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Founding teams? heterogeneity and new ventures' innovativeness

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Abstract

We aim at examining the extent to which the founding team diversity - in terms of education, competences and working experience ? impacts on firm innovative performance. In particular, we intend to study whether this impact varies across different sectoral contexts, given the extant differences in terms of knowledge bases, technological regimes, user-producer interaction modes and degree of output tangibility. Our analysis relies on data from a recent survey of newly established firms in the European Union. Results show that competencies heterogeneity seems to be positively associated with innovation, even when controlling for the sheer number of founders, their working experience and the breadth of competencies in the team. Interestingly, competencies heterogeneity is less relevant when a firm?s competencies are prevalently in the area of general management with respect to the case in which a firm?s competencies are mostly in the area of technical and engineering knowledge. Furthermore, competencies heterogeneity is particularly relevant for manufacturing firms specialized in the field of product design. Results therefore support our hypothesis that heterogeneity of competencies is more important for firms in which the knowledge base to be more specific and oriented towards technical applications.

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Abstract

We aim at examining the extent to which the founding team diversity - in terms of education, competences and working experience – impacts on firm innovative performance. In particular, we intend to study whether this impact varies across different sectoral contexts, given the extant differences in terms of knowledge bases, technological regimes, user-producer interaction modes and degree of output tangibility. Our analysis relies on data from a recent survey of newly established firms in the European Union. Results show that competencies heterogeneity seems to be positively associated with innovation, even when controlling for the sheer number of founders, their working experience and the breadth of competencies in the team. Interestingly, competencies heterogeneity is less relevant when a firm's competencies are prevalently in the area of general management with respect to the case in which a firm's competencies are mostly in the area of technical and engineering knowledge. Furthermore, competencies heterogeneity is particularly relevant for manufacturing firms specialized in the field of product design. Results therefore support our hypothesis that heterogeneity of competencies is more important for firms in which the knowledge base to be more specific and oriented towards technical applications.

1. Introduction

The relationship between founders' background and firms' performance has received substantial attention by scholars in management and innovation studies, particularly with reference of the analysis of new ventures. Existing contributions have emphasized the importance of demographic characteristics, education and previous work experience for firms' survival and growth (Steffens et al., 2012; Colombo and Grilli, 2005) as well as for innovation (Bantel and Jackson, 1989; van der Vegt and Janssen, 2003; Ostergaard et al., 2011). Within this group of studies, an interesting stream of literature has investigated the characteristics and dynamics of founding teams, looking in particular at the degree of homophily/diversity of founders and at its impact on firms' performance. The empirical evidence on this relationship is not conclusive, as there might be costs and benefits of team homophily (Bower et al., 2000; Ostergaard et al., 2011; Coad and Timmermans, 2012; Steffens et al., 2012; Kaiser and Müller 2013). Given the ambiguity in the relationship between team diversity and firm growth, more

recent contributions have analysed how team heterogeneity and its effects might vary across time (Youtie et al., 2012).

Starting from this literature, we claim that the relevance of founding team characteristics and diversity in terms of educational background and previous work experience reflects the differences across sectoral patterns of innovations (Pavitt, 1984, Castellaccci, 2008). In particular, the complexity of the knowledge base, the technological content of sectoral activity, the degree of user-producer interaction and the capital/labour intensity might affect the relevance of founders' heterogeneity in determining firm's performance. In this paper, we aim at investigating the relationship between team diversity and firm performance in different sectors, relying on data from the AEGIS survey, which was submitted to 4,004 founders of newly established firms in the period 2001-2007 in the European Union belonging to different manufacturing and service sectors. The survey contains detailed information on the founders' demographic characteristics, educational background and previous work experience, besides firm-specific and market-specific information (e.g. dynamic capabilities and innovative strategies).
Our analysis shows that competencies heterogeneity is positively associated with innovation, even when controlling for the sheer number of founders, their working experience and the breadth of competencies in the team. Interestingly, competencies heterogeneity is less relevant when a firm's competencies are prevalently in the area of general management with respect to the case in which a firm's competencies are mostly in the area of technical and engineering knowledge. Furthermore, competencies heterogeneity is particularly relevant for manufacturing firms specialized in the field of product design. Results therefore support our hypothesis that heterogeneity of competencies is more important for firms in which the knowledge base to be more specific and oriented towards technical applications.

The paper is structured as follow. Section 2 discusses the relevant literature and puts forward the hypotheses. Section 3 describes the data, while Section 4 illustrates the methodology, discussing the model we estimated and the variables used. Section 5 presents the results of the empirical analysis and Section 6 concludes, discussing managerial implications.

2. Diversity of founders and firm innovative performance: a review of the literature

2.1 Importance of founders' background and experience

The impact of founders' diversity on firm performance in terms of survival and growth has been for long discussed in the literature (Colombo & Grilli, 2005; Beckman et al., 2007; Dahl & Reichstein, 2007). Numerous studies show that different types of experience as well as years of formal education provide robust explanations for growth of emergent organizations (Dahl & Reichstein, 2007; Delmar & Shane, 2006; Gimeno et al. 1997). Several previous studies have also analyzed the relationship between innovation and the entrepreneur's characteristics or human capital (Nahapiet & Ghoshal, 1998; Shane; 2000; Santos-Rodrigues, H., 2010; Davidsson & Honig, 2003; Shane, 2000; Shepherd & DeTienne, 2005; Dahl and Reichstein, 2006). In particular, it is argued that the founder's background is shaped, among other factors, by previous working experience and education and that these will affect the entrepreneurs' ability to recognize new opportunities and innovate (Roberts, 1991; Becker 1964; Arrow, 1962; Cohen and Levinthal, 1990; Katila and Ahuja, 2002; Levitt and March, 1988). Pre-entry experience is considered particularly relevant in knowledge-intensive contexts, characterized by considerable uncertainty as those typical of high-tech sectors (Roberts, 1991). The existing research on the topic shows that education as well as previous working and entrepreneurial experience of founders play an important role for firm performance (Beckman et al., 2007; Dahl & Reichstein, 2007; Roure & Maidique, 1986; Delmar & Shane, 2006; Ucbasaran el al. 2003; Cooper et al., 1994).

In particular, a number of previous studies have investigated on how firm's innovativeness is influenced by human capital (Nahapiet & Ghoshal, 1998; Shane; 2000; Santos-Rodrigues et al., 2010). Human capital represents one of the most important determinants of firm performance in terms of innovation, since the innovative process start with people: from the discovery of technological opportunities and ideas generation, to the development of prototypes and manufacturing process (Ejermo and Jung, 2011). Human capital reflects the investment an individual has made in education, prior jobs, etc. and how such investment over time accumulates into cognitive skills and productive knowledge to generate returns (Becker, 1964). Both formal and informal human capital exercise an effect on organizational growth (Cooper et al. 1994).

Not many studies have focused on aspects of human capital affecting the individual's opportunity recognition and thus the probability to innovate (Davidsson & Honig, 2003; Shane, 2000; Shepherd & DeTienne, 2005; Dahl and Reichstein, 2006). According to Dahl and Reichstein (2006), every entrepreneur provides his company with the knowledge and skills acquired during his previous work and educational experiences. Moreover, since knowledge is the result of an individual's unique life experience, each person will have a different accumulation of human capital. These resources or capabilities available in a company at the time of entry into an industry often have a decisive impact on the strategy direction adopted by the company and on the value creation process (Helfat and Lieberman, 2002). This is confirmed by Shane (2000), which explains that founders' pre-entry knowledge and experience

about technologies and products, industry rules and regulations, customer needs and competitors affect the identification of new opportunities and development of entry strategy into a new market. Holbrook et al. (2000) emphasize the importance of pre-existing know-how possessed by a start-up in determining the future positioning of the company in a sector and claim that the "intangible assets" incorporated into this know-how are bound to the human capital of the company. In particular, the ability of firms to innovate partially depends on the possibility of exploiting knowledge developed through past activities, as the founders, when creating a new business, are willing to exploit at best the intangible assets they possess.

In general, it is widely recognized that innovative capabilities are developed, in part, by an individual past opportunity to learn (Arrow, 1962; Cohen and Levinthal, 1990; Katila and Ahuja, 2002; Levitt and March, 1988) and learning effects are strongly linked to individual characteristics such as previous experience and education (Becker 1964; Roberts, 1991). Scholars have found that most entrepreneurs identify entrepreneurial opportunities during their previous employments (Vesper, 1980; Bhide, 1994; Fiet, 1995), during which they gain access to information about industry characteristics, customers and suppliers. Previous relevant experience enables people to develop skills and acquire information that facilitate the formulation of an entrepreneurial strategy, the organization process and the acquisition of resources. Shane (2000) shows that some specific elements of knowledge, combined with technological knowledge, were required to ease the opportunity recognition process. These include, among others, information about users, customer problems and general knowledge of the market.

