

Knowledge Intensive Entrepreneurship: Going beyond the Schumpeterian entrepreneur

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Abstract: This paper presents a definition and stylized process model of knowledge intensive entrepreneurship. The paper proposes an integration of the Schumpeterian tradition with evolutionary theory and the innovation system approach. There is a clear need to go beyond the Schumpeterian entrepreneur, in order to properly take into account the diffusion, use and creation of knowledge in innovation and entrepreneurship, and its dynamic, evolving and systemic perspective. The modern economy is knowledge intensive, and hence knowledge intensive entrepreneurship can occur in all sectors and countries. The paper also presents empirical evidence of the empirical relevance of knowledge intensive entrepreneurship in the economy, based on a large scale survey. The paper concludes with recommendations for future research.

Key Words: Knowledge Intensive Entrepreneurship; Entrepreneurship; Knowledge Intensive Sectors; Innovation Systems

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1. INTRODUCTION

In claiming that entrepreneurship drives economic development, Schumpeter (1934, 1942) focuses the attention on how and why the activities of entrepreneurs create a disruptive, disequilibrium force in the economy, which in turn enables growth. Schumpeter highlighted that a key underlying process involves entrepreneurs using ideas in technical inventions, which they transform into innovations in the economy, for profits. Entrepreneurs develop new combinations by taking risks. Schumpeter's theories and the later Schumpeterian tradition of entrepreneurship provide vital insights into such processes. However, our argument here is that for an understanding of a significant part of entrepreneurship in modern economies we need to build upon these insights – but also go beyond the Schumpeterian entrepreneur. ¹

Our argument in this paper is that despite the richness of the analysis, the Schumpeterian tradition on entrepreneurship has not yet fully taken into account the diffusion, use and creation of knowledge in innovation and entrepreneurship, and its dynamic, evolving and systemic perspective. In this paper we propose an integration of the Schumpeterian tradition with evolutionary theory and the innovation system approach in order to propose a more nuanced definition and view of entrepreneurship, which we call knowledge intensive entrepreneurship.

This paper has been inspired by major empirical evidence: new entrepreneurial firms can be found in a variety of sectors from high tech to traditional industries, and new firms which are also innovative have been a major feature in the economy of most countries. Consequently, these firms have been the center of attention of many empirical studies both in general (see for example Acs et al, 2009; Audretsch and Turick, 2001 and OECD 2008)and regarding specific typologies, such as new technology based firms (for example Colombo et al. 2004), academic entrepreneurship and new engineering based firms (or example Autio, 1997) and new firms active in high technology sectors.

The usual conceptual reference for an economic analysis of new innovative firms is Schumpeter (1934, 1942) Schumpeter's theories and the later Schumpeterian tradition

of entrepreneurship have provided vital insights into the entrepreneurial process. The field of entrepreneurship related to Schumpeter research has evolved quickly, bringing in and analyzing new topics and phenomena (Carlsson et al 2013; Landström et al 2012). Some major themes in this tradition are that opportunities are created rather than discovered (Alvarez et al. 2013); entrepreneurs grasp existing opportunities and create new ones (Shane, 2000; Buenstorf, 2007); and that new firms challenge incumbents and transform the economic system by creating an entrepreneurial regime (Winter, 1984).

Our argument in this paper is that in order to understand these innovative firms active in a variety of sectors and activities, we need to build upon these Schumpeterian insights but also go beyond the Schumpeterian entrepreneur. The reason why we propose the need to go beyond the Schumpeterian entrepreneur, is that despite the richness of the analysis, the Schumpeterian tradition has not taken fully into account two key aspects that are at the base of new firms and innovation in the modern economy: namely knowledge and innovation systems.

On one hand, the modern emphasis on knowledge could be considered a continuation of the Schumpeterian tradition, in that knowledge is closely related to ideas and inventions. On the other hand, however, our emphasis on knowledge goes beyond the existing literature on entrepreneurship, because we focus upon the diffusion, use and creation of knowledge as a process involving both individuals and organizations in their innovation system context. Two important streams of literature, respectively, have inspired our thinking about knowledge in the context of entrepreneurship. One stream regards the role of individual and organizational knowledge. Knowledge – as gained through education, experience and so forth – affects how individual entrepreneurs are able to identify and react to opportunities (Shane 2003; Alvarez 2007). In this perspective, knowledge can be seen as an attribute of the individuals, which enables them to react more swiftly to external signals than competitors. Relatedly, organizational knowledge and learning are related to the way knowledge is absorbed, used and generated by an organization (Nelson and Winter 1982; Dosi et al 2001). Although existing research on organizational learning has been mainly applied to large firms, we are interested in its applicability to new and usually small entrepreneurial ventures. Thus, knowledge is seen as a key aspect enabling the entrepreneurial function and has a system attribute creating opportunities and thereby promoting economic

growth (Acs et al. 2009; Audretsch and Keilbach, 2007; Carlsson et al. 2013; Metcalfe 2004). Since knowledge creation is a collective endeavor - as well as an individual one - we aim to extend existing conceptualizations of entrepreneurship by taking on board innovation systems, in its various dimensions and in their evolution.

This paper presents the concept of knowledge intensive entrepreneurship. This conceptualization is based upon a synthesis and integration of the three different theoretical traditions: the Schumpeterian entrepreneur, evolutionary theory and innovation systems. We combine these traditions, because they are useful in explaining how entrepreneurship is related to individuals' and firm's knowledge in innovation and the innovation system. We recognize that Schumpeter (1949) talked about the entrepreneur as being active in a 'social environment' within large firms, but we wish to go beyond the firm's organizational boundaries to include relationships between the entrepreneur and the institutional environment, based upon a conceptualization that brings together entrepreneurial processes, knowledge and innovation systems. In the second part of the paper, we also provide evidence of the empirical relevance of knowledge intensive entrepreneurship in the economy.

In the next section, we discuss the three building blocks of the concept of knowledge intensive entrepreneurship: the Schumpeterian entrepreneur, evolutionary theory and the innovation system framework. On the basis of the theoretical discussion, in Section 3 we present a stylized process of the dynamics of a knowledge intensive entrepreneurial venture. Then in Section 4 we move to an empirically measurable definition of knowledge intensive entrepreneurship and in Section 5 we provide empirical evidence of the relevance of this type of new firms, of their knowledge intensity and of their interaction with innovation systems. Finally, in Section 6 we briefly discuss the way forward in terms of future research.

2. THE THREE BUILDING BLOCKS IN THE CONCEPTUAL FRAMEWORK

Our conceptualization of knowledge intensive entrepreneurship rests upon three theoretical building blocks: the Schumpeterian entrepreneur, the evolutionary approach to economic change and innovation systems.

2.1 The Schumpeterian entrepreneur

The Schumpeterian entrepreneur represents the main first building block for understanding knowledge intensive entrepreneurship. For the purpose of this paper, three characteristics of the Schumpeterian entrepreneur are relevant.

