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Methodology for Assessing Entrepreneurial Propensity of Technology Intensive Sectors

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Methodology for Assessing Entrepreneurial Propensity of Technology Intensive Sectors

Abstract

The objective of this deliverable is to explore the systemic properties of knowledge-intensive entrepreneurship. We develop: a) analytical framework on the relationship between knowledge intensive entrepreneurship (KIE) and innovation system by developing the concept of entrepreneurial propensity of innovation system, and b) methodology for assessment and measurement of knowledge intensive entrepreneurship at mezzo (sector) level for emerging high technologies.

Content

Executive Summary

This paper is oriented to systemically explore the nature of knowledge-intensive entrepreneurship as a largely distributed and systemic phenomenon, and to investigate the properties of knowledge-intensive entrepreneurship at firm and technology system levels. It develops an analytical framework that links the entrepreneurship research with the innovation systems approach. It also offers a set of detailed guidelines to be used for firm-level surveys, for the analysis of knowledge-intensive entrepreneurship at the level of several selected emerging technologies. In particular, we aim at providing a general framework to analyse how innovation systems affect knowledge intensive entrepreneurship.

Knowledge-intensive entrepreneurship involves a process that translates knowledge into innovation. Knowledge can refer to scientific knowledge, to technological knowledge but also to applied knowledge. Knowledge-intensive entrepreneurship is embedded in innovation systems composed of heterogeneous actors and networks of various types, and shaped by institutions (regulatory systems). Accordingly, it could be considered that entrepreneurship in general, and knowledge-intensive entrepreneurship in particular, constitutes one of the functions of an innovation system, which is also one of its core properties.

The traditional innovation system approaches focus strongly upon the components within the systems, i.e. organizations and institutions. Organizations are the players or actors, while institutions are the rules of the game, constituting constraints to the actions of the organizations or enablers of changes. In this research we refer to this as 'activities' in innovation systems, which are regarded as the determinants of the development and diffusion of innovations. The activities (determinants) influence innovation processes; it is a matter of causality. A satisfactory causal explanation of innovation processes almost certainly will be multi-level and multi-causal, and therefore should specify the relative importance of various determinants. These determinants cannot be expected to be independent of each other, but instead must be seen to support and reinforce - or offset – one another. Hence, it is important to also study the relations among various determinants of innovation processes (i.e. between each of the activities).

Opportunities are at the core of entrepreneurship. What constitutes entrepreneurial opportunity is generally seen as unproblematic. The dominant perspective is that entrepreneurship is a nexus of enterprising individuals and valuable opportunities. Individual differences are seen as crucial in the discovery of entrepreneurial opportunities.

But what constitutes then entrepreneurial opportunities? There is probably not one general answer to this, as it depends on the level (firm, industry, country) as well as on the disciplinary scope of inquiry (business, economics, sociology). In this particular deliverable, we consider three major sources of opportunities:

- Technological opportunities
- Market opportunities
- Institutional opportunities.

Our hypothesis is that entrepreneurship is driven by complementarities arising from the favourable interaction of all three types of opportunities. In the absence of one of these, entrepreneurial opportunities cannot be realised.

In continuation, methodology for assessment of knowledge intensive entrepreneurship at selected emerging high technology levels is suggested.

Introduction

This methodology paper builds on EPIS – Entrepreneurial Propensity of Innovation Systems conceptual framework developed earlier and empirically tested at national level for 27 EU countries in Radosevic and Yoruk (2013). It aims to test EPIS at emerging high technology sectors in the CEECs (i.e. bioenergy, advanced materials and low-Carbon operations in automotive and automotive parts sectors) and thus aims to contribute further to EPIS conceptual framework. The methodology for collecting data is based on surveys at firm level. This methodology paper will be followed by two empirical papers: One on biomass and one on low carbon technologies in advanced materials and automotive and automotive parts technologies. The common methodology presented in this paper may slightly be modified depending on the requirements of the analysis in each empirical paper.

The paper is organised as follows. Section 2 briefly re-visits the EPIS conceptual framework. Section 3 introduces and discusses the indicators that will be used in the analysis to investigate EPIS at technology/sector level. Appendix provides the survey questionnaire that will be used for data collection.

1. Conceptual Framework[1]

The entrepreneurial propensity of innovation system (IS) is its capacity to generate and exploit entrepreneurial opportunities in order to create new knowledge-intensive enterprises, new technologies (innovations) and new knowledge (Radosevic, 2007; 2010; Radosevic et al, 2010; Radosevic and Yoruk 2013). The underlying idea is that knowledge intensive entrepreneurship (KIE) is a *systemic* feature of IS and that new knowledge, innovation and new enterprises are inseparable elements of an entrepreneurial IS.

KIE is embedded in IS, which is composed of heterogeneous actors and networks of various types and is shaped by institutions (regulatory systems). Accordingly, it could be considered that entrepreneurship in general, and knowledge-intensive entrepreneurship in particular, constitutes not only one of the activities (or functions) of an innovation system (Edquist, 2005; Bergek et al, 2008) but also one of its core properties. In that respect, we can distinguish between entrepreneurial experimentation (i.e. new enterprises) as one of the inputs or activities in the IS and entrepreneurial propensity of IS as an outcome variable. In this latter aspect, entrepreneurship (cf. as property of IS) could be understood as a social process rather than solely an individual level activity undertaken by individuals who respond to external opportunities. We consider individuals as an important but overrated 'factor' in the exploitation of opportunities: the opportunities to which individuals 'respond' are *not exogenous but are shaped by them*. So, 'grasped opportunity' could not be really 'grasped' without actively creating it - i.e. shaping that opportunity.

[1] This section is largely based on Radosevic and Yoruk (2013).