Education is another key component of human capital, which is recognized as beneficial for discovering and exploiting opportunities. As a matter of fact, information and skills increase with education, including those enabling people to recognize and successfully engage in an entrepreneurial opportunity (Marvel & Lumpkin, 2007).

Kimberly and Evanisko (1981) suggest that higher levels of formal education are associated with greater receptivity to innovation and open-mindedness. The level of education is considered particularly important in the context of high tech companies, as it indicates the level of scientific specialization and know-how required to innovate in these fields (Hsu, 2007; Balconi & Fontana, 2009; Mariani & Romanelli, 2006). For example, Mariani and Romanelli (2006) found that PhD holders have the greatest number of European patents filed in 1988-1998. They suggest that the more a technology is science-intensive the highest is the probability of finding a positive correlation between level of education and inventive performance of firms. Ejermo and Jung (2011) also found that the number of PhDs in the team has a positive effect on patent productivity. However, not only the level of education seems to have an impact on the firm's level on innovation, but also the type of education received by

the founder (i.e. technical or managerial) might have an influence. In particular, it is assumed that

in high-tech sectors, technical and engineering backgrounds provide entrepreneurs with innovative skills (Almus and Nerlinger, 1999; Colombo & Grilli, 2005; Balconi & Fontana, 2009). This is confirmed by Licht and Nerlinger (1997), which provide evidence that innovative firms are mostly started by individuals holding an excellent education in a technical or engineering degree. Ferreira et al. (2013) report that age, education and training of the manager have a positive impact on a firm's innovative performance, while sector experience appears to hamper the latter. Koch and Strotmann (2006) claim that previously self-employed company founders are less innovative than company founders with prior work experience in the private sector or in scientific institutions.

Quite surprisingly, however, the relation between the nature of the education received by the founders

and the firm's innovativeness has received little attention in the empirical literature, as also suggested by Colombo and Grilli (2005) and by Ostergaard et al. (2011).

2.2 The importance of founders' diversity

A more recent stream of literature that cuts across different disciplines has looked at whether founders' diversity – mostly in terms of education and working experience – has a positive impact on firm performance (Ruef et al., 2003; Ostergaard et al., 2011; Steffens et al., 2012; Kaiser and Muller, 2013; Vogel et al., 2014) and, more relevantly, whether firms based on diverse teams outperform those based on founding teams with a high degree of homophily. The underlying idea behind this stream of research is that team performance depends upon the process of interaction across team members – in terms of communication and coordination (Hackman, 1983) – which in turn varies consistently according to the type of task to be performed, the work environment, and the individual knowledge and skills.

The potential benefits of diversity are thoroughly discussed in contributions from the literature on psychology and organizational behavior (e.g. Bower et al., 2000; Cohen et al., 2010; Haas, 2010). These studies usually look at the composition of teams in terms of biographical differences – gender, age, ethnicity, educational and sociocultural background – personality differences, and differences in initial abilities and leadership (Morgan and Lassiter, 1992). The way in which team composition can affect its performance can be explained by two competing theories: similarity theory and equity theory (Tziner, 1985). Similarity theory predicts that homogeneous teams are more efficient because of the mutual attraction by team members with similar characteristics (background and abilitites). Equity theory argues that team

performance positively depends upon the conflicts among different individuals, as team members compare themselves with the others in the group. Referring to the social categorization perspective, negative cognitive, emotional and behavioral biases can result when employees perceive other group members to be different from themselves (Gemser and Leenders, 2011). The effect of team composition on performance is mediated by factors such as the size of the team and the type of task. Bower et al. (2000) underline that the advantage of homogeneous vs. heterogeneous teams strongly depend upon the task. In particular, homogeneous groups work better if tasks have low difficulty – i.e. with low uncertainty, low processing demands and low complexity – while heterogeneous teams obtain higher levels of performance in case of high-difficulty tasks. Along this line of reasoning, Kaiser and Muller (2013) find that knowledge-based startups tend to be more heterogeneous in characteristics than other startups.

As far as management studies are concerned, the research has usually investigated this topic looking at different types of types of teams: top management teams – in large established companies as well as in new ventures (e.g. Bantel and Jackson, 1989; Wiersema and Bantel, 1992; Sapienza, 1997; Amason et al., 2006; Hambrick, 2007; Talke et al., 2010; Boone and Hendriks, 2009), cross- functional teams within organizations (e.g. Mohrman et al., 1995; Finegold and Wagner, 1998), and founders' teams (e.g Ucbasaran et al., 2003; Kaiser and Muller, 2013) and employee teams more in general (Youtie et al., 2012). As shown by some recent reviews on the topic, the evidence is far from being conclusive and diversity acts on firm performance in two opposite directions (Horwitz and Horwitz, 2007; Coad and Timmermans, 2012). However, similarly to what Bower et al. (2000) had previously found in their meta-analysis, there seem to be an important role for the specific task/activity taken into account when measuring firm performance, as well as for contextual variables (i.e. sectors). In other words, while diversity might have a positive impact in some contexts and in relation to some activity – e.g. knowledge-intensive startups – it might result in lower levels of performance in other cases – e.g when the activities are simple. In this respect, it is important to consider that starting a new company or making a company grow is very different from developing innovations.

The existing studies on entrepreneurial teams study how heterogeneous teams integrate resources and competences (Beckman & Burton, 2008; Ancona & Caldwell, 1992) and share the idea that having access to different types of competencies, skills, and knowledge embedded in human capital make new ventures founded by a team perform better than the solo entrepreneurs (Coad and Timmermans, 2012). Large team size stimulates firm growth, as it allows to accrued resources as well as to supply knowledge heterogeneity to accommodate for solving complex and non-rudimentary tasks (Beckman et al., 2007). Diversity among team members is optimal for start-ups, while recent research highlights that less diverse and more

technologically focused teams under certain environmental conditions perform better (Eesley et al. 2013). to guarantee the success of companies. The basic idea is that each member of the founding team brings valuable human, social, and financial capital to the team (Colombo & Grilli, 2005; Castanasias & Helfat, 1991).

In discussing the relationship between diversity and firm performance, the vast majority of works measure performance either in terms of (growth of) sales and profitability, or in terms of survival – particularly when examining new ventures. Quite surprisingly, there is a relatively scarce number of contributions that specifically look at the relationship between human capital diversity and innovations (Bantel and Jackson, 1989; Zajac et al., 1991; Ruef, 2000; Ruef et al., 2003; Van der Vegt and Janssen, 2003; Ostergaard et al. 2011) and most of them look at the impact of team/employee diversity on organizational innovations. The literature on cross-functional teams, for example, has shown that cross functional teams represent a very important factor for the development of successful innovations (Mohrman et al., 1995; Finegold and Wagner, 1998), as they allow people from heterogeneous backgrounds and functions to fruitfully interact with each other.

We aim at examining the extent to which the impact of founding team diversity - in terms of education (degree and type) and working experience - on firm innovative performance varies across different sectoral contexts. As mentioned by Ostergaard et al. (2011), the effect of team diversity might vary between sectors. In particular, we may think that different knowledge bases, technological regimes, user-producer interaction modes and degree of output tangibility and position in the value chain play an important role in affecting the way in which diversity impacts on innovation activity.

3. Data collection: the survey

The empirical investigation in this paper is based on original data and the results of the AEGIS survey, developed in the frame of the of the 7th FP project AEGIS. This survey, carried out in the period 2010-2011 and administrated by telephone interviews in native language, aimed to understand the determinants of knowledge-intensive entrepreneurship in Europe in different sectors and countries, with reference both to firm-specific dimensions (e.g., business environment, strategies, knowledge sources etc.) and to founders-specific characteristics (e.g., age, working experience, main areas of expertise, etc.). The survey indeed covered ten European countries (Denmark, Croatia, Sweden, France, Italy, Netherlands, UK, Germany, Greece, Portugal), and included high-tech medium- and low-tech sectors as well as knowledge – intensive and traditional services.