A first key characteristic is that the entrepreneur is as a visionary and leader, able to implement ideas and inventions into innovations: he/she thereby creates opportunities. A series of debates address whether opportunities are discovered (Kirzner, 1997; Alvarez, Barney 2007) or created (Lachmann 1986; Garud and Karnoe, 2001), or both are active in different contexts. With respect to this topic, studies have been conducted along a variety of perspectives (Short *et. al.* 2010) and have emphasised the differences of the two views in terms of epistemology (Alvarez and Barney, 2010), historical roots, the nature of the entrepreneur and the characteristics of the knowledge involved in the opportunity formation process (Alvarez *et. al.* 2013. In the view of ‘discovered’ opportunities, the opportunities exist, and some individuals and teams can more quickly identify and act upon them. These are often called Kirznerian opportunities. In the view of ‘created’ opportunities, the knowledge and business opportunities do not exist *a priori* but instead come together through the actions of entrepreneurs. These are often called Schumpeterian opportunities.

A second key characteristic is that the entrepreneur is a risk taker, who develops new combinations, and often if not always within an organizational context. The Schumpeterian tradition recognizes entrepreneurship as involving an element of risk taking. In a classic definition, entrepreneurship “pertains to the actions of a risk taker, a creative venturer into a new business or the one who revives an existing business” (Hébert and Link, 1989: 39). In this process of turning ideas and inventions into innovations, Schumpeter was interested in how entrepreneurial individuals act within new companies as well as within large companies – known respectively as Mark I and Mark II types. In carrying out their activities, entrepreneurs must act quickly to take advantage of an opportunity before their competitors do.

A third key characteristic is that the entrepreneur challenges incumbents through creative destruction, and thereby transforms the economic system to foster economic growth and development. Here, the role of the entrepreneur is to introduce new technologies, products, production processes and organizational forms: in this way, he/she destroys common ways of doing things, established products and existing production processes. Entrepreneurship thus leads to competition between entrants and

incumbents as well as changes in market structure, therefore bringing dynamism into the economy. The discussion in Schumpeter (1911) and (1943) portrays several characteristics and dimensions of this process. More recently, the Schumpeterian tradition has linked entrepreneurship to economic growth, by pointing to its role as a knowledge filter (Acs et al 2009). According to this view, the knowledge created in the economy is identified and exploited by the entrepreneur, and this process helps create knowledge spillovers and exploits opportunities. (Alvarez and Barney, 2007; Carlsson et al. 2013).

In sum, the analysis of the Schumpeterian entrepreneur specifies these key aspects of understanding entrepreneurship:

- Carrying out new combinations
- Facing uncertainty – and adapting to change
- Taking risks but also reaping profits
- Acting as a disruptive, dis-equilibrium force, which arises endogenously in the economy
- Driving wider processes of innovation and economic growth.

2.2 Evolutionary theory of economic change

The second building block of our conceptualization is the evolutionary theory of economic change. For evolutionary theory, innovation and dynamics are two fundamental aspects necessary to understand the working of the economy (Nelson and Winter, 1982; Metcalfe, 1988 and Dosi, 1988). Innovation is the driver of economic change. And three basic processes are at the base of the evolution of an economy: the creation of variety, selection and the retention of some key features (Nelson and Winter, 2002; Metcalfe 1988). Innovation and entrepreneurship represent fundamental components of the increase in the variety of products, production processes and organizational settings, and in the selection among companies in industries.

According to evolutionary economic theory, three aspects drive change, namely the creation and use of new knowledge through the exploration and exploitation of scientific and technological opportunities, the learning by individual and organizations,

and the search of new ways of doing things (Dosi and Nelson 2011; Metcalfe 1998; McKelvey 1996; Malerba 1992; Dosi 1988; Nelson 2011).

Within the evolutionary tradition, some contributions have focused on the role of knowledge in entrepreneurship and new firm formation (Loasby, 1999). In particular, entrepreneurs create new knowledge over time (Metcalfe 2004) and change the opportunity sets available through the interaction with the context (Holmén et. al 2007; Holmén and McKelvey 2013). One can also consider that the entrepreneurs act as knowledge filters in the economy (Audretsch and Keilbach 2007; Acs et al. 2009).

Analyzing the types of knowledge in entrepreneurship has also been linked to the experience and the knowledge accumulated by entrepreneurs in their previous activities. The knowledge referred to is usually education and work experience. Therefore, the knowledge accumulated by the founders and teams within an industry, as well as in scientific organization and in downstream or user activities are vital, because such knowledge diffuse also drives firm entry into industries and spinoff formation (Klepper 2016; Agarwal and Shah, 2015; Adams et al. 2016).

Evolutionary theory also claims that different technological regimes – as related to various dimensions of learning and knowledge – characterize the environment in which firms operate. These regimes in turn affect innovation, entry and the dynamics of industries. The key Schumpeterian distinction between an entrepreneurial setting and a routinized setting is defined in relation to innovation and industrial dynamics. This can be associated with different types of technological regimes in different sectors. The first type is characterized by high technological opportunities, low cumulateness of technological advance and low appropriability, which generates high rates of new firms formation and a highly turbulent sectoral environment. The second type is characterized by high technological opportunity but also high cumulateness and high appropriability, which leads to much lower entry of new firms and a more concentrated industrial structure (Winter, 1984 and 1987; Malerba and Orsenigo, 1997 and Breschi et al. 2000).

Finally, evolutionary theory emphasizes the relevance of co-evolutionary processes in the economy, where co-evolution refers especially to processes involves knowledge, organizations industrial structure and institutions (Nelson, 1994; Metcalfe, 2001; Murmann, 2003). As far as entrepreneurship is concerned, the notion of co-evolution

involves the knowledge of the entrepreneurs and the knowledge context that surrounds them. For example, McKelvey (1996) analyzes the co-evolution of scientific knowledge and innovation, which involves large firms and entrepreneurial ventures in order to explain the emergence of a new industry, the biotechnology industry.

In sum, evolutionary theory specifies these key aspects of understanding entrepreneurship:

- A process and a dynamic perspective
- Entrepreneurship as a process of searching and generating new knowledge
- Learning and problem-solving
- Relevance of previous knowledge and experience in affecting entrepreneurship
- Importance of the technological and knowledge context (regimes)
- Co-evolution of knowledge, new firms, industrial structure and institutions

2.3 The innovation system perspective.

Finally, the third building block refers to the role that innovation systems have in affecting entrepreneurship. Entrepreneurs do not act in isolation, but interact with a variety of other actors within specific institutional settings. In particular, research within the innovation system approach has pointed out that in their innovation process, firms interact with a wide range of heterogeneous actors ranging from suppliers and users, scientific organizations, government agencies and financial organizations (Edquist, 1997), each of which has specific knowledge and capabilities, and hence each contributes in a different way to learning and innovation (Lundvall, 2007). These organizations and institutions more broadly shape entrepreneurs' cognition and action and affect their interactions with other agents.

Innovation systems provide the context of learning in terms of sources of knowledge, capabilities that are shared, put together or integrated and channels through which knowledge flows from one actor to another. Therefore, we argue that following this framework, the links and networks of actors are of paramount importance in the innovation process and in the formation and development of entrepreneurship.

Institutions differ greatly in terms of types of impact upon the behaviour of entrepreneurs.

