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The Role of Founders in Young Firms? Innovative Performance: Empirical Evidence from Europe

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Abstract

This paper explores the effect of founder-specific characteristics on the innovative performance of newly-established firms. The study also takes into account firm characteristics and characteristics of a firm?s environment. The empirical analysis is based on data from a rich European survey that examined small firms between three and ten years of age across a wide industrial spectrum of knowledge-intensive services and manufacturing sectors in ten countries. The study provides evidence that aspects of both generic and specific human capital (founder education, prior working experience, prior exposure to academic research) along with founding team heterogeneity expressed in terms of diversity of functional expertise are vital to explaining the innovative effort of such firms. Important policy implications about the identification of high growth potential companies and the promotion of entrepreneurship among specific populations follow.

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Abstract: This paper explores the effect of founder-specific characteristics on the innovative performance of newly established firms. The study also takes into account firm characteristics as well as the characteristics of a firm's environment. The empirical analysis is based on data from a rich European survey that examined small firms between three and ten years of age across a wide industrial spectrum of knowledge-intensive services and manufacturing sectors in ten countries. The study provides evidence that aspects of both generic and specific human capital (founder education, prior working experience, and prior exposure to academic research) along with founding team heterogeneity expressed in terms of diversity of functional expertise are vital to explaining the innovative effort of such firms. Important policy implications about the identification of high growth potential companies and the promotion of entrepreneurship among specific populations follow.

1. Introduction

New firms have been identified as engines for growth, innovation and wealth creation. While a good share of young small firms are expected to be short lived, exiting the market within a few years from their formation (Watson and Everett, 1998; Headd, 2003; Knaup and Piazza, 2007; OECD, 2014), empirical evidence shows that surviving young firms, and especially a relative small share of them that manages to grow, account for a significant share of new job creation (Haltiwanger et al., 2010; Kane, 2010; Hathaway, 2013; Criscuolo et al., 2014; Coad et al., 2014). Firms that innovate successfully increase their chances of survival and growth and are, therefore, a key element for economic development and growth (de Jong and Marsili, 2006; Arvanitis and Stucki, 2012). These innovators with higher survival rate and better chances of growth are characterized as high-potential companies conjectured as 'the kind that create value and stimulate growth by bringing new ideas into the market, be they new technologies, new business models, or simply new and better ways of performing routine tasks' (Schramm, 2005, p.163). Yet, little is known on the determinants of the differential innovative performance of such firms.

Not surprisingly, the innovativeness of small young firms is considered to be strongly related to the characteristics of the specific resources on which they are able to draw. One type of resource that might be particularly relevant is the characteristics of the founding team, including their educational attainment, prior experience, age, and expertise. Following the resource-based view of the firm we conjecture that founders constitute an important strategic asset for young firms because a) they develop firm strategies and coordinate the required resources to implement them, and b), as these firms are small, the capabilities of founders serve disproportionately as critical resources to the creation of competitive advantage.

While empirical research has examined the relationship between the management team characteristics and the innovative performance of established firms, to the best of our knowledge only a limited number of studies have focused on the impact of founder characteristics on the innovation of young firms (some notable exceptions are Arvanitis and Stucki, 2012; Lynskey, 2004; Koch and Strotmann, 2008). Furthermore, relevant research in young firms is mainly limited

to new technology based firms and high-tech sectors (e.g. Colombo and Grilli, 2005).

This paper empirically explores the effect of founder characteristics on the innovative performance of newly established firms. Founder characteristics are embedded in a set of other important determinants of innovative activity. The analysis is supported by detailed survey information on a large sample of small companies 3-10 years old from ten European countries. These companies are in high-tech and low-tech manufacturing and knowledge-intensive business services (KIBS) sectors.

Our work departs from the existing literature in three respects. First, we use an extensive and more-refined set of variables to account for founder characteristics. We distinguish between generic and specific components of human capital (Becker, 1975). Generic human capital refers to traits acquired by founders through their formal education and general professional experience. Specific human capital relates to capabilities that the members of the founding team can directly apply to the newly established firm such as industry-specific knowledge obtained through prior employment in the same sector. It also includes entrepreneurial-specific capital that has been acquired through professional practice either in managerial positions or through prior firm ownership. Second, we attempt to identify the existence of synergistic effects that arise from the diversity of capabilities within the founding team such as founder functional expertise and professional experience. While it is often claimed in the literature that founding team heterogeneity may provide cognitive resources and social capital that can enhance team effectiveness thereby fostering growth and innovation, the nature and the exact impact of these synergies remains largely unexplored. Third, although our main focus is on founders' human capital we control for covariates that may also affect the innovative performance of young firms. We include two more determinants of innovative activity in our analysis: firm-specific characteristics and capabilities (firm size, sales in international markets, employees with university degrees, external networking activities) and characteristics depicting a firm's environment (environmental dynamism and intensity of competition).

Our results strongly endorse the importance of company founders for innovation performance. The education level of the firm founders exerts a positive and significant impact on both the R&D intensity and the radicalness of product innovation. Prior (same) industry working experience has a positive significant impact on R&D intensity but a much weaker effect on product innovation radicalness. Founder exposure to academic research prior to the establishment of the company has a positive and statistically significant impact on both innovation measures– extent of innovation radicalness and R&D intensity. Founder team diversity in terms of expertise appears significantly related to product innovation radicalness while it has a positive but statistically negligible effect on R&D intensity. The reverse is true for founder team diversity in terms of occupational background (negligible impact on both product innovation radicalness and R&D expenditure). Policy implications about the identification of high growth potential companies and the promotion of entrepreneurship among specific populations are discussed in the final section.

