Lending Dynamism to Innovative Capacity in the Periphery of Europe

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ABSTRACT

The main objective of this study is to identify the dynamic regional innovative features in the periphery of Europe that are hidden from the current "market failure" regional benchmarking practices. This study identifies the systemic failures in the "blue banana" regions and the performance highlights in the regions in the periphery of Europe. The paper used a systemic analytical tool that revealed important findings that characterize the European regional innovation terrain. It did a clustering statistical analysis that identified five types of regional innovation system patterns based on systemic performance weaknesses. The study exposed new modes of enhancing regional innovation capacity compared to the existing conventional and mostly linear policy implementation practices and provides benefits to policy makers in the periphery of Europe who wish to reform their innovation policies to focus on more effective results-oriented actions.
Key words: Innovation systems, regional development, innovation efficiency, innovation policies

Introduction

Regional innovation benchmarking reports, such as European Innovation Scoreboard usually praise regions of excellence from Finland, Sweden and regions in the industrial zone of Europe, called "blue banana" like the German regions. These reports assume an innovation development mode based on vast R&D expenses and infrastructures, following mainly the linear innovation development approach.

Even the Lisbon Treaty assumes that an increase in R&D expenses will be hopefully transformed them into marketable innovative results. The regions in the periphery of Europe seem to be observers and in some cases followers in the innovation arena. Would it be possible to overcome the regional innovation performance gap in the periphery of Europe following a dynamic approach that will capitalize in non-research based innovation, global innovation networks and innovation on demand methods?

This study identifies the systemic failures in the "blue banana" regions and the performance highlights in the peripheral regions of Europe concluding a diversified non-linear dynamic innovation policy using the Interaction Intensity Index (3I) regional analysis model (http://www.rrsa.ro/rjrs/V324.sotiris.pdf), that converges systemic analytical features with conventional benchmarking regional innovation exercices, presented by Zygiaris (2009).

The 3I innovation system analytical framework

The analytical framework utilizes the studies of Autio et al. (2004), Cooke et al. (2000) and Braczyk et al. (1998), concluding that there at least two subsystems within the innovation systems.

- Hamdouch and Moulaert (2004) describe the subsystem of knowledge production (R&D) that includes universities, R&D financial mechanisms and other research institutes, characterized by strong internal capabilities and open interfaces with external centers of excellence.
- Niosi (2002) refers to the subsystem of knowledge exploitation (innovation), consisting of enterprises, clusters, financial organizations, institutions of technology and markets.

Thus, the analytical framework can be applied either to a linear path (research to innovation systems) and also to a non-linear innovation path (global markets to innovation) systems. Within these two basic susbsystems, a number of processes make up the value chain of innovation as they illustrated in the studies of Liu and White (2000) employing respective innovation agents within the system as they described by Johnson and Jacobsson (2000).

The resulting analytical framework of Figure 1, called the Interaction Intensity Index- 3I, illustrates the ten interactions indicators and the corresponding European Innovation Scoreboard indexes, presented in Annex A, within the two subsystems of the innovation system.
Within the 3I model a number of systemic indicators are developed:

- **ISBR,** Innovation System Resource Balance, indicating the number of interactions that are above the corresponding EU mean. It can take values from 0 to 10.
- **K(s),** System Cost, a normalised indicator ranging from 0.0 to 1.0
- **REI** Research Efficiency Indicator ranging from 0.0 to 1.0
- **IEI**, Innovation Effectiveness Indicator ranging from 0.0 to 1.0
- The ten interaction indicators of Annex A ranging from 0.0 to 1.0