Innovation systems have been studied as primarily consisting of three types, each affecting entrepreneurship in various ways. A first type of innovation system is the national one. National innovation systems have a geographical dimension corresponding to a country including institutions and boundaries, and they were the first ones examined (Freeman, 1987; Lundvall, 1993; Nelson, 1993). National innovation systems affect the generation and diffusion of knowledge and the formation of entrepreneurship through universities and the educational system, public policy, national regulation and standardization. It has been shown that major differences exist in the national innovation system both among advanced countries and amongst emerging and developing countries (Lundvall, 2007). The architecture of the national systems may vary in structure and composition: some actors may be missing or do not have the necessary capabilities, some links may not work properly and mismatches among various parts of the systems may block change. All these factors may affect the innovation and entrepreneurship in a country.

Regional innovation systems represent another type of systems. Here the term regional encompasses the regional, local or cluster level. In regional systems the focus is on the interaction among local firms, clusters and institutions (Cooke 2004; Boschma and Frenken 2009; Boschma and Martin 2010). In regional systems knowledge is shared and exchanged in various ways, which in turn greatly affects the creation of entrepreneurship and the formation of industrial clusters.

Sectoral systems are a third type of systems. They highlight the major differences across sectors in terms of knowledge, non-firm actors and the institutions that support innovation. These differences among industries generate quite different sectoral systems in terms of knowledge base of innovative activities, role of suppliers, users, universities, financial organizations and government agencies, or institutions in terms of regulation, standards or labor markets (Malerba 2002; Malerba, 2004). Therefore entrepreneurship is affected by the specific sectoral system in terms of availability of knowledge, technological opportunities, supporting actors and institutional setting. The sectoral dimension of innovation system has been proven to be relevant in both advanced countries and emerging and developing ones (Malerba and Mani 2009; Lee and Malerba 2016).

Although presented as three types above, national, sectoral and regional systems interact in their effects on entrepreneurship. Entrepreneurship is affected by national system factors in terms of national policies and regulation, by sectoral system in terms of the specific sectoral knowledge actors and institutions which shape entrepreneurship, and finally by regional systems in terms of specific clusters in which new firms operate or regional or local policies and institutions.

In sum, the innovation system perspective specifies these key aspects of understanding entrepreneurship:

- The knowledge, supporting and institutional contexts in which entrepreneurs learn and innovate
- The complementarities in knowledge and capabilities that affect entrepreneurship
- The networks and channels through which knowledge is communicated, shared or generated
- The geographical and sectoral dimensions in which entrepreneurs operate and innovate

2.4 A definition of knowledge intensive entrepreneurship.

Knowledge intensive entrepreneurship is based on these three building blocks: the Schumpeterian entrepreneur, knowledge and evolutionary theory, and innovation systems perspective. From the above discussion we propose the following definition of knowledge intensive entrepreneurial venture:

Knowledge intensive entrepreneurial ventures are new learning organizations that use and transform existing knowledge and generate new knowledge in order to innovate within innovation systems.

This proposed definition of the knowledge intensive entrepreneurial venture implies that knowledge intensive entrepreneurship occurs as a process of learning and problem-solving aiming to benefit from opportunity identification, creation and exploitation. More broadly, this implies that knowledge intensive entrepreneurship involves individuals and organizations acting within knowledge networks and national, regional and sectoral contexts. These networks and contexts define the key

complementarities in capabilities and financial support, the knowledge sources to be used and the channels and types of possible innovative opportunities to be exploited or created.

3. A STYLIZED PROCESS MODEL OF KNOWLEDGE INTENSIVE ENTREPRENEURSHIP

In order to understand how the complex relationships discussed above play out within knowledge intensive entrepreneurship (KIE), this section proposes a process model of the dynamics between the individual, venture, firm and innovation system. The process model and the main variables are illustrated in Figure 1.

INSERT FIGURE 1 ABOUT HERE

a) *Origin*. On the left hand side of the figure, we represent the origin of KIE. The new knowledge intensive ventures originate from individuals and from a variety of organizations - educational organizations, incumbent firms, related industries, universities, public sector or other actors. We characterize the new ventures as being influenced by the entrepreneurs and teams with specific personal traits in terms of individual attributes, education, experience; and being financed in various ways including formal and informal sources such as from personal funds, to banks or other financial organizations, or companies.

b) *Knowledge*. On the upper left hand side of the figure, we place the concept of knowledge. The new venture is started and managed within a certain knowledge context, defined both in terms of knowledge bases needed for entrepreneurial activities and in terms of mechanisms that generate new knowledge.

c) *Opportunities*. In the lower left hand side of the figure, we have put opportunities. By this, we mean that the new venture exploits or creates market and technological opportunities. Literature suggests these processes are quite important during its entry and early development, as well in later managing and developing processes.

d) *Innovation systems*. This is represented by the dark arrows in the center of Figure 1. After its foundation, the new venture is affected by its linkages with innovation

systems, in the initial activities and subsequent growth.² Within innovation systems, we identify first of all actors and networks. For example, in Figure 1 we have isolated universities and research organizations that play a particular role in generating opportunities by creating advancements in new knowledge and technologies. Other key actors identified in Figure 1 are users, who may stimulate or even create entrepreneurship and innovation in various ways and degrees of intensity. They generally do so through knowledge related to market opportunities and customer demands. Suppliers also play a key role in creating knowledge and providing new technologies. Another major actor in Figure 1 is the government, which through various policies exerts a significant influence during the whole entrepreneurial process. Finally, institutions defined in a broad way may provide opportunities or establish enforcements as a result of the interactions among agents (such as contracts). Institutions can range from less binding to more binding, from less formal (such as traditions) to more formal (such as patent law or specific regulations).

In sum, Figure 1 helps specify how innovation systems can influence the entrepreneur's access to resources as well as the individuals' and organizations' perceptions about which innovative opportunities can be developed. They provide links to potential sources of knowledge, new capital, new employees, strategic alliance partners, and service providers. They also allow entrepreneurs to share others' information such as assessments about market and technological opportunities as well as lessons learnt from previous entrepreneurial activities.

e) *Management, business model and organization of KIE ventures.* The big arrow in the center of the Figure identifies the importance of many internal firm attributes, which affect how a specific KIE will develop and grow over time and will perform. The processes associated with the early life and subsequent activities of KIE ventures are affected by the management, strategy and organization of the KIE venture.. These help explain how and why the KIE venture continues to work with dimensions related to origin, knowledge and opportunities, after the firm has been started and develops further over time.

² For clarity of visualization in Figure 1 we have not put the geographical and sectoral dimensions of innovation systems – the national, the regional and the sectoral.

d) *Performance*. This is represented by circle on the middle to far right hand side. Performance is also linked to early events. As a result of the factors related to initial characteristics, knowledge, innovation systems as well as strategy and organization, the new venture will have a specific performance in terms of innovation, profitability and grow. In this paper, the performance of KIE is not discussed nor empirically analyzed.

e) *Selection and dynamics of market structure*. This is represented by the box at the far right hand side. This view of outcome in terms of processes helps highlight that the origin, early development, innovation, performance and growth of KIE has an impact on the selection process, and the dynamics of market structure in a sector. In general, our argument is that KIE fosters competition, challenges established leaders and increases the degree of variety of competences and firms in an industry. New technologies, products, and services can also result in new consumption patterns and create new market opportunities in the form of new goods and services. The implications of selection and the dynamics of market structure are that some KIE ventures will survive and grow, while others will decline and disappear from the scene.

