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LUND UNIVERSITY

REPORT 2012/02

Innovation Systems and Knowledge-intensive Entrepreneurship: Analytical Framework and Guidelines for Case Study Research

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October 2012

This report was prepared for the European Commission under Theme 8 "Socio-economic Sciences and Humanities" of the 7th Framework Programme for Research and Technological Development as part of the AEGIS project. More information about the project can be found at http://www.aegis-fp7.eu/

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EXECUTIVE SUMMARY

This deliverable develops 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 both industry and national level. Based on the notion of entrepreneurial propensity of innovation system we explore the nature of KIE as a largely distributed phenomenon, and provide guidelines on how to investigate the systemic properties of knowledge-intensive entrepreneurship at firm, sector and national levels. Firm level issues are explored in WP 4.2. and hence are not reported here.

KIE is embedded in innovation systems 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 one of the functions of an innovation system, but 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 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 entrepreneurial propensity of individual system of innovation we should study the relations among various determinants of innovation processes (i.e. between each of the activities). Highly complementary activities create highly entrepreneurial system of innovation (SI) while mis-matching activities weaken entrepreneurial propensity of SI.

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. We argue that this approach is not adequate for understanding the relationship between entrepreneurship and SI. From SI perspective, entrepreneurial opportunities emerge as confluence of three major sources of opportunities: Technological opportunities; Market opportunities, and 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.

We provide framework for quantitative assessment of KIE at country level as well as for assessment of knowledge intensive entrepreneurial opportunities. Basically, we approach to KIE as multi-dimensional phenomenon and we propose methodology based on two composite indicators. Within this work package we have agreed that the thrust of analysis will be at the sectoral level and we are conducting analysis of entrepreneurial propensity of two sectors (machine tools and software). With that aim we have developed guidelines for industry case study research which is a combination of quantitative as well as qualitative approach. This methodology also follows the basic logic of our approach based on the notion of entrepreneurial propensity of SI generated through interaction of activities in SI and moulded through three types of opportunities. A satisfactory explanation of entrepreneurial propensity of SI is multi-level and multi-causal, and therefore should specify the relative importance of various determinants at different levels. Hence, our analysis at sector and national level should be complementary though we may not be able at this stage to develop fully multi-level analytical framework which would integrate sectoral studies into national analyses.

AEGIS

Advancing Knowledge-Intensive Entrepreneurship and Innovation for Economic Growth and Social Well-being in Europe

Deliverable Title	**D2.2.1 "Innovation systems and knowledge-intensive entrepreneurship: Analytical framework and guidelines for case study research"**
Deliverable Lead:	UCL, ULUND
Related Work package:	WP2.2 "Knowledge-intensive entrepreneurship and national innovation systems"
Author(s):	Slavo Radosevic (UCL), Esin Yoruk (UCL), Charles Edquist (ULUND), Jon Mikel Zabala (ULUND)
Dissemination level:	Public
Due submission date:	22/11/2010
Actual submission:	19/11/2010
Version	Final
Project Number	225134
Instrument:	Collaborative Project (Large-scale integrating project)
Start date of Project:	01/01/2009
Duration:	36 months

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 both industry and national level.

Project co-funded by the European Commission under Theme 8 "Socio-Economic Sciences and Humanities" of the 7th Framework Programme for Research and Technological Development.

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Guidelines for initial outline

The main goal of this deliverable is to provide a general framework in order to analyse how national innovation systems affect knowledge intensive entrepreneurship. On it, we systemically explore the nature of knowledge-intensive entrepreneurship as a largely distributed phenomenon, and investigate the systemic properties of knowledge-intensive entrepreneurship. Besides, we also develop a set of guidelines to be used for firm-level case studies, for the analysis of knowledge-intensive entrepreneurship at the level of several selected sectors and for analysis of national innovation system activities that affect knowledge-intensive entrepreneurship.

Section 2 in the deliverable offers the definitions of the core concepts in the deliverable, that is, innovation and entrepreneurship. Then it moves on to discuss the different approaches to be found in the literature about innovation systems. In this sense, the relevance of the actors (agents, components) in the system is contrasted with most recent approaches based on the activities (functions) accomplished by these systems. Finally, it introduces the three types of opportunities we consider to be of significance to the study of the phenomenon of knowledge intensive entrepreneurship from a systemic perspective: technological, market and institutional opportunities.

As a result of it, Section 3 describes the analytical framework that allows to link the two streams of research, innovation studies and entrepreneurship studies. In this regard, we talk about the Entrepreneurial Propensity of Innovation Systems.

Section 4 introduces the guidelines we have developed for the realization of the case study research the work package is intended to. On it, we discuss the quantitative and qualitative aspects to be taken into consideration in each of the three types of opportunities discussed above.

Finally, section 5 concludes by offering a synthesis of the contribution of the deliverable, showing which are the complementarities and obstacles of the three types of opportunities considered.

Executive Summary

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1. INTRODUCTION AND DEFINITIONS

This deliverable (2.2.1.) provides the basic definitions (section 2), the analytical framework (section 3) and the guidelines for case study research (section 4) that will govern Work Package 2.2 as a whole.

The objectives of this work-package within the reporting period are as follows:

- To explore systemically the nature of knowledge-intensive entrepreneurship based on a series of related country and sector level studies
- To explore knowledge-intensive entrepreneurship as a largely distributed phenomenon, i.e. dispersed across different types of organizational forms
- To explore systemic properties of knowledge-intensive entrepreneurship at sector and national levels
- To develop a series of case studies about systemic aspects of knowledge-intensive entrepreneurship
- To develop a set of detailed guidelines to be used for analysis of knowledge-intensive entrepreneurship at the level of several selected sectors and for analysis of NIS activities that affect knowledge-intensive entrepreneurship.

No relevant deviations have been produced within this work package since the AEGIS project started.

This deliverable (2.2.1.) provides the basic definitions (section 1), and elements for analytical framework (sections 2 and 3), the analytical framework (section 4), guidelines for exploring knowledge intensive entrepreneurship at national level (section 5) and guideline for case study research at sectoral level (section 6). Annex 7 gives guidelines for interviewing industry experts as part of sectoral case studies.

1.1. Innovation

It is important to define "innovation" explicitly. To say that they are "novelties" is too general and fuzzy. **Innovations are new creations of societal (economic) significance mainly carried out by firms. They can be divided into new products and new processes that are developed and diffused. The products may be material goods or intangible services. The processes may be technological, organizational or marketing ones.**

OECD and Eurostat define innovation as: "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations" (OECD, 2005: 46).

There are essentially four types of innovation identified in the Oslo Manual for measuring innovation: product innovation; process innovation; marketing innovation and organisational innovation. AEGIS aims to explore all this four types of innovation.

1.2. Knowledge Intensive Entrepreneurship

What initially follows in this subsection is a general reflection of relevance for the entire AEGIS project.

"**Knowledge-intensive entrepreneurship**" (KIE) is defined as '*new firms that are innovative, have a significant knowledge intensity in their activity and develop innovative opportunities in diverse sectors. KIE have internal management, business models and organizations that are used in internal-external processes to translate knowledge into innovation*' (Malerba, ppt Lisbon meeting, 27th October 2010).

So, KIE are not **just start-ups**, as in the Global Entrepreneurship Monitor (GEM) survey and in official statistics. They also are not NGOs or existing firms older than 8 years old or standard goods and service providers in traditional industries. Yet, they are **not restricted to certain sectors**, as in high tech classifications. They may be operating in low-tech sectors as new, **innovative** and high knowledge intensity enterprises. They are innovative and are involved in a process that **translates knowledge into innovation**. AEGIS excludes from the analysis corporate entrepreneurship and instead focuses on new firms, innovators and knowledge operators that are involved in systematic, problem solving processes (ibid). Knowledge can refer to scientific knowledge, to technological knowledge but also to applied knowledge. KIE is embedded in innovation systems composed of heterogeneous actors and networks of various types, and shaped by institutions (regulatory systems). Accordingly, and as it will be discussed later (see section 2.3) it could be considered that entrepreneurship in general, and KIE in particular, constitutes one of the functions of an innovation system, which is one of its core properties (Kirzner, 1980). The entrepreneurs/new ventures refer to the perceived returns from innovating (ibid).

One could argue that a better term for "**Knowledge-intensive entrepreneurship**" would be "**Innovative Entrepreneurship**" as it makes a distinction between two kinds of entrepreneurship[1]:

A. Entrepreneurship that involves the development and diffusion of product innovations or process innovations = *innovative entrepreneurship*, and
B. Entrepreneurship that does not involve the above, e.g. when someone starts a new cleaning firm for home services. = *ordinary entrepreneurship* (which is not innovative)[2].

[1] We follow the Eurostat convention that in order to qualify a firm as innovative must have at least one innovation in the last three years.

[2] We can think of a new cleaning company sending in one person to clean a house for 5 hours. This would count for ordinary entrepreneurship. However, we can think about another entrepreneur setting up a cleaning company and sending in 5 people to clean a house in 1 hour. This would not count as new service but as significantly

Indeed, only A or *innovative entrepreneurship* is addressed in the AEGIS project. The distinction between innovative and ordinary entrepreneurship follows Schumpeter's distinction between economic growth as stationary process in terms of unchanged quality of economic activity and development which represent qualitative change. For Schumpeter, in contrast to Kirzner, a new business is not necessarily entrepreneurship. Metcalfe (2004) also thinks that it stretches the notion of entrepreneur too far. For him, "many business ventures are copies of existing businesses whose function is to ensure the continuity of economic activities through time, they are based on knowledge of well-established markets and practices, and in that sense bring nothing new to the economy" (Metcalfe, 2004: 159)[3]. This is not only a philosophical and conceptual but also a definitional and statistical problem, in which case, business demographics data, which measure entrepreneurship very broadly, should be taken as proxies for Kirznerian but not for Schumpeterian entrepreneurship. If we confine ourselves to the Schumpeter-Metcalfe definition, the subset of entrepreneurial firms would be confined to innovation-based firms. So, problems of entrepreneurial function and form are not trivial. They are probably not entirely solvable and their resolution will always be context specific i.e. having in mind the objective of inquiry.

On the other hand, distinction between knowledge intensive or not-knowledge intensive entrepreneurship is also central to the AEGIS project. In addition, there may be cases where distinguishing between innovative and ordinary entrepreneurship may not be a trivial task. For example, there are innovative enterprises that are not necessarily knowledge intensive (KI). Also, there are KI enterprises that are not necessarily innovative. However, a high knowledge intensity increases probability that a firm will recombine the existing knowledge and thus innovate. In short, any dichotomy that we use will have fuzzy boundaries and hence it seems better to use a broader definition for KIE which includes both innovation and knowledge intensity.

Definitions of entrepreneurship have been presented by, for example, Schumpeter (1934) and Kirzner (1973). For Schumpeter, entrepreneurs are also always innovators, but not so for Kirzner for whom entrepreneurship is seen as arbitrageur which re-establishes market equilibrium by exploiting market imbalances. Recently two important currents in this field are to stress "opportunities" and "firm creation" respectively. They are also central to the AEGIS project, which focuses on firm creation and on entrepreneurial opportunities.

According to the first view, entrepreneurs investigate how and why some individuals (Schumpeter, 1934) -or teams- (Schumpeter, 1949) identify (business) opportunities, evaluate them as viable, and then decide to exploit them, whereas others do not. In

improved service due to substantially reduced time and related change in firm organisation. Based on OECD/Eurostat criteria this would be still counted as innovation in services.

