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REGIONAL INNOVATION SYSTEM FAILURES AND HIGHLIGHTS

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Biographical note

Sotiris Zygiaris is a BSc graduate in Computer Science and MSc in Management Information Systems from Lamar University, USA. His PhD work and his research activities are focused on the study of regional innovation systems. For the last ten years he has been employed as a Researcher at URENIO research unit of Aristotle University of Thessaloniki engaged in regional development projects across Europe, regarding innovation strategies and regional innovation initiatives.

Abstract

The systemic analysis of innovation conceives complex analytical frameworks, with intense socio-technological aspects of knowledge generation and encompasses a detailed analysis of system failures. These frameworks are not suitable for benchmarking a wide range of regions, due to low availability of such elaborate data sources. On the other hand, metric regional innovation micro data offer the opportunity for large-scale cross-regional benchmarking exercise illustrating mainly the market failures of the innovation systems although this type of analysis does not provide any detailed systemic envisioning. Is the combination of these two analytical approaches possible? This study presents the Interaction Intension Indicator (3I) analytical framework, analysing system failures and highlights of various regional innovation deployment patterns along with the analysis of the Romanian innovation system.

JEL Classification: R11
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Introduction

The ‘systemic approach’ analyses regional innovation systems on the basis of evolutionary theories of economic and technological change and attempts to picture innovation as an evolving complex process (Edquist, 1997). The systemic approach identifies in detail the elements of interaction and the linkages between agents affecting innovation and the processes developed within the regional tissue (Lundvall, 1992; Nelson, 1993; Edquist, 1997). The systemic approach incorporates complex and sometimes chaotic (Martin and Sunley, 2003) frameworks of analysis, which are based on empirical studies that concentrate on the conditions of specific regional conditions. This analysis of innovation systems is based on the examination of ‘system failures’ (Metcalfe and Georghiou, 1998) that enables it to identify systemic problems, through systemic performance indicators.

The unavailability of complete data set across regions that could match this high level complexity makes the systemic approach unsuitable for evaluation or benchmarking of a wide range of regional innovation systems (Cooke et al., 2000; Braczyk et al., 1998; Todtling and Kaufmann, 2001; Enright, 2001). Thus, the systemic approach does not adequately gratify the demand set by policy makers for periodic benchmarking and evaluation of innovation policies.

Another approach the ‘metric approach” of regional innovation systems is measuring innovation on the basis of quantitative data from existing databases (mainly from Eurostat, and OECD). The choice seems entirely justified by the stability of these data sources, the validity of their context, but also by the frequency of their information renewal (Arundel and Hollanders, 2005). Most of the regional analysis studies have a wide range of regions involved and they structured on the basis of Community Innovation Surveys and European Innovation Scoreboard reports. Public bodies set innovation policies, with a direct focus on the impact of market failures (Faulkner & Senker, 1995). Even though they are offered a wide range of benchmarks for the innovation capacity among regions, they are deficient in detailed interpretation of these reports along the lines of specific system failures.

These approaches form a mosaic and determine a complex environment for the analysis of innovation. The feasibility of development of an analytical model, with the sufficient specificity of the systemic approach, but also the availability of cross regional micro-data is the main question raised by this study. This analytical model should be able to demonstrate a sufficient level of systemic abstraction, restricted to the level of data availability, to map specific system interactions. This availability of data sources for the system interaction mapping is contacted against European Innovation Scoreboard 2004, 2005 and 2005 regional (254) and national (30) data sets.

The analytical framework of regional innovation systems

A regional innovation system could be addressed as an agglomerated interaction of private and public organizations that collaborate according to institutional rules and regulate relationships that contribute in the generation, usage and diffusion of knowledge. The fact that demarcates this study is the attempt to incorporate existing regional data sets into an abstracted system model. The cross-referense of EIS data set availability and the interactions presented in empirical studies conceived the following drivers of innovative performance.

Policies for research funding is a key aspect of the innovation chain interacting among public bodies and the knowledge production subsystem. The central government, including agencies working for the central government, is the most often cited source of public support for innovation, followed by the local government, the EU and the Framework Programmes for RTD. The index 2.1 of EIS, Public R&D Expenditures, is identified as the main element to measure the funding of public policies for research.

The **availability scientific and research personnel and the attainment of education quality** is an important aspect of innovation (Graham and Diamond, 1997), interacting among the academia and the production of knowledge subsystem (Ketikidis and Zygiaris, 2007). The scientists have the ability to produce knowledge and research results and provide the codified knowledge that supports the knowledge spillover at regional level (Prahalad and Hamel, 1990). Two decades of empirical work suggest the significant influence of university research on R&D and innovation (Nelson & Rosenberg, 1994). The culture of innovation, conceived as the institutional (norms, values, formal and informal) influence on the human capital involved in an innovation process, perceives economic and technical challenges across the regional tissue.(Hofstede, 2001). Thus, regional human capital is a significant input to the innovation chain. The corresponding indicators of the EIS for the measurement of these factors are indicators 1.1 S & E Graduates, 1.2 Population with Tertiary Education, 1.4 Participation in Life-long Learning and 1.5 Youth Education Attainment Level.

Private investments in R&D are characterized by high levels of risk, which deter investors, particularly when the potential of counterfeiting research results is very high (Anton & Yao, 2002). The investment placements in research form the interaction among investors and the knowledge production subsystem. The high level of investment risk is another factor blocking investments away from basic research. Policy-makers encourage investments in research, through policies designed to protect intellectual property rights and by providing financial incentives. The investment houses aspire greater returns from their investments than the researchers. This is indicated in the literature as the «problem of asymmetric information» among investors and researchers (Leland & Pyle, 1977). These characteristics have a negative impact on investment in basic research, leading to market failures. EIS indicators, 2.5 university R&D expenditures financed by business sector and 2.2 Business R&D expenditures reflect investment in research.

The influence of research in innovation follow the path connecting patents and economic growth (Rodriguez and Crescenzi, 2006). The correlation between academic research and industrial patents (Sampat et al, 2003) conclude that university patents are the beginning of many industrial innovations. Pakes and Griliches (1984) suggest that patents should result in both profits and new R&D expenditures. They consider patents as a knowledge output in the knowledge production function, whereas R&D expenses are used as an input. Thus, patents as an intermediate result of the research subsystem form the interaction with the corresponding innovation production subsystem. EIS indicators 5.1 EPO patents per million population, 5.2 USPTO patents per million population, 5.3 triadic patent families per million population, 5.4 number of new community trademarks per million population and 5.5 number of new community designs per million population describe adequately this interaction.

In the decade of the 1990s, **venture capital** was introduced as a new source of funding innovation. OECD (1999a) defines venture capital as funds that are invested in developing new innovative businesses (Kaplan and Stromberg, 2000). Venture capitals invest in new products that are ripe to enter into the markets. They include head start (seed capital), which finance the start up of business and innovation to product development and marketing. The respective index of the EIS, which maps the interconnection between the venture capital organizations and the innovation subsystem is 3.4 early-stage venture capital (% of GDP).