In summary, our definition and process representation considers entrepreneurs as agents involved in using, generating and transforming knowledge, in order to innovate. It also emphasizes that the dynamics of the resources and capabilities of entrepreneurs is conditioned by the linkages and networks related to innovation systems.

4. DEFINING EMPIRICALLY KNOWLEDGE INTENSIVE ENTREPRENEURS

4.1 A measurable definition of KIE

Based on the above conceptual framework, we propose that four empirically measurable dimensions of KIE can be identified. Drawing upon Malerba, Caloghirou, McKelvey and Radošević (2015) and Malerba and McKelvey (2015), we define the following four key dimensions.

The first dimension is that KIE is a *new independent firm*. Given the theoretical role of entrepreneurs as stimulating change and given the need to exclude existing small business owners, a first element to define is the time of establishment, as well as status.

An empirical focus on KIE may concentrate on the early stage of the venture.³ Moreover, the firm should be independent and not a subsidiary or part of an existing organization.

The second dimension is that KIE has to be *innovative*. This is in line with Schumpeter's original focus on entrepreneur as introducing innovations into the market for profit motives. This also excludes firms that are only imitative or selling standardized goods and services. The literature on economics of innovation literature and innovation management has developed quite a few conceptualizations and measures for innovation and innovativeness.

The third dimension is that KIE ventures use *knowledge intensively* in the innovative and competitive process. Given the articulated and multidimensional nature of the modern economy, and how KIE ventures compete, knowledge should be defined broadly. Knowledge can be seen in relation to scientific and engineering knowledge as well as to design and application (area of use) knowledge. Specifically, by the concept of knowledge, we refer to firms, which use knowledge for systematic problem solving and for gaining a competitive advantage. In sum, we consider KIE ventures as knowledge operators, dedicated to the utilization of existing knowledge, the integration and coordination of different knowledge assets, and the creation of new knowledge.

The fourth dimension is that KIE *exploit innovative opportunity*. Opportunities may be driven by the rapid development of (potential) markets and of technology or by the combination of creative knowledge and design. Opportunities tend to emerge over time, as they are identified and tested in the market place. In particular, innovative opportunities can be defined as "the possibility to realize an economic value inherent in a new combination of resources and market needs, emerging from changes in the scientific or technological knowledge base, customer preferences, or the inter-relationships between economic actors" (Holmèn et al 2007).

By including these four dimensions, we propose the following definition of a knowledge intensive entrepreneurship (KIE) venture, which is useful for empirical work:

³ In the analysis presented below in Section 5, it is proposed an eight year window after the formal establishment.

KIE ventures are new firms that are innovative, have significant knowledge intensity in their activity, are embedded in innovation systems and exploit innovative opportunities in diverse evolving sectors and contexts.

This definition of a KIE venture is different from the other definitions of new firms mentioned in the Introduction. In fact, KIE ventures are different from new technology based firms (NTBF) (Colombo et al. 2004; Colombo and Grilli, 2005) or science-based firms, academic spin-offs or engineering-based firms (Autio, 1997) because KIE ventures are not limited to science or advanced technologies. Similarly, KIE ventures are different from firms active in high technology or R&D intensive industries because they are active also in low and medium tech sectors as well as in services. Finally, KIE ventures are not necessarily “gazelles” (Birch 1979; Henreksson and Johanson 2010) because there is no assumption that they are always fast growing.

5. THE EMPIRICAL EVIDENCE ON KNOWLEDGE INTENSIVE ENTREPRENEURSHIP

5.1 The role of innovation and knowledge in entrepreneurship in Europe

In recent years, researchers have attempted to provide extensive empirical evidence on the importance and characteristics of KIE. Among the various contributions, the books by Malerba (2011), McKelvey and Lassen (2013a), McKelvey and Lassen (2013b), Hirsch-Kreinsen and Schwinge (2014) and Malerba, Caloghirou, McKelvey and Radošević (2015) provide a broad empirical overview. They all investigate KIE as a relevant and articulated phenomenon that takes place in different national, regional or sectoral systems.

In this paper, we want to analyze the phenomena, based upon the empirical evidence coming from a large database of 4004 new European firms (younger than 8 years) operating in a large variety of sectors of the economy: the AEGIS database⁴. The survey focused upon KIE ventures, and clearly pointed out that knowledge is a major source of innovation and performance among young European firms. Results of empirical

⁴ AEGIS was a large-scale European Union research project, as specified in AEGIS (2013)

analyses using the survey can be found in Malerba et al. (2015) as well as in a series of forthcoming papers and book chapters. This survey consists of 4,004 responses by new firms to a rich questionnaire concerning the period 2007-2009. The questionnaire include questions on the founder and founding team, the process of firm formation the market environment, the innovation system, the strategy, innovation, the business model and the firms' performance and impact of the economic crisis on the new firm.

INSERT TABLE 1 HERE

The main results of the survey are presented in Caloghirou, Protogerou and Tsakanikas (2015) and are summarized in a few paragraphs. They regard the whole population of new firms and serves as an introductory and exploratory analysis before delving into the examination of KIE ventures, which are a part of the population. In terms of human capital, two out of three new firms (64.9%) have at least one employee with a university degree and half the firms of the sample employ post-graduates.

INSERT FIGURE 2 HERE

The ratio of the sum of all employees with a university degree or Master / PhD degree with respect to the sum of all employees is almost 30% for a university degree and 14% for a Master / PhD, but with significant variation among countries. In general, having a degree is positively related to the likelihood of survival of new firms and firm growth. In terms of sectors, the share of founders who are non-university degree holders is larger for low tech firms (60%) than for high-tech sectors (50%) and knowledge intensive services (KIBS) (28%). The main areas of expertise of the founders are related to tacit knowledge and the skills developed through formal education, but also during their previous employment. More than half of the founders have technical knowledge and 45% have general management skills.

INSERT FIGURE 3 HERE

The most important factor for the formation of the new firms is the professional experience in the same industry, followed by market knowledge and skills. Technical and engineering knowledge in the field along with founders' personal networks

established during their previous career path, are also rated as very important formation factors.

In terms of importance of specific sources of knowledge for exploring new business opportunities, clients or customers are the most important source of knowledge for the majority of firms. Suppliers are the second most important source, followed closely by in-house know how and competitors. Participation in government programmes funded by the EU or national public agencies and external R&D were ranked low. Firms seemed to prefer participating in trade fairs and conferences and reviewing scientific or technical journals rather than establishing collaboration with universities or public research organizations. The results are consistent across countries and sectors, at least for the major factors. However, firms from high tech sectors have generally evaluated all items higher, indicating their stronger effort to acquire knowledge. Firms from KIBS pay more attention to in-house sources of knowledge, whereas firms in low-tech sectors use competitors more as sources of knowledge.

Firms evaluate the extent to which networks contribute to their ability to gain access to a variety of resources such as information, advice and problem solving held by other actors. By far the most important outcome of any networking activity is contacting customers. Selecting proper suppliers is the second most important activity, followed by recruiting skilled labour. Half of the firms have rarely or never participated in any sort of agreement, not even a subcontracting agreement. Only around 20% of the firms often participate in strategic alliances or other technical cooperation agreements and even less (14%), in marketing / export promotion or licensing agreements. Subcontracting is the major type of agreement: however participation to technical agreements is ranked higher than strategic alliances in manufacturing sectors.