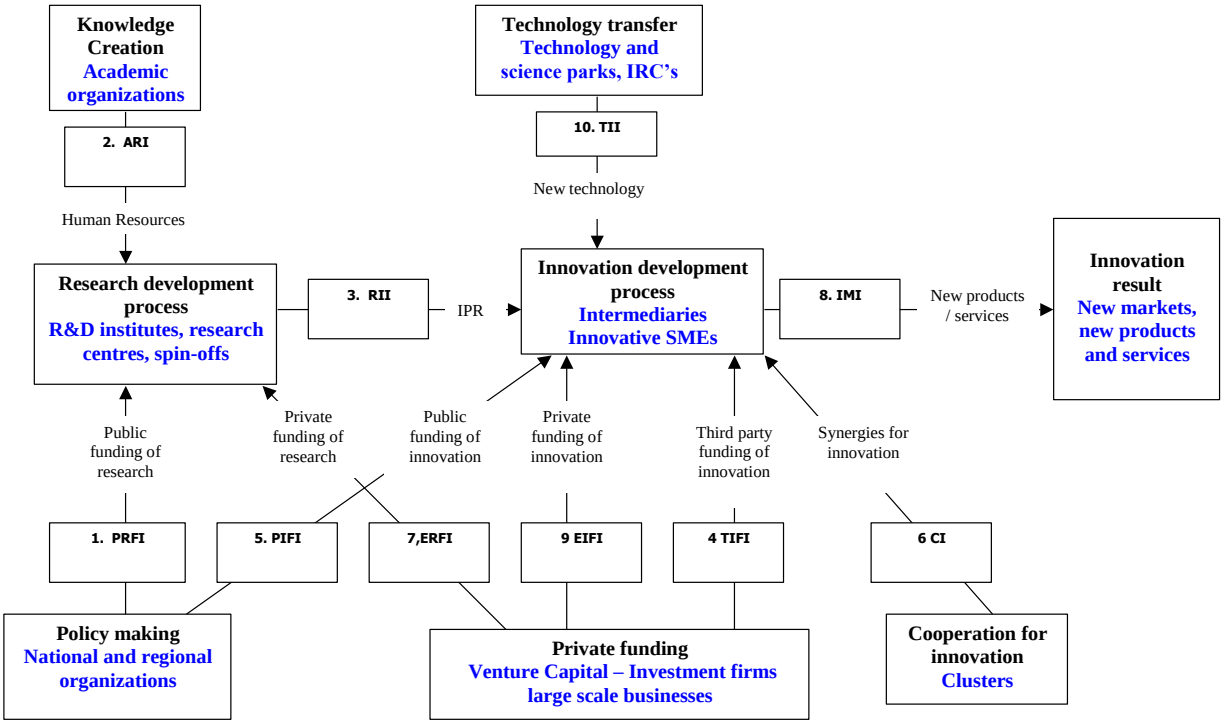
For the purpose of this study have been used the micro data of the European Innovation Scoreboard 2006, 2005 and 2004 for 254 European regions and 30 countries. The metric analytical frameworks like the European Innovation Scoreboard construct a composite innovation index on the basis of averaging all inputs and outputs.

An important contribution of the 3I analytical framework is that evaluates the outcomes of an innovation system in relation with the allocated resources to achieve these outputs. The important systemic analytical feature of the effectiveness of innovation systems must be considered to have an explicit view of not only of the outcome volume but also at what cost is achieved this volume.

Applying the analytical framework

Regional agglomeration of innovation resources
The ISBR indicator levels across the European regions indicates how balanced are the resources allocated among the ten interactions of the regional innovation systems and the

Figure 1: The Intensity Interaction Index (3I) analytical framework



degree of agglomerated resources in these interactions. The indicator illustrates the maturity, the completeness and spread range of resources across the innovation system.

The high agglomeration of industrial and research infrastructure in a zone called by Hospers (2002) "blue banana", that includes the wealthy industrial regions of western and northern Europe, had created a wealth dividend among these industrial nations and the countries in the periphery of Europe. With the emergence of knowledge economies and the globalization of markets the attention is shifting from industrialization to innovative activities of technological change.

A new zone of agglomerated innovation resources is developing across the Scandinavian, Northern and Western Europe regions forming a knowledge highway in Europe that is referred in this paper as "green banana". Regions in this zone benefit from the high concentration of research infrastructures. This mode of innovation development across Europe creates less favored regions in the periphery of Europe advancing the knowledge dividend.

The proximity provides an important beneficial effect for building innovation capacity concludes Baptista (2000). While Europe may become the most dynamic knowledge economy as it is argued by Archibugi and Coco (2005), the spatial characteristics and regional agglomeration of innovation resources in the "green banana" create less favored regions in the periphery of Europe. The regional agglomeration of innovation resources can be analyzed even further to investigate what types of resources are allocated across European regions. The basis of this knowledge dividend analysis is the geographical representation of the allocated resources regarding the ten interaction indicators and systemic performance indicators.