The results of the firm-specific variables are in line with the expectations. Exporting firms and firms with technology collaborations and networking activities with universities tend to have a higher innovation propensity than firms without such characteristics. Firms with more qualified employees (both in terms of formal education and training) appear to be more prone to product innovation radicalness, while venture capital funding has a positive and significant impact on R&D expenditure. Price competition appears to have a negative impact on innovation output while market dynamism is found to stimulate both product innovation radicalness and R&D expenditures. Firms in the medium-to-high tech manufacturing sectors have a higher tendency to introduce more radical innovations compared to firms operating in medium-to-low tech sectors and knowledge intensive business services. Last but not least, medium-to-high tech manufacturing and KIBS firms appear to have greater R&D activity than medium-to-low tech manufacturing firms.

The rest of the paper proceeds as follows: Section 2 provides a brief synthesis of the theoretical and empirical literature relating the impact of founder's human capital on firms' innovative performance and derives the main research hypotheses. Section 3 describes the dataset, the dependent and explanatory

variables and the econometric framework. Section 4 presents the results of the empirical analysis. Finally, section 5 offers a discussion of the main findings along with some policy implications.

2. Theoretical background and hypotheses

Human capital characteristics, including education, knowledge and skills, have long been considered as a critical resource for success in entrepreneurial firms (e.g. Unger et al., 2011; Pferrer, 1994; Sexton and Upton, 1985). The attention to human capital is reflected in the studies that have applied the concept to entrepreneurship (e.g. Chander and Hanks, 1998; Davidsson and Honing, 2003). While investors have always used the skills and experience of founders as highly important factors in their evaluation of firm potential, researchers argue that human capital will play an even larger role in the future because of the continuously growing knowledge-intensive activities in most work environments (e.g., Bosma et al., 2004; Honing, 2001).

Due to its idiosyncratic and socially complex quality, human capital encapsulated into the skills and knowledge of founders is relatively rare, difficult to trade, imitate and substitute, and, therefore can be considered as a source of competitive advantage according to the resource-based (Barney, 1991; Amit and Schoemaker, 1993) or the competence-based view of the firm (Dosi et al., 2000). More specifically, due the idiosyncratic, non-contractible nature of entrepreneurial judgment and the high costs of coordinating knowledge dispersed among different individuals, the distinctive capabilities of young firms are closely related to the knowledge and skills of their founders (Colombo and Grilli, 2005). Ultimately the capability of young organizations to sense and seize new opportunities in the marketplace while changing accordingly their resource base is “primarily residing in the few individuals constituting the entrepreneurial team and not always throughout the organization” (Boccardelli and Magnusson, 2006).

Therefore, entrepreneurs often play a dominant role in their business, especially when they are starting small. First, founders with a broader general knowledge base are presumed to have a better ability to effectively search their environment and identify new opportunities (e.g., Davidsson and Honig, 2003; Ucbasaran et al., 2003; Ucbasaran et al., 2008; Shepherd and DeTienne, 2005) –

which is the focal task of an entrepreneur and the precondition for entrepreneurial growth (Shane and Venkataraman, 2000). At the same time, entrepreneurs with a high degree of human capital are capable to fruitfully exploit new opportunities. The human capital of founders increases their productivity resulting in higher firm profits that can finance strategies for further growth (Bates, 1985). In addition, founders also make strategic decisions about whether to innovate or not. Their knowledge and skills are thus important resources for young firms and may also impact innovative activity (Arvanitis and Stucki, 2012).

In short, entrepreneurial firms benefit from their founders' human capital. Several previous studies have analyzed the relation between entrepreneur's human capital and the likelihood of new firm survival and the growth of surviving firms (e.g. Bates, 1990;Brüderlet al., 1992; Gimeno et al., 1997; Cooper et al., 1994; Brüderl and Preisendörfer, 2000; Stuart and Abetti, 1990;Eisenhardt and Schoonhoven, 1990; Colombo et al. 2004; Colombo and Grilli, 2005). On the aggregate, they suggest a positive relationship between the human capital of founders and the post-entry performance of young firms.

While there is empirical evidence suggesting a link between management characteristics and innovation activities in established firms (e.g. Hadjimanolis 2000, Romijn and Albaladejo 2002, Barker and Mueller, 2002, Chen et al., 2010), to our knowledge, few empirical studies have addressed the role of founders' human capital in determining young firms' innovative performance. An overview of the most recent relevant empirical research papers can be found in Table 1.

Table 1: Empirical papers on the impact of founder characteristics on young firm's innovation performance

Paper	*Sample*	*Country*	*Sectors covered*	*Founding team*	*Year the survey was conducted*
Kato et al (2014)	204 R&D oriented start ups	Japan	Manufacturing, software	One founder	2008
Arvanitis and Stucki (2012)	2393 young firms	Switzerland	Manufacturing, services, construction	Founding team	2000, 2003, 2006
Koch and Strotmann (2008)	547 start-ups	Germany	KIBS	One founder	2003
Marvel and Lumpkin	145 start-ups operating in	US	Techology-based ventures	Founder	2007

(2007)	university affiliated incubators				
Lynskey (2004)	240 firms up to 10 years old	Japan	Manufacturing	CEO	1999

Lynskey (2004) examined the determinants of innovative activity in Japanese technology-based manufacturing start-ups using several managerial characteristics such as the educational level, previous R&D experience, age, management experience and engagement of the CEO in a research network. An additional variable measured whether the CEO is also the firm's founder. Managerial variables appear to have little explanatory power while only the CEO's educational background and engagement in a network of researchers are positively related to the number of patent applications of young firms.