In terms of product innovation, the AEGIS results show that only 64% of the sample has introduced a new or significantly improved goods or services during the last three years. These goods and services represented almost 40% of the firms' sales (on average). This activity was not related to any public support initiatives for almost three out of four firms. More than 70% of the firms in the sample introduced some sort of process or organizational innovation during 2007-2009. Two out of three firms reported some R&D activity. Protection of intellectual property is primarily informal or semi-formal, across countries (Caloghirou et al. 2015).

5.2 The evidence on knowledge intensive entrepreneurship

5.2.1 Knowledge intensive entrepreneurship ventures is an empirically significant category of new firms

The above discussion has explored the population of new ventures in Europe and has highlighted the relevance of innovation, knowledge and innovation systems for a large majority of the new 4004 enterprises examined in the survey (Caloghirou et al. 2015; Malerba et al 2015; McKelvey and Lassen 2013a). But within population of these new enterprises examined, how many new firms fit the definition of knowledge intensive entrepreneurship that we have proposed above? We have defined KIE ventures as new firms that are innovative, have significant knowledge intensity in their activity, are embedded in innovation systems and exploit innovative opportunities in diverse evolving sectors and contexts.

In order to identify the differences between KIE ventures and other new firms, we have isolated a set of questions in the survey that can identify the main characteristics of a KIE venture and identify KIE ventures as compared to other new firms. They are:

- Innovative firms** (Q 27): whether the company has introduced new or significantly improved goods or services during the past three years
- Knowledge intensity: Education** (Q 5): whether the educational attainment of the founder was at least a bachelor degree or more
- Knowledge intensity: Skills** (Q 8): Whether the main areas of expertise of the founder(s) were technical and engineering or product design

We consider KIE ventures as those new firms whose founder has an education equal or greater than bachelor and have a technical and engineering knowledge or product design skills. In the total sample of 4004 firms, innovative firms include 2548 firms (Y/N indicator). Firms with Education OR Technological and Design Skills firms include 3858 firms. The combination of these dimensions gives a total of 2454 new firms (out of 4004 firms sampled) that are KIE ventures.

INSERT TABLES 2 AND 3 HERE

From Tables 2 and 3 one can see that KIE ventures are present in all countries and all sectors. As mentioned in the general discussion, KIE ventures are active in leading European countries as well as in less advanced ones. They are present across sectors, that is in high tech as well as in low tech sectors, and in manufacturing as well as in service sectors.

FINDING 1: KIE ventures are an empirically relevant phenomenon and are present across all European countries and all sectors

5.2.2 KIE ventures benefit greatly from innovation systems

In our definition we stated that KIE benefit greatly from being part of innovation systems. In order to prove this point, we base our analysis by selecting three sets of questions that indicate the relationships with the innovation system.

They are:

- **Sources of knowledge** for exploring new business opportunities (Question 24 in the AEGIS survey): the answers are on a scale from 1 (not important) to 5 (extremely important) for the following sources: Public research institutes; Universities; External commercial labs and R&D firms.

- Participation to agreements** (Question 26): scale from 1 (not important) to 5 (extremely important) for the following types of agreements: Strategic alliance, R&D agreement, Technical cooperation agreements

- Contribution to create and sustain competitive advantage** (Question 19): scale from 1 (not important) to 5 (extremely important) for the following links: Establishment of alliances; Networking with scientific research organization; Partnership with other firms.

In the answers to most of the single items in the questions on sources (Q24), participation (Q26) and contributions to competitive advantage (Q19), KIE ventures have answers equal or greater than 3 (on a scale from 1 not important to 5 extremely important), while other new firms do not present such high values for each of the items in the questions.⁵

⁵ The tests were run but the tables are not reported here.

In order to present a result that summarize the previous findings, we have created a synthetic indicator for each group of questions: Q24, Q26 and Q19.

INSERT TABLES 4, 5 AND 6 HERE

As one can see from Tables 4, 5 and 6, the values regarding the relevance of these dimensions related to innovation systems are higher for KIE ventures than for other new firms.

We have also created a super-synthetic indicator that summarizes the results by purring together Q24 and 26. This super-synthetic indicator for KIE and for other new firms is presented in Figure 4.

INSERT FIGURE 4 HERE

Figure 4 indicates that the difference between KIE and other new firms for the super synthetic indicator is significant at 1% and confirms that KIE interact more with the innovation system than other new firms.

FINDING 2: KIE ventures interact more with innovation systems than do other new firms

In order to confirm the previous results, we have conducted additional exercises. First, we have considered all the answers to the question Q24 on the sources of knowledge (and not just the ones selected above and analyzed). In fact Q24 considers all these following sources of knowledge: Customers; Suppliers; Public research organizations; Universities; External labs and R&D firms; Participation in nationally funded research programs; Participation in EU funded research programs, as reported in Figure 5.

INSERT FIGURE 5 HERE

The results of a difference between KIE and other new firms are confirmed: KIE rely more on innovation systems than other new firms. From Figure 5, the difference between the frequency distribution between KIE and other new firms is significant at 1%.

In addition, these results do not change if we use either a more strict indicator of KIE or a broader indicator of KIE, as visualized in Figure 6.

INSERT FIGURE 6 HERE

In the case of a more strict indicator of KIE (which we label SUPER-KIE), the indicator of KIE includes firms that are Innovative (2548) and have Education AND technological AND Design Skills. The total number of firms in this second more restricted sample is 917. The total of firms in the final sample of SUPER-KIE is 643 firms. In the case of a more broadly defined indicator of KIE (which we label BROAD-KIE), the indicator of KIE includes firms that are innovative (2548) and have Education OR technological OR design Skills (3961). The total number of firms in the final sample of BROAD-KIE is 2522 firms. Figure 6 thus shows that there are not major differences in the results for the three indicators.

5.2.3 Differences exist in the reliance on innovation systems for KIE belonging to different countries and sectors

Finally, we explored empirically whether there are differences in the type and importance of innovation systems for KIE that belong to different countries and sectors. As argued above, national and sectoral innovation systems differ across countries and across industries in various ways. Therefore our expectation is that KIE ventures, which are active in different countries or in different industries, should show differences in the type of involvement in the respective innovation systems. We have performed this empirical analysis for the questions on sources of knowledge, participation in agreements and external contribution. Results are indicative that there are differences for KIE that are active in different national systems and sectoral systems, although for reasons of space, results are not reported here. Hence our interpretation is that to create competitive advantages for KIE ventures, they are involved in different national innovation systems and sectoral innovation systems.

FINDING 3: Sectoral and national differences exist in the way KIE relates to innovation systems.

6. CONCLUSIONS AND THE WAY FORWARD

The paper has presented the concept of knowledge intensive entrepreneurship that moves beyond the Schumpeterian entrepreneur. By integrating evolutionary theory and the innovation system approach with the Schumpeterian entrepreneur, we propose that the concept of knowledge intensive entrepreneurship is able to take into account the major roles of innovation, knowledge and innovation systems into the entrepreneurial process.