The traditional innovation system approach focuses strongly on the components within the systems, i.e. organizations and institutions. Organizations are the players or actors, while institutions are the rules of the game, constituting constraints to the actions of the organizations or enablers of changes (Lundvall, 1992; Nelson, 1993, Breschi and Malerba, 1997; Malerba, 2004). In this research, we refer to 'activities' in innovation systems, which are regarded as the determinants of the development and diffusion of innovations (Edquist, 2005). We do not focus on the variety of organisational forms within and across IS but take a functional (activity) approach to IS (see Hekkert and Negro, 2009). The activities influence innovation processes both individually but also through mutual interaction. These determinants are not independent of each other, but instead support and reinforce – or offset – one another. Hence, in order to understand the entrepreneurial propensity of individual IS, we should study the relations among various determinants of innovation processes (i.e. between each of the activities). Highly complementary activities create a highly entrepreneurial system of innovation while mis-matching activities weaken the entrepreneurial propensity of IS. The more the different activities in the innovation system are congruent, the higher the entrepreneurial opportunities.[2]

Opportunities are at the core of entrepreneurship (Shane and Venkataraman, 2000; Shepherd and DeTienne, 2005; Lumpkin and Lichtenstein, 2005; Wiklund and Shepherd, 2005, 2008; Mitchell and Shepherd, 2010). What constitutes entrepreneurial opportunity is generally seen as unproblematic. The dominant perspective is that entrepreneurship is a nexus of enterprising individuals and valuable opportunities which ultimately leads to good firm performance (Miller 1983; Covin and Slevin, 1989; Lumpkin and Dess, 1996, 2001; Wiklund & Shepherd 2003; Salaran & Maritz 2009). Individual differences and how they interact with external factors are seen as crucial in the discovery of entrepreneurial opportunities. Yet, we argue that from an IS perspective, entrepreneurial opportunities emerge when three major sources of opportunities come together: technological opportunities, market opportunities, and institutional opportunities.

What constitutes entrepreneurial opportunities? There is probably no single general answer, as it depends on the level (firm, industry, country) as well as on the disciplinary scope of inquiry (business, economics, sociology). For example, Shane (2000) considers three major sources of opportunities: technological change, political/regulatory change and social/demographic change. From a SI perspective we consider (see Radosevic, 2010):

- • Technological opportunities
- • Market opportunities
- • Institutional opportunities.

Our main hypothesis is that entrepreneurship at an IS level is driven by complementarities arising from the favourable interaction of all three types of opportunities. This perspective is indeed an integration of three views on entrepreneurship: Kirznerian, Schumpeterian and Listian. In each of these views, entrepreneurship is a function of different driving factors:

- • Kirzner (1973): entrepreneurship = imbalances/ distortions/ asymmetries/ disequilibria in the market;

[2] This resonates well with the long-term perspective on economic growth as expounded by Freeman and Louca (2001) and with Kremer's (1993) O-ring theory of economic development.

- • Schumpeter (1934): entrepreneurship = technological opportunities;
- • List (1909): entrepreneurship = national system of political economy/institutional complementarities or synergies.

For Kirzner (1973), entrepreneurial opportunities are a function of imbalances, distortions, asymmetries and various disequilibria in the market. People use the information they possess to form a new means-ends framework that guides their entrepreneurial action. For Schumpeter (1934), entrepreneurship is a function of innovation opportunities, which are a key precondition for the generation of entrepreneurial rents, and their erosion through subsequent imitation processes. Generating innovation, which is enabled by inventions, is essential in explaining the existence of entrepreneurial opportunities. In our interpretation of List (1909), which here serves as an antecedent to the contemporary institutional economics and systems of innovation approaches, entrepreneurship is a function of the development of a national system of political economy and related institutional complementarities or synergies, which are conducive to entrepreneurship.

Entrepreneurship emerges through the interaction of different opportunities (technological, market and institutional opportunities) and is a systemic property of the IS. Technological opportunities are essential to innovative entrepreneurship as without them product and process innovations could not be developed technically. The question is whether these opportunities are permanent and spatially unlimited or temporary and localised. Research based on Schumpeter has shown that technological opportunities are localised, clustered in specific areas (Kogut and Zander, 1992; Antonelli, 1995) and bunched in specific periods (Perez, 2002). The role of market opportunities is central to entrepreneurship. The type of market opportunities (for example, short- vs. long-term) greatly affects the nature of entrepreneurship that emerges, and in turn is greatly influenced by the role of the institutional system in conveying information and creating incentives among similar or identical technological opportunities. These three types of opportunities cannot generate a dynamic innovation system on their own but only through their mutual interaction. Accordingly, an entrepreneurial IS is one able to nurture and exploit the interactions of these three opportunities. The determinants of opportunities in an IS are individual IS activities like those elaborated in Edquist (2005) (see Figure 1) or Bergek et al (2008).