Enterprise investment in innovation is an important attribute of the innovation process, linking private placement with the innovation subsystem. According to the literature review private financing of innovation is a key component of the chain of innovation, usually expressed by investments in the development of mature products for their entry into the market. A firm's innovation performance depends on the ability to bring together knowledge, ideas and market awareness into new or improved goods and services that better meet customer needs (Griffith et al, 2006). This interaction is mapped by the EIS indicators 3.1 SMEs innovating in-house (% of SMEs) and 3.3, innovation expenditures (% of turnover).

Public funding for innovation is an important driver of innovative performance set by public funding policies at national, regional and EU levels. Economists have long held the view that innovative activities are difficult to finance in a freely competitive market place. This line of reasoning is already widely used by policymakers to justify such interventions as the intellectual property system, government support of innovative activities, and new product development (Hall, 2005). This important interaction among public funding organization and the innovation subsystem is mapped by the the EIS indicator 2.4 percentage of enterprises that received funding for innovation to the total number of enterprises.

Clusters are regional agglomerations of interconnected organizations and enterprises toward innovative activities. The positive impact of clusters on regional innovativeness is widely accepted in literature (Porter, 1998). Firms rarely innovate by themselves and their capacity to create collaborative networks for innovative activities, is a critical variable for regional competitiveness (Landabaso et al, 2001), OECD (1999b). Thus, the formation of clusters benefits the regional innovation capacity and economic growth affecting positively the innovation production subsystem (Baptista, 2000). EIS indicator 3.2, innovative SMEs cooperating with others (% of all SMEs) map this interaction adequately.

According to the results of the literature review the outcome of innovation is **new products and services to the market** interconnecting the innovation subsystem to markets. The demand for innovation is the key economic mechanism that initiates the wealth generation processes. The economic impact of innovation depends on the extent to which new products, processes and services have been diffused throughout the economy (Muller et al, 2006). This result is the ultimate goal of innovation systems and designated by the EIS indicators, 4.2, high-tech exports as a share of total exports, 4.3 sales of new products on the market (% of turnover), and 4.4 sales of new to the company but not new to the market products (% of turnover).

New technological knowledge has positive effect in the innovation chain. According to the literature review technology is an important factor for the development of innovation (Cohendet and Joly, 2001). Non-technological innovation is an important element of firms' innovation activities, including the introduction of new organisational methods or new marketing methods (Schmidt and Rammer, 2002). High tech human capital is considered an important input into the innovation chain

(Evangelista and Savona, 2002) The interface of the innovation subsystem with the technology transfer node is defined by the indicators 2.3, Share of medium-high-tech and high-tech R&D (% of manufacturing R&D expenditures), 3.6 SMEs using non-technological change (% of SMEs), 4.1, Employment in high-tech services (% of total workforce), 4.5 Employment in medium-high and high-tech manufacturing (% of total workforce).

The three basic methods of systemic analysis are:

- the intensity of interactions among innovation actors
- the cost of innovation processes
- the efficiency of innovation processes

Analysis based on the intensity of interactions

These drivers of innovative performance illustrate the correlations between system interactions and corresponding EIS indicators. These interactions are presented in table 1.

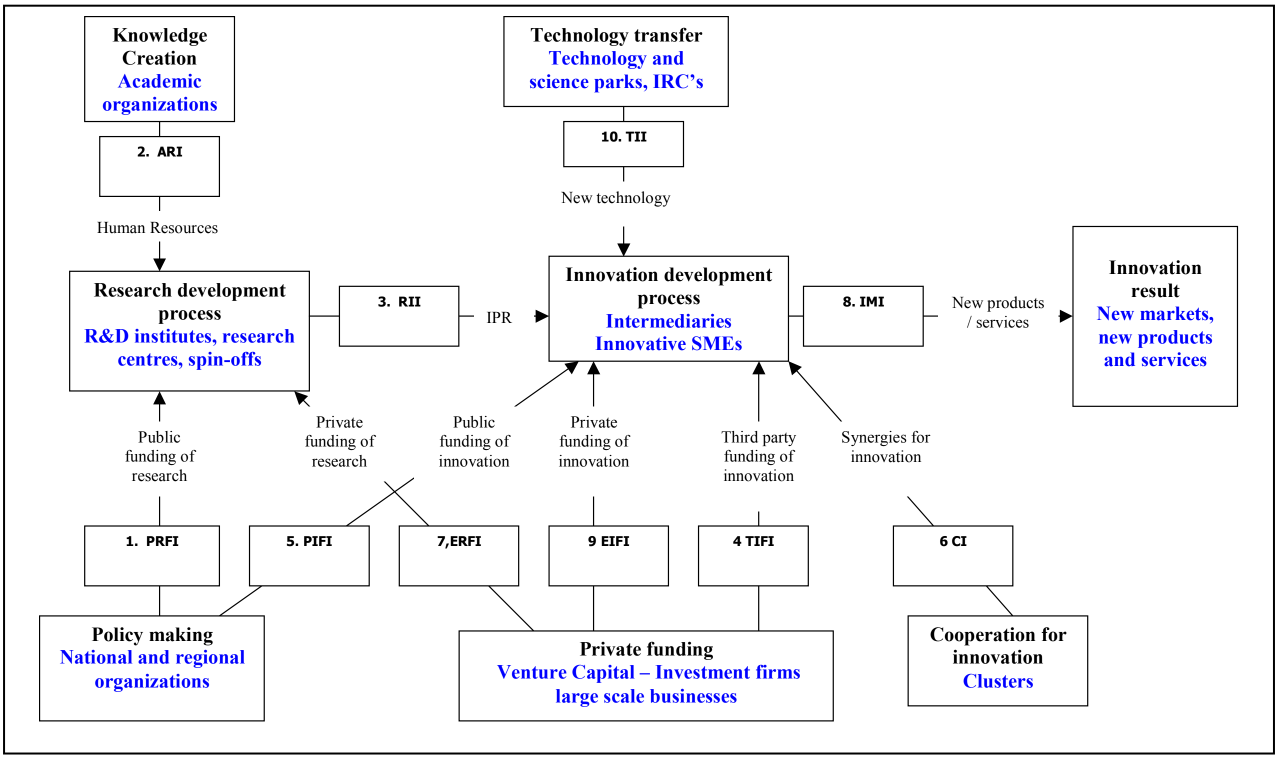
Table 1. Innovation system interactions

Interconnections of the innovation systems	Interaction intensity indicator
1. Public research funding interaction	**PRFI**
2. Academia and Research Interaction	**ARI**
3. Research and Innovation interaction	**RII**
4. Thrird party innovation financing interaction	**TIFI**
5. Public innovation funding interaction	**PIFI**
6. Cluster Interaction	**CI**
7. Enterprise research funding interaction	**ERFI**
8. Innovation and market Interaction	**IMI**
9. Entreprise innovation financing interaction	**EIFI**
10. Technology and innovation interaction	**TII**

The interactions of table 1, are formulated as a weighted sum of its normalised component indicators: $CI_c = \sum_{q-1}^{Q} w_q I_{qc}$ with $\sum_q w_e = 1$ and $0 \le w_q \le 1$, for all q=1,…Q and c=1,…,M. Q is the number of component indicators and M is the number of regions. For instance ERFI is the weighted sum of 3.1 and 3.3 EIS indicators. In this study the same weight value is provided to all indexes. The resulting analytical framework of figure 1 mirrors the findings of the literature review and the index interaction correspondence that is presented in annex A, this framework is called the **Interaction Intensity Index- 3I**.