The agglomeration of resources for public funding for research is denoted by the PRFI indicator. These resources are concentrated in an axis of regions that consist of Finish (2 regions), Swedish(4), German(12), Dutch(7), North UK regions, Island, the French regions of Ile de France, Midi-Pyrenees, Languedoc-Roussillon and Meditarranee, the Italian regions of Lazio and Centro and the Austrian regions of Wien and Steiermark. Around this axis there are

smaller zones in Ireland, London, in the Belgian region of Vlaams Gewest and in the Polish region Mazowieckie. In the periphery of Europe the allocated public funding for research becomes minimal with the exception of some metropolitan areas like Athens, Madrid and Lisbon, Crete and Cecily.

Private funding for research, denoted by the ERFI indicator, is one of the major policy issues set by the Lisbon agenda. In detail the German regions of Braunschweig, Bayern, Stuttgart, Baden-Wurttemberg, the Dutch regions of Noord-Brabant, Limburg, Zuid-Nederland, the Swedish regions of Vastsverige, Sydsverige, Stockholm, five UK regions, four Austrian regions, five French regions and the Italian region of Piemonte present excellence in attracting private funds for research. The periphery of Europe suffers for underinvestment for research with exception of the moderate performance of Bulgaria, Lithuania and Island.

The availability of scientific and technological human resources is indicated by Ketikidis and Zygiaris (2007) as an important element of the innovation process. The European map representing the level of scientific human resource supply for the indicator ARI, presents high agglomeration in the regions of Northern Europe, mainly in all the Scandinavian, UK, the Baltic and German regions and some smaller poles are developing among the Switzerland and French regions. In the periphery of Europe human resources are developing scarcely with the exception of Cyprus and Central Spain regions.

The spatial representation of IPR resources, for the indicator RII, presents agglomeration in the regions of Finland (3 regions), Sweden (5), France (3), Germany (25), Holland (3), UK (2), Austria (1) and Luxemburg. IPR as an intermediate result of the innovation system verifies the leadership of the "green banana" regions and profound weakness of the peripheral regions to produce IPR results.

The regional agglomeration of Third Party financing, TIFI, is concentrated in the Scandinavian regions of Sweden, Belgium Holland and Finland the surrounding of London regions, the Switzerland regions, twelve German regions, the French region, Ile de France, Midi-Pyrénées, Rhone-Alpes, Alsace and Bretagne. In the periphery of Europe there is a performance gap in attracting venture capital with the exception of a limited number of regions such as Athens, Crete, Lisbon and Madrid.

Public funding policies for innovation, denoted by the PIFI indicator, are spread out more evenly than other resources throughout Europe responding to the market failures of weak innovation performance in the periphery of Europe. Finish, Swedish and Austrian regions present a high level of performance, with the region of Wien to perform optimally. Some high performance poles also appear in the Italian regions of Lombardia, Emilia Romagna, Lazio, the Greek region of Attica, Cyprus, Malta, the French region Ille de France, the region of Lisbon, the Dutch regions Ultrecht, Noord Brabant, the Baltic regions and the German regions of Stuttgart and Braunschweig. The member states are enforcing policies to increase their innovation capacity according to the Lisbon treaty.

Enterprise funding innovation policies, denoted by the EIFI indicator, present high level of resources in the regions of Germany, Austria, Switzerland, Ireland, Cyprus, Attica, Madrid, Lazlo and the North Italian regions. The rest of European regions including the Scandinavian regions have not managed to attract a significant amount of private funds for innovation.

The regional agglomeration of networking and clustering resources is denoted by the CI indicator. The Scandinavian regions present an excellent performance followed by the Hungarian regions of Kozep-Magyarorszag, Eszak-Alfod and Dunantul, some regions of Germany, France Holland, Island and Austria and Cyprus.

Technology transfer resources, denoted by the TII indicator, are concentrated in the "green banana" regions of Germany Stuttgart, Karlsruhe, Baden-Württemberg, Darmstad, the Finish, Czeck Republic, South Eastern UK, Austrian regions and Madrid. There are not only intensive technology transfer activities in the "green banana" zone, but also a considerable level of activities spread out in the surrounding regions.

New product development is the ultimate end result of innovation systems, denoted by the IMI indicator. The European regional present a different outlook regarding new product development in relation with the previously examined resources. The agglomeration of NPD resources is mainly outside the "green banana" zone in the Spanish regions of Madrid, Aragon, Navarra, Castilla y León, Cataluna, Pais Vasco, the French regions de France, Rhone-Alpes, Midi-Pyrenees, the Czech Republic regions, Ireland, Scotland and the Finlsh regions Etela-Suomi, Manner-Suomi.