We have presented the definition of knowledge intensive entrepreneurial ventures as new learning organizations that use and transform existing knowledge and generate new knowledge in order to innovate within innovation systems; and of knowledge intensive entrepreneurship as a process of learning and problem-solving aiming to benefit from opportunity identification, creation and exploitation. We have also presented a detailed process model of knowledge intensive entrepreneurship.

In the second part of the paper we have proposed an empirical definition of knowledge intensive entrepreneurial ventures as new firms that are innovative, have a significant knowledge intensity in their activity, are embedded in innovation systems and exploit innovative opportunities in diverse sectors and contexts. On the basis of this definition we have identified knowledge intensive entrepreneurial ventures among a sample of more than 4000 new European firms. We have found that knowledge intensive entrepreneurial ventures are an empirically relevant phenomenon and are present across all European countries and all sectors; that they benefit more from innovation systems than other new firms do; and that there are national and sectoral differences in the way knowledge intensive entrepreneurial ventures relate to the innovation systems.

From the analysis conducted in this paper, some major research questions emerge and delineate future areas of research along interesting and rich trajectories.

The first one is the need to further work on the identification of the main patterns of knowledge intensive entrepreneurship at the country, sectoral and regional levels.

Research could also concentrate on how innovation systems affect the processes which lead to the generation and selection of the new ventures.

A second trajectory of research regards the analysis of the processes of knowledge generation and transformation by knowledge intensive entrepreneurship. A way forward is to focus upon the interactions between internal learning by entrepreneurs and teams, the development of firm capabilities and the role external networks.

A third trajectory refers to the effects of innovation systems on knowledge intensive entrepreneurship. This means the need to analyze and discuss how and why different national, sectoral or regional systems affect the process of entrepreneurship. And how innovation systems affect the recognition of market and technological opportunities as well as the generation of new opportunities. This could also include a special study on the whole entrepreneurial process and dynamics of market structure as introduced in this paper. In particular the co-evolution between the new venture, knowledge and innovation systems need to be disentangled and examined more in depth.

A fourth trajectory concerns the development of reliable measurements that may link case studies, survey analyses and indicators and that would allow extensive quantitative work at the firm, sector and country level, both over time and across countries and sectors. One aspect is to focus upon the effects of knowledge and innovation systems on innovation, performance and growth, both theoretically and empirically.

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Figure 1: A stylized process model of knowledge intensive entrepreneurship

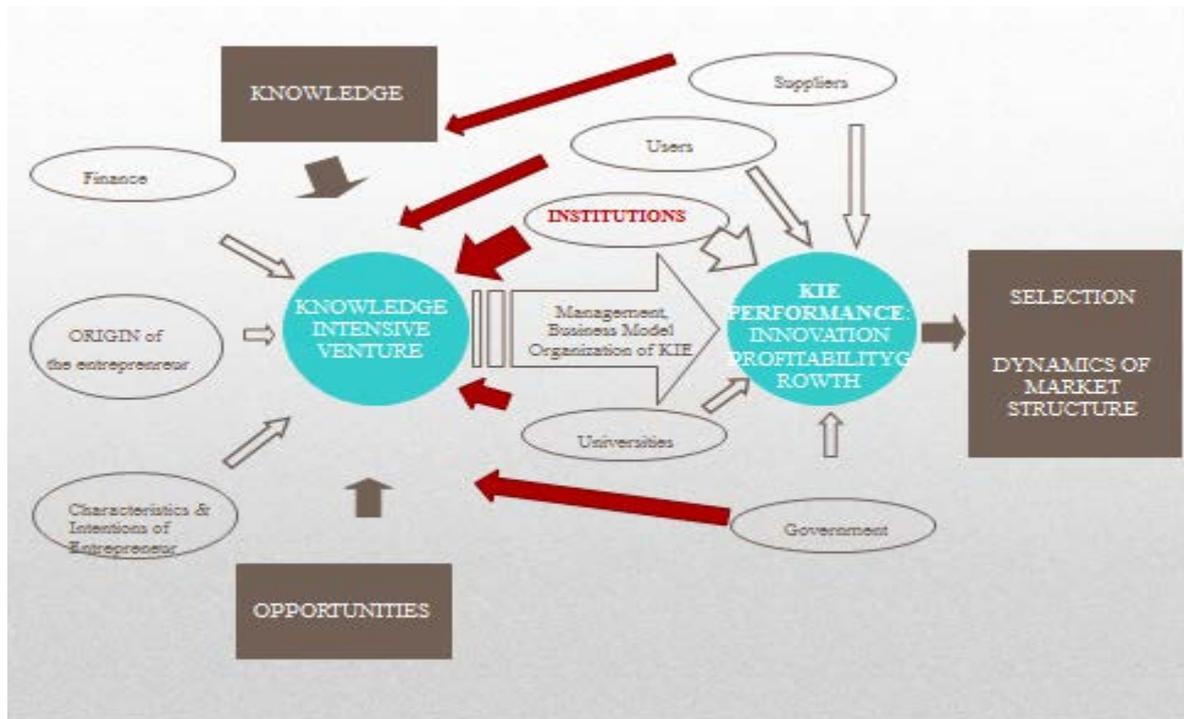
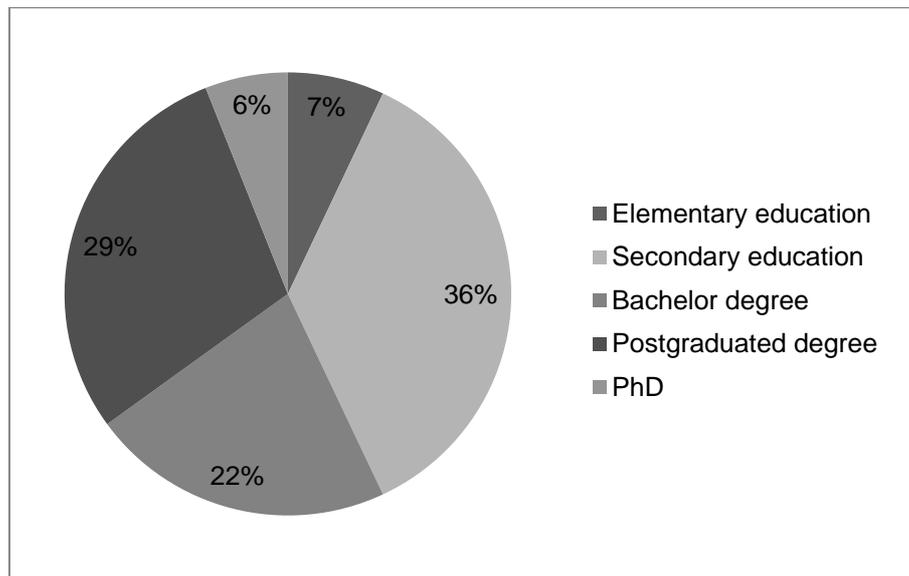


Table 1: AEGIS: Survey responses per country / sectoral group

| | Responses | | | Total |
|----------------|---------------------------|-------------|-------------|--------------|
| | High manufacturing | Low | KIBS | |
| Croatia | 35 | 115 | 50 | 200 |
| Czech Republic | 25 | 92 | 83 | 200 |
| Denmark | 34 | 69 | 227 | 330 |
| France | 68 | 196 | 306 | 570 |
| Germany | 67 | 160 | 330 | 557 |
| Greece | 22 | 184 | 125 | 331 |
| Italy | 57 | 316 | 207 | 580 |
| Portugal | 31 | 170 | 130 | 331 |
| Sweden | 34 | 108 | 192 | 334 |
| UK | 47 | 192 | 332 | 571 |
| Total | 420 | 1602 | 1982 | 4,004 |