The 3I analytical model, as it is presented in diagram 1, form the basis that gratify the requirements of this study. The systemic approach implies that there should be a balanced allocation of resources, among the interconnections to maximize the efficiency of innovation systems and also to avoid inefficiencies and waist of innovation resources from low intensive interactions. According to the ABC analysis a minimal satisfactory level for indicator intensity is 70% of the average indicator intensity value over the sample of regions, then, the binary value of one is assigned for indicators greater or equal to 70% of the average value to a variable; otherwise the value of zero is assigned to it. Thus, the new variable, Indicator Balance Status determines positively or negatively if the value of the indicator is greater or not to the average sample value. The **Innovation System Resource Balance – (ISRB)**, is defined as the total of positive indicator balance status for all system interactions. It can be assigned values from minimum zero to maximum ten.

Figure 1. The interaction Intenisty Index (3I) analytical framework



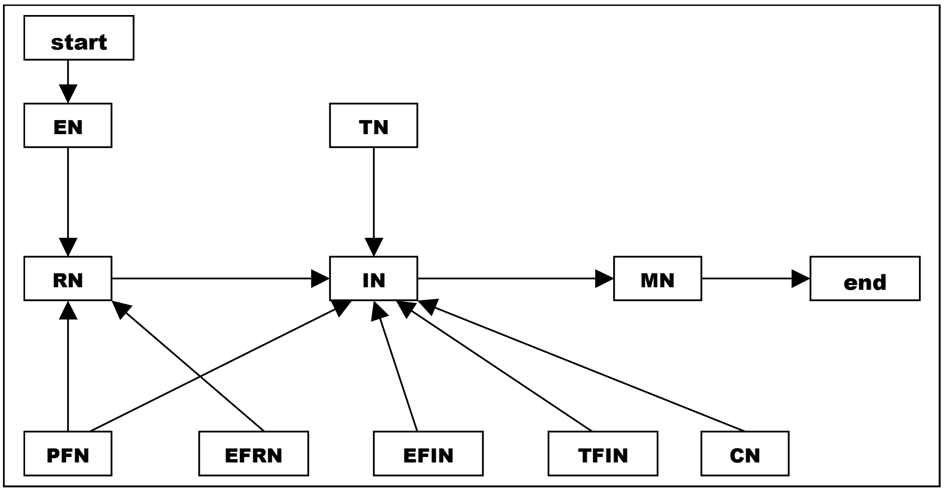
An analysis based on the cost of innovation processes

The cost analysis of innovation processess propose a new conceptual model, which is based on the graph theory (Spulber & Yoo, 2005). The basic elements of analysis are the interconnections and the nodes. The nodes are the end points interconnections that represent critical points of the graph such as the node of research and the node of innovation. Interconnections are characterized by the cost that they bring to the node.

Table 2. The nodes of the analytical framework

Innovation system graph nodes	**Acronym**
Public financing organization node (PFN)	**PFN**
Research Node (RN)	**RN**
Education Node(EN)	**EN**
Third party financing for Innovation Node (TFIN)	**TFIN**
Enterprise financing for Innovation Node (EFIN)	**EFIN**
Enterprise financing for Research Node (EFRN)	**EFRN**
Cluster Node (CN)	**CN**
Technology transfer node (TN)	**TN**
Innovation Node (IN)	**IN**
Market Node (MN)	**MN**

Figure 2. The node representation of the 3I analytical framework



Representing the analytical framework as a graph, we consider that the deployment of human resources is the beginning of the graph that ends with the development of new products in the market. Using as a base the studies of (Autio et al, 2004; Cooke et al, 2000; Braczyk et al, 1998) there two basic sets of processes.

- The subsystem knowledge production (R&D), includes universities, R&D financial mechanisms and other research institutes, characterized by strong internal capabilities and open interfaces with external centers of excellence (Hamdouch and Moulaert, 2006; Braczyk et al, 1998).
- The subsystem implementation and exploitation and diffusion of knowledge (Innovation), consisting in large of businesses, clusters, networks of enterprises, financial organizations, institutions of technology and markets (Cooke, 2004; Niosi, 2002; OECD, 2000).

Within these two basic susbsystems, a number of processes make up the value chain of innovation (Liu and White, 2000; Johnson and Jacobsson, 2000), employing respective innovation agents within the system. Some early analytical frameworks are examining the interaction among the innovation agents of a system (Galli and Teubal, 1997). A significant progress to the analysis had taken place with incorporation of simulation models and graph theories to optimise innovation system performance (Andersen and Lundvall, 1997). For each node when the total incoming resources (inputs) is equal with the outputs then this node presents zero friction cost. (Spulber & Yoo, 2000). Thus, the friction in these two basic nodes are:

Research node friction: $A(RN) = K(RII) - (K(PFI)+K(ARI)+K(ERFI))$,

Innovation Node Friction: $A(IN) = K(IMI) - (K(RII)+K(TIFI)+K(PIFI)+K(CI)+K(EIFI)+K(TII))$

System Cost $K(s) = K(PFI)+K(ARI)+K(ERFI)+(-K(RII))+(TIFI)+K(PIFI)+K(CI)+K(EIFI)+K(TII)+A(IN)+(-K(IMI))$, where $K(X)$is the cost of interconnection X, and $A(Y)$ is the friction in node Y.

An analysis based on the efficiency of processes

In the analysis of efficiency all factors of cost are connected with specific outcomes. This analysis is used for the measurement of efficiency of the allocated resources in the system of innovation. Is the efficiency indicator is described as the total of resulting outcomes divided by his total cost involved. The efficiency indicator in the two basic nodes of research and innovation (Autio et al, 2004) are defined by the elements presented in table 3.

Table 3. Efficiency indicator elements

Efficiency Indicators	Inputs	Outputs
Research Efficiency Indicator – REI	1, 2, 7	3
Innovation Efficiency Indicator – IEI	3,4,5,6,8,10	8

Thus the following indicators could be defined:

Research Efficiency Indicator, REI = (TIFI) / ((PRFI) + (ARI) + (ERFI))

Innovation Effectiveness Indicator, IEI = (IMI) / ((RII) + (TIFI) + (PIFI) + (CI) + (IMI) + (TII))

The Innovation System Efficiency, ISEI is composed by these two indexes.

For the purpose of this study have been used the micro data of the European Innovation Scoreboard 2006, 2005 and 2004 for 254 European regions and 30 countries. These two databases require some further processing. The imputation of missing values and the normalization of data.