New product development as the most important output of an innovation system is a critical indicator for the efficiency of innovation systems. The agglomeration layout presents new innovation forces in Europe that although do not agglomerate high levels of input resources they manage to effectively be more efficient in utilizing these resources.

Figure 2 illustrates the levels of allocated innovation system cost across the European regions. The map verifies that "green banana" regions are the most heavily resources regions. The Scandinavian, German Denmark Holland, Belgium, Switzerland, Northern Italy and Eastern France regions are the most costly systems. In the periphery Attica, Cyprus and Lisbon are the most costly systems. Some European regions present excellent performance in the research or knowledge production subsystems. These regions have high Research Efficiency indicator and agglomerate research resources and infrastructures.

Figure 2: European regional innovation system cost K(s)

There is a research zone that includes mainly the German regions of Freiburg, Luneburg, Koblenz, Oberpfalz, Dusseldorf, Bayern, Darmstadt, Stuttgart, Baden-Württemberg, the Austrian region of Vorarlberg, the Holland's regions Noord-Brabant, and Zuid-Nederland and Luxemburg.

Some regions with moderate research efficiency performance belong to Finland, Sweden, France, Switzerland, Belgium and the Italian regions of Lombardia and Emilia-Romagna. The rest of European regions present low research efficiency performance, having difficulties to transform the allocated resources for research into research results. Other

European regions are more efficient in transforming the allocated innovation resources into results.

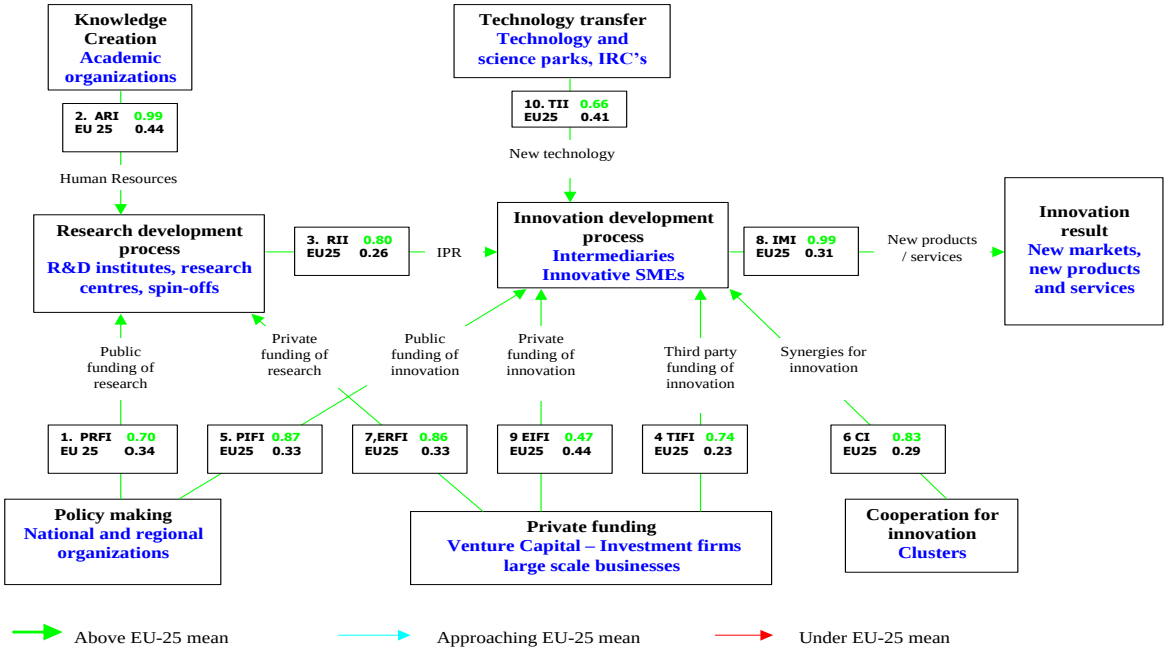
There is an extraordinary innovation efficiency performance in the Spanish regions of Extremadura, Madrid, Melilla, Murcia, Andalucia, Galicia, Valenciana, Mancha, Castilla y León, Pais Vasco, Aragon, Cataluña, the Czech Republic regions of Praha, Jihoychod, Strední Cechy, Strední Morava, Jihozapad, Moravskoslezko, Severovychod, the Hungarian regions of Del-Dunantul and Eszak-Alfold, the Irish regions of Southern and Eastern, Border, Midlands and Ireland, the Romanian regions along with Malta have high values of Innovation efficiency Indicators capitalizing optimally the limited allocated resources for innovation.