Koch and Strotmann (2008) analyzed the impact of founder characteristics (professional background, age and sex, dummy for team foundations, information on whether the concrete idea from the founder's former occupation was decisive for foundation) on the innovation performance of German start-ups in the knowledge-intensive business sector. Like Lynskey (2004) they find only a few significant effects. Male founders tend to be linked to more radical innovations than female founders and firms of founders that were self-employed before establishment have introduced fewer innovations than the firms of founders that were employed in the private economy.

Marvel and Lumpkin (2007) studied the effects of technology entrepreneur's human capital in determining firm's innovation at the start-up phase. In particular, they examined how the experience, education, and prior knowledge of entrepreneurs relate to innovation radicalness. Their findings suggest that both general and specific human capital are important to innovation outcomes. More specifically they found that innovation radicalness was positively associated with formal education and prior knowledge of technology.

Arvanitis and Stucki (2012) studied the impact of founder attributes on the innovative performance of young firms in Switzerland and found that the combination of different founder characteristics such as university education (at best a combination of technical and commercial education), prior experience in R&D, and strong motivation to realize own innovative ideas increases the

likelihood that a start-up has innovative activities, especially the likelihood of R&D activities.

Kato et al. (2014) investigated the role of human capital in the innovative performance of 204 R&D oriented Japanese start-ups using diverse measures of human capital such as educational attainment, prior work experience, prior managerial experience, previous experience of product/process innovation and founder's age at start-up. They find that certain types of founder's characteristics, namely their innovation performance prior to start-up are directly associated with innovative outcomes, whereas, founder higher education has an indirect effect on innovation performance through R&D investment.

2.1 Founder characteristics affecting innovative performance

Following Becker (1975) a distinction is often made in the literature between generic and specific dimensions of human capital. Generic human capital relates to the general knowledge acquired through formal education and professional experience. Specific human capital includes capabilities of individuals that can directly be applied to the entrepreneurial practice in the newly established firm (Colombo and Crilli, 2005). The generic human capital of the founders of a new firm is usually approximated by their educational attainments and by the years of work experience before establishing the new firm or simply by the founders' age. The entrepreneurs' higher educational attainment can be expected to positively affect the innovative performance of new ventures. First, the individual through education acquires skills and abilities and in many cases discipline-specific knowledge that is difficult to develop through on-the-job training/experience. Second, education facilitates future learning – it sharpens the ability of individuals to process complex information and to engage more efficiently in prospect learning routines. Third, irrespective of the knowledge and skills acquired in university, the ability to successfully complete studies signals competence which may well assist entrepreneurs to raise capital and facilitate networking with customers (Bakes-Geller and Werner, 2006). Thus through formal education people acquire skills that may help them sense and seize innovative opportunities in the surrounding environment (Shane, 2000; Barker and Mueller, 2002; Davidsson and Honig, 2003). In addition, the conceptualization of higher

education as a source of skills and abilities with substantial value for entrepreneurial venturing appears to be relevant to contexts where continuous absorption of complex, specialized knowledge forms a basis for competitiveness and thus favours innovation (Backes-Geller and Werner, 2006; Unger et al., 2011).

The entrepreneur's education is supplemented by work experience, which provides the tacit knowledge required for formulating strategy, acquiring resources and all the other necessities associated with venture performance (Cooper et al., 1994). Experience encompasses work experience and other practical on the job learning or informal education such as training. Work experience both in terms of depth and broadness across markets is assumed to increase human capital (Becker, 1964). Through work experience individuals obtain information and develop skills that assist the formulation of entrepreneurial strategy, the acquisition of resources, and the process of organizing. In this way experience increases human capital and at the same time decreases uncertainty about the value of opportunities. In addition, breadth in work experience, i.e. participation in more markets provides access to diverse types of information required for opportunity identification. To summarize, entrepreneurs who have greater generic human capital, i.e. greater educational attainment and professional experience, will have a greater ability to identify and seize innovative opportunities. Therefore,

Hypothesis 1a: Founders' educational attainment is positively related to innovation performance.

Hypothesis 1b: Founders' professional experience is positively related to innovation performance.

As to the specific component of human capital, founders' knowledge and capabilities are very much connected to what entrepreneurs have learned in the organization they were previously employed (Cooper and Bruno, 1977; Van de Ven et al., 1984). Previous knowledge acquired in organizations in the same industry can be a key strategic asset if it can be effectively transferred to the new firm (Shane, 2000; Klepper, 2001). In particular, prior industry-specific experience may yield valuable knowledge regarding technologies, customer needs, strengths and weaknesses of competitors which can be profitably used in

the new entrepreneurial setting (Regeans et al., 2005) and affect considerably the ability to detect innovative opportunities (Shane, 2000). Moreover, founders' endowments of social capital are more beneficial if the industry of the new firm and the one of the incubating organization are relevant, as the new firm can more directly exploit the personal relationships network developed by the founders in their previous occupations (Colombo and Grilli, 2005). Thus, in order to be able to identify and exploit opportunities for new products and services, it is important for firm founders to be familiar with customer needs, technology developments and market requirements in the specific industry.