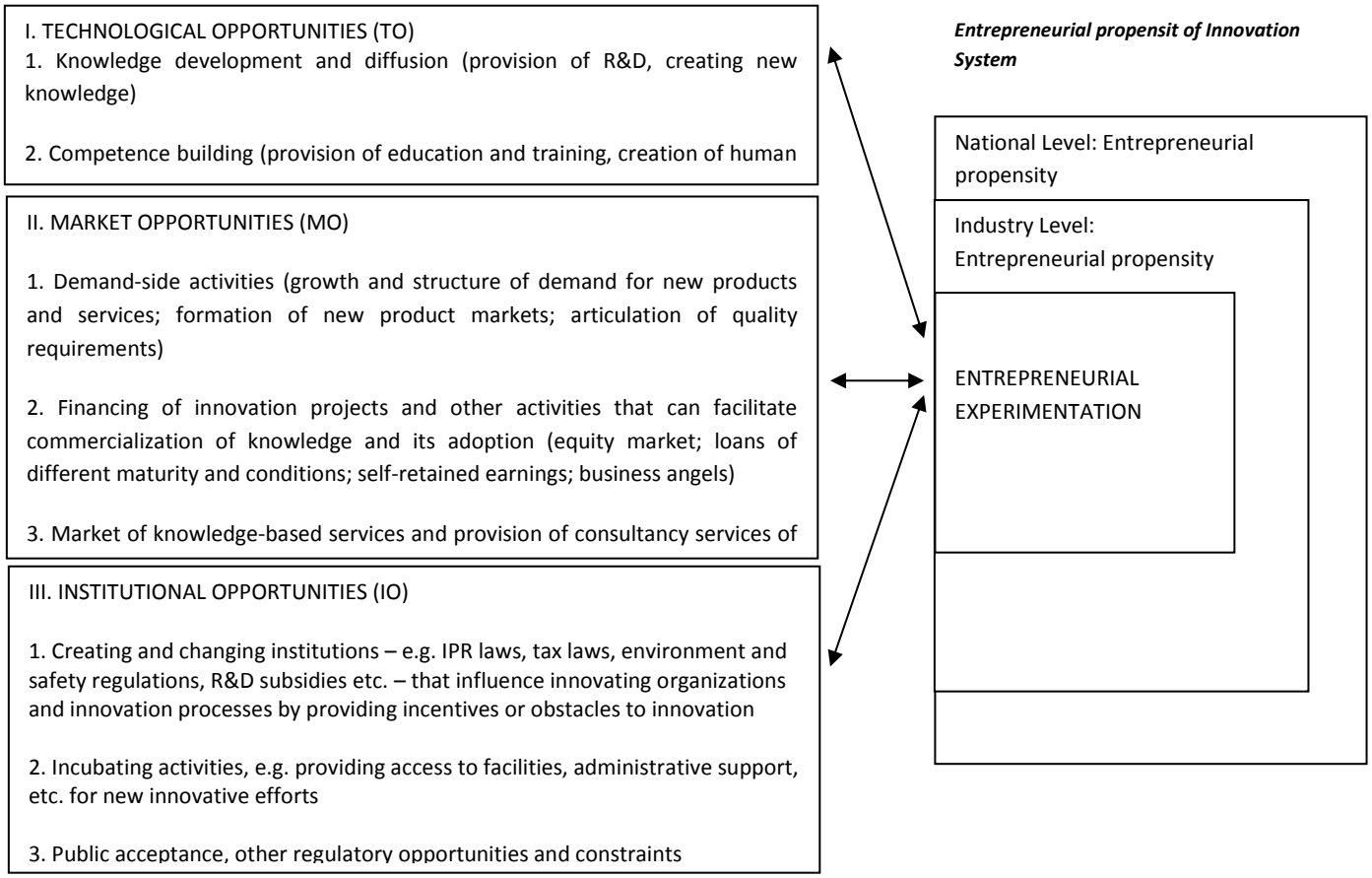
Figure 1 further develops the logic of our approach by depicting the relationships between the different activities in the IS, including entrepreneurial experimentation. These activities are shaped through different types of entrepreneurial opportunities which are not exogenous (as in the mainstream approach) but rather constitutive of the SI. The co-evolution of different activities generates different entrepreneurial propensities of the SI.

From a systemic perspective, knowledge intensive entrepreneurship (KIE) and thus entrepreneurial experimentation also includes new technology and innovation, new knowledge, and new enterprises. These three activities are based on new enterprises and on corporate entrepreneurship and assume the involvement of public organisations. For example, large enterprises play a prominent role as innovators as well as generators of new knowledge. They do not operate independently of knowledge networks many of which are either led or supported by public organisations. Our approach is not concerned with the question ‘who is entrepreneur’ (Gartner, 1988). Who is

performing the entrepreneurial function is a 'secondary' issue compared to the primary issue of identifying whether and what entrepreneurship activity takes place.

Figure 1 indicates our major focus on the issue of how entrepreneurial experimentation contributes to the overall functioning of a sectoral, regional or national IS. The operation of entrepreneurship cannot be understood outside the overall functional set up of a system of innovation, i.e. links with other activities.

Figure 1. The relationship between entrepreneurial experimentation and other activities in an IS.
Opportunities and Activities in the Innovation System



Source: Based on Edquist (2005), Edquist and Chaminade (2006) and Radosevic (2007) and taken from Radosevic and Yoruk (2013).

2. Research Methodology

EPIS conceptual framework has been developed by Radosevic et al. (2010) based on Edquist (2005), Edquist and Chaminade (2006) and Radosevic (2007) and has been tested methodologically and empirically at national level by Radosevic and Yoruk (2013) using a sample of 27 EU countries. In this paper, EPIS framework is re-visited to suit to selected emerging high technology sectors of advanced materials, low-carbon technologies in the automotive and automotive parts and biomass in bioenergy in the CEECs.

2.1. Operationalisation of Concepts

In this research, the concepts of KIE, TO, MO and IO are operationalised by using the manifest indicators in Table 1. The survey questionnaire has been designed in the way that values for each manifest.

Table 1. Indicators used in this research.

Index	Sub-index	Component	Indicators at firm level
Index of Knowledge Intensive Entrepreneurship (KIE)		New enterprises	-Factors effecting entrepreneurial activity -Net entry rate
		Economic Performance	-Sales growth rate during the last five years -Employment growth rate during the last five years
		New technology, innovation and knowledge intensity	-Number of innovations during the last three years -Patents granted -Trademarks granted -ISO9001, 14001 certificates -Royalty and license fees receipts (% of turnover) -Production process sophistication
Index of Knowledge Intensive Entrepreneurial Opportunities IKIEO = TO + MO + IO	Technological Opportunities ITO = RND + SKILL + KNWK	Knowledge development and diffusion	-R&D expenditures (% in turnover) -Royalty and license fees payments (% of turnover) -Availability of latest technologies -Firm-level technology absorption -FDI and technology transfer -Capacity for innovation
		Competence building in skills	-Number of employees (with PhDs, master's, Graduates) -R&D personnel (% in total employment) -Engineers (% in total employment) -Quality of the educational system -Quality of math and science education -Local availability of specialized research and training services -Extent of staff training -Brain drain
		Knowledge and value chain networks	-Importance of cooperation partners in innovation activity -Value chain breadth -Local supplier quantity -Local supplier quality -University-industry research collaboration -Availability of scientists and engineers -Quality of scientific research institutions
	Market Opportunities IMO = DEMAND + FINANCE	Demand side activities	-Share of exports in turnover -Foreign market demand -Domestic market demand -Buyer sophistication: buyer's purchasing decision -Type and importance of customers
		Financing of innovation processes and other activities	-Kind of funding received for a particular research project and its importance -Ease of access to loans -Venture capital availability
	Institutional Opportunities IIO = REGULATION + SUPPORT	Regulatory environment	-Burden of government regulation -Efficiency of legal framework -Transparency of government policymaking -Strength of auditing and reporting standards -IPR protection
		Public support to incubating &other supporting activities	-State of cluster development -Favouritism in decisions of government officials -Wastefulness of government spending -Government procurement of advanced technology products -Opportunity to sell new products in public tenders

The indicators in Table 1 aim to identify and capture the exploitation of opportunities by knowledge intensive entrepreneurial ventures. They suggest a first idea of what kind of knowledge or information we need to understand and collect under each of three types of opportunities.