The firms selected for interviews were drawn from Amadeus database (Bureau Van Dijk), and were requested to be truly newly established firms in the period 2001-2007 (i.e. all firms that have changed their legal status or generally have been under any legal changes, transformations, name change etc, and that are generally reported as new firms in the business registries were excluded). The survey ultimately led to a final sample of 4004 new firms with a rather successful 31.2% average response rate (with same differences across countries). More information on the survey methodology, the selection of the suitable database for identifying target firms and of the target sample size, and the implementation strategy and method can be retrieved at http://cordis.europa.eu/project/rcn/91092_en.html.

Across countries, 55% are manufacturing firms and 45% service firms. The country distribution of firms is the following: 5.99% Croatia; 4.87% Czech republic; 3.82% Denmark; 15.22 France; 13.31 Germany; 9.26% Greece; 15.85 Italy; 8.98 Portugal; 10.16 Sweden and 12.54 United Kingdom.[1] Manufacturing firms are far more diffused (above 60% in the national sample) in Croatia, Czech Republic, Greece, Italy and Portugal, whereas in Denmark, France, Germany, Sweden and UK service firms prevail (above 50% in the national sample).

4. Drivers of innovation and estimation framework

4.1 The dependent variable

For the purpose of the present analysis, innovation is measured as a dummy variable taking value 1 if the firm introduced new or significantly goods or services in the past three years with respect to the time of the survey. The majority of the surveyed firms (64%) appear to have introduced some new or significantly improved goods or services during the last three years, while the rest (36%) did not report any kind of innovative activity related to specific products or services.[2]

Innovation is estimated by means of a logit model as follows:

[1] The country distribution of firms is not representative of each country's participation in the sample. If that was the case, then almost ¾ of the survey (75% of the sample) should be drawn only from France, Germany, and Italy whereas in other countries like Greece, the sample would have to be very small. The AEGIS survey instead aimed to assure that the final sample should be of adequate size in order to perform a sound and solid statistical analysis at the national, international but also at the sectoral levels.

[2] We are aware that to some extent this measure may overstate firms innovative activities as an innovation new to the firm is not necessarily new to the market and, a fortiori, to the world. Still, in this work, innovation assumes a relative connotation, i.e. a novelty with respect to the past not with respect to some best practice realised elsewhere. This is especially relevant as the sample includes more advanced and less advanced countries as well more technology intensive and less technology intensive sectors.

$$\mathbf{Pr}(Y_i > j) = G(X\beta_j) = \frac{\mathbf{exp}(\alpha_j + X_i\beta_j)}{1 + [\mathbf{exp}(\alpha_i + X_i\beta_j)]} \qquad j = 0, 1$$

where Y represents the dependent variable (Innovation), X is the vector of the covariates and β the vector of coefficients. Following the literature, innovation is made dependent on a set of firm- and founding team-specific variables i.e. X (see subsequent sections); the goal is to identify robust correlations between innovation and some firm- and founding team-specific characteristics, rather than identifying cause-effect relationships. We explore, in particular, the role of competencies breadth, heterogeneity and specialization as well as their interplay, while controlling for the firm's size, age, human capital, nature of competition, strategy, on the one hand, and the size of the founding team, and their average working experience, on the other.
The selection of the covariates, that include both team- and firm-level variables, is based on the literature and their statistical significance in the regression analysis. The description of the variable and their summary statistics (also reported by sector) are available in annex.

4.2 Measuring competencies' heterogeneity

The AEGIS survey provides interesting information about the main areas of expertise of the founders that are relevant for the operation of the new venture, which can be considered as the main competencies made available to the firm at the time of its birth. Each of the founders was asked to indicate his/her main areas of expertise out of five fields: technical and engineering knowledge, general management, product design, marketing, finance. Each founder could select up to five fields of expertise.

Several indicators have been proposed in the literature to capture heterogeneity in a given population, such as entropy-based measures of diversity, coefficient of variation or standard deviation (for a review see, Coad and Timmermans, 2012). Given the categorical nature of the variable of interest (i.e., the field of expertise or competencies), we opted for the so-called Blau-index, that can be defined as the opposite of the more traditional Hirschman-Herfindal index of concentration. It is computed as the one minus the sum of the squared shares of team members with competency k, s_k, as summarized below:

Competencies heterogeneity =

where *n* is the number of competencies fields. The more homogeneous team competencies are, the closer the index gets to 1/*n* and it approaches 1 the more heterogeneous teams are.
As a consequence, the this index is scale dependent. To correct for scale effects, we adjusted it as follows:

Competencies heterogeneity = ——

This adapted index as well ranges from 0 if all team members have the same set of competencies to 1if each founder have competencies in different fields. It has to be noted that also solo founder firms can show some heterogeneity; in fact, theoretically speaking, there could be cases of solo founder firms exhibiting the same heterogeneity of multiple founders firms.

4.3 Founding team covariates

As far as team level covariates are concerned, we in particular considered the following elements. At first, a control for the number of founders was introduced, measured as the count of founders in the firm's founding team, which ranges from 1 to 4. The average size of the founding team is small (2 persons). The grand majority of firms (over 90% across countries) were founded by up to 4 founders, while a very small percentage of companies (6%) were set up by larger teams (5 to 9 persons). For the purpose of the present analysis, therefore, only firms with up to 4 founders are considered.

Next, we introduced a measure of the average working experience of founders, measured as the average number of years of working experience of the founders. The literature indeed indicates that more experienced founders are more likely to launch more innovative and successful ventures (Klepper and Sleeper, 2005). This control is also necessary as the number of competencies a founder can accumulate can increase with his/her working experience, thus affecting competencies heterogeneity. In the present case, the professional experience of founders is on average 12 years, with insignificant variation across countries and sectors and only for 6% of the founders this is their first job.

Also, we controlled for the breadth of competencies in the founding team, by counting the number of fields of competencies available in the founding team with respect to the following ones: technical and engineering knowledge, general management, product design, marketing, finance. This variable ranges from 1 to 5; it takes value 1 if there is only one field of competencies in the team and it takes value 5 if all out of the five fields are available in the team. On average, the founding team covers up to two fields of expertise in the founding teams up to two founders and up to three fields in the founding team of more than two founders. As noted above, in fact, heterogeneity can statistically increase simply because of size effects.

Finally, we considered the main area of competencies in the founding team, by computing the share of available competencies in each of the five fields out of the total number of

competencies in the founding team. Descriptive evidence indicates that the main area of expertise of founders is technical and engineering knowledge (52%) followed by general management knowledge (45%). Equal shares of them have marketing (29%) and finance expertise (29%) and one out of four has product design knowledge, which seems to be the less important area of expertise.

4.4 Firm level covariates

The AEGIS survey makes available several information about firms characteristics and the environment in which they operate. Our attention in particular is concentrated on the following dimensions:

- size and age
- human capital
- the main characteristics of the business environment
- the main strategy pursued
- sensing and seizing the opportunities for innovation
- the external sources of knowledge
- the relevance and use of networks.

The effect of age, largely discussed in the literature, is captured through a variable indicating the foundation year. The effect of size, similarly and extensively discussed in the literature, is captured through an ordinal variable measuring the number of full time employees grouped in seven size classes: 1 employee only; 2 to 5 employees; 6 to 10 employees; 11 to 20 employees; 21 to 50 employees; above 50 employees. The majority of firms (63.6%) are micro firms, i.e. up to 9 full-time persons, whereas only a very small share of them (0.28%) can be regarded as large or very large firms (>250 employees). On average, the surveyed firms employ 11 persons which is quite natural since in their grand majority (88.4%) they employ less than 50 persons.

The human capital in the firm is measured with the share of employees holding a bachelor degree (or higher attainment) on total employees. The educational level of human capital can be considered as high: 2/3 of all new companies have employees holding a university degree, moreover, half of them (52%) employ people with a post-graduate degree (PhDs included). Especially knowledge-intensive business services show a higher employees' educational level with respect to high and low-tech manufacturing.

The survey proposes respondents to evaluate several statements characterizing their business environment. To synthesize this information, we used factor analysis with principal component

analysis extraction method and oblimin rotation method.[3] We obtained two factors. The first factor refers to the following statements: the lifecycle of products is typically short; customers regularly ask for new products and/or services; the speed of technological change is high; a company only succeeds if it is able to launch new products/services continuously. We called it competition based on new products/technologies. The second factor refers to the following statements: the activities of our major competitors are unpredictable and competition is very intense; price competition is prevalent; quality competition is prevailing. We called it competition based on prices and/or quality. It is worth observing that competition that is based on quality is the main characteristic of the business environment of new firms that participated in the survey. Still however, price competition is an important factor along with a need for product innovation. Firms from high tech manufacturing sectors seem to stress the importance of constant innovation to a greater extent than other sectors, since demand from customers is also more intense in these sectors.