In statistical science the phenomenon of missing values on a set of data is very common. To solve this problem eloped different statistical methods have developed. (Bacelar and Nicolau, 2002). Missing values are substituted by the predicted values obtained from a regression analysis. The dependent variable of the regression is the indicator hosting the missing value and the regressor is the indicator showing the highest degree of correlation with the dependent variable. Let us assume to have an indicator xj only observed for r countries but missing for the remaining M-r countries.

Let us identify a fully observed indicator xi with the highest correlation with xj. We compute the regression of on xj using xi complete observations, and we impute the M-r missing values using the predicted parameters from the regression, $x_{jk} = a_j + \beta_j x_{ik}$, k=1,…,M-r. The parameters α and β are estimated with the ordinary least squares method.

Normalization's purpose is to manage multiple heterogeneous data sets, allowing the comparison between these sets of data. The creation of a composite indicator requires compatibility data. The innovation indicators are incompatible with each other, and contain different units of measurement. In the rescaling technique, every index of region c, in a given year is converted using the formula $I^t_{ic} = \frac{x^t_{ic} - \min_c(x^t_i)}{\max_c(x^t_i) - \min_c(x^t_i)}$, where $\min_c(x^t_i)$ and $\max_c(x^t_i)$ are the lower and higher values of x^t_{ic} in all regions c in a given year t. Thus the normalized index I_{ic} takes values between 0 and 1.

Applying the analytical framework

The purpose of the application of analytical framework is to test its use in various innovation system development patterns. The application of the analytical framework has presented some important findings that characterize the European regional innovation terrain. For example, some regions like Finland's Etela-Suomi, are characterized as cohesive regions that present excellent innovation performance indicators for research and innovation, highly balanced systems along with high level of cost to attain these results. Figure 3 presents the analytical framework for Etela Suomi along with performance indicators in comparison with EU-25 mean values.

This study agrees with Hollanders (2007) and (Pinto, 2009) and (Komninos and Tsamis, 2008) studies for the excellence of the coherence regions, although it presents an important system failure. These regions present excellence as far as the results of the research and innovation subsystems but at a high cost. As it is presented in figure 4, although the system cost is above European mean the efficiency on these two subsystems is almost reaching the average. Thus, there is an important space for the increase of the innovation system results, with the same level of allocated resources.

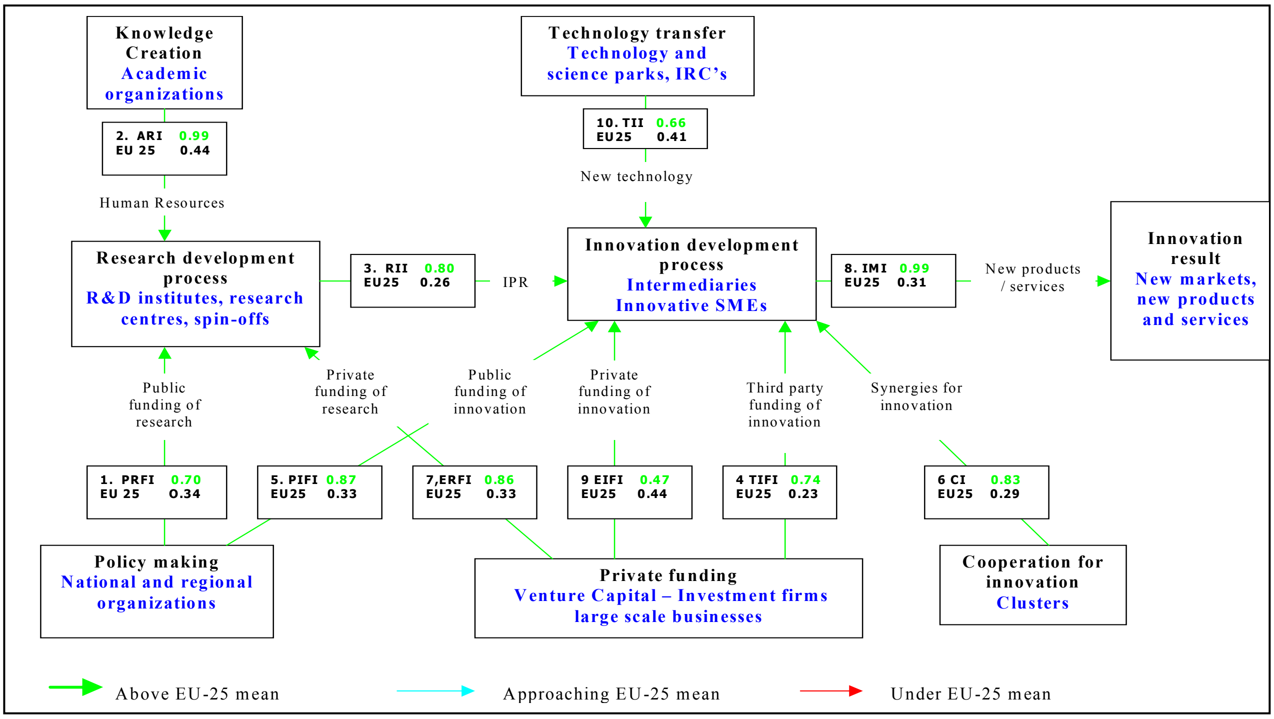


Figure 3. The 3I model for the Etela Suomi region

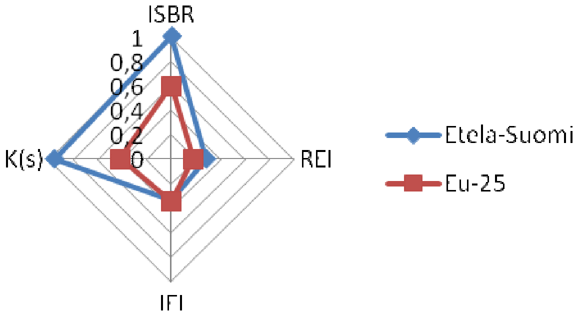


Figure 4. Systemic performance indicators for the Etela Suomi region

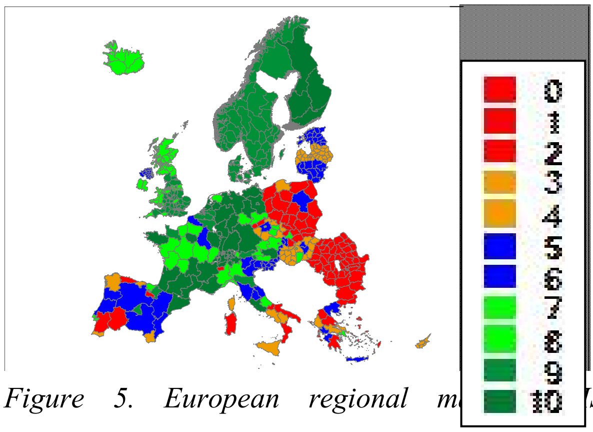


Figure 5. European regional m ISBR performance

This system failure, the **efficiency deficit,** could be a threat to these regions, especially in the case of budget cuts due to financial crisis of 2009. Due to this threat (Geiger, 2009), the cohesive regions must undertake actions of re-engineering their innovation systems that will improve the efficiency of innovation processes, capitalizing even better on the allocated resources, without any potential increase in system cost. Some sixty one cohesive regions concentrate mainly in Belgium, Sweden, Finland, Austria, Holland, Italy and France. Figure 6 presents the European map of Regional Innovation System Resource Balance (ISBR). The indicator illustrates the maturity, the completeness and the width of spread of resources across the innovation system. Coherence regions are forming an important innovation zone of heavily resourced innovation systems from the northern to central Europe. This innovation resource agglomeration formulate a zone "green banana in comparison with the "blue banana" (Hospers, 2002) of European regional industrial agglomeration.