Innovative activities also imply mastering a certain level of specific know-how. Prior work experience in a scientific working environment appears to be conducive to innovation. The public science base can be found useful both in nurturing fruitful ideas that later on may be turned into important innovations in a specific business context and in maintaining networking relations with previous employers that can be of great value to the new firm (Romijn and Albaladejo, 2002). Founding teams with previous research experience – e.g. prior work experience in university or research institute – will impact thesmall firm's ability to grow and be innovative and may be in part substitute for the firm's lack of a track record. This is because this type of knowledge is required to appraise the potential of competing research streams, to develop R&D strategies, to organize and coordinate research projects and to orchestrate research resources towards the development of more valuable capabilities (Lynskey, 2004; Arvanitis and Stucki, 2012).

In sum, taking into consideration that specific knowledge types are conducive and necessary to recognize opportunities, founders who have more and better quality work and research experience will be aware of a greater variety of opportunities and will be able to bear more innovative outcomes. Therefore,

Hypothesis 2a: Founding teams exhibiting prior industry experience would tend to initiate more innovative activities than firms with founders with little or no prior industry experience.

Hypothesis 2b: Founding teams with R&D experience tend to initiate more innovative activities than firms with founders with little or no prior R&D experience.

A parallel stream of research suggests diversity within a team is considered beneficial for achieving desirable outcomes (Harrison and Klein, 2007). The key idea is that teams whose members are dissimilar in terms of the information type they possess – be it knowledge, functional background or experience – are likely to outperform homogeneous teams (Argote and Ingram, 2000). Founding teams with diversity in terms of knowledge and expertise may increase the information for problem solving, foster the team's ability to interpret the new firm's internal and external environment from different angles and thus enhance the ability of the group to find effective solutions to problems (Watson et al., 1993). As a consequence, team heterogeneity may create synergistic effects based on the founders' specific cognitive and human capital resources and foster innovative performance. Empirical evidence also suggests that when both technical and commercial skills are combined within the founding team, young technology-based firms enjoy highest growth and innovative performance (Colombo and Grilli, 2005).

We additionally take into account whether team founders have a diversified professional background, as different professional backgrounds of individuals in an entrepreneurial team might increase the existing stock of knowledge and enhance the perception of opportunities. Thus, heterogeneity, in terms of occupational background and experience, implies that a new firm may have access to a wider range of practices, routines and norms, based on the collective distinct experiences of the team. Thereby, founders with different occupational backgrounds might be expected to have a higher probability to produce innovation. Therefore,

Hypothesis 3a: Greater heterogeneous functional experience on the young firm's founding team increases innovation (or has a positive impact on innovative performance).

Hypothesis 3b: Greater heterogeneous occupational experience on the young firm's founding team increases innovation (or has a positive impact on innovative performance).

Founder characteristics are, of course, part of a broader context affecting innovation. We consider two important sets of contextual factors that will provide our controls: firm-specific factors and industry-specific factors.

2.2 Firm-specific factors

Firm characteristics such as size and export orientation are likely to affect the innovative performance of young enterprises. Larger firms are generally expected to devote more resources to innovation projects than smaller ones. Competing on international markets requires competitive advantages. Thus, the export orientation of a firm is expected to be positively correlated with its innovative activity (Roper and Love, 2002).

Among the internal factors conducive to firms' innovative activities, the literature highlights the knowledge, skills and expertise brought into the firm by its workforce obtained through earlier experience, education, training etc. Firms require an adequate stock of qualified manpower to sense new market and technology opportunities and to absorb new knowledge that might be turned into innovative products and services. The inability to recruit high quality staff (e.g. engineers, scientists) can be a serious impediment to a firm's subsequent growth and innovation (Romijn and Albaladejo, 2002). Firms can further enhance their human capital stock over time by offering internal and external staff training. Therefore, the education and training of workforce is expected to be positively associated with innovative performance.

It is imperative for young small firms to try to overcome the liability of newness and smallness by using external sources of knowledge and networking activities in order to identify innovative opportunities and complement their limited resource base with additional resources and new knowledge. Universities, in particular, are a recognized repository of public knowledge (Nelson, 1986) which is part of the total stock of externally available knowledge accessible to young firms, especially those that have not accumulated enough R&D assets through their own internal efforts. Other very important external sources of knowledge include customers and suppliers. Collaborations assist firms to use efficient and cost effective ways to access additional or complementary resources that can speed up progress and advance set targets. Especially technology

cooperation agreements have become a strategically important part of business decision-making in many industries in recent years in both high and low-tech sectors. They include all sorts of cooperative R&D or technology arrangement such as joint ventures, technology partnerships and informal networking arrangements. The various types of collaborations appear to play a special role when new firms try to develop competitive advantages. Collaboration is important for startups to gain the knowledge necessary to develop or acquire the capabilities needed for new product development, R&D and innovation (Haeussler et al., 2012; Stam et al., 2007; Park et al., 2002). Thus external knowledge sources such as universities and targeted collaborative agreements are expected to have a positive effect on young firms' innovative activities.

Last but not least, the availability of risk capital is usually regarded as an important determinant to the innovation process and the fuel for emerging start-up firms (Lynskey, 2004). Thus it is expected that the availability of venture capital, angel investors, and guaranteed high-risk bank loans stimulate innovation in young firms.