The main strategy pursued by the firm is captured through a set of dummy variables, one taking value 1 if the main strategy is based on cost leadership (i.e. offering standardized products and services at low price) and zero otherwise, one taking value 1 if the main strategy is based on differentiation (i.e. offering unique products and services) and zero otherwise, one taking value 1 if the main strategy is based on the exploitation of opportunities in new niche markets and zero otherwise, being the last the reference category. Interestingly, cost leadership is adopted by a larger percentage of firms in Greece and Portugal, whereas in Sweden ¾ of the examined firms responded that they offer unique products / services. On the other hand in Croatia, Portugal and Italy, more than 30% of each sample tries to exploit opportunities in niche markets. Cost leadership is adopted by low tech firms to a greater extent than other sectors, with no other significant differences across sectors.

The survey proposes respondents to evaluate several statements regarding sensing and seizing the opportunities for innovation. As noted above, to synthesize this information, we used factor analysis with principal component analysis extraction method and oblimin rotation method.[4] We obtained three factors. The first one refers to the following statements: our firm actively observes and adopts the best practices in our sector; our firm responds rapidly to competitive moves; we change our practice in response on customer feedbacks; our firm regularly considers the consequences of changing market demand in terms of new products and services; our firm is quick to recognize shifts in our market (e.g. competition, regulation, demography); we quickly understand new opportunities to better serve our customers. We called it opportunities stemming from adaptation to change. The second factor refers to the

[3] The oblimin rotation method is rapidly gaining consensus and use in the scientific community. For a discussion on this issue, see Fagerberg and Srholec (2008). We retained factor loadings greater than 0.4. Results of the factor analysis are reported in annex.

[4] We retained factor loadings greater than 0.57 Results of the factor analysis are reported in annex.

following statements: there is a formal R&D department in our firm; there is a formal engineering and technical department in our firm; design activity is important in introducing new products/services to the market. We called it opportunities stemming from internal R&D. The third factor refers to the following statements: we implement systematic internal and external personnel training; employees share practical experiences on a frequent basis. We called it opportunities stemming from learning and training. Firms evaluated their ability to sense and seize opportunities rather generously. Three "market" capabilities were ranked first: changing practices based on customer feedback, adopting best practices in the sector and understanding new opportunities to better serve customers. However more than 65% of the firms do not have a formal technical or R&D department.

The survey also proposes to evaluate the importance of several external sources of knowledge.[5] As in the previous cases, to synthesize this information, we used factor analysis with principal component analysis extraction method and oblimin rotation method.[6] We obtained two factors. The first factor refers to the following external sources of knowledge: public research institutions; universities; external commercial labs/R&D firms/technical institutes; trade fairs, conferences, exhibitions; scientific journals and other trade or technical publications; participation in nationally funded research programs; participation in EU funded research programs (Framework Programs). We called it science-based external knowledge sources. The second factor refers to the following external sources of knowledge: clients or customers; suppliers; competitors. We called informal external knowledge sources. It is interesting to observe that clients / customers are the most important source of knowledge for the examined firms, followed by suppliers, in-house know-how and competitors (especially in low tech). Participation in funded programs (EU or national) and generally external R&D were ranked at the bottom of the list. Firms also prefer to participate in trade fairs and conferences and reviewing scientific or technical journals to a greater extent than establishing collaboration with universities or public research institutes.

Finally, in terms of relevance and use of networks, we again applied factor analysis to summarize information from the survey with principal component analysis extraction method and oblimin rotation method.[7] We obtained one factor only referring to the extent to which the firm participated/contributed to the following operations: contacting customers/suppliers; selecting suppliers; recreating skilled labor; collecting information about competitors; accessing distribution channels; assistance in obtaining business loans/attracting funds; advertising and promotion; developing new products/services; managing production and operations; assistance in arranging taxation or other legal issues; exploring export

[5] We concentrated on the external sources of knowledge because, as noted above, 65% of firms in the sample do not have internal technical or R&D department. This does not exclude that a firm also creates knowledge internally.
[6] We retained factor loadings greater than 0.37. Results of the factor analysis are reported in annex.
[7] We retained factor loadings greater than 0.55. Results of the factor analysis are reported in annex.

opportunities. By far the most important outcome of any networking activity in all countries is in contacting customers. Selecting the proper suppliers is the second most important activity, followed by recruiting skilled employees, especially in KIBS. On the other hand, networks do not seem very helpful in terms of exploring export opportunities or obtaining funding.

5. The impact of on competencies heterogeneity on innovation

Tables 3 and 4 present the results of the estimation of innovation drivers. Both tables present results for the whole sample and for the manufacturing sub-sample and services sub-sample, as in the literature it is frequently claimed that their innovation modes differ quite substantially. Table 3 present the estimates for the three samples in three main steps. First, the regression includes only control variables; next the effect of competencies heterogeneity is considered and finally we introduce the competencies specialization profile of the firm measured, as discussed in section 4.2, the share of a firm's competencies in each field of expertise, being specialization in finance the reference category.[8]

We comment the results following this order, highlighting the differences between manufacturing and services when statistically relevant. As far as the firm level control variables are concerned, it is interesting to observe the negative effect of age (which is barely significant only in models 6 and 9 for the services sub-sample), the positive effects of size, and of human capital. All these results are highly consistent with the literature. Expectedly, business environment in which competition is based on new products and technologies are more favorable to innovation whereas business environment in which competition is based on price are less conducive to innovation.

In terms of business strategy, both cost leadership strategy and (to a lesser extent) differentiation strategy seem less conducive to innovation with respect to niches exploitation strategy. Possibly, this is also due to the newness of the surveyed firms as the creation of a niche market could be a rather short term effect of the initial launching of a new firm. Once a new firm (a start up) creates a market, soon some competition turns up either from established firms or from even newer firms. Training and learning are important leverages to sense and seize opportunities for innovation both in manufacturing and services; interestingly, however, this factor seems more important in services whereas the capacity to adapt to change seems more relevant in manufacturing. Finally, business networks are perceived as important and useful in the operation of the firm.

More importantly, moving to models 2, 5 and 8, competencies heterogeneity seems to be positively associated with innovation, in all samples, supporting our hypothesis that

[8] Due to missing data for some questions of the survey the observations included in the estimates are 2949.

heterogeneity is an important driver of recombinatorial activity and innovation. This effect is strongly significant also controlling for the sheer number of founders, their working experience and the breadth of competencies in the team. This results persists also after introducing the competencies specialization profile of the firm (models 7 to 9). With the exception of general management, specialization in one of the other fields is more conducive to innovation with respect to specialization in finance.

[TABLE 3 ABOUT HERE]

To better describe the diversity of the impact of competencies heterogeneity in the three samples according to the competencies specialization profile of the firm, we interacted the heterogeneity variable with four out of the five variables accounting for a firm's competencies specialization profile. Results are displayed in Table 4. We present the results when considering the interaction of competencies heterogeneity and specialization in technical and engineering knowledge as the reference case and next when considering the interaction of competencies heterogeneity and specialization in general management as the reference case. In the first case (i.e. specialization in technical and engineering knowledge is the reference case, models 1 to 3), results indicate that competencies heterogeneity is less relevant when a firm's competencies are prevalently in the area of general management with respect to the case in which a firm's competencies are prevalently in the area of technical and engineering knowledge. On the other hand, when specialization in general management is the reference case (models 4 to 6), results indicate that heterogeneity of competencies is more relevant for firms specialized in the area of technical and engineering knowledge, and also for manufacturing firms specialized in the field of product design and for service firms specialized in the field of marketing. Results therefore lend support to our hypothesis that heterogeneity of competencies is more important for firms in which the knowledge base to be more specific and oriented towards technical application.

[TABLE 4 ABOUT HERE]

6. Conclusions

The paper has investigated the role of founders' competencies' heterogeneity for innovation within a sample of European new established firms. The relevance of founding teams' educational background and competencies has been largely discussed within the literature and an important stream of contributions have specifically looked at the impact of founders' diversity – mostly in terms of education and working experience – on firm performance. The present work has relied upon the existing contributions on the topic, but has extended them in two ways. First, it has considered the effects of heterogeneity of founders competencies on

innovative activity, instead of looking at the link between heterogeneity of employees/teams and sales or profits. Second, it has in depth studied the extent to which the relationship varies across different sectors and contexts, examining not only the differences between manufacturing and services, but also the differences across different sets of founding teams' competencies.