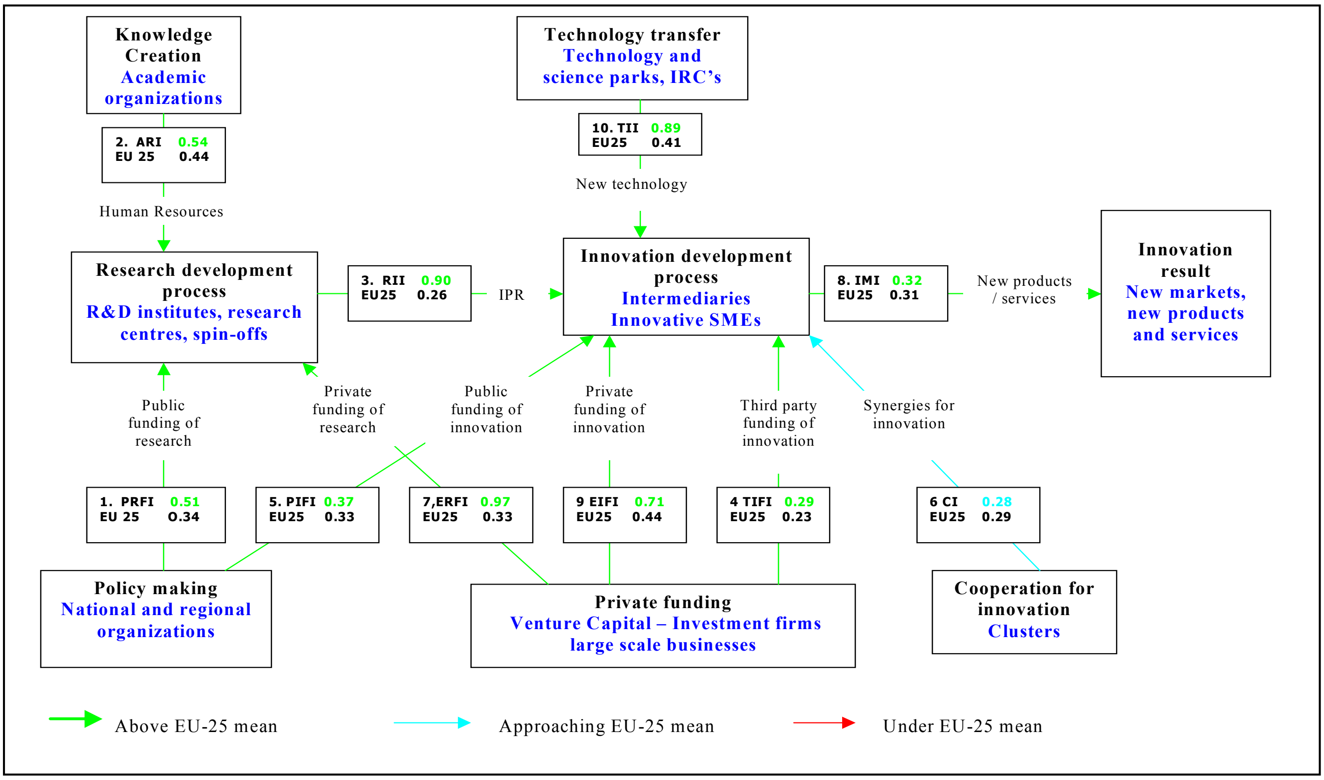


Figure 6. The 3I framework fthe Baden-Wurttemberg region.

Another important innovation deployment pattern concerns mainly with industrial regions that have developed strong research ties and infrastructure. These research oriented regions (Swann & Birke, 2005), follow mostly a linear innovation development process (Godin, 2002). Innovation is inspired from the research results of prominent research institutes and industrial centers, as it has been described in the analysis of "milieux innovateurs" (Doloreux & Parto,2004). These research oriented regions present a cohesive innovation system, although the research orientation weakens the ability for

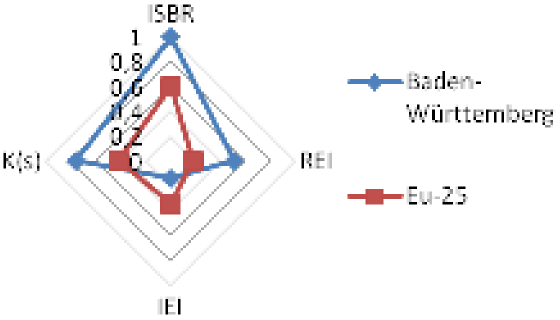


Figure 7. Innovation system performance indicators for the Baden-Wurttemberg region

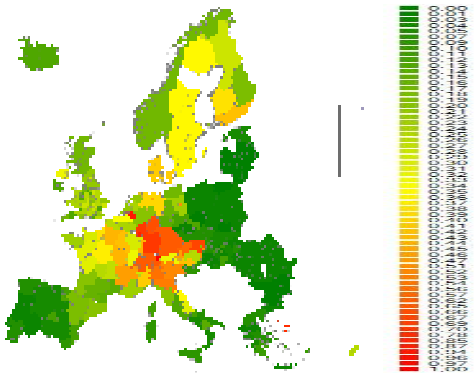


Figure 8. Regional agglomeration of research oriented regions

the interactive monitoring of innovation process with the market needs. In figure 7, the excellent level of the research subsystem is undermined with relatively lower efficiency of the innovation subsystem (Linden et al, 2007).