[3] It could be argued what Metcalfe regards as bringing nothing new to the economy. In fact, these 'copies' bring employment, growth, sustainability, etc. to the economy. Maybe they are indeed not radical innovators, but as we know, adaptation is also a way to innovate.

turn, the exploitation of these opportunities results in product, firm, industry and wealth creation (based upon Brush et al., 2003; Shane and Venkataraman, 2000; Landström, 2005). According to the second view, entrepreneurship is the creation of organizations, i.e. the process by which new organizations come into existence (Gartner, 1998; Landström, 2005). Among these new organizations, firms are the most central ones.

We will here employ a definition of KIE which is focused on innovativeness, knowledge intensity in firms, firms' creation and new opportunities. Thus, in line with the rest of the AEGIS project we consider KIE as:

- New firms which are innovative
- Firms that have a significant knowledge intensity in their activity, and
- Firms that perceive, capture and respond to new opportunities (i.e. market, technological and institutional opportunities)[4].

The assumption we make within the AEGIS project is that the KI entrepreneurial activity in turn may lead to structural, institutional and societal changes in the innovation system; since entrepreneurs are "agents of change" (Schumpeter, 1934)[5]. In order to emphasize the innovative nature of KIE we will also use the term *innovative KIE*.

(Innovative) **entrepreneurship**[6] is often said to be a missing link in converting knowledge into economically relevant activities and thereby in economic growth (Landström, 2005). However, this is difficult to show empirically in an unambiguous way.

2. INNOVATION SYSTEMS: COMPONENTS AND ACTIVITIES

For the reasons presented in section 2.1, non-firm public organisations do not normally influence the innovation processes directly but influence (change, reinforce, improve) the context in which the innovating firms operate. What then is this context?

[4] This third element of definition is important since firms can be innovative but due to external or internal factors not responding to all entrepreneurial opportunities.

[5] For more details about the relevance of entrepreneurs as drivers of institutional change, the reading of the D.2.3.1 on "Knowledge-intensive entrepreneurship, national systems of innovation and European varieties of capitalism: A conceptual framework" is recommended.

[6] Note that "entrepreneurship" is, of course, not the same as "entrepreneurship research" (Shane and Venkataraman, 2000).

A general, theoretical answer to this question is that the context is all those things that influence innovation processes, i.e. all the determinants of innovation processes.[7] The literature on systems of innovation (SI) shows that the SI approach is largely about the *determinants* of innovation processes – not about their consequences (Edquist, 1997).[8]

The traditional SI approaches, such as Lundvall (1992) and Nelson (1993), focused 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. Recently, some authors have focused more on what **happens** in the systems (Edquist, 2005; Bergek et al., 2008).

One way of addressing what happens in SIs is the following. At a general level, the main or 'overall' **purpose** of SIs is to pursue innovation processes: that is, to develop and diffuse innovations (Palmberg, 2006). From now on, what we call **'activities' in SIs** (for a list of activities, see Box 1) as the determinants of the development and diffusion of innovations. A presence of variety of different types of activities in SI increases chances that the system will be more robust in terms of innovation dynamics. Examples of activities are R&D as a means of the development of economically relevant knowledge that can provide a basis for innovations, or the financing of the commercialization of such knowledge, i.e. its transformation into innovations.

Box 1: Key Activities in Systems of Innovation

I. Provision of knowledge inputs to the innovation process

1. Provision of R&D and, thus, creation of new knowledge, primarily in engineering, medicine and natural sciences.

2. Competence building, e.g. through individual learning (educating and training the labour force for innovation and R&D activities) and organisational learning.

II. Demand-side activities

3. Formation of new product markets.

4. Articulation of quality requirements emanating from the demand side with regard to

[7] We will come back to this later in this section.

[8] This does not contradict the fact that the consequences of **innovations** are extremely important – for productivity growth, employment, the environment, social conditions, military force, etc. But the system of innovation *approach* does not deal with these consequences or does not deal with them in an explicit manner.

new products.

III. Provision of constituents for Sis

5. Creating and changing organisations needed for developing new fields of innovation. Examples include enhancing entrepreneurship to create new firms and intrapreneurship to diversify existing firms; and creating new research organisations, policy agencies, etc.

6. Networking through markets and other mechanisms, including interactive learning among different organisations (potentially) involved in the innovation processes. This implies integrating new knowledge elements developed in different spheres of the SI and coming from outside with elements already available in the innovating firms.

7. Creating and changing institutions – e.g., patent laws, tax laws, environment and safety regulations, R&D investment routines, cultural norms, etc. – that influence innovating organisations and innovation processes by providing incentives for and removing obstacles to innovation.

IV. Support services for innovating firms

8. Incubation activities such as providing access to facilities and administrative support for innovating efforts.

9. Financing of innovation processes and other activities that may facilitate commercialisation of knowledge and its adoption.

10. Provision of consultancy services relevant for innovation processes, e.g., technology transfer, commercial information, and legal advice.

Source: Edquist (2005)

An alternative term for 'activities' could be 'functions'. We have chosen 'activities' in order to avoid the connotation of 'functionalism' or 'functional analysis' as practiced in sociology. Functionalism focuses on the **consequences** of a phenomenon rather than on its **determinants**. The fact that determinants of innovation processes are in focus in the systems of innovation approach - see above - is a strong argument for not using the term 'functions' in this context. (Edquist, 2005: 204). Hence we use the term **activities** as equivalent to **determinants** of the innovation process.

This approach has also been used as a basis for a general definition of a SI. According to this definition **a system of innovation includes "all important economic, social, political, organizational, institutional and other factors that influence the development, diffusion and use of innovations"** (Edquist, 1997: 14; Edquist 2005:

183; Edquist and Hommen 2008: 6)[9]. This definition does not explicitly point to networks or interactions which are central to SI concept. However, Freeman (1987: 1) defines National System of Innovation (NSI) as "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies" highlighting networks and interactions as the core elements of the system. Accordingly, the former definition can be slightly modified in a way that this aspect is taken into account. Hence, we suggest that SI includes 'all important economic, social, political, organizational, institutional and other factors that in **mutual interaction** influence the development, diffusion and use of innovations'.

If a SI definition does not include all the determinants of innovation processes, which of the potential determinants to exclude and why, has to be justified. This is quite difficult since, at the present state of the art, we do not know the determinants of innovation processes systematically and in detail (Edquist, 2005). Obviously, then, we could miss a great deal by excluding some determinants, since they might prove to be very important once the state of the art has advanced. For example, 25 to 30 years ago, it would have been natural not to regard the interactions of organizations as determinants of innovation processes. Now we know that these interactions are important determinants of innovation processes. This definition, moreover, is fundamental to the 'activities-based' approach to studying SIs (Edquist and Chaminade, 2006).[10]

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 (Radosevic, 2007), 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). This simply indicates that causal explanations in the social sciences are extremely complex and very difficult to pursue.

[9] This definition is actually very different from the older ones.

[10] In the SI literature, there is not much explicit discussion of what a "system" (of innovation) actually is. There is such a discussion in Edquist (2005), where also the elements of a SI are specified – *and this discussion can be added here (if called for)*. Another discussion that could be added is to ask the question about exactly which components (organizations and institutions) constitute SI in the Nelson and Lundvall senses. Other scholars talk about innovation systems as involving an "intricate interplay between micro and macro" (Lundvall, 2007: 101). The evident question is what this means in specific terms. We argue that we need these specifications in order to be able to carry out empirical studies of innovation systems. We need to know what to look for, which data, etc. However, there is not even an agreement that knowing the elements of the systems in detail is important. Some people argue that different definitions are OK and that vagueness is an advantage. In our view the SI approach requires more rigorous definitions and approaches.

Since the late 1990s, some authors have addressed issues related to specifying the activities influencing the overall function of SIs (Galli and Teubal, 1997; Johnson and Jacobsson, 2001; Liu and White, 2001). Such a focus on 'activities' within systems of innovation emphasizes strongly what **happens** in the systems – rather than their components. In this sense the activities approach provides a more **dynamic** perspective, and can capture how various activities that influence specific innovation processes may change the performance with regard to these innovations – and thereby how the whole system changes. The dynamism does not come from the mere existence of activities but from their mutual interaction which leads to complementarities or synergies. The activities approach also has a larger potential to point out why a certain system of innovation performs badly - or well - with regard to a certain kind of innovation. A bad performance may result due to 'missing' activities or their inappropriate 'matching'. This is of considerable importance for the design and implementation of innovation policies. The activities approach is simply more useful for **policy** purposes (Chaminade and Edquist, 2006).

Johnson (2001) introduces several benefits for this functional or activity approach towards SIs. First, it provides a tool for setting system borders. Second, it can be used to describe the state of a system, which allows studying its internal dynamics. Third, it also allows for the assessment of the performance of a SI (in Radosevic, 2007: 10).

In this contribution we place greater emphasis on activities than much of the early work on SIs. Nonetheless, this emphasis does not mean that we can disregard or neglect the components of SIs and the relations among them. Organisations or individuals perform the activities; institutions provide incentives and obstacles influencing these activities. To understand, explain and influence innovation processes, we therefore need to address the relations between activities and components, as well as among different kinds of components (i.e. organisations and institutions). However, we believe that understanding the dynamics of each of the activities and the division of labour between public and private organizations in performing them may be a useful departure point for discussing the role of the government in stimulating innovation processes by means of innovation policies.

No consensus has yet emerged among innovation researchers as to which terminology to use and which specific activities to include. This is natural since innovation research has not yet been able to identify in a specific enough manner the determinants of the development and the diffusion of different kinds of innovations. In other words, this trajectory of research is still in an immature stage. The state of the art is simply not advanced enough - what provides abundant opportunities for further research. Box 1 introduces a hypothetical list of ten activities based on the literature and on our own knowledge of innovation processes and their determinants, as discussed in Edquist (2005) and Edquist and Chaminade (2006). The activities are not ranked in order of importance, but the list is structured into four thematic categories: (I) the provision of knowledge inputs to the innovation process, (II) demand side activities; (III) the provision of constituents of SIs and (IV) support services for innovating firms. Each of the different activities may be considered a partial determinant of the development and diffusion of innovations. We may expect this list to be amended based the analysis of SIs in this AEGIS project.

As complementary to Edquist (2005) and Edquist and Chaminade (2006), Bergek et al. (2008) propose a functional dynamics approach to analyzing innovation systems concept. Their 'functions' directly influence the development, diffusion and the use of new technology and thus the performance of SI. Identification of a number of functions was made in an attempt to see whether there was any agreement between SI approaches with regard to what they described 'happened' in the system and if so identify the key processes that they agreed upon. They found that different approaches in the literature on SI shared an understanding of a set of basic 'functions', defined as the contribution of a component or a set of components to the overall function of the IS. However, careful comparison of the taxonomy that we use in this work package and Bergek et al. (2008) taxonomy shows that five out of seven functions in Bergek et al. are broadly similar to those used in our methodology. The two different ones – legitimation and development of externalities – do not seem to be the most relevant in the context of the AEGIS project. Legitimation issues apply primarily to very new technologies where issues of social and political acceptance play major role. We think that 'development of externalities' could not be considered as activity or function in innovation system as it basically constitutes an outcome of interactions in the SI. Also, Edquist (2005) captures the key role of networks and the support services to innovative firms, whereas Bergek et al. (2008: 413) refers to formal and informal networks as a structural component of the technological system (TS). Besides, their role is not clear when the functional pattern of TS is discussed.