Overall, our results show that competencies heterogeneity is positively associated with firms' innovative activity, even when controlling for the sheer number of founders, their working experience and the breadth of competencies in the team. However, competencies' heterogeneity is less relevant when a firm's competencies are prevalently in the area of general management with respect to the case in which a firm's competencies are mostly in the area of technical and engineering knowledge. Furthermore, competencies heterogeneity is particularly relevant for manufacturing firms that are specialized in the field of product design. The findings are in line with the idea that having a founding team with heterogeneous competencies is particularly important for firms in which the knowledge base is more specific and oriented towards technical applications.

The findings have important managerial implications for the organizations and success of new ventures. First, they underline that heterogeneity is associated with innovation, which is in line the recent emphasis on the workforce diversity as a key factor for firms' success and as an important driver for increasing opportunities for creative thinking and different ideas. Leveraging on a mix of competencies allows companies to solve business problems and pursue a process of sustainable business growth over time. Second, they stress that, as companies operate in different sectors and are endowed with different sets of competencies, the extent to which founders' heterogeneity matters for firms' innovative activity depends very much on the specific context and business activity. Going beyond the basic distinction between complex and simple activities, the findings allow us to emphasize that, companies should look for heterogeneity especially when their activities are very much oriented towards product design and they are very much concentrated on engineering and technical knowledge.

References

Amason, A.C., Shrader, R.C., Tompson, G.H. (2006). Newness and novelty: Relating top management team composition to new venture performance. *Journal of Business Venturing*, 21: 125-148.

Ancona, D. G. and D. F. Caldwell (1992). Demography and design: predictors of new product team performance. *Organization Science* 3(3): 321-341.

Balconi and Fontana (2011). Entry and innovation: an analysis of the fables semiconductor business. *Small Business Economics*, 37: 87-106.

Bantel, K. and S. Jackson (1989). Top management and innovations in banking: does the composition of the top team make a difference? *Strategic Management Journal*, 10: 107–124. Becker (1964). Human capital: A theoretical and empirical analysis. New York: Columbia University Press.

Beckman, C., Burton, M.D. and C. O'Reilly (2007). Early teams: the impact of entrepreneurial team demography on VC financing and going public. *Journal of Business Venturing*, 22: 147–173.

Beckman, C.M. and M.D. Burton (2008). Founding the Future: Path Dependence in the Evolution of Top Management Teams from Founding to IPO. *Organization Science*, 19(1): 3-24.

Bhide (1994). How entrepreneurs craft strategies that work. *Harvard Business School Review*, March-April: 150-161.

Bowers, C.A., Pharmer, J.A. and E.Salas (2000). When member homogeneity is needed in work teams: A meta-analysis. *Small Group Research*, 31: 305–327.

Boone, C. and W. Hendricks (2009). Top management team diversity and firm performance: Moderators of functional-background and locus-of-control diversity. *Management Science*, 55: 165–180.

Castanias, R.P. and C.E. Helfat. (1991). Managerial resources and rents. *Journal of Management*, 17(1): 155-171.

Castellacci, F. (2008). Technological paradigms, regimes and trajectories: Manufacturing and service industries in a new taxonomy of sectoral patterns of innovation. *Research Policy*, 37: 978-994.

Coad A. and Timmermans B. (2012). Two's Company: Human Capital Composition and Performance of Entrepreneurial Pairs. SPRU Working Paper Series 201, available at http://www.sussex.ac.uk/spru/documents/sewp201.pdf.

Cohen, W.M. and D.A. Levinthal (1990). Absorptive capacity: a new perspective of learning and innovation. *Administrative Science Quarterly*, 35 (1), 128–152.

Cohen et al, (2010).

Colombo, M.G. and L. Grilli (2005). Founders' human capital and the growth of new technology-based firms: A competence-based view. *Research Policy*, 34(6): 795-816.

Cooper, A.C., Gimeno-Gascon F.J. and C.W. Yoo (1994). Initial human and financial capital as predictors of new venture performance. *Journal of Business Venturing*, 9(5): 371-395.

Dahl, M.S. and T. Reichstein (2007). Are You Experienced? Prior Experience and the Survival of New Organizations. *Industry and Innovation*, 14(5): 497-511.

Davidsson, P. and B. Honig (2003). The role of social and human capital among nascent entrepreneurs. *Journal of Business Venturing*, 18(3): 301-331.

Delmar, F. and S. Shane (2006). Does experience matter? The effect of founding team experience on the survival and sales of newly founded ventures. *Strategic Organization* 4(3): 215-247.

Eesley, C.E., Hsu, D.H. and E.B. Roberts (2013). The Contingent Effects of Top Management Teams on Venture Performance: Aligning Founding Team Composition with Innovation Strategy and Commercialization Environment. *Strategic Management Journal*, 35(12): 1798-1817.

Ejermo, O. and T. Jung (2011). Team experience of inventors and inventive performance. 6th Annual Conference of the EPIP Association. Lund.

Fagerberg Jan E. and Shrolec M. (2010). National innovation systems: Capabilities and economic development. *Research Policy*, 37(9): 1417-1435

Fiet, J.O. (1995). Risk avoidance strategies in venture capital markets. *Journal of Management Studies*, 32(4): 551-574.

Finegold, D., and K. Wagner (1998). The search for flexibility: Skills and work-place innovation in the German pump industry. *British Journal of Industrial Relations*, 36 (3): 469-487.

Ferreira, J.J.M., Raposo, M.L. and C.I. Fernandes (2013). Does innovativeness of knowledge-intensive business services differ from other industries? *The Service Industries Journal*, 33 (7-8): 734-748.

Gemser and Leenders (2011).

Gimeno, J., Folta, T., Cooper, A. and Woo, C. (1997). Survival of the fittest? Entrepreneurial human capital and the persistence of underperforming firms. Administrative Science Quarterly, :750-783.

Haas, H. (2010). How can we explain mixed effects of diversity on team performance? A review with emphasis on context. *Equality, Diversity and Inclusion: An International Journal*, 29(5):458-490.

Hackman, J.R. (1983). A normative model of work team effectiveness (Technical Report No. 2). New Haven, CT: Yale University.

Hambrick, D.C. 2007. Upper echelons theory: an update. *Academy of Management Review*, 32(2): 334 – 343.

Helfat, C. and M. Lieberman (2002). The Birth of capabilities and the importance of prehistory. *Industrial and Corporate Change*, 11: 725-760.

Holbrook, D., Cohen, W.M., Hounshell, D.A. and S. Klepper (2000). The nature, sources, and consequences of firm differences in the early history of the semiconductor industry. *Strategic Management Journal*, 21: 1017-1041.

Horwitz, S. and I. Horwitz (2007). The effects of team diversity on team outcomes: a meta-analytic review of team demography. *Journal of Management* 6: 987–1015.

Hsu, D.H. (2007). Experienced entrepreneurial founders, organizational capital, and venture capital funding. *Research Policy*, 36: 722–741.

Kaiser, U. and B. Müller (2013). Team Heterogeneity in Startups and its Development over Time. IZA DP No. 7284.

Katila, R. and Ahuja, G. (2002). Something old, something new: A longitudinal study of search behavior and new product development. *Academy of Management Journal*, 45: 1183-1194.

Kimberly, J.R. and M.J. Evanisko (1981). Organizational innovation: The influence of individual, organizational, and contextual factors on hospital adoption of technological and administrative innovations. *Academy of Management Journal*, 24(4): 689-713.

Klepper S. and Sleeper S. (2005). Entry by Spin-offs. *Management Science*, 51(8): 1291-1306

Koch, A. and H. Strotmann (2006). Absorptive Capacity and Innovation in the Knowledge Intensive Business Service Sector. *Economics of Innovation and New Technology*, 17(6): 511–531.

Licht, G. and E. Nerlinger (1997). New technology-based firms in Germany: A survey of the recent evidence. *Research Policy* 26: 1005–1022.

Mariani, M. and M. Romanelli (2006). "Stacking" or "picking" patents? The inventors' choice between quantity and quality. LEM Working Papers Series 2006/06, Sant'Anna School of Advanced Studies.

Marvel, M.R. and G.T. Lumpkin (2007). Technology entrepreneur's human capital and its effects on innovation radicalness. *Entrepreneurship Theory & Practice*, 31(6): 807-28. Mohrman, S.A., Cohen, S.G. and A.M. Mohrman (1995). Designing team-based organizations: New forms for knowledge work. San Francisco: Jossey-Bass.