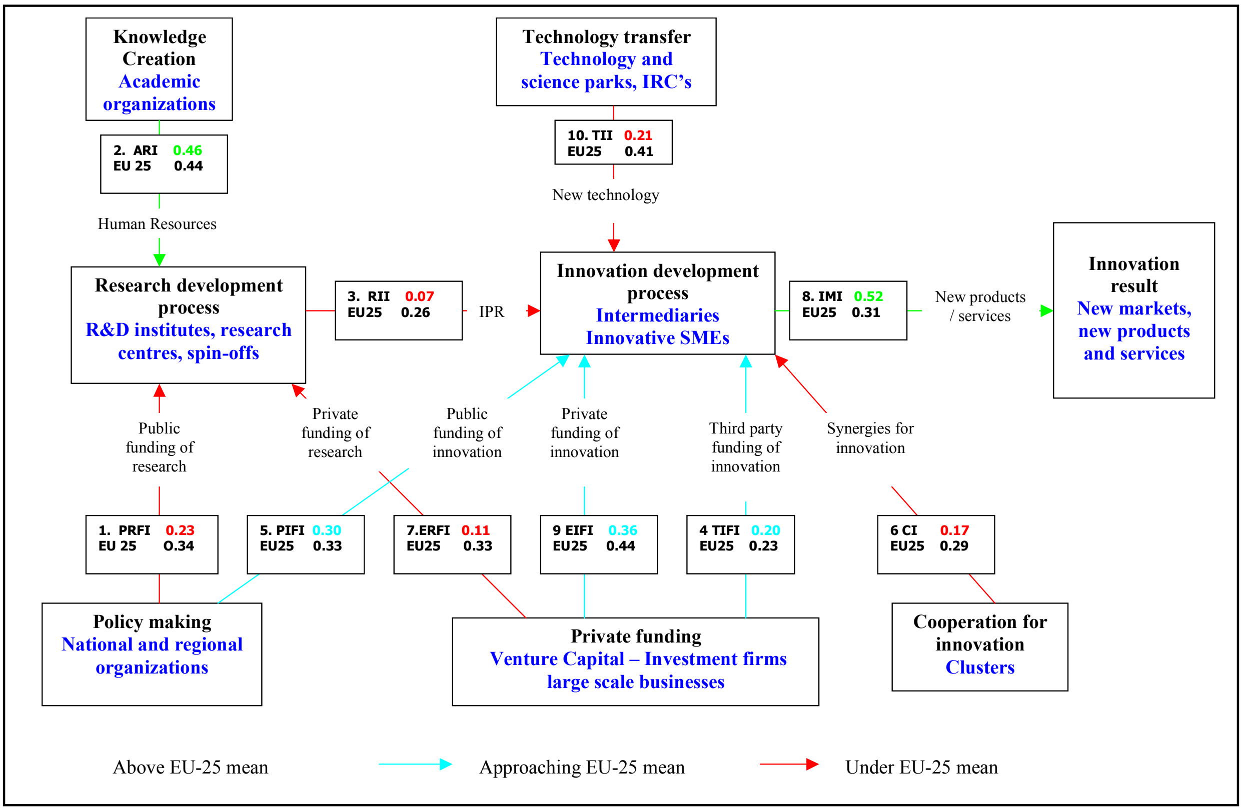


Figure 9. The 3I framework for the Valenthia region.

While the efficiency indicator is above EU-mean, along with cost of the system the innovation efficiency indicator presents a relatively low value. This innovation efficiency deficit is an important systemic failure. While the cost of the system is high, the resources that are allocated for the deployment of innovation do not deliver the expected results. In the linear development approach, the innovation efficiency deficit is an indication of low convergence of the research results with the market needs. While the Baden-Wurttemberg region is an example of

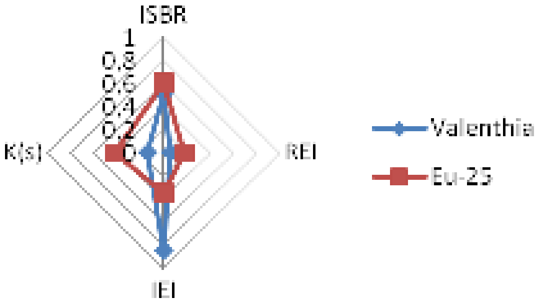


Figure 10. Innovation system performance indicators for the Valenthia region

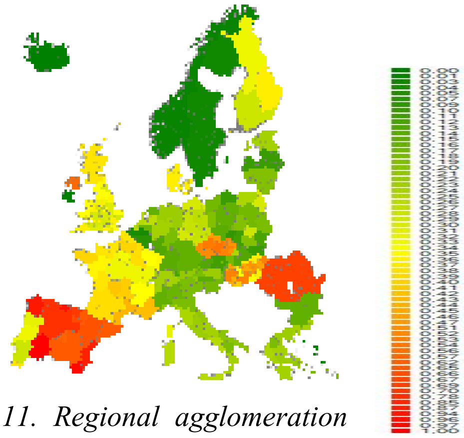


Figure 11. Regional agglomeration c “market pull” regions

excellence regions in mostly all metric analysis reports the systemic approach reveals an important system failure. The innovation deficiency calls for networking actions that will improve the research target areas with market needs. Some forty three European research oriented regions belong mainly to Germany, Holland, Austria and Italy, as it is presented in figure 8.

While across the European terrain most regions present strong research oriented innovation processes, there are some regions that do not follow this traditional linear model. Some regions have managed to develop innovation results by having developed reflective processes to the global market needs. This "market pull" regions utilize external research resources and new technologies to adapt, synthesize and convert them into the innovative results required by the global markets (Neely & Hii, 1998). These market pull regions have very low performance of the research subsystem, while present high efficiency in the innovation subsystem, as its shown in figure 10.. An example of dynamic regions, the region of Valenthia is presented in figure 9. These dynamic regions have been described by the European region as process innovation regions (EU, 2007), since they have develop special global networking capabilities to innovate on demand. Dynamic regions are the new forces in the innovation race among European regions. Usually metric innovation analysis reports categorize these regions as middle scale regions, since they use composite innovation indicators. In the case of European Innovation Scoreboard the Summary Innovation Index (SII) is the average of all indicators. The low performance in the research performance measurements decreases the value of the composite indicator overlooking the extraordinary innovation efficiency results.

With the use of the systemic framework we can envisage the important systemic **innovation efficiency outperformance.** Some twenty two dynamic regions in Europe belong mainly to Spain, Czech Republic, Scotland and Ireland. In figure 11, the European terrain of innovative regions is concentrated in the regions of Extremadura, Madrid, Melilla, Murcia, Andalucia, Galicia, Valenthia, Mancha, Castilla y León, Pais Vasco, Aragón, Cataluña, Praha, Jihovýchod, Strední Cechy, Strední Eastern, Border, Midlands and Western.

In the periphery of Europe Malta and Romania also present an extraordinary innovation efficiency performance, that need to be examined carefully as far as the conditions that create the favorable environment for the flourishing of innovation. In the latter cases the limited resources allocated to innovation are capitalized optimally. Most of these dynamic regions are located outside the "green banana" zone, despite the fact that most of the regions in the periphery of Europe present low innovation capacity (figure 6), with exception of some innovation islands that are formed around metropolitan centers like Athens, Madrid and Lisbon.

In the periphery of Europe are some innovation systems that present extraordinary performance and characteristics. Examples of such cases are the innovation systems of Malta and Romania.