3. ENTREPRENEURIAL OPPORTUNITIES[11]

Opportunities are at the core of entrepreneurship (Shane and Venkataraman, 2000). As pointed out by Shane (2003: 10) "the entrepreneurial process begins with the perception of the existence of opportunities, or situations in which resources can be recombined at a potential profit". What constitutes entrepreneurial opportunity is generally seen as unproblematic. The dominant perspective is that entrepreneurship is a nexus of enterprising individuals and valuable opportunities (ibid). Individual differences are seen as crucial in the discovery of entrepreneurial opportunities.

This perspective which pervades research is focused on entrepreneurship as micro phenomena. However, we are interested in entrepreneurship as macro phenomena and hence we find this perspective of limited relevance. In continuation, we try delineate differences between these two perspectives which we will label as 'Individual – opportunities nexus' (I-O) and entrepreneurial propensity of innovation system

[11] This section draws on Radosevic (2007) and on its revisions (Radosevic, 2010).

perspective (EP). For graphic depiction of our argument see Figure 1 below and for its further application see figure 2.[12]

I-O nexus view entrepreneurship as key property of individuals which enables them to discover and exploit new opportunities. From SI perspective we view entrepreneurship as being not only property of enterprising individuals but also property of systems of innovation. Entrepreneurship activity is not only individual level activity but also social activity which is dependent not only on interactions of enterprising individuals but also on structural features of economic system. From entrepreneurship perspective key structural feature of economic system is its capacity to generate different entrepreneurial opportunities independent of individuals' capacity to recognise and exploit them. In summary, within this perspective entrepreneurial activities and entrepreneurial propensities of IS are not derived directly from behaviour of enterprising individuals but from structure of entrepreneurial opportunities and activities in SI.

At the micro level, entrepreneurial opportunities exert their effect through actions of enterprising individuals. However, at the macro level we assume generally enterprising individuals which operate within given structure of entrepreneurial opportunities. These opportunities represent initial conditions which through activities in SI and their interactions generate different entrepreneurial propensities of SI and thus different scales of entrepreneurial activities.

The process or mechanism that links entrepreneurial opportunities with outcomes in terms of entrepreneurial activities and entrepreneurial propensities are **interactions between SI activities or i.e. complementarities**. In general, complementarities are processes when two or more phenomena reinforce each other. More formally, Milgrom and Roberts (1994) define it as a group of activities where doing more of any subset of them increases the returns to doing more of any subset of the remaining activities.

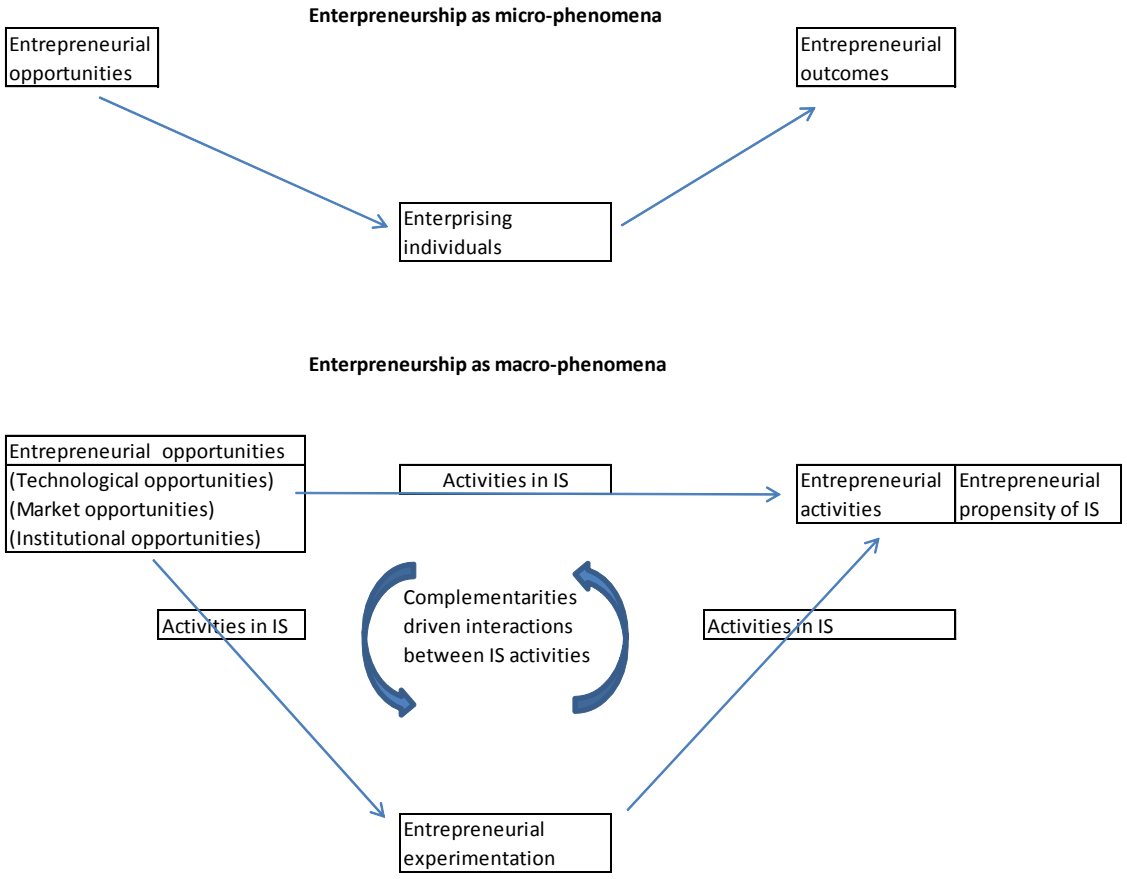
Entrepreneurship opportunities represent initial conditions while activities in SI are moderating the impact of enterprising individuals on entrepreneurship activity. Activities and their mutual interactions and impact on entrepreneurial experimentation as one of activities in SI produces entrepreneurial activities. This chain of interacting mechanisms based on principle of complementarity jointly generates different entrepreneurial propensities of SIs.

Mechanism or process of interaction will be triggered when there are mutually compatible set of opportunities which we have decomposed (see below) on technological, market and institutional opportunities. If there are not mutually compatible set of structural opportunities enterprising individuals by themselves will not be able to generate entrepreneurship activities as SI will not have sufficient

[12] This section of paper has greatly benefited from Mayntz (2004). We are grateful to Hartmut Hirsch-Kreinsen and Isabel Schwinge for drawing our attention to this valuable methodological paper.

entrepreneurial propensity. The individual propensity to entrepreneurship is function not only of individual characteristics (social, psychological, economic etc) but also of **structural (systemic)** features independent of action of individuals. This is different from I – O perspective where entrepreneurial opportunity (EO) appears in the model only as determinant of the action of individuals while entrepreneurial activity is an aggregate effect of entrepreneurially driven individual behaviours reacting on externally given opportunities. In our perspective, entrepreneurial activities and entrepreneurial propensity are caused by structural features of SI as depicted through different activities in SI and their mutual interactions driven by mechanism of complementarities or deterred by missing complementarities. So, unlike I – O perspective we assume that there exist macro-level mechanisms that generate entrepreneurial activities. This is not to deny that entrepreneurial opportunities are not exploited by enterprising individual but only that such framework is not very helpful for understanding entrepreneurship from macro perspective i.e. at sectoral and national levels.

Figure 1: Two views on entrepreneurship



Source: Radosevic (2010)

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). 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:

- 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. This perspective is actually 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 on the market
- 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 posses to form 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.[13] Generation of innovation, which is enabled by the state of 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.

[13] However, inventions or the state of Science and Technology (S&T), which is an important basis for innovation, are exogenous to Schumpeter's model.

3.1. Technological opportunity

For Schumpeter, technology opportunities are exogenous to the economic system as he considers them unlimited, while innovation opportunities are endogenous, i.e. their supply is influenced by market demand (Langlois, 2003). However, as inventions are economically irrelevant unless they are turned into innovations we can conditionally interpret that Schumpeter perceived entrepreneurship ultimately as a function of technological opportunities, which are latent and are exploited in near equilibrium situations.

Schumpeter's bunching hypothesis has been elaborated through analysis of the long-term structural determinants of technological opportunities in Freeman and Perez (1988) and Perez (1983). Perez (2003) develops this further by bringing into the logic of long-term techno-economic structural change, the role of productive and financial capital. Production capital is fixed and knowledge-bounded, while financial capital is flexible and mobile. Their functional separation guarantees dynamism in the market system and produces dynamics related to the coupling and uncoupling of their relationship, which varies along different stages of the technology cycle.

Understanding of technological opportunities has been further enriched through research on sector specific technological regimes in which sector specific differences in technological opportunities operate as one of the determinants of differences in technological regimes (Breschi et al., 2000). Shane (2003) reviews a large literature on entrepreneurship on the basis of which he concludes that "industries differ in the entrepreneurial opportunities that they create, with some industries at some points in time being more fertile grounds for entrepreneurial activity than others" (Shane, 2003: 19). Studies of business demographics (OECD, 2003: Ch. 4) have shown that the cross-industry variation for entry and exit rates is exceptionally high in young ICT related services sectors, but a lot lower in more mature industries. Thus, some of Schumpeter's predictions are corroborated.

In summary, technological opportunities are essential to entrepreneurship as without them product and process innovations could not be realised. The question is whether these opportunities are permanent and unlimited or whether they are localised. Research since Schumpeter has shown that technological opportunities are localised and clustered in specific areas and bunched in specific periods.

3.2. Market opportunity

The role of market opportunities in entrepreneurship is central to the views of the Austrian economists, and especially Kirzner. The point of departure for them is the uneven distribution of economic information across economic agents, which creates multiple arbitrage opportunities in which products and resources are shown to be incorrectly valued in their current uses (Hayek, 1945). The entrepreneur exploits these disequilibria or distortions in the market, to produce a new equilibrium (Kirzner, 1973). Uncertainty and asymmetric information underlie the market process that leads to different perceptions of market opportunities. As prices do not contain information

about future goods and services, future technology and potential new entrant entrepreneurs are forced to make conjectures about the causes of price movements. If their conjectures are correct they have discovered new inter-temporal and inter-spatial differences in demand and supply, which give rise to temporary entrepreneurial rents.

If market opportunities were the only determinant of entrepreneurship we would expect that entries would be driven by relatively high profits in a given industry, and exits would occur primarily in sectors with relatively low profits. Hence, there would be a negative cross-sectional correlation between entry and exit rates. However, a stylised fact in business demographics is that entry and exit rates are generally highly correlated across industries, in both the OECD and the developing countries (Bartelsman et al., 2005). The process of 'creative destruction' that occurs suggests that there are other factors, such as technological and institutional opportunities, that drive the process of new firm formation and exit. Differences in entry/exit rates may also be interpreted as differences in institutional opportunities across different countries controlling for market and technological opportunities. This is not to deny the relevance of market opportunities in understanding the dynamics of entrepreneurship, but rather to point to the multi-dimensional nature of the opportunities.

To sum up, the (non)existence and the type of market opportunities may greatly impact on the nature of entrepreneurship that emerges which in its turn may be greatly influenced by the role of the institutional system in conveying information and creating incentives among similar or identical technological opportunities. Kirzner's analysis is based on an environment in which entrepreneurial opportunities already exist; he does not take account of undeveloped markets. However, in transition and emerging economies and also in new technological areas, the market formation function is usually undeveloped. Market opportunities only exist where needs have been articulated. Yet, the process of articulation is deeply connected to the (non)existence of institutional opportunities.