Morgan and Lassiter (1992).

Nahapiet, J. and S. Ghoshal (1998). Social capital, intellectual capital, and the organizational advantage. *Academy of Management Review* 23(2): 242-266.

Østergaard, C.R., Timmermans, B. and K. Kristinsson (2011). Does a different view create something new? The effect of employee diversity on innovation. *Research Policy*, 40(3): 500-509.

Pavitt, K. (1984). Sectoral patterns of technical change: towards a taxonomy and a theory. *Research Policy* 13: 343–373.

Roberts, E.B. (1991). Entrepreneurs in High Technology: Lessons from MIT and Beyond. Oxford University Press: New York.

Ruef, M. (2000). Strong ties, weak ties and islands: structural and cultural predictors of organizational innovation. *Industrial and Corporate Change*, 11(3): 427-449.

Ruef, M., Aldrich, H.E. and Carter N.M. (2003). The social structure of founding teams: Homophily, strong ties, and isolation among US entrepreneurs. *American Sociological Review*, 68(2): 195-222.

Santos-Rodrigues, H., Dorrego, P.F. and C.F. Jardon (2010). The influence of human capital on the innovativeness of firms. *International Business & Economics Research Journal*, 9(9): 53-64.

Shane, S. (2000). Prior knowledge and the discovery of entrepreneurial opportunities. *Organization Science*, 11(4): 448–469.

Shepherd, D.A. and D.R. DeTienne (2005). The impact of prior knowledge and financial reward on the identification of opportunities. *Entrepreneurship Theory and Practice*, 29(1): 91–112.

Steffens, P., Terjesen, S. and Davidsson P. (2012). Birds of a feather get lost together: New venture team composition and performance. *Small Business Economics*, 39(3): 727-743.

Talke, K., Salomo, S. and K. Rost (2010). How top management team diversity affects innovativeness and performance via the strategic choice to focus on innovation fields. *Research Policy*, 39: 907-918.

Tziner, A. (1985). How team composition affects task performance: Some theoretical insights. *Psychological Reports*, 57: 1111-1119.

Ucbasaran, D., Lockett, A., Wright, M., and P. Westhead (2003). Entrepreneurial founder teams: Factors associated with member entry and exit. *Entrepreneurship Theory and Practice*, 28(2): 107-128.

van der Vegt, G. and O. Janssen. (2003). Joint impact of interdependence and group diversity on innovation. *Journal of Management*, 29(5): 729–751.

Vesper, K. (1980). New Venture Strategies. New York: Prentice Hall.

Vogel, R., Puhan, T.X, Shehu, E., Kliger, D. and B. Heese (2014). Funding decisions and entrepreneurial team diversity: A field study. *Journal of Economic Behavior and Organization*, 107(B), 595-613..

Wiersema, M. and K. Bantel (1992). Top management team demography and corporate strategic change. *The Academy of Management Journal*, 35 (1), 91–121.

Zajac, E.J., Golden, B.R. and S.M. Shortell (1991). New organizational forms for enhancing innovation: the case of internal corporate joint ventures. *Management Science*, 37(2): 170–184.

Table 1. Variables description

Variable	Description
Innovation	Dummy variable = 1 if the firm has introduced new or significantly improved goods or services in the past t3 years and 0 otherwise
Foundation year	Year of foundation of the firm
Size	Ordinal variable which is measured by the number of full time employees grouped in seven size classes: 1 employee only; 2 to 5 employees; 6 to 10 employees; 11 to 20 employees; 21 to 50 employees; above 50 employees
Share of employees with university degree	Share of employees holding a bachelor degree on total employees
Competition based on new products/technologies	Factor referring to the following statements describing the firm business environment: the lifecycle of products is typically short; customers regularly ask for new products and/or services; the speed of technological change is high; a company only succeeds if it is able to launch new products/services continuously
Competition based on price and/or quality	Factor referring to the following statements describing the firm business environment: the activities of our major competitors are unpredictable and competition is very intense; price competition is prevalent; quality competition is prevailing
Cost leadership strategy	Firm strategy based on offering standardized products and services at low cost
Differentiation strategy	Firm strategy based on offering unique products and services
Opportunities - adaptation to change	Factor referring to the following statements regarding the sensing and seizing of opportunities within firm: our firm actively observes and adopts the best practices in our sector; our firm responds rapidly to competitive moves; we change our practice in response on customer feedbacks; our firm regularly considers the consequences of changing market demand in terms of new products and services; our firm is quick to recognize shifts in our market (e.g. competition, regulation, demography); we quickly understand new opportunities to better serve our customers
Opportunities - training and learning	Factor referring to the following statements regarding the sensing and seizing of opportunities within firm: we implement systematic internal and external personnel training; employees share practical experiences on a frequent basis
Opportunities - internal R&D	Factor referring to the following statements regarding the sensing and seizing of opportunities within firm: there is a formal R&D department in our firm; there is a formal engineering and technical department in our firm; design activity is important in introducing new products/services to the market
Science-based external knowledge sources	Factor referring to the following external sources of knowledge: public research institutions; universities; external commercial labs/R&D firms/technical institutes; ; trade fairs, conferences, exhibitions; scientific journals and other trade or technical publications; participation in nationally funded research programs; participation in EU funded research programs (Framework Programs)
Informal external knowledge sources	Factor referring to the following external sources of knowledge: clients or customers; suppliers; competitors
Business networks intensity and usefulness	Factor referring to the extent to which the firm participated/contributed to the following operations: contacting customers/suppliers; selecting suppliers; recreating skilled labor; collecting information about competitors; accessing distribution channels; assistance in obtaining business loans/attracting funds; advertising and promotion; developing new products/services; managing production and operations; assistance in arranging taxation or other legal issues; exploring export opportunities
Number of founders	Number of founders in the firm's founding team
Average working experience of	Average number of working experience of the founders

founders	
Number of competencies areas in the founding team	Number of fields of competencies available in the founding team with respect to the following fields: technical and engineering knowledge, general management, product design, marketing, finance
Competencies heterogeneity	Opposite of the Herfindal index computed on the squared share of competencies in the founding team in the following five fields: technical and engineering knowledge, general management, product design, marketing, finance
Technical and engineering knowledge	Share of competencies in the founding team in the field of technical engineering and knowledge
General management	Share of competencies in the founding team in the field of general management
Product design	Share of competencies in the founding team in the field of product design
Marketing	Share of competencies in the founding team in the field of marketing
Finance	Share of competencies in the founding team in the field of finance

Table 2. Summary statistics, by sector

	Full sample					Manufacturing					Services				
Variable	Obs.	Mean	Std. Dev.	Min	Max	Obs.	Mean	Std. Dev.	Min	Max	Obs.	Mean	Std. Dev.	Min	Max
Innovation	3141	0.63	0.48	0	1	1729	0.65	0.48	0	1	1412	0.603	0.489	0	1
Foundation year	3141	2004.07	2.13	2000	2007	1729	2003.88	2.12	2000	2007	1412	2.004	2	2001	2007
Size	3114	3.12	1.76	0	7	1716	3.47	1.74	0	7	1398	2.69	1.68	0	7
Share of employees with university degree	3141	0.36	0.41	0	1	1729	0.23	0.33	0	1	1412	0.52	0.43	0	1
Competition based on new products/technologies	3141	0	1	-2.47	2.22	1729	0.04	1.00	-2.47	2.22	1412	-0.06	1.00	-2.47	2.16
Competition based on price and/or quality	3141	0	1	-3.18	2.10	1729	0.04	1.05	-3.13	2.10	1412	-0.04	0.93	-3.18	2.10
Cost leadership strategy	3141	0.16	0.37	0	1	1729	0.19	0.39	0	1	1412	0.14	0.34	0	1
Differentiation strategy	3141	0.58	0.49	0	1	1729	0.55	0.50	0	1	1412	0.61	0.49	0	1
Opportunities - adaptation to change	3141	0.01	0.99	-3.29	1.55	1729	-0.02	1.04	-3.29	1.55	1412	0.05	0.93	-3.13	1.55
Opportunities - training and learning	3141	0	1	-3.38	1.96	1729	-0.09	0.99	-3.38	1.89	1412	0.09	1.01	-3.10	1.96
Opportunities - internal R&D	3141	-0.01	1	-2.08	2.69	1729	0.04	0.97	-2.08	2.69	1412	-0.07	1.03	-1.83	2.62
Science-based knowledge sources	3141	0	1	-1.31	3.11	1729	0.04	1.02	-1.31	3.11	1412	-0.05	0.97	-1.31	3.08
External knowledge sources	3141	0	1	-3.65	1.99	1729	0.15	0.99	-3.65	1.99	1412	-0.18	0.99	-3.65	1.99
Business networks intensity and usefulness	3141	0	1	-2.40	2.23	1729	0.16	1.02	-2.40	2.23	1412	-0.19	0.95	-2.40	2.23
Number of founders	3141	1.85	0.87	1	4	1729	1.85	0.87	1	4	1412	1.85	0.88	1	4
Average working experience of founders	3141	1.23	9.31	0	55	1729	1.22	9.61	0	55	1412	1.24	8.94	0	52
Number of competencies areas in the founding team	3141	2.38	1.45	0	5	1729	2.45	1.48	0	5	1412	2.30	1.41	0	5
Competencies heterogeneity	3141	0.66	0.46	0	1	1729	0.69	0.45	0	1	1412	0.63	0.47	0	1
Technical and engineering knowledge	2949	0.32	0.33	0	1	1609	0.31	0.31	0	1	1340	0.35	0.35	0	1
General management	2949	0.26	0.28	0	1	1609	0.26	0.27	0	1	1340	0.27	0.29	0	1
Product design	2949	0.11	0.20	0	1	1609	0.14	0.22	0	1	1340	0.09	0.17	0	1
Marketing	2949	0.15	0.22	0	1	1609	0.16	0.21	0	1	1340	0.15	0.23	0	1
Finance	2949	0.14	0.21	0	1	1609	0.14	0.19	0	1	1340	0.15	0.23	0	1