We will use the conceptual framework structured in Figure 1 to form the basis for this research at the sector and technology level. Despite all the efforts carried out, data for some of the quantitative indicators proves to be difficult to obtain at 4 digit level as we intend to. In that case, we need to rely on information from qualitative data gathered by interviews at firm level and their perception/assessment of the sector they are operating in. We provide the questionnaire so as to develop this qualitative part of the research in Appendix 1. Particularly for the indicators to identify institutional opportunities, World Economic Forum – Global Competitiveness Report (WEFGCR) proves to be an invaluable guide. We use most of its survey questions as tailored to firms in our firm-level questionnaire to understand about the awareness of firms about their institutional environment. Unfortunately, WEFGCR data are available only at the national level and if we were to use this data at national level we need to assume that institutional factors operate equally across different sectors which may not always be the case. On the other hand, indicators that are chosen as proxies are those where we do not expect major sectoral variations. A multiple case study analysis will show whether there are such differences across technologies/sectors.

Below we highlight the indicators that we will use in this research in order to explore the association between KIE and the activities in the innovation system categorized according to entrepreneurial opportunities (see Figure 1). This will allow us to research the co-evolution/complementarities between different types of opportunities (MO, TO, IO) in growth of entrepreneurial ventures in high-tech fields.

2.1.1. Entrepreneurial activities (creating and changing organisations)

Entrepreneurship, defined as creating and changing organisations is one of the ten activities in IS (see Figure 1). In addition to being an activity, entrepreneurship is also a property of IS. This means that we are interested in the analysis of the scale and scope of entrepreneurial activities as they can be depicted from the analysis of structural business statistics through data on new start-ups and exits as well as the introduction of new technologies together with the growth of young firms and changes in innovation activities. However, we are also interested in other activities in IS and how they affect and reflect entrepreneurship. Hence, we are interested in entrepreneurship activities as directly observed through firm demographics as well as indirectly by exploring how different activities in IS makes it more or less entrepreneurially oriented.

We examine knowledge intensive entrepreneurship (KIE) under three components: New enterprises, performance and new technology, innovation and knowledge intensity. The following indicators are the ones we consider to utilise in the qualitative part of the research for the analysis of the entrepreneurial activities:

New enterprises

- Factors affecting entrepreneurial activity: In the survey, in question 19, we asked firms to rate several factors, such as barriers to funding, market access, technological know-how, technological collaboration, finding and keeping skilled employees and barriers created by MNEs, that influence their entrepreneurial activity.

- Number of new entrants and exits into the sector: This is a sector-level indicator used for descriptive purposes. It is not possible to reach such information at this level of technologies (i.e. there is no classification of advanced materials, low-C technologies and biomass in NACE or ISIC) informing us about the number of births of enterprises, number of deaths of enterprises, net business population growth. Q.18 in the survey questionnaire aims to gather information on this aspect of entrepreneurial behaviour. We believe that this attempt serves to its best. We decided to ask such a question to firms, since firms are almost always alert and best informed regarding the new entries and exits into their sector.

Economic Performance

- Total sales (2012, last 5 years' average)
- Sales growth (during the last 5 years and 2012 to 2013)
- Sales growth (very fast, fast, slow, static, declining)(last 5 years' total, 2012 to 13)
- Employment growth rate of the firm: Growth in total number of employees in the firm from start of the firm to date and during the first 5 years. It also differentiates between, growth in number of employees with PhDs and Master's.

New technology, innovation and knowledge intensity

- Number of new products/processes/services introduced onto the market (during the first 5 years, during the last 5 years, in 2012)
- Patent applications by the firm
- Patents received by the firm
- Trademarks held by the firm
- ISO9001 and ISO140001 certificates held by the firm
- Royalty and license fees receipts (% of turnover)
- Production process sophistication (i.e. whether the firm uses mostly labour-intensive production technologies or state-of-the-art technologies, adapted from WEFGCR Q.11.07)

2.1.2. Technological opportunities

Technological opportunities comprise issues such as below. These relate to input indicators for development of new technologies:

- What are R&D strategies of entrepreneurs? How do they exploit the results thereof?
- Do entrepreneurs invest in education and training of their employees or largely rely on externally generated skills? What is the extent of continuous vocational training in the sector?
- What is the situation on labour market in the sector in terms of readily available and skilled personnel?
- What are typical strategies of KIE in the sector in relation to skilled human resources and labour market?

- Who and what are entrepreneurs' sources of knowledge? How do they engage into networking with 'knowledge suppliers' like value chain partners, universities and public R&D?
- Based on these we consider knowledge development and diffusion, skills and knowledge and value chain networks as components of technological opportunities.

Knowledge development and diffusion

The indicators we seek for in this case, intend to capture input indicators related to R&D and other new knowledge creation activities to explore how entrepreneurs influence R&D and other related activities and therefore can exploit the results/outcomes (in the form of product or process development, patents and publications) achieved from such activities.