3.3. Institutional opportunity

Market and technological opportunities have been accepted in the literature as important determinants of entrepreneurship. However, the role of institutional opportunities has not been explicitly taken into account in this context. Both Schumpeter and the Austrian economists abstracted from the institutional context of the market economy, or only briefly touched on this aspect[14] and mainstream treatments of institutions as constraints rather than as opportunity sets of interdependent transacting partners (Schmid, 2004), have played a role. This is somewhat surprising given the current view that without the rule of law, including the

[14] Institutional opportunities relate to 'broad' NIS i.e. they consists of institutions, norms and rules (formal and informal) that affect (directly or indirectly) the innovation process.

property rights and the enforceability of contracts, capitalism might not have been possible (Baumol, 2002; de Soto, 2000). So, any entrepreneurially driven change is deeply institutional in the sense that it requires and induces a series of institutional changes. Entrepreneurship creates new institutional structures, but also becomes a part of them.

As Freeman (1987) has pointed out, the antecedent to the systems of innovation approach was Friedrich List (1909). In his book 'The National System of Political Economy' he was the first to point to the importance of national technological capabilities, to the importance of what we would today call NIS, for individual businesses, and to the trade off between static allocative and dynamic allocative efficiency (Farrell, 1957). So, List was the first to develop the idea that the national system of political economy matters for growth. The NIS is sub-system of the national system of political economy and it embodies the diversity of institutional arrangements, i.e. constraints and opportunities. From the perspective of entrepreneurship, Schmid's (2004) comprehensive work is useful to explain why an IS represents an institutional opportunity. Schmid (2004: 1) defines institutions as "human relationships that structure opportunities via constraints and enablement. A constraint on one person is opportunity for another….Institutions define the opportunity sets of interdependent transacting parties". This understanding of institutions originates from the nature of the technology and products, which generate interdependencies. From our perspective, it is important to consider Schmid's (2004) point that current interdependencies are determined by technology, but also that technology may change them. While creative destruction does play a role Schmid points out that "it is institutions that influence who gets created and who gets benefits and bears the costs" (ibid). In short, we can imagine situations of abundant technological opportunities and market opportunities which are not realized due to pervasive institutional obstacles (Autio, 2009). The interdependencies among agents have not been resolved in a manner that would allow exploitation of market and technological opportunities.

Shane (2003) also elaborates extensively on the effects of the institutional environment on opportunity exploitation. He discusses a variety of variables from the economic environment (income, capital gains and property taxes, economic growth and societal wealth, etc), political environment (freedom, rule of law and property rights, decentralisation of power), socio-cultural environment (social desirability of entrepreneurship, presence of role models and specific cultural beliefs). The role of institutional opportunities in the emergence of new industries has been detailed in the sociological and organisational literature. These works argue that new industries based on radical product innovations, require constitutive legitimacy to flourish (Rao, 2004). Hence, the recognition of legitimation as a function in IS (Bergek et al., 2008).

Thus, we can see that institutional opportunities, although not much theorised in relation to entrepreneurship, are essential in matching technological and market opportunities. The perspectives on institutional opportunities highlighted here suggest that institutions structure interdependencies among agents and thus mediate the coupling between market and technology opportunities. They structure interdependencies among agents.

4. ANALYTICAL FRAMEWORK: ENTREPRENEURIAL PROPENSITY OF INNOVATION SYSTEM

In Section 2 (see Box 1) we identified the activities of an innovation system (Edquist, 2005) and in Section 3 we argued that from a SI perspective entrepreneurship is the outcome of the simultaneous emergence of three types of opportunities – technological, market and institutional (Radosevic, 2007).

In this section, we further develop an analytical framework that will guide the research in this work package as a whole. This framework will be supplemented with guidelines for carrying out the assessment of KIE and knowledge intensive entrepreneurial opportunities at country level (5), actual case studies at industry (5) and firm level (4.2). These will be supplemented with methodology for assessment of knowledge intensive entrepreneurship and knowledge intensive entrepreneurial opportunities at national level (4.3).

We start with grouping the activities in Box 1 according to the framework of entrepreneurial opportunities, which are also central to our definition of knowledge intensive entrepreneurship. In Box 1 activities are grouped based on their functional similarity. Different activities represent or generate different types of opportunities and from the systemic view entrepreneurship could be considered as favourable outcome of interaction of several types of opportunities (Radosevic, 2007). Hence, we will also group activities in SI into market, technological and institutional opportunities (ibid). One can think that determinants of the innovation process also overlap with and represent the activities of the firm divided across market, technological and institutional opportunities in the innovation system. This additional grouping is important as it should improve our understanding on how KIE responds to external market, technology and institutional opportunities but also how it actively generates these opportunities. This suggests another categorization than that of Box 1 which involves all the same indicators and measures (see Table 1).

Table 1. Entrepreneurial opportunities and key activities in the innovation system

Radosevic (2007)	Edquist (2005)
Technological opportunities	Provision of knowledge inputs to the innovation process (provision of R&D, competence building –i.e. individual and organisational learning) Knowledge networks (institute and value chain interactions)
Market opportunities	Demand-side activities (formation of new markets, articulation of new product quality requirements) Market for knowledge based services Financing of innovation processes

Institutional opportunities	Creating and changing institutions (re patents, tax, environment, safety regulations, etc. as incentives or obstacles to innovation) Institutional support for incubation activities (innovation centres; industrial parks etc.)

Entrepreneurship takes place in a systems context and there are close relations between entrepreneurship and innovation. Then first obvious link between entrepreneurship and innovation in the terminology that we are using here, is the fact that activity number 5 out of the Key activities in Systems of Innovation (Box 1) is "Creating and changing organizations". Examples include enhancing entrepreneurship to create new firms and intrapreneurship to diversify existing firms. We defined entrepreneurship as the creation of firms as well as exploitation of entrepreneurial opportunities by firms as measured by their innovativeness, business performance and growth (section 2.2). Hence, entrepreneurship is one of the ten activities in SI (Edquist, 2005).[15] Hence, it is necessary to distinguish between entrepreneurial activities and interaction of entrepreneurial activities and other activities within SI.

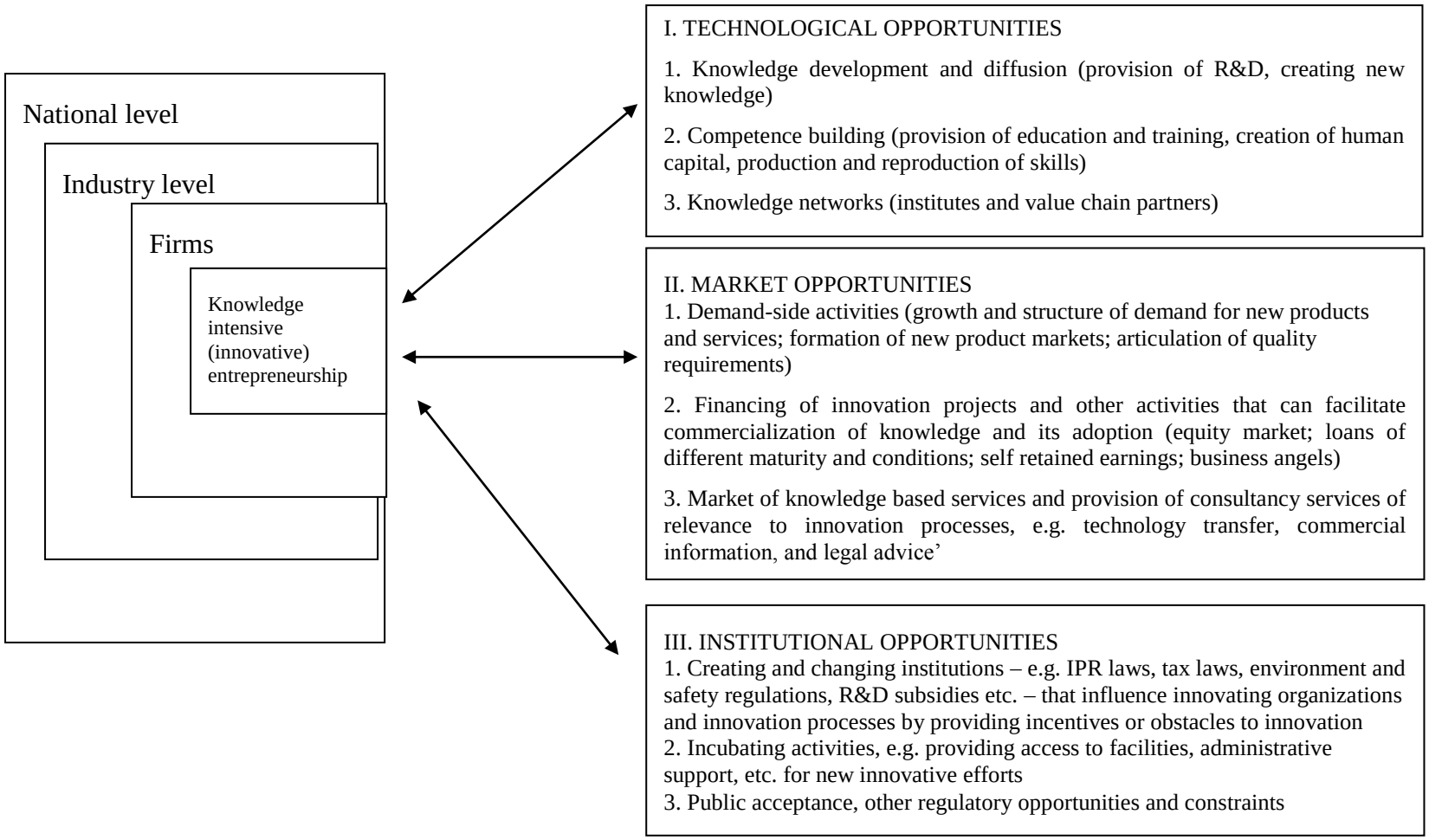
Therefore, we are interested in the interaction/relationship between activity 5 – creating and changing organisations - (see Box 1) which can be considered as the main entrepreneurial activity and other nine activities in an innovation system (i.e. Provision of knowledge inputs to the innovation process; Demand-side activities; Provision of constituents for SIs; Support services for innovating firms) categorized according to the entrepreneurial opportunities.

Their overall interaction should indicate **entrepreneurial propensity of IS** i.e. degrees to which a SI is conducive to entrepreneurship and nature of its propensity. This can be interpreted as the relation between entrepreneurship and all the other activities in SI. This means that there are also the following relations between entrepreneurship and other determinants of innovation processes (activities in innovation systems; see Figure 2) as categorized into technological, market and institutional opportunities, which generate entrepreneurship as a systemic phenomenon embedded in the SI framework. Arrows in Figure 2 indicate the interaction between entrepreneurship as one of activities in SI and other activities in SI which jointly result in different entrepreneurial propensities of firms, industries and national economies.

[15] Bergek et al. (2008) also list 'entrepeneurial experimentation' as one of seven determinants of the development and diffusion of innovations.

Figure 2. The relationship between entrepreneurship as a property of IS and the activities of IS.

Entrepreneurial propensity of Innovation System *Activities in the Innovation System*



Source: based on Edquist (2005), Edquist and Chaminade (2006) and Radosevic (2007).