Table 3. Drivers of innovation: the role of competencies heterogeneity

Dependent variable: Innovation = 1	ALL (1)	MANUFACTURING (2)	SERVICES (3)	ALL (4)	MANUFACTURING (5)	SERVICES (6)	ALL (7)	MANUFACTURING (8)	SERVICES (9)
Foundation year	-0.012	0.014	-0.051	-0.013	0.013	-0.051*	-0.018	0.010	-0.059*
	(0.020)	(0.027)	(0.031)	(0.020)	(0.027)	(0.031)	(0.021)	(0.028)	(0.032)
Size	0.105***	0.111***	0.113***	0.103***	0.109***	0.109**	0.100***	0.104**	0.108**
	(0.028)	(0.038)	(0.044)	(0.028)	(0.038)	(0.044)	(0.029)	(0.040)	(0.045)
Share of employees with university degree	0.583***	0.882***	0.366**	0.587***	0.879***	0.375**	0.635***	0.871***	0.445***
	(0.111)	(0.183)	(0.148)	(0.111)	(0.183)	(0.149)	(0.116)	(0.194)	(0.154)
Competition based on new products/technologies	0.224***	0.146**	0.319***	0.225***	0.146**	0.321***	0.204***	0.107	0.330***
	(0.047)	(0.063)	(0.071)	(0.047)	(0.063)	(0.071)	(0.049)	(0.067)	(0.073)
Competition based on price and/or quality	-0.158***	-0.116*	-0.236***	-0.160***	-0.116*	-0.243***	-0.145***	-0.093	-0.253***
	(0.050)	(0.065)	(0.080)	(0.050)	(0.065)	(0.080)	(0.052)	(0.070)	(0.083)
Cost leadership strategy	-0.575***	-0.372**	-0.884***	-0.575***	-0.375**	-0.880***	-0.557***	-0.371**	-0.813***
	(0.131)	(0.172)	(0.205)	(0.131)	(0.172)	(0.205)	(0.135)	(0.180)	(0.206)
Differentiation strategy	-0.209**	-0.169	-0.244	-0.206**	-0.172	-0.232	-0.267***	-0.249*	-0.267*
	(0.100)	(0.136)	(0.150)	(0.100)	(0.136)	(0.150)	(0.103)	(0.142)	(0.154)
Opportunities - adaptation to change	0.179***	0.294***	0.034	0.181***	0.293***	0.037	0.192***	0.325***	0.035
	(0.061)	(0.082)	(0.093)	(0.061)	(0.082)	(0.093)	(0.064)	(0.087)	(0.096)
Opportunities - training and learning	0.085*	0.048	0.136**	0.082*	0.048	0.130**	0.089*	0.065	0.121*
	(0.045)	(0.063)	(0.065)	(0.045)	(0.063)	(0.065)	(0.047)	(0.067)	(0.068)
Opportunities - internal R&D	0.340***	0.274***	0.410***	0.340***	0.272***	0.415***	0.333***	0.247***	0.424***
	(0.050)	(0.068)	(0.075)	(0.050)	(0.068)	(0.076)	(0.051)	(0.070)	(0.077)
Science-based knowledge sources	0.086	0.049	0.132	0.085	0.048	0.130	0.096*	0.072	0.134
	(0.053)	(0.069)	(0.083)	(0.053)	(0.069)	(0.083)	(0.054)	(0.072)	(0.084)
External knowledge sources	-0.015	-0.049	0.035	-0.016	-0.053	0.039	-0.028	-0.066	0.025
	(0.051)	(0.069)	(0.076)	(0.050)	(0.069)	(0.076)	(0.053)	(0.073)	(0.079)
Networks intensity and usefulness	0.250***	0.242***	0.286***	0.252***	0.247***	0.283***	0.234***	0.240***	0.253***
	(0.053)	(0.069)	(0.086)	(0.053)	(0.068)	(0.086)	(0.055)	(0.072)	(0.088)
Number of founders	-0.006	0.026	-0.056	-0.004	0.025	-0.050	0.028	0.071	-0.029
	(0.051)	(0.070)	(0.077)	(0.051)	(0.070)	(0.077)	(0.053)	(0.073)	(0.079)
Average working experience of founders	-0.007	-0.005	-0.011	-0.007	-0.006	-0.011	-0.004	-0.002	-0.009
	(0.004)	(0.006)	(0.007)	(0.004)	(0.006)	(0.007)	(0.005)	(0.006)	(0.008)
Number of competencies areas in	0.074**	0.123***	0.003	0.001	0.051	-0.084	0.010	0.054	-0.054

the founding team									
	(0.030)	(0.040)	(0.047)	(0.045)	(0.058)	(0.072)	(0.047)	(0.062)	(0.077)
Competencies heterogeneity				0.302**	0.307*	0.340*	0.341**	0.348*	0.388*
				(0.136)	(0.184)	(0.208)	(0.138)	(0.188)	(0.210)
Technical and engineering knowledge							0.569**	0.647*	0.380
							(0.240)	(0.361)	(0.327)
General management							0.272	0.202	0.303
							(0.242)	(0.358)	(0.335)
Product design							0.656**	1.005**	-0.156
							(0.298)	(0.395)	(0.511)
Marketing							0.705**	0.918**	0.358
							(0.283)	(0.423)	(0.394)
Constant	24.509	-27.666	102.432	25.939	-25.759	103.876*	36.710	-20.885	118.242*
	(39.767)	(53.709)	(62.278)	(39.814)	(53.814)	(62.235)	(41.507)	(56.850)	(64.249)
Observations	3114	1716	1398	3114	1716	1398	2926	1598	1328
Pseudo-R-squared	0.123	0.110	0.152	0.124	0.112	0.153	0.127	0.117	0.156
Log lik.	-1803.831	-990.363	-796.704	-1801.330	-988.951	-795.342	-1680.269	-908.872	-751.878
Chi-squared	410.282	207.903	210.428	413.668	210.047	212.150	396.189	203.142	213.950

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Country and sector dummies included

Table 4. Divers of innovation: the role of competencies heterogeneity across specialization fields