2.3 Industry-specific factors

Markets with intensive competition necessitate greater flexibility and would in general force firms to become more innovative (Katila and Shane, 2005). However, as the experience and resources of young firms are limited, intensive price competition may prevent also innovation (Arvantitis and Stucki, 2012). Furthermore, market dynamism, usually interpreted as technological change or environmental volatility in general (e.g. Teece et al., 1997; Ambrosini et al., 2009), can be conducive to innovation.

3. Methods

3.1 Data

The data used in the quantitative analysis originate in the AEGIS[1] survey. Carried out during Fall 2010 and Spring 2011, the survey purported to identify the motives, characteristics and patterns in the creation and growth of knowledge-intensive young firms in high-tech manufacturing, low-tech manufacturing and knowledge intensive business services. [2]For the purpose of this study we delineated young firms as those founded between 2001 and 2007 i.e. firms that had been established for 10 years or less at the time of the survey and also had managed to exceed the critical three-year survival threshold. At the time of the survey, then, the sample firms were between 3 and 10 years old (average firm age 6.81 years) and were established in ten European countries: Croatia, Czech Republic, Denmark, France, Germany, Greece, Italy, Portugal, Sweden, and UK. The countries were selected strategically in order to include the largest four economies and some of the medium and small economies in Europe belonging into different socioeconomic configurations (e.g. Nordic countries, southern European countries, eastern European countries). In order to capture newly-established firms the survey instrument included a set of screening questions to detect a) firms that were just legal reincarnations of already existing firms, b) subsidiaries of existing companies, and c) mergers, acquisitions, or joint ventures of existing firms. Such firms were characterized as non-eligible for the survey.

Data were collected through telephone interviews using a structured questionnaire. The questionnaire covered questions on basic information about the firm, its strategy, innovation and business models and the market environment. It also included detailed questions about the founder characteristics at the time of

[1] EU funded research project "Advancing Knowledge-Intensive Entrepreneurship and Innovation for Economic Growth and Social Well-Being in Europe" (AEGIS), 7th Framework Programme for Research and Technological Development, European Commission

[2] The sectors represented in the AEGIS survey are as follows. High-technology manufacturing: aerospace, computers and office machinery, radio television and communication equipment, manufacture of medical, precision and optical instruments. Medium-high technology manufacturing: manufacture of electrical machinery and apparatus, manufacture of machinery and equipment, chemicals. Medium-low technology manufacturing: paper and printing, textile and clothing, food, beverages and tobacco, wood and furniture. Knowledge-intensive business services: telecommunications, computer and related activities, research and experimental development, and selected business service activities.

firm formation. As we have information for up to four representative firm founders and less than 5% of the companies in the sample have more than four founders, we are able to describe the characteristics of the whole founding team.

The primary data source for the survey population was the Amadeus Database. However additional data sources were used (Kompass, Dun&Bradstreet) as during the interview process (screening questions) it was found out that a large number of firms recorded as new were actually not so. An initial sample of 23,405 firms was randomly drawn from the entire population of firms available in the aforementioned databases. Among them 10,581 were judged as not eligible for the survey by the screening part of the questionnaire. The final sample of eligible firms to be contacted was 12,824 out of which approximately 4,000 accepted to respond to the questionnaire, thus resulting in an average response rate of 31 % across all ten countries (Table 2). The response rate is within the range common in the SME literature and when surveys heavily involve young and small firms (Dennis 2003; Newby et al. 2003). To evaluate non-response bias, we tested for statistically significant differences between final and early responses (Armstrong and Overton, 1977; Lambert and Harrington 1990). The final responses were the proxy for non-respondents and early responses the proxy for respondents. The t-tests and chi-square tests performed to identify differences between the two groups indicated no statistically significant results and therefore no response bias was identified.

Table 2: Age and size class distribution of sample firms

Age class	No of firms	%	Size class	No of firms	%
3-5 years	1421	36	Micro	2865	72
6-8 years	1475	37	Small	986	25
9-10 years	1066	27	Medium sized	111	3
Total	3962	100	Total	3962	100

The vast majority of the firms in the sample are small. Micro firms (<10 employees) account for 72% of the total, including a 8.5% share of non-employers (no employees besides the owner). Firms with 10-49 employees (small) account for an additional 25% of the sample while the next size category (50-249 employees) (medium) accounted for just 3% of the total. This structure conforms to earlier findings whereby most firms remain “micro”, a relatively small portion

grow to become “small”, a very small portion become “medium”, and only very few grow to “large” (Landstrom and Johannisson, 2001).

Table 3: Country distribution of firms

Country	Number of firms
Czech Republic	199
Croatia	196
Denmark(DK)	329
France(FR)	568
Germany (DE)	548
Greece(GR)	326
Italy (IT)	573
Portugal (PT)	327
Sweden (SE)	326
United Kingdom(UK)	570
Total	3962

Manufacturing included high tech, medium to high tech, medium to low tech and low technology sectors. Knowledge intensive business service sectors were also included (Table 4).

