator based on the ties each

firm founder shows in a patent network. Taking this connectivity indicator for the whole database would explain roughly the same as the *TECH – EXP* variable introduced above. To get additional insights we reduce our sample to the 21 cases (Model 3) where entrepreneurs possess prior technological knowledge. On this smaller number of cases, we then test for the impact of collaborative research experience additionally to the technological experience in general.

$$\begin{aligned}
 P_{(INNO-SUC=1|TECH-EXP=1)} = & \beta_0 + \beta_2 * PRE - NET \\
 & + \beta_3 * MARKET - EXP \\
 & + \beta_4 * PATENT - INT
 \end{aligned}$$

4.2 Estimation results

Our estimation results are reported in table 4. Each column represents the results for one of our models: first model 1 with an estimation containing only the control variables, then model 2 with an estimation on the impact of prior technological knowledge and finally model 3 with a test of collaborative research experience with the reduced sample.

The result for Model 1 indicates that experience of "how-to-do-a-business", labeled as *MARKET – EXP*, does not influence the innovative success. Due to this result we have to reject hypothesis 1 on the influence of market experience on the innovative success of newly founded businesses. The variable indicating a firm formation in a patent intensive sector (*PATENT – INT*) has a significant positive influence on the probability to become innovatively successful. This is a first hint towards the influence sectoral conditions have on start-ups' innovative success. The fitness of the estimation result is expressed by the McFadden pseudo- R^2 value and the number of correct forecasts. The McFadden R^2 of this first model is 0.124 which means that 12.4% of the real observations are explained by the independent explanatory variables. The number of correct forecasts is a post-estimation classification under the minimum mean squared discrete prediction error criterion. In our first model 69 of 85 observed values are correct forecasts ⁷.

After testing the model with control variables the variable of prior technological knowledge (*TECH – EXP*) is included in model 2. The

⁷ Terza (2006) has shown that for binary regressions the threshold parameter is not arbitrary and that other values than 0.5 are not optimal (Terza 2006, p.75). Following this an estimated result is correct if the estimation error is below 0.5 in the case of binary regressions.

Table 4. Regression results

Dependent variable Method Variables	Model 1	Model 2	Model 3
	INNO-SUC Binary Logit	INNO-SUC Binary Logit	INNO-SUC Binary Logit
(INTERCEPT)	-2.598 (0.000)	-4.072 (0.000)	-8.874 (0.108)
TECH-EXP		3.212 (0.002)	
PRE-NET			8.282 (0.082)
MARKET-EXP	-0.583 (0.501)	-1.890 (0.105)	-3.818 (0.176)
PATENT-INT	1.973 (0.005)	2.553 (0.005)	6.784 (0.118)
McFadden R^2	0.124	0.367	0.625
Total obs.	85	85	21
No. of correct forecasts	69	71	18
p-value in parenthesis			

coefficient for this independent variable has a significant positive value. Therefore, for our sample we can not reject hypothesis 2. If a firm founder possesses technological knowledge at the stage of formation, the likelihood to become successfully innovative in the following period increases. This is independent from patenting behavior of the sector the newly founded firm is assigned to. Again market knowledge as a further dimension of prior knowledge does not influence the probability of further innovations.

After showing impacts of different kinds of knowledge on the likelihood of entrepreneurial innovative success, we test the influence of collaborative research experience on a subgroup of our data base. As mentioned above, this subgroup include only those cases in which the firm founder possesses prior technological knowledge. So model 3 in table 4 includes the embeddedness of the firm founder in a research community. The metric variable $PRE - NET$ has a positive influence on further innovative success, significant on a 10% level which is quite sufficient considering the small data base. Contacts to other researchers in terms of being co-inventor on a patent application in the period before business formation fosters the innovative success in the period after starting the business. We therefore cannot reject hypoth-

esis 3. The quality of prediction of the model is quite sufficient. The value of McFadden pseudo- R^2 is 0.625 and the prediction for 18 of the 21 observations is correct.

5 Conclusion and further perspectives

This paper is concerned with the influence of different kinds of prior knowledge an entrepreneur can possess at the stage of firm formation. Measuring the firm performance in terms of further innovative success, our empirical results show no evidence that prior market or organizational knowledge enhances firms' capabilities to be successfully innovative. This finding, which is contrary to comparable studies like Buenstorf (2006) or Dunne et al. (1988), probably results from our dependent variable of innovative success. In following studies we intend to include start-ups' economic development to deepen and strengthen our analysis in this respect.

Concerning the technological experiences or knowledge of entrepreneurs, our finding is in line with comparable empirical studies (e.g. Agarwal & Bayus 2005, Klepper & Simons 2000, Shane 2000). Our empirical results show that firm formations by technologically experienced founders are more likely to be successfully innovative than firms set up by entrepreneurs without such prior knowledge. Including the embeddedness within a research community we distinguish how such prior technological knowledge has been gathered. We show that entrepreneurs with more contacts to other inventors are more likely to be successful innovators. This is a first hint towards the importance of collective activities for further innovative success. In general this finding is in a line with empirical studies showing a positive influence of networking activities on the individual (Combs & Ketchen 1999, Belderbos et al. 2004, e.g.) as well as on systemic innovative success (Doloreux et al. 2004, Fritsch & Franke 2004, Asheim & Coenen 2005, e.g.).

In further steps we want to enlarge this study both quantitatively and qualitatively. The current database contains only a small sample of the firm formations in the entire area of Jena. Therefore, we want to include all start-ups between 1990 and 2005. In addition, information available about firm growth and development shall be included to gain a deeper insight into the relation between prior knowledge and firm performance.

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