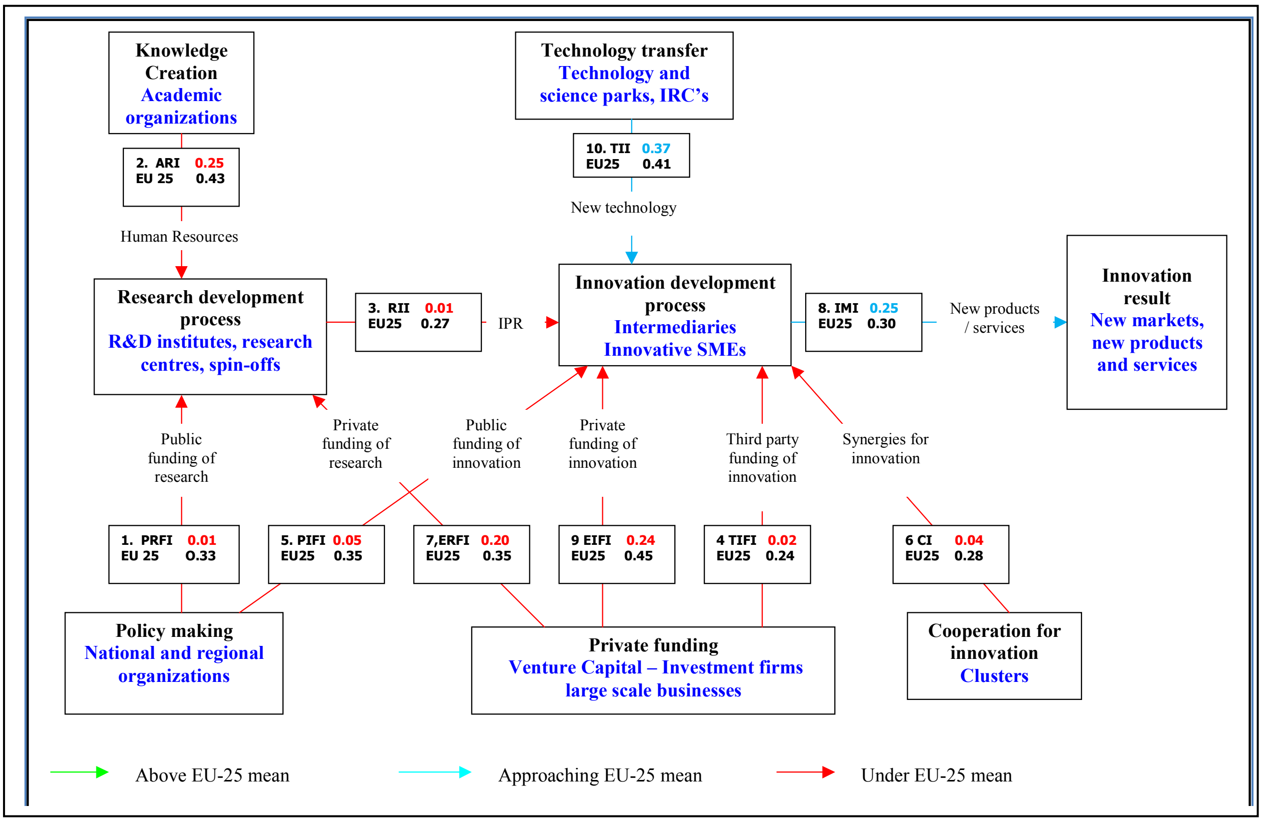


Figure 12. The 3I framework for Romania

This paper will examine the national system of Romania at national level, since there are not available data at regional level by Eurostat for the targeted years. The analysis of each regional innovation system of Romania could be exercised at later stage upon the availability of these data. The systemic performance values of the Romanian innovation system in comparison with EU-25, USA and Japan national innovation systems are presented in the table of annex B. The Romanian innovation system, as most in the South-East Europe, suffers for under spending with very low cost k(s) indicator reaching out the value of 0,03. The interaction

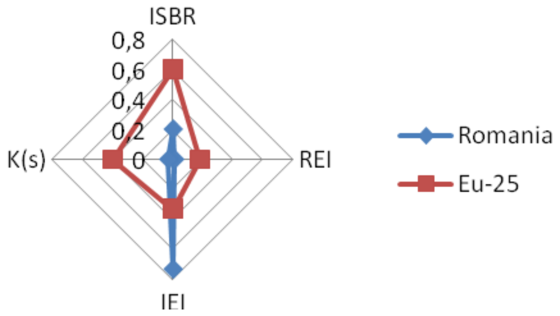


Figure 13. Innovation system performance indicators for Romania

intensity indicators present an important gap from the coherence European countries. The Academia and Research interaction (ARI) (0,25, EU25=0,45) is showing signals of an emerging academic research supported by an exceptional Enterprise Research Funding Interaction (ERFI) (0,2, EU25=0,47).

The metric reports for the Romanian innovation system present it as usual as a case of a less favored region regarding the innovation capacity by averaging all indicators into a composite indicator. Examining in detail the Romanian innovation system, there is an important systemic feature that exhibits signals of transformation into a dynamic "market pull" system. There is an important emerging path between technology transfer and innovation results, as it is shown in figure 12. Thus the system capitalizes on technology transfer and new technological advances to create new products and services.

This **technology based innovation efficiency** shows an important trend of the Romanian Innovation System, that must be further examined with the regard to local characteristics and processes regarding the technological transfer of knowledge and the involved actors (technology parks, corporate technological structures). Another issue of analysis is the degree of diffusion of these technological knowledge into the Romanian society and the influence that imposes into the specification of research priorities in the national research system. Figure 13 verifies these observations regarding the performance of the Romanian innovation system. Although there is a significant underperformance regarding the allocated resources, the balance of resources and efficiency of the research subsystem, there is an over performance in the innovation efficiency subsystem. That remark does not place Romania in the leading innovation countries, but is an indication of an efficient management at the level of the limited allocated resources for innovation. The requirement for further analysis of the qualitative elements of the Romanian innovation system could lead to prospective best practices at European level.

Conclusions

The aim of this paper is to illustrate the analytical capabilities of the 3I model envisaging failures and highlights of systemic nature of the regional innovation systems. The paper has presented various innovation employment patterns and illustrated the hidden by the metric analysis approach system features. The coherence regions are the milestones of the European innovation system.

The 3I study uncovered hidden problems in the efficiency of these regions that could be a potential threat in the case of budget cuts. In the case of research oriented regions the innovation efficiency deficit that is created from the linear approach to innovation is an important systemic failure that also has not been uncovered by the metric analytical approach. The 3I analytical approach has been used to reveal the regional innovation capabilities of the dynamic regions that deploy innovation without any significant research capacity. These regions are presented in the metric analytical approaches as medium performance, due to the averaging of all indicators into a composite indicator. Also the close systemic analysis of the Romanian innovation system has presented a case of possible best practice regarding “technology push” innovation. The envisaging of systemic failures and highlights provides signals for further qualitative analysis that could lead to respective policies for innovation deployment. These examples of system failure identification using an abstracted systemic model and metric data measurements proves the feasibility of the suggested approach as generic analytical framework for regional innovation analysis.

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Annex A.