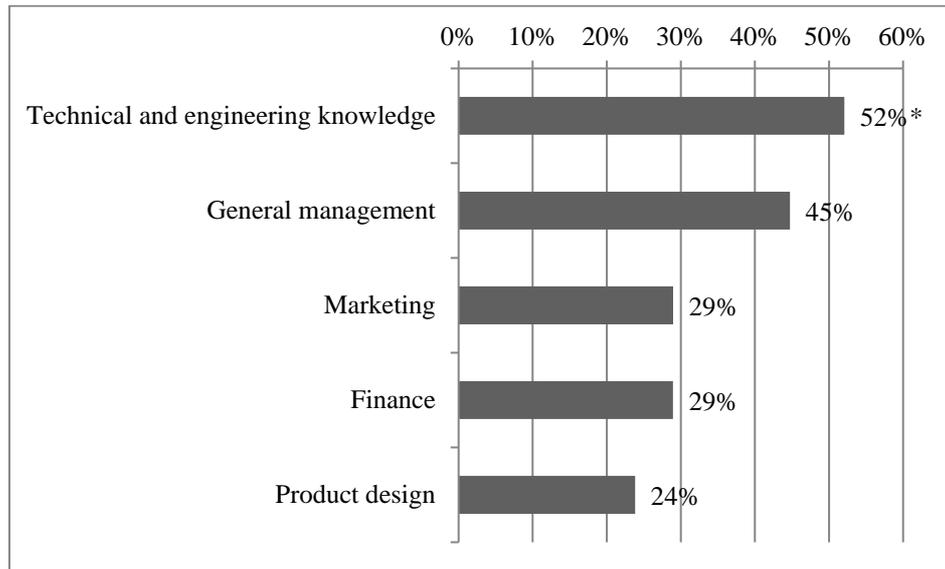
Source: AEGIS survey

Figure 2: AEGIS Survey: Highest educational attainment of founders of new firms (N=7589)



Source: Aegis Survey, Caloghirou et al (2015)

Figure 3: AEGIS survey: Main areas of expertise of the founders of new firms (N=7792)



*The percentages do not add up to 100% due to multiple responses
Source: Caloghirou et al. (2015)

TABLE 2: KIE vs other new firms in various countries

Source: AEGIS

| | KIE | Other New Firms | Total |
|----------------|--------|-----------------|--------|
| Croatia | 64 | 136 | 200 |
| | 4,13% | 5,54% | 5,00% |
| Czech republic | 65 | 135 | 200 |
| | 4,19% | 5,50% | 5,00% |
| Denmark | 136 | 194 | 330 |
| | 8,77% | 7,91% | 8,24% |
| France | 262 | 308 | 570 |
| | 16,90% | 12,55% | 14,24% |
| Germany | 230 | 327 | 557 |
| | 14,84% | 13,33% | 13,91% |
| Greece | 114 | 217 | 331 |
| | 7,35% | 8,84% | 8,27% |
| Italy | 171 | 409 | 580 |
| | 11,03% | 16,67% | 14,49% |
| Portugal | 127 | 204 | 331 |
| | 8,19% | 8,31% | 8,27% |
| Sweden | 132 | 202 | 334 |
| | 8,52% | 8,23% | 8,34% |
| UK | 249 | 322 | 571 |
| | 16,06% | 13,12% | 14,26% |
| Total | 1550 | 2454 | 4004 |
| | 100% | 100% | 100% |

Table 3: KIE vs other new firms in various sectors. Source: AEGIS

| | KIE | Other New Firms | Total |
|-----------------------|---------|-----------------|---------|
| Advertising | 39 | 77 | 116 |
| | 2,52% | 3,14% | 2,90 |
| Aerospace | 1 | 0 | 1 |
| | 0,06% | 0,00% | 0,02 |
| Architectural and eng | 145 | 172 | 317 |
| | 9,35% | 7,01% | 7,92 |
| Basic metals | 10 | 21 | 31 |
| | 0,65% | 0,86% | 0,77 |
| Chemical industry | 15 | 36 | 51 |
| | 0,97% | 1,47% | 1,27 |
| Computer and related | 155 | 363 | 518 |
| | 10,00% | 14,79% | 12,94 |
| Computers and office | 7 | 13 | 20 |
| | 0,45% | 0,53% | 0,50 |
| Fabricated metal prod | 81 | 133 | 214 |
| | 5,23% | 5,42% | 5,34 |
| Food, beverages and t | 110 | 187 | 297 |
| | 7,10% | 7,62% | 7,42 |
| Labor recruitment and | 27 | 17 | 44 |
| | 1,74% | 0,69% | 1,10 |
| Paper and printing | 236 | 382 | 618 |
| | 15,23% | 15,57% | 15,43 |
| Radio-television and | 9 | 26 | 35 |
| | 0,58% | 1,06% | 0,87 |
| Research and experime | 21 | 50 | 71 |
| | 1,35% | 2,04% | 1,77 |
| Selected business ser | 367 | 465 | 832 |
| | 23,68% | 18,95% | 20,78 |
| Technical testing and | 25 | 35 | 60 |
| | 1,61% | 1,43% | 1,50 |
| Telecommunications | 8 | 16 | 24 |
| | 0,52% | 0,65% | 0,60 |
| Textile and clothing | 87 | 122 | 209 |
| | 5,61% | 4,97% | 5,22 |
| Wood and furniture | 101 | 132 | 233 |
| | 6,52% | 5,38% | 5,82 |
| Other | 106 | 207,00 | 313,00 |
| | 6,84% | 8,44% | 7,81 |
| Total | 1550,00 | 2454,00 | 4004,00 |
| | 100,00 | 100,00 | 100,00 |

Table 4: A synthetic indicator for all items regarding the importance of external sources of knowledge

| | Not Important | Important | Total |
|-----------------|---------------|-----------|-------|
| Other New Firms | 1292 | 258 | 1550 |
| | 83,35 % | 16,65% | 100% |
| KIE | 1860 | 594 | 2454 |
| | 75,79% | 24,21% | 100% |
| Total | 3152 | 852 | 4004 |
| | 78,72% | 21,28% | 100 |

* These responses correspond to question 24 in the survey. In this case, important means that all the items have answers of at least important or more (greater or equal to 3).