The bullet points below all have a relation to the identification, creation or capturing/exploitation of opportunities in knowledge intensive activities. They should give a first idea of what kind of knowledge or information we need to understand and collect under each of three types of opportunities.

1. Technological opportunities:

- What are R&D strategies of entrepreneurs? How do they exploit the results thereof?
- How do they protect results of their innovative efforts? Do entrepreneurs publish or patent?
- 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?

2. Market opportunities:[16]

- What are market opportunities in the respective country? Is sectoral 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? Do the KI entrepreneurial firms that are able to meet quality requirements and product novelty expectations increase their market shares?
- 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

[16] 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.

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).

3. Institutional opportunities:

- 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?
    - How easy is it to purchase a property form another business (seller) and to transfer the property to the buyer's name so that the buyer can use the property for expanding its business?
    - 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?
- 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?

In section 5 the analytical framework presented above is supplemented with guidelines for the case study research. The framework is converted into a set of detailed guidelines to be used for national, sectoral and firm level case studies (also see Annex 1). The innovative entrepreneurship is influenced by diverse activities whose entrepreneurial properties should be explored. These relationships determine the entrepreneurial propensity of innovation system. We defined **entrepreneurial innovation system** as the one that (Radosevic, 2007):

- can change the balance between individual and cooperative entrepreneurship, based on changing technological opportunities;
- is able to enhance both aspects of entrepreneurship: market opportunities and alertness, as well as entrepreneurial and technical skills; and

- can resolve the trade-off between generating uncertainty through deregulation, liberalisation and product market reforms, and support for business models and institutions that pool uncertainty.

These properties represent long-term characteristics of SI and can be assessed only in a longitudinal historical research where we can observe changing modes and drivers of entrepreneurship. Our focus in the AEGIS project is medium to short-term, rather than long-term longitudinal. Hence, an entrepreneurial SI is the one that best generates and exploits entrepreneurial opportunities at current technological regime of industry. So, our research will require good understanding of technological regime of industry in terms of knowledge based, technological opportunities, appropriability and cumulativeness.

Based on Breschi et al. (2000) the dimensions of a technological regime are:

- Technological opportunities which reflect the likelihood of innovating for any given amount of money invested in search. High opportunities provide powerful incentives to undertake innovative activities and denote an economic environment that is not functionally constrained by scarcity.
- Appropriability of innovations summarized the possibilities of protecting innovations from imitation and of reaping product from innovative activities. High appropriability means the existence of ways to successfully protect innovations.
- Cumulativeness of technical advance is related to the fact that today knowledge and innovative activities form the base and the building blocks of tomorrow innovations: an innovation generates a stream of subsequent innovations, which are a gradual improvement on the original one, or creates new knowledge which is used for other innovations in related areas.
- The properties of the knowledge base relate to the nature of knowledge underpinning firms' innovative activities. Technological knowledge involves various degrees of specificity, tacitness, complexity and independence and may greatly differ across technologies.

Within the sectoral level analysis of the reserch we will follow sectoral innovation system approach. Following Malerba (2002) sectoral innovation systems consist of:

- *Knowledge base and learning processes* which involve different degrees of accessibility, opportunities, cumulativeness and different knowledge bases (i.e. different technological regimes) (Breschi et al., 2000);
- *Basic technologies, inputs and demand*, with key links and dynamic complementarities;

- *Filiere (development blocks)* which involve type and structure of interactions among firms and non-firms organizations like firms, users, suppliers, non-firm organizations such as universities, financial institutions, government agencies, local authorities, individuals, firms' sub-units (such as the R&D or the production department) and groups of firms (such as industry consortia);
- *Institutions*;
- *Processes of generation of variety and of selection*; and
- *Variety or generation of new firms* as selection reduces heterogeneity via market and non-market selection (public services).

These elements are taken into account in our methodology for sectoral the studies to be undertaken within this WP. However, in the primary research stage we do not need to accommodate our approach to the sectoral systems of innovation perspective. We believe that our functional approach, which is based on interaction between entrepreneurial and other activities (functions), is robust enough to shed light on entrepreneurial propensity of sectoral innovation systems in different countries. It is worth repeating that the aim we follow is to explore whether the entrepreneurial propensity of sectoral systems differs significantly across the 8 countries included in the WP (Sweden, Denmark, UK, Poland, Czech Republic, Croacia, Greece and Hungary) and how these differences can be explained. Hence, we are not aiming to produce a 'standard' sectoral innovation system study as we are much more interested in the entrepreneurial propensity of innovation system and in inter-country differences emerging from different entrepreneurial propensities. Entrepreneurship assumes heterogeneous firms and variety of search and exploitation strategies and hence such analysis should be also based on strong micro-analysis.[17]

Although, our focus is sectoral[18] our conclusions should be of relevance to the national level. So, we suggest that in draft stage of sectoral studies we re-visit whether we want to explore those selected issues at national level which strongly affect results on entrepreneurial propensity of innovation systems.

The sectoral studies to be accomplished within this work package, we have agreed to focus on computer related activities (NACE Rev.1.1 K72) and manufacture of machine tools (NACE Rev.1.1 DK29.4) as the two sectors under analysis. As Shane (2003: 19) observes "industries differ in the entrepreneurial opportunities that they create, with some industries at some points in time being more fertile grounds for entrepreneurial activity than others". The choice of these sectors is the compromise of several factors which have to do with data availability, previous studies on different industries, AEGIS project criteria and the need to look at the knowledge intensive

[17] This will be particularly given attention in WP 4.2, for which separate methodology for analysis of pairs of successful and less successful KIEs have been developed.

[18] The sectoral approach followed in this WP will be complemented with firm level analysis in WP 4.2.

sectors as well as the relevance of the sectors for the countries considered. The guidelines for industry case study research we have developed (see also Annex 1) provide generic views and should hence be need revised in every country analysis in order to adapt them to particularities in each of the 8 countries. In particular, emphasis should be put on the features of technological regimes in terms of the nature of the technology, competition and organisational landscapes. In addition, the broader national context in which the industry operates should also be introduced, which will represent the framework of incentives and constraints as well as the framework or enabling and hindering factors. Finally, we should bear in mind that the current version of methodology is very much product of deductive reasoning i.e. methodology is developed based on new conceptual developments within innovation studies literature. It is expected that the final version of methodology will be developed during the course of the work on study of the two sectors as many of required insights into viable methodology can be generated only by applying it to the real industry context.

We are hoping that the empirical analyses of these two sectors in each of 8 countries should give us good empirical basis for assessing entrepreneurial properties of SI in different countries. It is unlikely that these properties can be derived through a set of simple indicators but more likely through the combination of quantitative and qualitative analysis. The entrepreneurship is multidimensional phenomenon and cannot be entirely captured at one level only. Although it emerges as an individual 'act' it is also systemic phenomenon i.e. shaped and conditioned by a variety of macro, meso and micro factors (Dopfer et al., 2004). The sectoral level should enable us better comparative perspective as technology and industry can be kept relatively constant. In addition, industry level enables us to capture diversity of entrepreneurial strategies in a specific industry context.

What is entrepreneurial propensity of a SI? In the context of KIE it is capacity of a SI to generate new enterprises in knowledge intensive sectors, to generate sales based on innovation and to increase its knowledge intensity.

5. METHODOLOGY FOR ASSESSMENT OF COUNTRY LEVEL KNOWLEDGE INTENSIVE ENTREPRENEURSHIP AND KNOWLEDGE INTENSIVE ENTREPRENEURIAL OPPORTUNITIES

In our original research plan we did not prioritise research at national level. The assumption was that the issue of entrepreneurial propensity is difficult to handle at national level in comparative and quantitative manner. However, as we progressed in research at industry level we the decided to try to develop a set of indicators which would be (however imperfect) proxies for KIE activities as well as proxies of KIE opportunities. This was motivated primarily by our wish to make national analyses of entrepreneurial propensities of IS comparable and coherent. Hence, this methodology should be seen not as replacement for qualitative analysis but as its supplement.

National knowledge intensive entrepreneurship is country's capacity to generate new enterprises in knowledge intensive sectors, to generate sales based on innovation and to increase its knowledge intensity.

When comparing the performance of countries on different dimensions, a typical composite indicator will take the form (Freudenberg, 2003: 7):

$I = \sum_{i=1}^{n} w_i X_i$, where:

I: Composite index,

X_i: Normalised variable,

w_i: Weight of the X_i, $\sum_{i=1}^{n} w_i = 1,$ and $0 \le w_i \le 1$

i: 1,…, n.

Thus, in order to ensure comparability of country level analyses we have developed composite index of knowledge intensive entrepreneurship (IKIE).

Based on definition of national KIE we consider that national

IKIE = NE + NTI + NK

where

NE= new enterprises

NTI = new technology and innovation

KI = knowledge intensity

1. 1. New enterprises (NE) in knowledge intensive (AEGIS) sectors is composed of four indicators:

1.1.1. Net entry rate

1.1.2. Five-year old enterprises employment growth rate: number of persons employed in the reference period (t) among enterprises newly born in t-5 having survived to t divided by the number of persons employed in t-5 by the same enterprises, expressed as a percentage growth rate (2 or 3 year average)

1.1.3. Survival rate 5: number of enterprises in the reference period (t) newly born in t-5 having survived to t divided by the number of enterprise births in t-5

(2 or 3 year average)

1.1.4. 5 year old enterprises' share of the business population

1.2. Indicator of New technology and innovations (NTI) is composed of:

1.2.1. % of innovative enterprises

1.2.2. % of innovation expenditures in GDP or turnover

1.3. Indicator of knowledge intensity is composed of:

1.3.1. Residents' patent applications

1.3.2. Scientific and journal articles

1.3.3. Royalty and license fees receipts

1.3.4. Knowledge intensive services (% of GDP)

Sources, availability and weights for each of these three categories and their indicators are given in Table 2. Method of calculation of IKIE index is normalization (standardization)19 followed by summation (aggregation)20 of components with equal weights[21] given to each of subcategories. Cronbach's alpha reliability test along with factor analysis will be applied to the individual indicators to test whether the indicators are measuring the same underlying construct before we compute the indices.

[19] Commonly used methods for normalization (standardization) include standard deviation from the mean, distance from the group leader, distance from the mean or distance from the best and worst performers.

[20] Linear, geometric or multi-criteria aggregation might be applied. Normalization method must be compatible with the aggregation method (OECD, 2008: 33).

[21] In the existing literature there are numerous weighting methods with pros and cons. These vary from equal weighting to use of statistical models such as factor analysis (FA)/principal component analysis (PCA) or 'benefit of the doubt' (BOD) approach which is sensitive to national priorities and weights are country specific having a number of estimation problems (OECD, 2008: 32). Based on our already developed conceptual framework, we use equal weighting method applied on each component. OECD (2008:31) states that "most composite indicators rely on equal weighting, i.e. all variables are given the same weight. This essentially implies that all variables are 'worth' the same in the composite, but it could also disguise the absence of a statistical or an empirical basis, *e.g.* when there is insufficient knowledge of causal relationships or a lack of consensus on the alternative. Moreover, if variables are grouped into dimensions (components) and those are further aggregated into the composite, then applying equal weighting to the variables may imply an unequal weighting of the dimension (the dimensions grouping the larger number of variables will have higher weight). This could result in an unbalanced structure in the composite index." That is why we give the same weight to each component as based on our conceptual framework and then determined the weight of each individual indicator to achieve a balanced structure in the composite index.