2. Academia and Research Interaction	**ARI**	1.1 S & E Graduates, 1.2 Population with Tertiary Education, 1.4 Participation in Life-long Learning 1.5 Youth Education Attainment Level.
3. Research and Innovation interaction	**RII**	5.1 EPO patents per million population 5.2 USPTO patents per million population 5.3 Triadic patent families per million population 5.4 Number of new community trademarks per million population 5.5 Number of new community designs per million population describe adequately this interaction.
4. Thrird party innovation financing interaction	**TIFI**	3.4 early-stage venture capital (% of GDP)
5. Public innovation funding interaction	**PIFI**	2.4 Percentage of enterprises that received funding for innovation to the total number of enterprises
6. Cluster Interaction	**CI**	3.2 Innovative SMEs cooperating with others (% of all SMEs)
7. Enterprise research funding interaction	**ERFI**	2.5 University R&D expenditures financed by business sector 2.2 Business R&D expenditures reflect investment in research
8. Innovation and market Interaction	**IMI**	4.2 High-tech exports as a share of total exports 4.3 Sales of new products on the market (% of turnover) 4.4 Sales of new to the company but not new to the market products (% of turnover)
9. Entreprise innovation financing interaction	**EIFI**	3.1 SMEs innovating in-house (% of SMEs) 3.3, innovation expenditures (% of turnover).
10. Technology and innovation interaction	**TII**	2.3 Share of medium-high-tech and high-tech R&D (% of manufacturing R&D expenditures) 3.6 SMEs using non-technological change (% of SMEs) 4.1 Employment in high-tech services (% of total workforce) 4.5 Employment in medium-high and high-tech manufacturing (% of total workforce).

Annex B.

	COUNTRY	PRFI	ARI	RII	TIFI	PIFI	CI	ERFI	IMI	EIFI	TII	ISBR	REI	IEI	K(S)
EU25	E.U. members - 25	0,42	0,43	0,34	0,30	0,41	0,31	0,41	0,39	0,47	0,49	10	0,19	0,34	0,45
EU15	E.U. members - 15	0,43	0,44	0,42	0,30	0,41	0,32	0,42	0,45	0,52	0,56	10	0,23	0,36	0,48
BE	Belgium	0,31	0,53	0,38	0,34	0,58	0,33	0,62	0,26	0,71	0,58	10	0,18	0,14	0,71
CZ	Czech Republic	0,26	0,31	0,05	0,01	0,16	0,11	0,14	0,21	0,34	0,50	5	0,04	0,37	0,19
DK	Denmark	0,52	0,69	0,62	0,77	0,13	0,47	0,44	0,64	0,59	0,57	9	0,27	0,42	0,57
DE	Germany	0,49	0,38	0,68	0,25	0,61	0,31	0,67	0,44	0,83	0,75	10	0,31	0,24	0,73
EE	Estonia	0,29	0,50	0,03	0,10	0,09	0,40	0,26	0,20	0,44	0,30	6	0,02	0,29	0,28
EL	Greece	0,19	0,31	0,03	0,09	0,44	0,19	0,23	0,17	0,42	0,24	3	0,03	0,21	0,31
ES	Spain	0,25	0,37	0,24	0,13	0,44	0,08	0,33	0,20	0,35	0,35	7	0,18	0,23	0,29
FR	France	0,53	0,56	0,35	0,35	0,52	0,32	0,30	0,42	0,61	0,49	10	0,17	0,31	0,55
IE	Ireland	0,18	0,65	0,31	0,28	0,13	0,10	0,23	0,39	0,06	0,42	5	0,21	0,66	0,07
IT	Italy	0,35	0,22	0,31	0,05	0,76	0,02	0,14	0,37	0,50	0,46	6	0,30	0,35	0,39
CY	Cyprus	0,07	0,43	0,14	0,10	0,55	0,66	0,09	0,09	0,80	0,09	4	0,16	0,02	0,65
LV	Latvia	0,05	0,36	0,01	0,10	0,07	0,13	0,34	0,08	0,34	0,18	3	0,00	0,15	0,13
LT	Lithuania	0,30	0,53	0,01	0,09	0,13	0,44	0,51	0,16	0,42	0,15	5	0,00	0,25	0,25
LU	Luxemburg	0,01	0,29	0,59	0,09	0,36	0,20	0,32	0,65	0,41	0,49	6	0,69	0,66	0,19
HU	Hungary	0,36	0,28	0,03	0,01	0,35	1,00	0,42	0,26	0,12	0,40	6	0,02	0,25	0,47
MT	Malta	0,01	0,05	0,09	0,10	0,04	0,01	0,01	0,43	0,48	0,25	2	1,00	1,00	0,02
NL	Netherlands	0,47	0,48	0,58	0,32	0,76	0,20	0,37	0,32	0,26	0,42	8	0,31	0,24	0,47
AT	Austria	0,44	0,41	0,53	0,15	1,00	0,36	0,36	0,52	0,49	0,57	9	0,31	0,33	0,63
PL	Poland	0,20	0,36	0,02	0,08	0,01	0,20	0,19	0,21	0,47	0,17	4	0,01	0,47	0,12
PT	Portugal	0,28	0,10	0,08	0,31	0,70	0,22	0,06	0,41	0,69	0,23	6	0,13	0,38	0,50
SI	Slovenia	0,37	0,49	0,09	0,10	0,18	0,22	0,43	0,17	0,25	0,52	5	0,04	0,23	0,27
SK	Slovakia	0,06	0,32	0,01	0,01	0,06	0,06	0,05	0,38	0,54	0,28	3	0,01	0,89	0,06
FI	Finland	0,71	0,79	0,65	0,81	0,97	0,54	0,61	0,57	0,55	0,73	10	0,22	0,25	1,00
SE	Sweden	0,70	0,77	0,71	1,00	0,45	0,48	0,67	0,19	0,39	0,78	9	0,23	0,05	0,96
UK	United Kingdom	0,42	0,70	0,36	0,46	0,17	0,23	0,39	0,36	0,40	0,50	9	0,17	0,34	0,38
BG	Bulgaria	0,17	0,33	0,02	0,10	0,01	0,03	0,50	0,06	0,13	0,18	2	0,00	0,21	0,00
RO	Romania	0,01	0,25	0,01	0,02	0,05	0,04	0,20	0,25	0,24	0,37	2	0,01	0,73	0,03
TR	Turkey	0,24	0,13	0,01	0,10	0,13	0,10	0,52	0,06	0,16	0,14	2	0,00	0,16	0,06
IS	Island	1,00	0,54	0,22	0,39	0,22	0,45	0,62	0,07	0,65	0,57	8	0,07	0,00	0,69
NO	Norway	0,53	0,68	0,22	0,39	0,39	0,45	0,36	0,08	0,40	0,46	9	0,10	0,02	0,61
CH	Switzerland	0,43	0,63	0,96	0,47	0,25	0,36	0,52	0,55	1,00	0,71	10	0,44	0,29	0,70
US	United States	0,57	0,42	0,41	0,60	0,13	0,60	0,47	0,58	0,38	0,34	9	0,20	0,50	0,40
JP	Japan	0,59	0,45	0,46	0,60	0,13	0,60	0,53	0,53	0,38	0,47	9	0,21	0,42	0,47
Mean values		**0,33**	**0,43**	**0,27**	**0,24**	**0,35**	**0,28**	**0,35**	**0,30**	**0,45**	**0,41**	**7**	**0,18**	**0,33**	**0,40**