Table 4: Sectoral group distribution of firms

Sectoral group*	Number of firms
High tech manufacturing	86
Medium high tech manufacturing	328
Medium low tech manufacturing	280
Low tech manufacturing	891
Knowledge intensive business services	2377
Total	3962

*OECD classification

3.2 Measures

Dependent variable

In empirical studies of firm innovation it is common to proxy innovation by using either input or output indicators even though there are some well-articulated problems (Tether, 2003; Rogers, 2004). In view of the complexity of the

innovation process characterized by several stages before market introduction, an approach relying on a single measure may leave out important relationships and produce results that are not robust (see e.g. Kleinknecht et al. 2002; Rogers, 1998). In this study we use two innovation indicators covering both the input and output side of the innovation process. As an input measure we utilize the share of R&D expenditures in firm turnover. Innovation output is measured using the degree of radicalness of *product innovation* as an ordinal variable taking the values of 1 (= no innovation); 2 (= new-to-firm); 3 (=new-to-market); and 4 (= new-to-world product innovation).

Independent variables

The explanatory variables can be subdivided in three groups. The first group encompasses indicators to describe the human capital of the entrepreneurs focusing both on generic and specific human capital as well as on the founding team's diversity. The second and third groups include control variables corresponding to firm and industry-specific determinants of innovation respectively. The explanatory variables are summarized in Table 5.

To examine the effect of the founding team on the innovative performance of young firms, we consider six key attributes as described below:

Educational attainment: For each individual member of the founding team we measure educational attainment using an ordinal variable taking the values: 1-elementary education; 2-secondary education; 3-Bachelor degree; 4-Postgraduate degree; 5-PhD degree. We average across team members to derive an overall measure of founders' education.

Professional experience: The years of work experience before establishing the new firm is proxied by the age of founders at the time of the firm's founding. Each founder's age is measured using four different age groups, namely below 30 years, 30-39, 40-49, and over 50years of age. We average across age group of team members to obtain an overall measure of founders' age.

Prior industry specific experience: The average years of work experience of founders in the same industry of the firm in question before its foundation.

Prior working experience in university or research institute/lab: A binary variable taking the value of 1 when at least one of the founding team members had previously been exposed to academic research.

Team diversity in terms of expertise: For each founder we could distinguish between five main areas of expertise (i.e. technical/engineering; general management; product design; marketing; finance). More than one answer was possible for each individual. The *diversity* of experiences among team members is calculated with Blau's index (1997) ($1-\sum_{i=1}^{p} p_i^2$), where p_i is the fraction of team members with experience i. This index takes values between 0 and 1. A higher index indicates more mixed teams in terms of expertise.

Team diversity in terms of occupational background: For each founder we measured his/her last occupation before founding the firm in question choosing among different options such as firm owner, firm employee, self-employed, university or research institute employee, government employee or unemployed. We measure occupational diversity within founding teams using Blau's index.

Turning to firm-specific factors, we use a large set of variables to describe the characteristics of the firm. *Firm size* is measured by the natural logarithm of full-time employees. *Sales in international markets* is a continuous variable measuring the percentage of sales obtained in international markets in the last three years. It reflects the degree to which a firm pursues opportunities beyond domestic markets. In order to capture worker skills, we use two variables to measure the quality of the firm's human capital as expressed by educational qualifications and employee training. *University degree* is a continuous variable measuring the number of employees with a university degree. *Employee training* is a binary variable taking the value of 1 when the firm puts emphasis on systematic, internal and external, personnel training and 0 when no emphasis is put on training. *Venture capital funding* is a binary variable taking the value of 1 when the firm has received venture capital funding and 0 when no such funding has been received. N*etworking with universities* is a single Likert-type variable asking respondents to evaluate the importance of universities as knowledge sources for exploring new opportunities (1:not important; 5:extremely important). *Technology collaboration* is a multi-item Likert-type scale variable which measures the extent

of participation (1: not at all; 5: very often) in different types of formal agreements such as R&D agreements, technical cooperation agreements, licensing agreements and research contract-outs.

Finally, industry-specific factors relate to the type and strength of competition in the market as perceived by the company. The market environment is approximated by two dimensions: market dynamism and market competition (again using Likert-type scales: 1: completely disagree; 5: completely agree). *Market dynamism* measures the extent to which the market environment changes rapidly due to technological advancement and the need to continuously introduce new products. *Market competition* is a single item measure of competitive intensity as reflected in price competition. Finally, to capture industry specific effects we include dummies controlling for the three large sector groups. Country dummies are also included in all calculations.

Table 5: Definition of variables

	Variable	Description/measurement
Innovation measures	Product Innovation	Ordinal variable measuring the degree of radicallness of product innovation over the last three years
	R&D intensity	Average percentage of firm sales spent on R&D over the last three years
Founder characteristics	Educational attainment	Educational attainment of founders averaged over across founding team
	Professional experience	Average age of founders at the time of firm founding
	Prior industry experience	Average number of years of professional experience of founders in the same industry before firm's foundation
	Prior working R&D experience	One for firms with one or more founders with prior working experience in university or research institute/lab
	Team diversity in expertise	Diversity in areas of expertise within founding team measured by Blau's index
	Team diversity in occupational background	Diversity in occupational background within founding team measured by Blau's index
Firm-specific characteristics	Sales in international markets	Percentage of sales obtained in international markets in the last three years
	Size	Natural logarithm of full-time employees
	Employees with university degree	Number of employees with a university degree
	Employees' training	One for firms that put emphasis on systematic employees' training
	Venture capital funding	One for firms that have received venture capital funding
	Networking with universities	Single Likert-type question evaluating the importance of universities as knowledge sources