IKIE is an outcome variable. According to our conceptual approach KIE is the outcome of interaction of three types of opportunities: market, technological and institutional opportunities which could be considered as input variables. Hence, we have created also composite index of knowledge intensive entrepreneurial opportunities. This is also composite index which is composed of different proxies for each of three types of opportunities.

Accordingly index of knowledge intensive entrepreneurial opportunities (IKIEO) is calculated as

IKIEO = TO + MO + IO

where

TO = technological opportunities

MO = market opportunities

IO = institutional opportunities

Technological opportunities are capabilities and skills of enterprises and population, investments in new knowledge creation and diffusion, and knowledge linkages. So, basically technological opportunities are proxied by stocks and flows of knowledge generation and diffusion. A basic idea is that given MO and IO technological opportunities are dependent on capabilities and skills of country.

Index of technological opportunities (ITO) is composed of three sub-components: knowledge generation or R&D, skills or proxies of competence building (SKILL) and of knowledge networks (KNNTWK).

Accordingly:

ITO = RD+SKILL+KNNTWK

2.1. Component of knowledge generation or R&D is composed of:

2.1.1. Relative R&D expenditures in GDP (GERD % GDP), and

2.1.2. Relative business expenditures for R&D in GDP (BERD %GDP)

2.2. Component of competence building or skills is composed of:

2.2.1. %R&D personnel (in total employment)

2.2.2. % of population with tertiary education

2.2.3. Answer on question 12.02 Quality of scientific research institutions in WEF Global Competitiveness Reports

2.2.4. Answer on question 12.06 Availability of scientists and engineers in WEF Global Competitiveness Reports

2.3. Component of Knowledge and value chain networks (KNNTWK) is composed of:

2.3.1. Firms involved in innovation cooperation (% in total)

2.3.2. Job-to-job mobility of HRST (%)

2.3.3. Answer on question 11.05 Value chain breadth in WEF Global Competitiveness Reports

Market opportunities can be conceived as real and potential purchasing power of economy, changing number of potential and existing users for knowledge intensive products and services.

Index of market opportunities consists of three components: Demand side activities (DEMAND), Financing of innovation processes and other activities (FINANCE), and Market for KIS incl. provision of consultancy services relative to innovation processes (MKIS).

Accordingly

IMO= DEMAND+FINANCE+MKIS

3.1. DEMAND subcomponent consists of:

3.1.1. GDP per capita (USD) (proxy for quality of demand)

3.1.2. GDP growth (annual %) (proxy for growth of demand)

3.1.3. Openness=Share of trade(X+M) in GDP (proxy of external demand)

3.1.4. Answer on question 6.15 Buyer sophistication: buyer's purchasing decision in WEF Global Competitiveness Reports

3.2. FINANCE subcomponent consists of:

3.2.1. Domestic credit to private sector (% of GDP)

3.2.2. Stocks traded (% in GDP)

3.2.3. Venture capital (early and expansion and replacement) (%of GDP) OR

3.2.4. Answer on question 8.05 Venture capital availability in WEF Global Competitiveness Reports

3.3. MKIS subcomponent consists of:

3.3.1. High-tech sector enterprises (manufacturing & KIS) (% in total enterprises)

3.3.2. Turnover of high-tech sector enterprises

3.3.3. Employment in knowledge intensive sectors (% in total employment)

Institutional opportunities are legal, regulatory, policy, social and cultural factors which can operate as enablers/inducements or obstacles to KIE.

Index of institutional opportunities (IIO) consists of two components: regulatory (REGULATION) and policy support for KIE (SUPPORT).

Accordingly:

IIO = REGULATION + SUPPORT

4.1. REGULATION component consists of:

4.1.1. Answer on question 6.06 Number of procedures required to start a business in World Bank Ease of doing business surveys

4.1.2. Answer on question 6.07 Time required to start a business in World Bank Ease of doing business surveys

4.1.3. Answer on question 1.02 IPR protection in WEF Global Competitiveness Reports

4.1.4. Answer on question 1.21 Strength of investor protection in WEF Global Competitiveness Reports

4.1.5. Answer on question 1.09 Burden of government regulation WEF Global Competitiveness Reports

4.1.6. Answer on question 1.11 Efficiency of legal framework WEF Global Competitiveness Reports

4.2. Public support to incubation and other entrepreneurial activities (SUPPORT) consists of:

4.2.1. Answer on question 11.03 State of cluster development in WEF Global Competitiveness Reports

4.2.2. Declared clustered membership among enterprises in cluster-like environment (%)

4.2.3. Interest in public procurement (% firms in total)

4.2.4. Opportunity to sell innovations on public tenders (% in enterprises with direct experience with public tenders)

We are fully aware of limitations of composite indicators as well as weaknesses which arise from inadequate or poor proxies. First, entrepreneurial opportunities (EO) are not simple summation of individual opportunities but their interaction. What would be mathematical expression of such interaction is an issue which would require further research. Second, it is very difficult to capture international dimension of TO, MO and IO. Are value chains enhancing or diminishing entrepreneurial propensity of NIS depends on the interaction in open economy context. How to account for that remains an issue. Despite these limitations we believe that that more rigorous conceptual and quantitatively oriented framework is necessary in order to organise qualitative presentations and discussion of slippery concept as it is entrepreneurial propensity of NIS. Hence, limits of this approach should be seen in the context of our current understanding of entrepreneurial propensity of NIS.

Table 2. Indicators for composite indices (at national level) (Base year: 2007[22])

Category	Index	Subcategory	Quantitative Indicators	Source and availability	Indicator weight*
Entrepreneurial Activity	Composite Index of Knowledge Intensive Entrepreneurship (IKIE) IKIE= (NE+NTI+KI) (summation after standardization)-	Creating & changing organisations	**New enterprises (NE) in knowledge intensive (AEGIS) sectors:** Net entry rate Five-year old enterprises employment growth rate: number of persons employed in the reference period (t) among enterprises newly born in t-5 having survived to t divided by the number of persons employed in t-5 by the same enterprises, expressed as a percentage growth rate (2 or 3 year average) Survival rate 5: number of enterprises in the reference period (t) newly born in t-5 having survived to t divided by the number of enterprise births in t-5 (2 or 3 year average) 5 year old enterprises' share of the business population	 Eurostat (Business Demography)	 1/12 1/12 1/12 1/12
		New technology and innovation	**New technology and innovations (NTI):** % of innovative enterprises % of innovation expenditures in GDP or turnover	 Eurostat	 1/6 1/6
		Knowledge intensity	**Knowledge intensity (KI):** Residents' patent applications Royalty and license fees receipts Knowledge intensive services (% of GDP)	 World Bank World Bank Eurostat	 1/9 1/9 1/9

[22] 2007 is the latest year for data availability in Eurostat common throughout all EU countries.

Technological Opportunities	Composite index of technological opportunities (ITO) ITO=(RD+SKILL+KNNTWK)	Knowledge development and diffusion	**R&D (RD):** GERD % GDP BERD %GDP	 World Bank/Eurostat Eurostat	 1/6 1/6
		Competence building	**Skills (SKILL):** %R&D personnel (in total employment) % of population with tertiary education 12.02 Quality of scientific research institutions 12.06 Availability of scientists and engineers	 Eurostat WEFGCR	 1/12 1/12 1/12 1/12
		Knowledge Networks	**Knowledge and value chain networks (KNNTWK):** Firms involved in innovation cooperation (% in total) Job-to-job mobility of HRST (%) 11.05 Value chain breadth	 Eurostat WEFGCR	 1/9 1/9 1/9
Market Opportunities	Composite index of market opportunities (IMO) IMO=(DEMAND+FINANCE+MKIS)	Demand side activities	**DEMAND:** GDP per capita (USD) (proxy for quality of demand) GDP growth (annual %) Openness=Share of trade(X+M) in GDP 6.15 Buyer sophistication: buyer's purchasing decision	 WEFGCR World Bank Eurostat WEFGCR	 1/12 1/12 1/12 1/12
		Financing of innovation processes and other activities	**FINANCE:** Domestic credit to private sector (% of GDP) Stocks traded (% in GDP) 8.05 Venture capital availability	 World Bank Eurostat WEFGCR	 1/9 1/9 1/9
		Market for KIS incl. provision of consultancy services relative to innovation processes	**MKIS:** High-tech sector enterprises (manufacturing & KIS) (% in total enterprises) Turnover of high-tech sector enterprises Employment in knowledge intensive sectors (% in total employment)	 Eurostat	 1/9 1/9 1/9

Institutional Opportunities	Composite index of institutional opportunities (IIO) IIO=(REGULATION + SUPPORT)	Regulatory environment	**REGULATION:** 6.06 Number of procedures required to start a business 6.07 Time required to start a business 1.02 IPR protection 1.09 Burden of government regulation 1.11 Efficiency of legal framework	 World Bank –Ease of doing business/ WEFGCR WEFGCR 	 1/10 1/10 1/10 1/10 1/10
		Public support to incubating &other supporting activities	**SUPPORT:** 11.03 State of cluster development Declared clustered membership among enterprises in cluster-like environment (%) Interest in public procurement (% firms in total) Opportunity to sell innovations on public tenders (% in enterprises with direct experience with public tenders)	 WEFGCR EC Innobarometer on clusters2006 EC Innobarometer 2009	 1/8 1/8 1/8 1/8

*Each subcategory related to each index is assumed to have equal weight over 1. Thus, each indicator weight is determined accordingly.

6. GUIDELINES FOR INDUSTRY CASE STUDY RESEARCH

We will use the analytical framework structured in Figure 2 to form the basis for case study research at the sectoral level. Below, in Table 3 we highlight the indicators that we will use in the case study research at sectoral level[23] in order to explore the association between the knowledge-intensive entrepreneurship concept and the activities in the innovation system categorized according to entrepreneurial opportunities (see Box 1 and Figure 2).

We not only rely on quantitative indicators but also on qualitative data gathered from interviews and discussions with industry experts and key informants from the industry associations (see Annex 1 for guidelines of interviews with industry experts). We also provide some hints to collect such qualitative information below.

In order to indicate dynamics of change in industry, we will collect data for the period 1996- 2007.[24] In the next sections we discuss the details related to Table 3.

[23] Table 3 also shows the indicators that will be collected for firm-level research that will feed into W.P.4.2.

[24] Majority of data is available in EUROSTAT, which also allows for reliable country level comparison. Data which are not available in EUROSTAT are collected via National Statistical Offices of countries.

Table 3. Indicators for industry case study research (SECTORAL and FIRM level analysis).