Dependent variable: Innovation = 1	ALL	MANUFACTURING	SERVICES	ALL	MANUFACTURING	SERVICES
	(1)	(2)	(3)	(4)	(5)	(6)
Foundation year	-0.019	0.011	-0.059*	-0.019	0.011	-0.059*
	(0.021)	(0.029)	(0.032)	(0.021)	(0.029)	(0.032)
Size	0.103***	0.114***	0.110**	0.103***	0.114***	0.110**
	(0.029)	(0.041)	(0.045)	(0.029)	(0.041)	(0.045)
Share of employees with university degree	0.647***	0.893***	0.449***	0.647***	0.893***	0.449***
	(0.117)	(0.196)	(0.155)	(0.117)	(0.196)	(0.155)
Competition based on new products/technologies	0.206***	0.112*	0.333***	0.206***	0.112*	0.333***
	(0.049)	(0.067)	(0.074)	(0.049)	(0.067)	(0.074)
Competition based on price and/or quality	-0.143***	-0.090	-0.256***	-0.143***	-0.090	-0.256***
	(0.052)	(0.070)	(0.082)	(0.052)	(0.070)	(0.082)
Cost leadership strategy	-0.564***	-0.369**	-0.828***	-0.564***	-0.369**	-0.828***
	(0.135)	(0.181)	(0.207)	(0.135)	(0.181)	(0.207)
Differentiation strategy	-0.275***	-0.267*	-0.274*	-0.275***	-0.267*	-0.274*
	(0.104)	(0.144)	(0.155)	(0.104)	(0.144)	(0.155)
Opportunities - adaptation to change	0.192***	0.334***	0.030	0.192***	0.334***	0.030
	(0.064)	(0.087)	(0.097)	(0.064)	(0.087)	(0.097)
Opportunities - training and learning	0.090*	0.063	0.121*	0.090*	0.063	0.121*
	(0.047)	(0.067)	(0.068)	(0.047)	(0.067)	(0.068)
Opportunities - internal R&D	0.331***	0.241***	0.424***	0.331***	0.241***	0.424***
	(0.051)	(0.071)	(0.078)	(0.051)	(0.071)	(0.078)
Science-based knowledge sources	0.095*	0.071	0.130	0.095*	0.071	0.130
	(0.055)	(0.072)	(0.085)	(0.055)	(0.072)	(0.085)
External knowledge sources	-0.029	-0.067	0.019	-0.029	-0.067	0.019
	(0.053)	(0.072)	(0.080)	(0.053)	(0.072)	(0.080)
Networks intensity and usefulness	0.240***	0.252***	0.258***	0.240***	0.252***	0.258***
	(0.055)	(0.072)	(0.088)	(0.055)	(0.072)	(0.088)
Number of founders	0.020	0.070	-0.045	0.020	0.070	-0.045
	(0.054)	(0.074)	(0.081)	(0.054)	(0.074)	(0.081)
Average working experience of founders	-0.004	-0.003	-0.009	-0.004	-0.003	-0.009
	(0.005)	(0.006)	(0.008)	(0.005)	(0.006)	(0.008)
Number of competencies areas in the founding team	0.000	0.043	-0.063	0.000	0.043	-0.063
	(0.049)	(0.064)	(0.082)	(0.049)	(0.064)	(0.082)
Competencies heterogeneity	0.757***	0.814**	0.862**	-0.272	-0.342	-0.250
	(0.258)	(0.358)	(0.390)	(0.272)	(0.369)	(0.423)
Technical and engineering knowledge				0.069	0.172	-0.121
				(0.193)	(0.274)	(0.273)
General management	-0.069	-0.172	0.121			
	(0.193)	(0.274)	(0.273)			
Product design	-0.093	-0.064	0.005	-0.023	0.108	-0.115
	(0.338)	(0.391)	(0.726)	(0.350)	(0.402)	(0.750)
Marketing	0.089	0.491	-0.194	0.158	0.663	-0.315
	(0.281)	(0.447)	(0.383)	(0.290)	(0.460)	(0.397)
Finance	-0.375	-0.157	-0.347	-0.306	0.015	-0.468
	(0.315)	(0.560)	(0.400)	(0.323)	(0.571)	(0.412)
Competencies heterogeneity* Technical and engineering knowledge				1.029**	1.157**	1.112*

				(0.414)	(0.564)	(0.652)
Competencies heterogeneity* General management	-1.029**	-1.157**	-1.112*			
	(0.414)	(0.564)	(0.652)			
Competencies heterogeneity* Product design	0.037	0.688	-1.293	1.066**	1.845***	-0.180
	(0.530)	(0.657)	(1.016)	(0.517)	(0.627)	(0.993)
Competencies heterogeneity* Marketing	-0.106	-0.660	0.203	0.923*	0.497	1.316*
	(0.438)	(0.619)	(0.687)	(0.483)	(0.685)	(0.754)
Competencies heterogeneity* Finance	-0.580	-1.012	-0.337	0.449	0.145	0.776
	(0.481)	(0.768)	(0.662)	(0.506)	(0.768)	(0.753)
Constant	38.527	-22.337	118.417*	38.457	-22.509	118.538*
	(41.722)	(57.243)	(64.695)	(41.721)	(57.241)	(64.691)
Observations	2926	1598	1328	2926	1598	1328
Pseudo-R-squared	0.129	0.122	0.159	0.129	0.122	0.159
Log lik.	-1675.931	-903.325	-749.241	-1675.931	-903.325	-749.241
Chi-squared	400.285	210.284	216.777	400.285	210.284	216.777

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Country and sector dummies included

Appendix

Table A1. Factors for the characteristics of the firm business environment

Statements characterizing the firm business environment	Competition based on new products/ technologies	Competition based on prices/ quality
... the life cycle of products is typically short	**0.69**	-0.32
... customers regularly ask for new products and/or services	**0.77**	-0.02
... the speed of technological changes is high	**0.59**	0.17
... the activities of our major competitors are unpredictable and competition is very intense	0.15	**0.69**
... a company only succeeds if it is able to launch new products/services continuously	**0.61**	0.22
... price competition is prevalent	-0.12	**0.85**
... quality competition is prevailing	0.10	**0.41**

Note: Extraction method: Principal component analysis; rotation method: Oblimin. Number of observations is 3141. Factor loadings greater than 0.4 in bold.

Table A2. Factors regarding the sensing and seizing of opportunities within the firm

Statements about the sensing and seizing of opportunities within the firm	Opportunities stemming from adaptation to change	Opportunities stemming from training and learning	Opportunities stemming from internal R&D
Our firm actively observes and adopts the best practices in our sector	**0.67**	0.15	-0.14
Our firm responds rapidly to competitive moves	**0.76**	-0.01	0.05
We change our practices based on customer feedback	**0.77**	-0.04	-0.10
Our firm regularly considers the consequences of changing market demand in terms of new products and services	**0.81**	-0.04	0.05
Our firm is quick to recognize shifts in our market (e.g. competition, regulation, demography)	**0.82**	-0.03	0.05
We quickly understand new opportunities to better serve our customers	**0.80**	0.02	-0.02
There is a formal R&D department in our firm	-0.11	0.02	**0.83**
There is a formal engineering and technical studies department in our firm	-0.03	0.11	**0.79**
Design activity is important in introducing new products/services to the market	0.37	-0.10	**0.57**
We implement systematic internal and external personnel training	-0.11	**0.91**	0.12
Employees share practical experiences on a frequent basis	0.30	**0.68**	-0.07

Note: Extraction method: Principal component analysis; rotation method: Oblimin. Number of observations is 3141. Factor loadings greater than 0.57 in bold.

Table A3. Factors for external knowledge sources

External sources of knowledge	Science-based external knowledge sources	Informal external knowledge sources
Clients or customers	-0.20	**0.77**
Suppliers	0.004	**0.72**
Competitors	0.06	**0.64**
Public research institutes	**0.81**	0.02
Universities	**0.83**	-0.02
External commercial labs/R&D firms/technical institutes	**0.75**	0.04
Trade fairs, conferences and exhibitions	**0.37**	0.34
Scientific journals and other trade or technical publications	**0.50**	0.13
Participation in nationally funded research programmes	**0.87**	-0.11
Participation in EU funded research programmes (Framework Programmes)	**0.82**	-0.09

Note: Extraction method: Principal component 0.82a-0.10nalysis; rotation method: Oblimin. Number of observations is 3141. Factor loadings greater than 0.37 in italics.

Table A4. Factors for the intensity and usefulness of networks

Types of operations	Intensity and usefulness of networks
Contacting customers/clients	**0.55**
Selecting suppliers	**0.66**
Recruiting skilled labor	**0.64**
Collecting information about competitors	**0.64**
Accessing distribution channels	**0.66**
Assistance in obtaining business loans/attracting funds	**0.65**
Advertising and promotion	**0.65**
Developing new products/services	**0.67**
Managing production and operations	**0.72**
Assistance in arranging taxation or other legal issues	**0.61**
Exploring export opportunities	**0.61**

Note: Extraction method: Principal component analysis; rotation method: Oblimin. Number of observations is 3141. Factor loadings greater than 0.55 in bold.