- R&D expenditures (% in turnover)
- Royalty and license fees payments (% of turnover)
- Firm-level technology absorption (whether firm is aggressive in absorbing new technology or not, adapted from WEFGCR Q. 9.02)
- FDI and technology transfer (If the firm is in a joint venture with a foreign firm or has a foreign partner, sister firm, whether foreign direct investment is an important source of new technology in the firm or not, adapted from WEFGCR Q.9.04)
- Capacity for innovation (whether the firm obtains technology from licensing or imitating foreign companies or by conducting formal research and pioneering their own new products and processes, adapted from WEFGCR Q.12.01)

Competence building

These activities relate to the characteristics of entrepreneurs and the labour force in the KIEs, education and training of the workforce in the firm, creation of human capital, production and reproduction of skills and use of labour markets by the firm. They are operationalised by:

- Skilled labour (with PhDs, Master's, university graduates)
- R&D personnel (% in total employment)
- Engineers (% in total employment)
- Quality of the educational system (whether the educational system with regard to skills in the technology field of the firm meets the needs of a competitive economy or not, adapted from WEFGCR Q. 5.03)
- Quality of math and science education (whether math and science education in schools are among the best in the world or lag far behind most other countries, adapted from WEFGCR Q.5.04)
- Local availability of specialized research and training services (whether specialized research and training services in the technology field are available from world-class local institutions or not, adapted from WEFGCR Q.5.07)
- Extent of staff training (whether the general approach of the firm to human resources is to invest heavily to attract, train, and retain employees or not, adapted from WEFGCR Q. 5.08)

- Brain drain (whether talented people in the firm almost always remain in the firm/country or normally leave to pursue opportunities in other firms/countries, adapted from WEFGCR Q.7.09)

Knowledge networks with institutes and value chain partners

Knowledge networks are important for knowledge acquisition in the firm. We intend to explore entrepreneurs' sources of knowledge and how they engage into networking with suppliers through mechanisms such as value chain and interactive learning in order to innovate. We are also interested in exploring how networks are shaping strategies of KIEs. These are operationalised using the indicators below:

- Importance of co-operation partners in innovation activity
- Importance of kind of innovation co-operation
- Assessment of interactions with partners in the sector
- The nature of collaboration between the KIEs and other firms in the same sector; interactions with universities and research institutes (i.e. whether these interactions are more like technical support or more like strategic alliance aiming at a specific product/process development, or subcontracting etc.)
- Domestic vs. foreign origin of innovation partners
- Degree of the role of users and their involvement in innovation in the sector
- Value chain breadth (whether exporting companies in your technology field are primarily involved in individual steps of the value chain, e.g., resource extraction or production or present across the entire value chain, e.g., do not only produce but also perform product design, marketing sales, logistics and after-sales services, adapted from WEFGCR Q. 11.05)
- Local supplier quantity (whether local suppliers in your technology field are largely nonexistent or numerous and include the most important materials, components, equipment, and services, adapted from WEFGCR Q. 11.01)
- Local supplier quality (whether the quality of local suppliers in your technology field is very poor or very good, adapted from WEFGCR Q.11.02)
- University-industry research collaboration (whether R&D collaboration between the firm and local universities is minimal or intensive and ongoing, adapted from WEFGCR Q.12.04)
- Availability of scientists and engineers (whether scientists and engineers in your technology field in your country are rare or widely available, adapted from WEFGCR Q.12.06)
- Quality of scientific research institutions (whether scientific research institutions related to your technology field (e.g. university laboratories, government laboratories in your country) are nonexistent or the best in their fields internationally, adapted from WEFGCR Q.12.02)

2.1.3. Market opportunities

Market opportunities[3] are based on issues below:

- What are market opportunities in the respective country? Is technological demand sophisticated and performance driven or cost based and standardized?
- Who are major customers of KIE in the sector?
- What are marketing strategies of entrepreneurs?
- Are entrepreneurs able to meet quality requirements from lead users (customers)? And, are they able to meet or foresee demand for new products?
- What is the nature of relationships with buyers and suppliers in terms of knowledge intensity, contractual form and proximity? Are there demanding buyers in the sector that drive or facilitate innovation process? How do network relationships with buyers and suppliers shape the strategies of KI entrepreneurial firms?
- How many enterprises are involved in incubating activities, i.e. supporting activities related to establishment and growth of newly established firms?
- What is the availability of knowledge intensive or consultancy services? Do enterprises rely on external providers of these services?
- What is the availability of finance for establishing new firms in the sector? For growth of new firms?
- What is the availability of finance for innovation projects in terms of maturity and diversity of conditions (bank loans, venture capital, business angels).

Based on these we consider demand-side activities and financing of innovation activities as components of market opportunities.

Demand-side activities

Demand-side activities relate to nature of consumer demand and its degree of technical sophistication, formation of new markets as well as companies' exploitation strategies from a demand perspective; the entrepreneurs' relationships with users and how quality requirements and technical specifications are articulated and formed. The indicators considered for this section are:

- Share of exports in turnover
- Foreign/domestic market demand
- Type and importance of customers
- Buyer sophistication: buyer's purchasing decision (whether buyers make purchasing decisions based solely on the lowest price or based on a sophisticated analysis of performance attributes, adapted from WEFGCR Q.6.15)

Financing of innovation processes and other activities

Finance is an important determinant of market opportunities on both supply and demand side. On supply side, these involve financial sources such as venture capital, bank loans, public funds, etc. that

[3] In our framework market opportunities are about markets of goods and services as well as about capital markets while labour markets are one of determinants of technological opportunities.

can facilitate commercialization of knowledge and its adoption. On demand side, they involve type of market contracts and their terms of financing.

- Kind of funding received for a particular research project
- Ease of access to loans (whether it is easy to obtain a bank loan with only a good business plan and no collateral, adapted from WEFGCR Q.8.03)
- Venture capital availability (whether it is easy for entrepreneurs with innovative but risky projects to find venture capital, adapted from WEFGCR Q.8.04)

2.1.4. Institutional opportunities

Institutional opportunities comprise issues as below:

- What is the regulatory system for doing business for KIE?
  - How easy it is to establish company?
  - How easy it is to employ and make employees redundant?
  - Which is the administrative burden in paying taxes and contributions?
  - To what extent do collateral and bankruptcy laws protect the rights of borrowers and lenders and thus facilitate lending?
  - Are there any procedural requirements for exporting and importing?
  - Which is the efficiency of the judicial system in resolving a commercial dispute?
- How do entrepreneurs influence legitimacy?
- Are IPR practices favourable to knowledge intensive innovators (cf. piracy, copyright etc.)
- Are there regulatory problems in adoption and diffusion of new technology in the sector?
- Are there mechanisms of public support to knowledge intensive (technology based) SMEs like S&T parks, innovation centres and public venture capital?