		Quantitative Indicators (1996-2007)	Level	Source	Qualitative Aspects	Level	Source
Entrepreneurial Activity	Creating & changing organisations	New firms: New entrants Exits Rate of exit (5 years after foundation) Employees in new entrants	sector	NSO (business demography)	Factors behind growth of highly entrepreneurial firms Mergers and acquisitions in industry; their motives	Sector	Expert interviews
		Innovation: Wage adjusted labour productivity (as proxy for innovation) Firms with product/process innovations Firms with intra-, extra-mural innovation activities	sector	Eurostat CIS			
		Knowledge intensity : Patent applications to EPO (per M population) Patents granted by USPTO (per M population) Licensing income (% sales in 2009)	sector Firm	Eurostat Firm Interviews			
Technological Opportunities	Knowledge development and diffusion	R&D expenditures (% in value added)	sector	Eurostat or NSO	R&D organisation Relationships between in-house and extra-mural R&D	Sector & Firm	Expert interviews & Firm interviews
		Innovations during the last 3 years (elaborations on each innovation re R&D and design, finance and marketing) Licensing payment (%sales in 2009)	firm	Firm interviews			
	Competence building	Employees (% in total) R&D personnel (% in total employment)	sector	Eurostat or NSO	Skilled labour recruiting and keeping Types of training activities and programs taking place in the sector	Sector & Firm	Expert interviews & Firm interviews
		Share of skilled employees (MSc&PhD) in total in 2009 Academic qualification of entrepreneurs (categorical variable) Kind and levels of experience of entrepreneurs (categorical variable)	firm	Firm Interviews			
	Knowledge Networks	Firms involved in innovation cooperation	sector	CIS	Role of value chain actors Role of users	Sector & Firm	Expert interviews &

		Innovation networks (elaborations on each innovation re networks)	firm	Firm interviews	Knowledge networks with universities and other firms Identification of customers		Firm interviews
Market Opportunities	Demand side activities	Sectoral turnover (%in total GDP) Exports (% in total exports) Imports (% in total imports)	sector	Eurostat	Growth potential of the market and of the sector Prices of inputs (taxes, energy, etc) Customer and leading user strategies	Sector & Firm	Expert interviews & Firm interviews
	Financing of innovation processes and other activities	GFI in tangible goods GFI in machinery and equipment Personnel costs	sector	E'Stat	R&D tax incentives and other subsidies Problems in the sector regarding financial sources for KIEs	Sector & Firm	Expert interviews & Firm interviews
		Venture capital Bank loans Public funds Private sources Innovations (elaborations on each innovation re finance)	firm	Firm interviews			
	Market for KIS incl. provision of consultancy services of relative to innovation processes	-			Kinds of knowledge intensive services (KIS) or consultancy services available to firms Most frequently used services of this type	sector	Expert interviews
Institutional Opportunities	Regulatory environment	Barriers for setting up a company (categorical variable) Obstacles for entrepreneurial activity in the company (categorical variable)	firm	Firm interviews	Quality of regulatory environment IPR protection Regulatory obstacles to entrepreneurial activity	sector	Expert interviews
		6.06 Number of procedures required to start a business 6.07 Time required to start a business 1.02 IPR protection 1.09 Burden of government regulation	country	WEFGCR			
	Public support to incubating &other supporting	11.03 State of cluster development Declared cluster membership among enterprises in cluster-like environment (%) Interest in public procurement (% firms in total) Opportunity to sell innovations on public tenders (% in	country	WEFGCR EC Innobarometer on clusters2006 EC Innobarometer 2009	Reasons for being located in supporting organisations Facilities provided in these organisations Most frequently used services in these organisations	sector	Expert interviews

	activities	enterprises with direct experience with public tenders)					

NSO: National Statistics Offices.

6.1. Entrepreneurial activities (creating and changing organisations)

Entrepreneurship, defined as creating and changing organisations is one of the ten activities in SI. Apart from being an activity, entrepreneurship is also a property of SI. 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 SI 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 SI makes it more or less entrepreneurially oriented.

The following indicators are the ones we have considered in the quantitative part of the research for the analysis of the entrepreneurial activities as defined by three dimensions, namely new firm, innovativeness and knowledge intensity:

New firm

- *Number of new entrants and exits into the sector (2000-2009)*: number of births of enterprises, number of deaths of enterprises, net business population growth, business churn (birth rate + death rate), birth rate (number of enterprise births divided by the number of active enterprises in reference period t), death rate (number of enterprise deaths divided by the number of active enterprises in reference period t).

- *Survival rate 5 years after foundation*

- *Employment in new entrants and exits:* number of employees in the population of active enterprises, number of employees in the population of births, number of employees in the population of deaths, employment share of enterprise births (number of persons employed in t among enterprises newly born in t divided by the number of persons employed in t among the stock of enterprises active in t), average size of newly born enterprises (number of persons employed in the reference period t among enterprises newly born in t divided by the number of enterprises newly born in t), employment share of enterprise deaths (number of persons employed in the reference period (t among enterprise deaths divided by the number of persons employed in t among the stock of active enterprises in t), average employment in enterprise deaths: number of persons employed in the reference period t among enterprise deaths in t divided by the number of enterprise deaths in t).

Innovativeness

- *Innovative firms*: Share of firms with product/process innovations and share of firms with intra- and extra-mural innovation activities. Labour productivity: Wage adjusted labour productivity is referred to as a proxy variable for innovations in the firm.

Knowledge Intensity

- *Patent applications*: Patent applications to EPO per million population.
- *Patents granted*: Patents granted by USPTO per million population.
- *Licensing income*: Licensing income as percentage of sales in 2009. This data have been obtained from firm interviews in two sectors in eight countries.

The data provided by each country study will depend on the data availability at the respective national statistical offices. As we already have pointed out above, this quantitative information needs to be complemented with data collected through interviews with industry experts and key industrial associations. The type of questions addressed in this qualitative research will deal with such aspects like e.g. mergers and acquisitions in the sector, their motives and drivers, factors behind the growth of highly entrepreneurial firms in the sector, etc. For more details about the type of questions included in this qualitative section, the reading of the Annex 1 is strongly recommended.

6.2. Technological opportunities

6.2.1. Knowledge development and diffusion

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

The quantitative indicators related to Knowledge development and diffusion are:

- R&*D expenditures in the sector*: share of R&D expenditure in value added, total intra-mural R&D expenditure or total R&D expenditure as % of GDP.
- *Innovations in the firm during the last three years*: Number of innovations (new or significantly improved products/processes or services introduced onto the market during 2006 to 2010. This data have been obtained from firm interviews in two sectors in eight countries. It also captures information about R&D and design activities related to each innovation.

- *Licensing payment*: Licensing payments as percentage of sales in 2009. This data have been obtained from firm interviews in two sectors in eight countries. As in the previous case, this quantitative information needs to be complemented with data collected through interviews (see Annex1) to elaborate on R&D organisation in the sector and the relationships between extramural and in-house R&D activities.

6.2.2. Competence building

These activities relate the characteristics of entrepreneurs and the labour force and particularly the skilled labour force in the firms, 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.

The quantitative indicators included in this case are:

- *Employment*: Number of employees, number of part-time employees, number of employees in FTE, growth rate of employment (%), number of persons employed per firm, share of employment in manufacturing total, number of hours worked by employees.
- *R&D manpower in the sector*: Total number of R&D personnel, share of R&D employment in the number of persons employed (%), total number of researchers FTE.
- *Skilled labour*: Employees with postgraduate degrees (MSc and PhD) in the sector as % of total employees. This data have been obtained from firm interviews in two sectors in eight countries.
- *Academic qualification of entrepreneurs*: Elementary, secondary, higher education BSc/BA, MA/MSc or PhD achievements of enterprise founders. This data have been obtained from firm interviews in two sectors in eight countries.
- *Kinds and levels of experience of entrepreneurs*: The last occupation of the founder before establishing the enterprise and the level of professional experience measured by years. This data have been obtained from firm interviews in two sectors in eight countries.

6.2.3. Knowledge networks with institutes and value chain partners

- *Firms involved in innovation cooperation*: Share of firms actively engaged in innovation co-operation with other firms or institutes in the SI.

- *Innovation networks*: Firms' involvement in knowledge networks with value chain partners, universities and research institutes as related to each innovation they have introduced onto the market during the last three years. This data have been obtained from firm interviews in two sectors in eight countries.

This quantitative information needs to be complemented with data collected through interviews (see Annex1), which includes questions about Role of value chain actors, role of users, knowledge networks with universities and other firms and identification of customers.

6.3. Market opportunities

6.3.1. Demand-side activities

Demand 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 quantitative indicators considered for this section are:

- *Sectoral output and market size* in terms of value of products and services: Sectoral growth rate, turnover, production value, value added at factor cost, turnover from principal activity at the NACE Rev.1 4-digit level, turnover from industrial activities, turnover from service activities, turnover from trading activities of purchase and resale and intermediary activities (agents), turnover per person employed, share of value added in manufacturing total, share of production value in manufacturing total, share of turnover in manufacturing total, gross operating surplus/turnover (gross operating rate) %, share of gross operating surplus in value added.

- *Exports and imports*: total exports of goods (million euro), total imports of goods (million euro), export share of the sector in total GDP, import share of the sector in total GDP, export to import ratio of the sector.

In the qualitative research (see Annex 1) we should ask industry experts about aspects as the growth potential of the market and of the sector, the prices of inputs (taxes, energy etc) making local producers competitive, who are the customers, what their

purchases look like and what are customer strategies, the articulation of interest by leading users and customers in the sector, etc.

6.3.2. 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 can facilitate commercialization of knowledge and its adoption. On demand side, they involve type of market contracts and their terms of financing. The quantitative indicators included in this case are:

- *Investments*: Gross investment in tangible goods, net investment in tangible goods, Gross investment in machinery and equipment, payments for long term rental and operational and financial leasing of goods, investment per person employed, investment rate (investment/value added at factor cost).
- *Labour costs*: personnel costs, share of personnel costs in production (%), average personnel costs (costs per employee), labour cost per employee FTE, share of personnel costs in total purchases of goods and services, employer's social charges as percentage of personnel costs.
- *Venture capital/ Bank loans/ Public funds/ Private Sources*: Forms of funding used to establish the KIE. This data have been obtained from firm interviews in two sectors in eight countries.
- *Funding innovations*: Source of funding and amount of funding (exploring the use of R&D tax incentives, R&D grants, etc.) used for each innovation introduced onto the market during the last three years in the firm. This data have been obtained from firm interviews in two sectors in eight countries.

Similarly, the qualitative research of this section should include opinions from industry experts about the sources of funds available for a company recently starting in the sector, sources of funds available for innovation in the sector, problems in the sector regarding financial sources for KIE, etc.

6.3.3. Market for knowledge intensive service including provision of consultancy services of relevance to innovation processes.

This last section relates to what extent KIE can make use of knowledge intensive services that are available in technology transfer, commercial information and legal service forms.

In this section we consider some other qualitative aspects like the types of knowledge intensive or consultancy services available to firms in the sector, the most frequently

used knowledge intensive services in the sector (i.e. technological, business, etc.), the state support programs available to firms to make use of consultancy services.

6.4. Institutional opportunities

6.4.1. 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 like centres of excellence. How regulatory framework affects behaviour of companies, especially in terms of innovation investment? Due to the qualitative character of this type of opportunities, the analysis will be only focused on the opinions of industry experts, since no quantitative information has been found up to date. It is very challenging to obtain sectoral level quantitative data in this category. Yet, we have formalised a few firm-level quantitative indicators. We also trust that most of the national indicators presented in Table 2 will also be valid for use to be reflected to sectoral level of analysis, particularly for the computer related activities. Apart from that, we totally rely on the qualitative data gathered from expert interviews to shed light on this sectoral level of the research. Thus, the quantitative indicators in this case are:

- *Barriers for setting up a company*: These relate to the identification of tax, labour market, bankruptcy, competition, copyright and patent protection laws and legislations that may be acting as barriers to company establishment in the regulatory environment. This data have been obtained from firm interviews in two sectors in eight countries.

- *Obstacles for entrepreneurial activity in the company*: These relate to risks formed by technology, demand, funding, market and labour market constraints that may act as obstacles for firms in finding specific niches in the sector, This data have been obtained from firm interviews in two sectors in eight countries.

In the qualitative research we should ask industry experts about 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, etc.