	Formal technology collaboration	Multi-item Likert-type scale variable capturing the extent of firm's participation in different types of formal technology agreements
Industry-specific characteristics	Price competition	Single-item Likert-type variable capturing the intensity of price competition in the principal industry
	Market dynamism	Two-items Likert-type variable capturing the speed of technological change and the need to continuously launch new products/services

Table 6: Descriptive statistics

Variable	Mean	S.D.	Min.	Max.
Product innovation	1.20	1.082	0.00	3.00
R&D intensity	12.46	19.356	0.00	100.00
Founder's characteristics				
Educational attainment	2.90	0.986	1.00	5.00
Professional experience	2.99	0.786	1.00	4.00
Prior industry experience	12.57	9.192	0.00	55.00
Prior experience in R&D	0.03	0.161	0.00	1.00
Team diversity in functional expertise	0.46	0.297	0.00	0.80
Team diversity in occupational background	0.14	0.226	0.00	0.75
Firm specific characteristics				
International sales	14.45	26.492	0.00	100.00
Size	1.74	1.069	0.00	7.24
Employees with university degree	3.69	10.268	0.00	200.00
Employees training	0.42	0.493	0.00	1.00
Venture capital funding	0.02	0.140	0.00	1.00
Networking with universities	2.09	1.074	1.00	5.00
Formal technology collaborations	1.87	0.842	1.00	5.00
Industry specific variables				
Price competition	3.44	1.322	1.00	5.00
Market dynamism	3.24	1.011	1.00	5.00
Medium-to-low tech industries	0.30	0.456	0.00	1.00
Medium-to-high tech industries	0.10	0.306	0.00	1.00
Knowledge business intensive services (KIBS)	0.54	0.499	0.00	1.00
Valid No of observations 3340				

4. Empirical results

To capture different aspects of innovative activity we estimate our model for both innovation input and output. Since innovation output is proxied by a categorical ordinal variable, an ordered probit model is employed to estimate the effects of the predictor variables on the probability to introduce product

innovation of different degrees of radicalness. For innovation input (R&D intensity) we apply a tobit regression model. Tobit regression refers to regression models in which the range of the dependent variable is censored in some way, meaning that values tend to be concentrated either at the higher or the lower limit of the data. The R&D intensity data are left censored with a clustering at zero, reflecting that a considerable number of firms in our sample do not report R&D expenditures.

Table 7 presents the results of the econometric analysis for both innovation output and innovation input. Regarding innovation output, the results of the ordered probit model (average marginal effects) are reported for the most radical form of product innovation (new-to-the world) as these are expected to refer to important innovations. The results of the tobit model are reported as the marginal effects on the latent dependent variable y^* (partially observed only when R&D intensity is positive) and the marginal effects for the censored sample (marginal effects on the actual R&D expenditures for firms that both exhibit and don't exhibit such activity).

Table 7: Determinants of innovation in young firms

Variable	**Radicalness of innovation**	**R&D intensity**	
	marginal effects for ordered probit model	tobit model marginal effects for y*	tobit model marginal effects for censored sample
Founder's characteristics			
Educational attainment	0.013765***	2.283875***	1.417935***
Professional experience	-0.008387ns	-1.976197***	-1.226914***
Prior industry experience	0.000128ns	0.115925**	0.071972**
Prior experience in R&D	0.064782***	8.209641***	5.096925***
Team diversity in functional expertise	0.067303***	3.386645**	2.102586**
Team diversity in occupational background	-0.007575 ns	2.576989ns	1.599914ns
Firm specific characteristics			
International sales	0.000995***	0.1123181***	0.0697323***
Size	0.013220***	0.3542778ns	0.2199521ns
Employees with university degree	0.001546***	-0.014924ns	-0.009266ns
Employees training	0.015703**	-0.7917974ns	-0.4915845ns
Venture capital funding	0.036453ns	16.26571***	10.09851***
Networking with universities	0.008842**	3.120094***	1.937099***

Formal technology collaborations	0.041450***	6.372426***	3.956297***
Industry specific variables			
Price competition	-0.018539***	-1.546661***	-0.9602386***
Market dynamism	0.041261***	4.539372***	2.818253***
Medium-to-low tech industries	0.015159 ns	2.735938ns	1.698597ns
Medium-to-high tech industries	0.061056***	8.249597***	5.121732***
KIBS	0.003834 ns	4.775891***	2.965095***
Constant		-31.25325***	
	Log likelihood:-4161.93 LR(X^2):605.51***	Log likelihood= -11054.19 LR(X^2):874.09*** Pseudo R^2=0.0380	
Number of obs.	3340	3340	

Notes: Average marginal effects are reported for the ordered probit and tobit models respectively. Country dummies are included in all models. Three and two asterisks correspond to p<0.01 and p<0.05 respectively.

Agreeing with prior literature, the education level of firm founders exerts a positive and significant impact on both the R&D intensity and the radicalness of product innovation. On the contrary, the extend of prior work experience as approximated by the average age of the founding team members is found to have an insignificant effect on product innovation radicalness and a negatively significant impact on R&D input. This practically means that of the general human capital hypotheses, hypothesis 1a is supported while hypothesis 1b is not supported.

Of the specific human capital variables, prior industry working experience appears to have a negligible effect on product innovation radicalness but a positively significant impact on R&D intensity. Moreover, founder previous R&D exposure has a positive and statistically significant impact on both innovation measures (output and input). Thus, regarding the specific human capital hypotheses, hypothesis 2a is partially supported while hypothesis 2b is clearly confirmed.