We consider regulatory environment and supporting activities as two distinct components of the institutional opportunities.

Regulatory environment (Creating and changing institutions)

These relate to effects of regulations in industry like company law, IPR laws, tax laws, environment and safety regulations, R&D support that influence innovation process such as centres of excellence. How regulatory framework affects behaviour of companies, especially in terms of innovation investment? The quality of regulatory environment and extent of regulatory pressures (e.g. regulations on IPR laws, tax laws, environment and safety regulations, R&D investment, IPR practices, etc.), the intellectual property protection in the sector, regulatory obstacles to entrepreneurial activity, barriers in setting up the company in the sector, whether employment laws are reducing the flexibility of employment and how, if there are institutional (regulatory) obstacles to export, etc. fall into this category. WEFGCR survey questions provide very good basis for these issues, thus we ask modified versions of these questions to firms for their assessment of the sector they operate in.

- IPR protection (whether intellectual property protection and anti-counterfeiting measures are weak and not enforced or strong and enforced, adapted from WEFGCR Q. 1.02)
- Burden of government regulation (whether complying with administrative requirements (permits, regulations, reporting) issued by the government is burdensome or not, adapted from WEFGCR Q. 1.08)
- Efficiency of legal framework (whether the legal framework for private businesses to settle disputes and challenge the legality of government actions and/or regulations is inefficient and subject to manipulation or efficient and follows a clear, neutral process, adapted from WEFGCR Q.1.09)
- Transparency of government policymaking (whether firms are usually informed clearly by the government of changes in policies and regulations affecting your industry, adapted from WEFGCR Q.1.10)
- Strength of auditing and reporting standards (whether financial auditing and reporting standards regarding company financial performance are weak or strong, adapted from , WEFGCR Q.1.16)

Public support to incubating and other supporting activities

Here we refer to policy mechanisms of institutional support to new entrepreneurs like business incubators, S&T parks, innovation centres, centres of excellence, industrial parks etc. We intend to explore how entrepreneurs engage in incubating activities and also to publicly supported programs for innovation promotion.

- Favouritism in decisions of government officials (whether while deciding upon policies and contracts, government officials usually favour well-connected firms and individuals or are neutral, adapted from WEFGCR Q.1.06)
- Wastefulness of government spending (whether the composition of public spending is wasteful or efficiently provides necessary goods and services not provided by the market, adapted from WEFGCR Q.1.07)
- State of cluster development (whether well-developed and deep technological clusters are widespread or nonexistent, adapted from WEFGCR Q. 11.03)
- Government procurement of advanced technology products (whether government procurement decisions result in technological innovation or not, adapted from WEFGCR Q.12.05)

2.2. Methods of Analysis and Data

This methodology paper precedes and is linked to two further papers that will present empirical evidence on bioenergy/biomass and low-carbon activities in the manufacturing industry. The analyses will be based on multiple case studies approach with 'firm' as the unit of analysis. Wherever possible multiple case designs are preferred to single case designs since they allow for comparability with another group and/or the control group, thus providing some level of validity and robustness (Lijphart, 1975). Since this research is based on a previously tested and statistically validated theoretical framework (see Radosevic and Yoruk, 2013) a multiple case studies approach can be safely implemented (Yin, 2003).

Our case studies are mainly based on survey questionnaire and greatly supplemented with quantitative data from Amadeus database and web search on companies, technologies and policies regarding specifically the selected technologies.

3. Synthesis and Conclusion

We try to produce synthesis by analysing the mutual relationships between different activities in SI. In doing this we apply the following matrix by answering on the following questions. The matrix works from the top (explanatory) to the left hand-side (dependent).

Table 2. Complementarities between technological, market and institutional opportunities

	Technological opportunity *(Knowledge development and diffusion; Competence building; Knowledge networks)*	**Market opportunities** *(Demand; Finance; Services market)*	**Institutional opportunities** *(regulatory environment; policy support for incubation and growth)*
Technological opportunity *(Knowledge development and diffusion; Competence building; Knowledge networks)*		Are MO, especially demand significant pull for exploitation of TO? Is market sophisticated and does it impose high technology requirements on firms? Is market competitive and conducive to innovation? Is market of specialized knowledge intensive services developed?	Is regulatory environment conducive to generation and exploitation of TO? What specific institutional obstacles limit exploitation of TO?
Market opportunities *(Demand; Finance; Services market)*	Are inter-firm relationships developed and conducive to technology diffusion? Is technological capability in the sector factor of its competitive advantage?		Is regulatory support conducive to exploitation of market opportunities i.e. is regulatory framework market friendly? Are there product market regulations that are inhibiting exploitation of MO?
Institutional opportunities *(regulatory environment; policy support for incubation and growth)*	What policy measures would help innovative capacity of the sector? Is policy targeting the right deficiencies in the sector? Are there regulatory barriers to innovation and entrepreneurship?	What are institutional barriers to entry and exit? Is regulatory environment inhibiting or facilitating exploitation of market opportunities?	

The more the number of activities in the IS that are reinforcing each other or that are complementing each other in terms of quality and effectiveness, we may expect that the more entrepreneurial opportunities the IS will generate. By decomposing entrepreneurial opportunities into technology, market and institutional opportunities and by aggregating activities in IS in these groups we should be able to better understand what the entrepreneurial propensity of IS is – i.e. its propensity to generate entrepreneurial opportunities. However, along with the assessment of the level of the

entrepreneurial propensity the value of our analyses should also contribute in identifying specific obstacles and (mis)matches in the IS whose identification can be useful to innovation policy.

APPENDIX 1

EU FP7 Project GRINCOH - Growth-Innovation-Competitiveness: Fostering Cohesion in Central and Eastern Europe _ Questionnaire[4]

Name of the firm:
Name and job title of the interviewee:
Date of interview:
Country of the firm:

1. What is the foundation date of your firm? ……

2. If your company grew out of another pre-existing organization, how would you characterize the company's relation with the organization of origin currently?
… Corporate spin-out
… University spin-off
… Partner
… Competitor
… Customer
… None of the above. It's an independent company/start-up.