6.4.2. 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, i.e. relate to publicly supported programs for innovation promotion. We again draw the quantitative indicators from those among national level in Table 2.

We should ask incubator managers and industry experts about the reasons to be located in supporting organisation or to benefit from public support programs, the facilities provided to the firms in the supporting organisations, the most frequently used services by the firms in these programs or organisations, etc. (see Annex 1).

7. SYNTHESIS

Upon completion of data collection the analyst will try to produce synthesis by analysing the mutual relationships between different activities in SI. In doing this you may want to apply the following matrix by answering on the following questions. The matrix works from the top (explanatory) to the left hand-side (dependent).

Table 4. Complementarities between technological, market and institutional opportunities

	Technological opportunities *(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 opportunities *(Knowledge development and diffusion; Competence building; Knowledge networks)*		Are MO, especially demand significant pull for exploitation of TO? Is market competitive and conducive to innovation? Is market of specialized knowledge intensive services conducive to innovation and growth?	Is regulatory environment conducive to generation and exploitation of TO? 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?
Market opportunities *(Demand; Finance; Services market)*	Are inter-firm relationships developed and conducive to technological development? 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? What are institutional barriers to entry and exit? Is regulatory environment inhibiting or facilitating exploitation of market opportunities?
Institutional opportunities *(regulatory environment; policy support for incubation and growth)*	What new institutional opportunities or constraints are emerging due to new technological opportunities?	What new institutional opportunities or constraints are emerging due to new market opportunities?	

The more there are 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 IS will generate more entrepreneurial opportunities. 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 is the entrepreneurial propensity of IS i.e. propensity to generate entrepreneurial opportunities. However, more than the assessment of the level of the entrepreneurial propensity the value of our analyses should be in identifying specific (mis)matches in the IS whose identification can be useful to innovation policy.

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9. ANNEX 1.- GUIDELINES FOR INTERVIEWING INDUSTRY EXPERTS

Despite all the efforts, data for some of the quantitative indicators may prove to be difficult to obtain. In that case, we will complement the quantitative research with qualitative research and we will need to rely on receiving qualitative data by interviews and discussions with industry experts and other key informants from the industry associations.

It would be very helpful if you can aim at Incubators or Technology Development Centres or alike where entrepreneurial firms initially may prefer to start their operations. You could interview the directors of such centres particularly aiming at firms operating in machine tools and computer sectors. We reckon that for the computer sector this could be easier than for the machine tools. Another place of interest would be industry association(s) but also known entrepreneurs in the industry.

There are three points to take into account while talking to industry experts:

1. We aim to identify factors that facilitate or hinder entrepreneurial behaviour in the sector. Therefore, interviews with industry experts which are familiar with the range of entrepreneurial strategies in the sector would be valuable. Ideally, you want to rely on several industry experts in order to double check responses and to get a balanced picture of the sector.

2. Although, our focus is sectoral (which in WP 4.2 will be complemented by the firm level analysis for partners that participate in this WP) our conclusions should be of relevance to the national level. So, we suggest that after first draft of sectoral studies we re-visit whether we want to explore those selected issues at national level which strongly affect results on entrepreneurial propensity of innovation systems.

3. It would be highly desirable to get idea of change and see whether that change can be detected in quantitative data which you are collecting for years: 2000, 2005, 2009. In particular, we are interested in changing factors that affect formation of new firms as well as entrepreneurial growth of established firms. By entrepreneurial growth we mean innovations of firms in terms of new products, new processes and new organisational innovations (including business models).

Below are the guides for developing the interviews, including questions. It is essential that you do get answers on questions below so that reports and replies can be compared across eight countries which are participating in this WP.

In explaining to your interviewees what you are interested in we suggest that you point to the factors that affect entrepreneurship and entrepreneurial growth of new and established firms in the sector. It may be possible that based on your knowledge of industry or industry analyses you may already know answer on specific questions. In

that case, you may use your limited time for more detailed examination of other issues.

1. ENTREPRENEURIAL ACTIVITIES

- Please, evaluate the rate of formation of new firms in the sector in the last 10-20 years? Are there specific sub-periods with respect to new firm formation?

- Please, evaluate the rate of productivity, technological upgrading and employment in the sector?

- What is the typical pattern of growth of firms in the sector? Generic expansion? Mergers and acquisitions? Networking i.e. growth through non-equity links like contracting?

- Are there some common factors behind the growth of highly entrepreneurial firms in sector or they are largely idiosyncratic (firm specific)? If there are some common factors that high growth firms in the sector share, please, discuss them. If they are largely company specific, please, discuss them on specific examples.

- Who are typical entrepreneurs in the sector? Where from do they come? From old established enterprises in the same industry? Or from universities and R&D organisations? Do most of them have high formal education (MSc and PhD) or they have accumulated industry specific experience?

- How important are external partners and organisation for entrepreneurial growth of firms? Please, discuss the relevance of the following linkages for growth of firms: large firms – small firms' links? Foreign – domestic firms links? Firms and public research organisations?

- Do entrepreneurial (high growth) firms collaborate with other firms in the sector, with research institutes and/or universities? Do they collaborate more or less with these actors compared to the general trend in the sector?

- Do entrepreneurs prefer incubators for the location of their firms or not? Discuss.

2. MARKET OPPORTUNITIES

a. Demand-side activities

- What is growth potential of the national and international (export) market of the sector? Which specific segments of the market have been growing the fastest in the last 10-20 years?

- Please assess whether demand in the sector is emergent (new products and services) or mature (established products and services)? Please, discuss.

- Competition in the local market is limited and price cutting is rare or competition is intense as market leadership changes over time? Local market in your industry is dominated by a few companies or is spread among many firms?

- Please assess the extent of foreign competition and compare with the local competition? Are there problems in openness of foreign markets? Your foreign markets are mainly neighbouring countries or truly global? Discuss.

- Please assess how prices of inputs (taxes, wages, energy etc) are affecting competitiveness of local producers? If some of these factors are strongly affecting competitiveness please discuss.

- What is market structure of buyers in terms of size? Are there discernable market segments in industry? If yes, please, discuss.

- Who are typical customers, and what are their typical purchases? Are there discernable customer strategies in the sector? Are there discernable differences between different customers in terms of prices, technological sophistication, quality etc.?

- What is the general level of sophistication of domestic and foreign buyers (users)? Buyers are unsophisticated and make choices based on the lowest price? Or buyers are knowledgeable and demanding and buy based on superior performance attributes? Are buyers (users) highly segmented in terms of technological sophistication and technology requirements?

b. Financing of innovation processes and other activities

- How easy it is to obtain a bank loan?

- What is the typical structure of sources of funds available to a company recently starting in the sector (bank loans, venture capital, business angels, etc)? What are the typical sources of funds to established firms? Please, explain differences.

- Please assess availability of funds for investment in terms of availability, maturity and costs of capital.

- Are there significant differences between sources of funds for current operations from funding for innovation projects? Please, explain.

- How buyers fund their purchases?

- Entrepreneurs with innovative but risky projects can generally find venture capital in your industry?

- Raising money by issuing shares on the local stock market is nearly impossible or quite possible for good company in the industry?

c. Market for business services, inputs, including labour and knowledge intensive business services

- How is equipment and machinery specific to your field obtained in your country? Almost always imported or almost always locally available from capable suppliers?

- How are knowledge intensive or consultancy services specific to your field obtained in your country? Almost always imported or almost always locally available from capable suppliers?

- Evaluate the local availability of specialized research and training services in the sector?

- Are there support programs available to firms to make use of consultancy services? Do enterprises rely on external providers of these services? (rarely or frequently)?

- What is the situation on labour market in the sector in terms of readily available and skilled personnel (with graduate and postgraduate degrees)?

- Are there difficulties in recruiting highly skilled labour in the sector? If yes, discuss.

- What types of highly skilled labour proves difficult to recruit (i.e. research, technical, engineering, sales and marketing, financial and accounting, managerial, etc.)?

- The hiring and firing of workers is impeded by regulations or flexibly determined by employers?

3. TECHNOLOGICAL OPPORTUNITIES

a. Knowledge development and diffusion

- Describe industry structure in the sector in terms of size (large- medium and small firms)

- Please explain typical innovation strategy(ies) in the sector.

- Please explain which organisations undertake R&D in the sector. Are they continuous or intermittent spenders?

- Are there non-private R&D organisations in sector which cooperate with the business sector? Explain.

- Companies in your industry are not able to absorb quickly new technology or quite effective in absorbing new technology? Discuss

- Assess the extent of use of licensing of foreign technology as means of acquiring new technology.

b. Competence building

- The general approach of companies in the sector to human resources is to invest little in training and employee development or invest heavily to attract, train and retain employees?

- Are there training activities and programs taking place in the sector organised by external providers? If yes, what are participation rates by firms in the sector in those kinds of training activities?

- What is the extent of intra-firm continuous vocational training in the sector?

c. Knowledge networks with other firms, institutes and value chain partners

- Please explain the role of local firms in international value chain? Are they primarily involved in production stage or also sell products under their own brands?

- Please assess the nature of collaboration between firms in the industry as well as interactions with universities and research institutes? Are these collaborations strategic alliance aiming at a specific product/process development or are they oriented towards technical support through contracts or subcontracting?

- What is the extent of collaboration with domestic firms and institutes when compared to foreign firms and institutes?

- Please assess cooperation with buyers (users) and suppliers in the sector

- Are users involved in innovation in the sector? If yes, discuss.

- Are there are mergers and acquisitions in industry that are motivated by access to technology? If yes, please, discuss

4. INSTITUTIONAL OPPORTUNITIES

a. General regulatory environment[25]

The overall aim in this section is to find out how regulatory framework affects behaviour of companies, especially in terms of innovation investment:

- Barriers in setting up the company in the sector,
- Regulatory obstacles to entrepreneurial activity in the sector,
- How easy it is to employ and make employees redundant? Whether employment laws are reducing the flexibility of employment and how.

[25] A majority of these questions are about country specific conditions and the evidence is available through World Bank Doing Business database. Hence, in interviews with industry experts you may only want to double check are there **industry specific regulations** which shape the industry business environment.

- How easy is it to purchase a property from another business (seller) and to transfer the property to the buyer's name so that the buyer can use the property for expanding its business?
- 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.,
    - Assess the administrative burden in paying taxes and contributions.
    - Asses the degree to which collateral and bankruptcy laws protects the rights of borrowers and lenders and thus facilitate lending.
    - Are IPR practices favourable to knowledge intensive innovators (cf. piracy, copyright etc)?
    - Assess the efficiency of the judicial system in resolving a commercial dispute.
    - Assess the complexity of bankruptcy proceedings.
    - Are there regulatory problems in adoption and diffusion of new technology in the sector?
    - Are there institutional (regulatory) obstacles to export? Procedural requirements for exporting and importing?

b. Sector specific regulations

- Are there sector specific regulatory barriers that hinder market competition?

- Are there sector specific technical standards that operate as inducement of technological innovation?

c. 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, i.e. relate to publicly supported programs for innovation promotion

We should ask incubator managers and industry experts about

- Are there mechanisms of public support to knowledge intensive (technology based) SMEs like S&T parks, innovation centres and public venture capital?

- reasons to be located in supporting organisation or to benefit from public support programs,
- facilities and services provided to the firms in the supporting organisations,
- the most frequently used services by the firms in these programs or organisations.
- Are there specific socio-cultural obstacles that hinder technology based entrepreneurship in industry?

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