Regarding the variables reflecting founding team's heterogeneity, team diversity in terms of expertise appears to be significantly related to product innovation radicalness as well as R&D intensity following the hypothesized direction. Therefore, hypothesis 3a is confirmed. On the contrary, while one may assume that teams with founders from different occupational backgrounds could be more innovative due to information advantages than team foundations where all the founders have the same background, our results corroborating with the

findings of Koch and Strotmann (2013) do not confirm this hypothesis. More specifically, they indicate a negligible impact on both product innovation radicalness and R&D expenditure and thus hypothesis 3b is rejected.

The results of the firm-specific and industry-specific variables are in line with expectations. Exporting firms and firms with technology collaborations and networking activities with universities tend to have a higher innovation propensity than firms without such characteristics. Firms with more qualified employees (both in terms of formal education and training) appear to be more prone to product innovation radicalness, while venture capital funding has a positive and significant impact on R&D expenditure. Price competition appears to have a negative impact on innovation output while market dynamism is found to stimulate both product innovation radicalness and R&D expenditures. Firms in the medium-to-high tech manufacturing sectors have a higher tendency to introduce more radical innovations compared to firms operating in medium-to-low tech sectors and knowledge intensive business services. Last but not least, medium-to-high tech manufacturing and KIBS firms appear to have greater R&D activity than medium-to-low tech manufacturing firms.

5. Discussion and implications

The purpose of this study has been to investigate the impact of founder characteristics on the innovative activity of young firms. In doing so we also take into account other determinants of innovation suggested by the literature, namely firm characteristics and characteristics of a firm's market environment. The empirical analysis was based on data from a recent rich European survey that examined young firms between 3 and 10 years of age, across a wide industrial spectrum of knowledge-intensive services and manufacturing sectors in ten countries. The current study provides evidence that aspects of both generic and specific human capital along with founding team heterogeneity characteristics are critical for explaining innovative activity.

For specific human capital the results highlight the vitality of previous R&D experience to both radical innovation and R&D intensity. This finding is in line with Arvanitis and Stucki (2012) implying that innovative activities necessitate a

certain level of innovation-specific know-how. This type of knowledge is required to manage effectively available research resources, to devise R&D strategies and to organize and coordinate relative projects (Lynskey, 2004). In addition prior industry experience appears to impact positively R&D intensity suggesting that founders with professional experience in organizations of the same industry as the new firm have accumulated valuable market and technology knowledge (e.g. knowledge of ways to serve markets, knowledge of customer problems, information on how certain market operate) that may facilitate opportunity recognition that thus strengthen their decision to invest in specific research directions in their new venture.

However, our findings do not support the hypothesis that the length of working experience in general (proxied by the founding team's average age) has a positive impact on a young firm's innovative performance. On the contrary we find that it exerts a significantly negative effect on R&D intensity, despite general expectations that experience enhances human capital and the variety of opportunities an individual may be able to recognize. The fact that work experience in *the same sector of the new firm* has a positive impact on innovation highlights the key role of industry-specific capabilities of founders in providing young firms with a competitive advantage.

Corroborating with previous empirical research (Arvanitis and Stucki, 2012, Lynskey, 2004, Kato et al, 2014) we also find that founders' educational attainment is significantly related to both measures of innovation activity. Education increases a person's stock of information and skills, including those required to identify and pursue an entrepreneurial opportunity successfully (Marvel and Lumkpin, 2007). Entrepreneurs with higher formal education will tend to invest more in R&D and at the same time are more likely to introduce a radical product innovation.

Lastly, we checked for the existence of synergistic effects arising from the presence within the founding team of complementary skills. Our findings highlight that increased diversity in terms of functional expertise, i.e. the simultaneous presence of technological, commercial and managerial skills, enhances the ability of firms to pursue radical innovation and at the same time boosts R&D intensity by bringing together a larger pool of perspectives,

alternative solutions and ideas which make it easier to cope with the difficulties that typify with the innovation process in a young firm.

Overall, our findings suggest that founders' characteristics seem to be significant determinants of a firm's involvement in innovative activities i.e. its R&D intensity and introduction of radical product innovations. For policy makers this provides important information. Worldwide, governments scramble to identify firms with a high growth potential. As innovation can be an important precondition for growth it is essential to understand the factors determining the potential of a young company for innovation. Identification costs of high innovation and growth potential decline when these determining factors are easily observable. Our results indicate that information about the individuals forming a young firm's founding team may be used for this purpose.

In addition, taking into consideration that the educational attainment and previous research exposure of founders may be strongly related to innovative entrepreneurship, an important policy implication would be to create a larger pool of high-potential would-be entrepreneurs among, for example, university graduates and people working in R&D labs in universities and research centers. This can be achieved by providing such populations with the necessary entrepreneurial skills and by cultivating, in general, a mindset for innovation and entrepreneurship.

Last, and very important for Europe in particular, the finding that prior industry experience of founders can be a driver of innovative activity in young firms points at the need to encourage middle aged, highly educated people that used to work for large or smaller enterprises but are currently unemployed due to the crisis, downsizing, closure or delocalization of their companies to reengage through setting up new enterprises. They should be encouraged through specific start-up programmes – for instance initiated by local chambers of commerce, business organizations, institutions for promoting entrepreneurship, and specializing government agencies – to complement their accumulated technical and market skills and knowledge with those skills necessary to undertake entrepreneurial action.

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