3. Where is your firm located?
… Science/Technology Park
… Incubating Centre/ Technology Development Centre
… Industrial Cluster specific to sector my firm operates in
… Industrial Cluster open to any kind of firm
… None of the above. Independent location.

4. Please estimate the percentage of funding coming from the following sources for starting/establishing your company.

Own financial resources (own savings)	
Funding from family member	
Funding from previous employer (corporate venturing, university incubator technology transfer)	
Business angel	
Venture capital	
Funding from a bank (please specify)_____	
Public funding from national government or local authorities (programs supporting entrepreneurship, etc.) - loan	
Public funding from national government or local authorities (programs supporting entrepreneurship, etc.) – grant	
European Union funds (programs supporting SMEs, etc.)	
Other sources (please specify) ……	
TOTAL	100%

[4] We are thankful to Iciar Dominguez Lacasa for her very helpful comments and remarks in preparation of the survey questionnaire.

5. Please fill in the table below about the employees in your firm (full time equivalents).

	Total number of employees	**Number of employees with university diplomas (college, BSc)**	**Number of employees with Master's degrees (MSc or MA)**	**Number of employees with PhD degrees**
At the start of your firm				
5 years after establishment of your firm				
Currently				

6. Please estimate the scale of growth of sales of your company.

	Total growth during the first 5 years after establishment	**Total growth during the last 5 years**	**Annual growth from 2012 to 2013**
Very fast (more than 20%) ($x > 20\%$)			
Fast (between 10 and 20%) ($10\% < x \leq 20\%$)			
Slow (between 2 and 10%) ($2\% < x \leq 10\%$)			
Static (between minus and plus 2%)($-2\% < x \leq 2\%$)			
Declining (below minus 2%) ($x \leq -2\%$)			

7. Please state the number of innovations (i.e. new products/processes/services) introduced onto the market by your firm. Please differentiate between whether they have been new-to-firm, new-to-country or new-to-world.

	During the first 5 year period after establishment			**During the last 5 year period**			**In 2012**		
	New-to-firm	**New-to-country**	**New-to-world**	**New-to-firm**	**New-to-country**	**New-to-world**	**New-to-firm**	**New-to-country**	**New-to-world**
Number of new products									
Number of new processes									
Number of new services									

Note for Q.7: An **innovation** is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organisation or external relations.

8. What is the share of exports in your turnover?

During the last 5 years	In 2012

9. How many patents/trademarks/ISO9001 certificates has your firm obtained?

	During the last 5 years	In 2012
Patent applications		
Patents hold		
Trademarks hold		
ISO9001 certificates hold		

10. Does your firm conduct design activities? Yes ... No ...
An engineering **design** process is the formulation of a plan to help an engineer at the shop-floor to build a product with a specified performance goal. This process involves a number of steps, and parts of the process may need to be repeated many times before production of a final product can begin.

11. What is the main source of design activity conducted? Please tick as appropriate.
Customers' designs …
Other companies' designs …
Company's own design …
Other (please specify) …

12. What is the average share of **income** from licensing (and royalties) or other form of intellectual assets in your total revenues during the last **5** years? …%.

13. What is your average share of **payments** for licensing (and royalties) or any other form of intellectual assets in your total revenues during the last **5** years? …%

14. Is there a research and development (R&D) unit in your firm? Yes ... No ...
R&D unit is the unit in the firm where the primary function is to conduct research and engineering prototype applications with the sole aim to develop new products and new processes.

15. If there is not an R&D unit, is there a systematic and periodically reconsidered R&D programs/projects to produce new products/processes/services? Yes ... No ...

16. Please estimate the share of R&D expenditures in total sales of your firm.

	During the last 5 year period	In 2012
Share of R&D expenditures in your turnover/sales		

17. Please give information about the R&D personnel (as full time equivalent) employed in your firm.

	Total number of R&D personnel	Total number of engineers
At the start of your firm		
Currently		

Note: The number of **R&D personnel** involves full and part time employees, however, no internships, leasing workers or temporary personnel.

18. Can you estimate approximately how many new firms started operations in your technology field in your country and how many firms closed down during **the last year**?
Estimated number of new firms established .....
Estimated number of firms closed down .....

19. Please evaluate the extent to which the following factors create obstacles in the entrepreneurial activity of your firm:
1=not at all/ 7=to a great extent

	1	2	3	4	5	6	7
Technology risk							
Large sunk investment (Capital stock in which we have invested has limited flexibility – i.e. we cannot serve a sufficiently diversified customer base using this equipment)							
Funding constraints							
Demand or market constraints							
Marketing problems (i.e. lack of marketing and management know-how)							
Lack of technological know-how							
Difficulty in finding partners for technological collaboration (i.e. joint product production, technical assistance, etc.)							
Difficulty in finding employees with technical skills							
Difficulty in keeping employees with technical skills							
Competition and barriers of entry created by large companies (i.e. MNEs)							
Other (please specify) ……..							

20. This question is about technology issues in your firm. Please evaluate the extent (in a scale of 1 to 7) for each statement below.

	1	**2**	**3**	**4**	**5**	**6**	**7**
In your firm, production processes used are (1 = labour-intensive methods or previous generations of process technology, 7 = the world's best and most efficient process technologies)							
Your firm is (1 = not able to absorb new technology, 7 = aggressive in absorbing new technology)							
If your firm is in a joint venture with a foreign firm or has a foreign partner (i.e. a parent firm, sister firm), your foreign partner (1 = brings little new technology into your firm, 7 = is an important source of new technology for your firm)							
Your firm obtains technology (1 = exclusively from licensing or imitating foreign companies, 7 = by conducting formal research and pioneering their own new products and processes)							

21. This question refers to human skills and training. Please evaluate the extent (in a scale of 1 to 7) for each statement below.