Table 5: A synthetic indicator for all items regarding the importance of participation in Agreements Knowledge

| | Not important | Important | Total |
|-----------------|---------------|-----------|---------|
| Other New Firms | 1450 | 100 | 1550 |
| | 93,55% | 6,45% | 100,00% |
| KIE | 2059 | 395 | 2454 |
| | 83,90% | 16,10% | 100,00% |
| Total | 3509 | 495 | 4004 |
| | 87,64% | 12,36% | 100,00% |

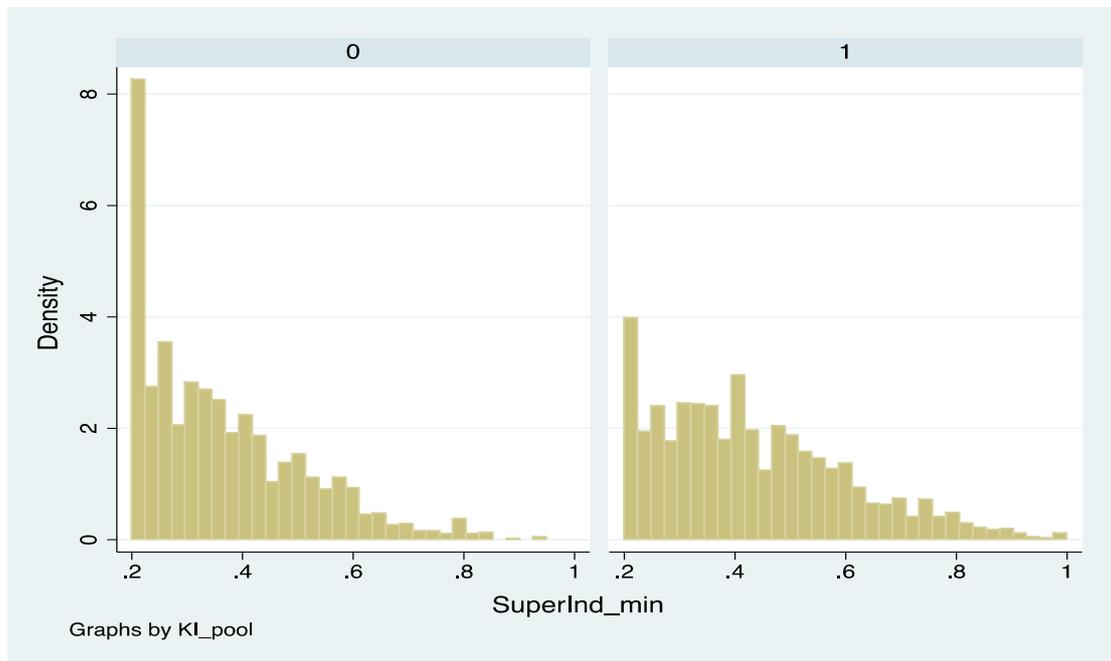
* These responses correspond to part of question 26 in the survey. In this case, important means that all the items have answers of at least important or more (greater or equal to 3).

Table 6: A synthetic indicator for all items regarding the importance of external contribution to create competitive advantage

| | Not Important | Important | Total |
|-----------------|---------------|-----------|---------|
| Other New Firms | 1220 | 330 | 1550 |
| | 78,71% | 21,29% | 100,00% |
| KIE | 1564 | 890 | 2454 |
| | 63,73% | 36,27% | 100,00% |
| Total | 2784 | 1220 | 4004 |
| | 69,53% | 30,47% | 100,00% |

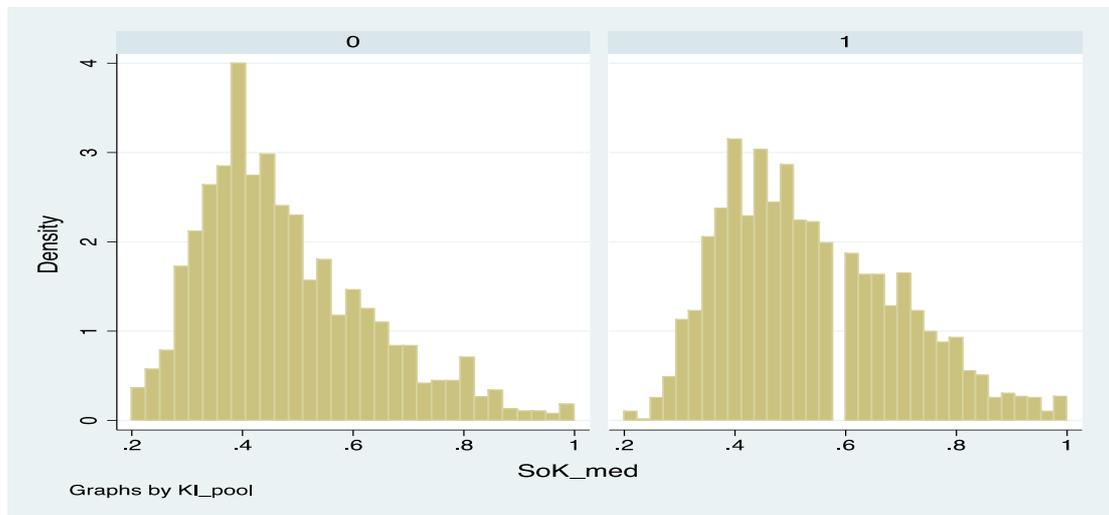
* These responses correspond to part of question 26 in the survey. In this case, important means that all the items have answers of at least important or more (greater or equal to 3).

Figure 4: A super synthetic indicator regarding the importance of external sources of knowledge to the firms



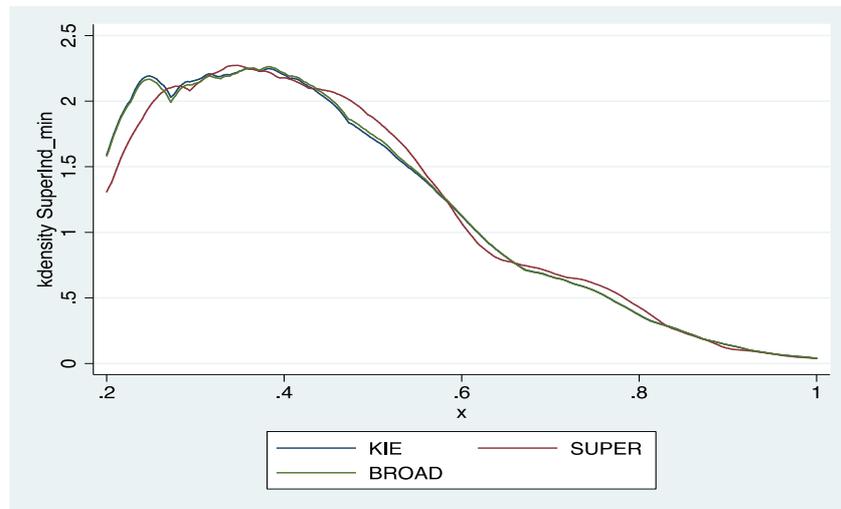
* The indicator is based upon survey questions 24 (4,5,6,11) and 26 (1,2,3). On the horizontal axis, there is the value of the super synthetic indicator while the vertical axis is frequency of each value. other new firms = 0; KIE =1. The results of the Ranksum test indicate that the difference between KIE and other new firms is significant at 1%

Figure 5: A super synthetic indicator regarding the importance of sources of knowledge to the firms



* The indicator is based upon survey question 24 (1,2,4,5,6,9,10,11). On the horizontal axis, there is the value of the super synthetic indicator while the vertical axis is frequency of each value. other new firms = 0; KIE =1. The results of the Ranksum test indicate that the difference between KIE and other new firms is significant at 1%

Figure 6: Comparison of the KIE, SUPER-KIE and BROAD-KIE indicators



* On the horizontal axis, there is the value of the super synthetic indicator while the vertical axis is frequency of each value. other new firms = 0; KIE =1.