	1	2	3	4	5	6	7
The educational system in your country specifically with regard to raising skills in your technology field (1 = does not meet the needs of a competitive economy, 7 = meets the needs of a competitive economy)							
In your country, specialized research and employee training services particularly in your technology field are (1 = not available, 7 = available from world-class local institutions)							
The general approach of your firm to human resources is (1 = to invest little in training and employee development, 7 = to invest heavily to attract, train, and retain employees)							
Your firm's talented people (1 = normally leave to pursue opportunities in other firms, 7 = almost always remain in the firm)							

22. This question is about knowledge networks and the supply chain. Please evaluate the extent (in a scale of 1 to 7) for each statement below.

	1	2	3	4	5	6	7
R&D collaboration between your firm and local universities is (1 = minimal or nonexistent, 7 = intensive and ongoing)							
Scientific research institutions related to your technology field (e.g. university laboratories, government laboratories in your country) are (1 = nonexistent, 7 = the best in their fields internationally)							
Scientists and engineers related to your technology field in your country are (1 = nonexistent or rare, 7 = widely available)							
Local suppliers in your technology field in your country are (1 = largely nonexistent, 7 = numerous and include the most important materials, components, equipment, and services)							
The quality of local suppliers in your technology field in your country is (1 = very poor, 7 = very good)							
If your firm is exporting, you are (1 = primarily involved in individual steps of the value chain, e.g., resource extraction or production, 7 = present across the entire value chain, e.g., do not only produce but also perform product design, marketing sales, logistics and after-sales services)							

23. This question is about your innovation collaboration activities. Please evaluate the importance of the following types of partners for your firm in collaborating specifically to introduce new products /processes /services onto the market. Please fill in the below matrix using a scale from 1 to 7. (1=not important, 7=very important). Please also state whether the partners are of domestic or foreign origin.

	Origin of partner		Type of co-operation						
	Domestic	Foreign	Strategic alliance	R&D agreement	Technical support	Licensing agreement	Subcontracting	Research contract-out	Other (please specify)
University									
Research institute									
Customer									
Supplier									
Parent/sister firm									
Government									
Consultant									
Other (please specify)									

Notes for Q.23:

Strategic alliance is a formal cooperation relationship between two or more parties to pursue a set of agreed upon goals, while remaining independent organizations. The alliance often involves technology transfer (access to knowledge and expertise), shared expenses and shared risk.

R&D agreement is an agreement between firms to jointly undertake research and development activities, in order to pool know-how and to share the costs and risks of inventing new products.

Technical support is the provision of advice and/or skills in the form of specialist personnel, training, scholarships and grants for research and development.

Licensing agreement is a contractual right agreement that gives someone permission to do a certain activity or to use certain property owned by someone else. Licenses protect proprietary rights in software and other computer products. A license allows an intellectual property rights holder (the "licensor") to make money from an invention or creative work by charging a user (the "licensee") for product use.

Subcontracting is signed between the company and an individual or in many cases a business to perform part or all of the obligations of a contract related to a specific project. The incentive to hire subcontractors is either to reduce costs or to mitigate project risks.

Research contract-out is the process of contracting the research and development business function to an external provider such as a university or a research organization.

24. This question is about the nature of demand and finance availability in your technology field. Please evaluate the extent (in a scale of 1 to 7) for each statement below.

	1	2	3	4	5	6	7
Customers of your firm make purchasing decisions (1 = based solely on the lowest price, 7 = based on a sophisticated analysis of performance attributes)							
Your firm sells its high technology products in the domestic market (1=none, 7= almost all production)							
Your firm sells its high technology products in the foreign market (1=none, 7= almost all production)							
How easy is it in your country for a firm with innovative but risky projects to find venture capital? (1 = impossible, 7 = very easy)							

25. Please evaluate the importance of the following types of customers for your company.
1=not at all/ 7=to a great extent

	1	2	3	4	5	6	7
Large firms							
Small and medium sized firms							
Public sector							
Final consumers (e.g. private households, private consumption)							
Other sources (please specify) ……							

26. This question is about the extent of public support in your technology field in your country.
Please evaluate the extent (in a scale of 1 to 7) for each statement below.

	1	2	3	4	5	6	7
In your country's economy, how widespread are well-developed and deep clusters with regard to your technology field? (1 = nonexistent, 7 = widespread)							
Do firms in your technology field have contacts with government officials in your country? (1 = yes, officials usually favour well-connected firms and individuals, 7 = no, officials are neutral)							
The composition of public investment with regard to your technology field in your country is (1 = is wasteful, 7 = efficiently provides necessary goods and services not provided by the market)							
Have you or companies that you know in your technology field been involved in public tenders to sell your new products? (1 = never, 7 = very often)							
With regard to your technology field in your country, government procurement decisions result in technological innovation (1 = strongly disagree, 7 = strongly agree)							

27. Please evaluate the importance of funding coming from the following sources for financing of innovation activities in your firm.
1=not at all/ 7=to a great extent

	1	2	3	4	5	6	7
Own financial resources (own savings)							
Funding from family member							
Funding from a bank							
Public funding from national government or local authorities (programs supporting entrepreneurship, innovation, etc.) - loan							
Public funding from national government or local authorities (programs supporting entrepreneurship, innovation, etc.) – grant							
European Union funds (programs supporting SMEs, etc.)							
R&D tax incentives							
Other sources (please specify) ……							

28. This question is about legal framework and regulations in your technology field in your country. Please evaluate the extent (in a scale of 1 to 7) for each statement below.

	1	2	3	4	5	6	7
Complying with administrative requirements (permits, regulations, reporting) issued by the government in your country is (1 = burdensome, 7 = not burdensome)							
Intellectual property protection and anti-counterfeiting measures in your country are (1 = weak and not enforced, 7 = strong and enforced)							
Financial auditing and reporting standards regarding company financial performance in your country are (1 = extremely weak, 7 = extremely strong, the best in the world)							
The legal framework for private businesses to settle disputes and challenge the legality of government actions and/or regulations in your country is (1 = inefficient and subject to manipulation, 7 = efficient and follows a clear, neutral process)							
Are firms usually informed clearly by the government of changes in policies and regulations affecting your technology field in your country? (1 = never informed; 7 = always informed)							

29. Would you like to receive the final report with the results of the survey?
If yes, please give the e-mail addresses for the reports to be sent to:

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