The typologies of regional innovation systemic performances

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. The study followed a clustering statistical analysis that had identified five types of regional innovation system patterns based on the systemic performance weaknesses and highlights. The selection of clustering parameters was based on a factoring analysis that presented high correlation for the IEI, REI, ISBR and K(s) indicators.

The first type characterized as "cohesive regions" present excellent innovation performance indicators for the research and innovation subsystems. This study agrees with Arundel and Hollanders (2005), Pinto (2009) and Komninos and Tsamis (2008) studies for the excellence in innovation regions presenting as an example the 3I analytical framework for the Etela Suomi region in Figure 3.

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



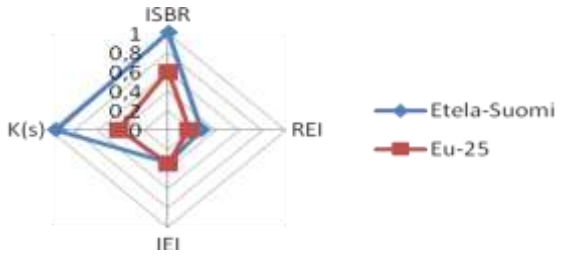
The added value that this study offers is the fact that identifies a significant space of improvement by identifying a systemic failure. These regions present excellence as far as the results of the research and innovation subsystems but at relatively high cost.

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 by improving the system effectiveness. 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.

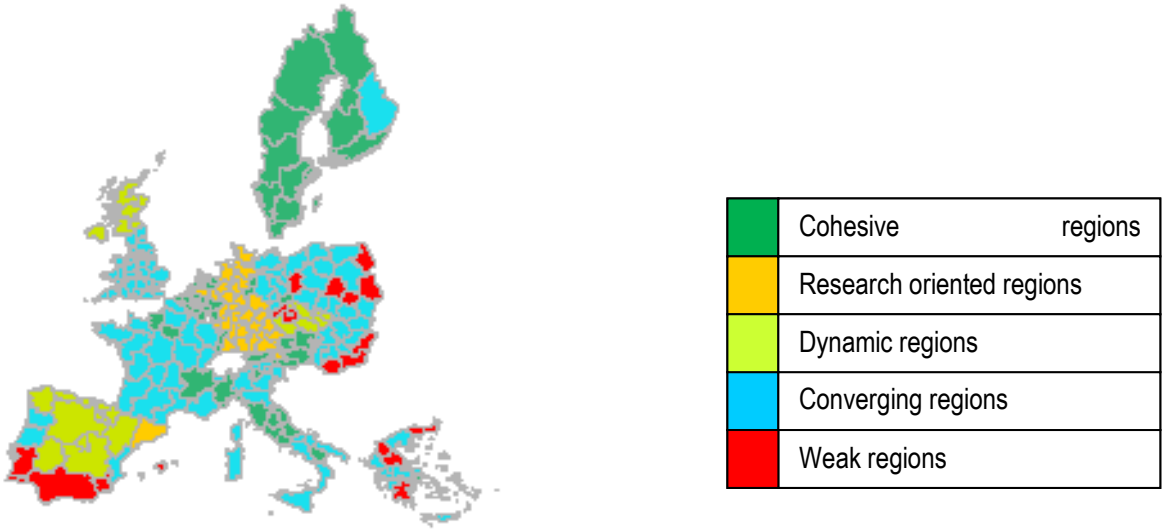
Due to this threat, the cohesive regions must undertake actions of re-engineering their innovation systems that will improve the efficiency of innovation processes, capitalizing even better on the allocated resources, without any potential increase in system cost.

Figure 4: Systemic performance failure for the Etela Suomi region



Some sixty one cohesive regions concentrate mainly in Belgium, Sweden, Finland, Austria, Holland, Italy and France, as it is illustrated in Figure 5.

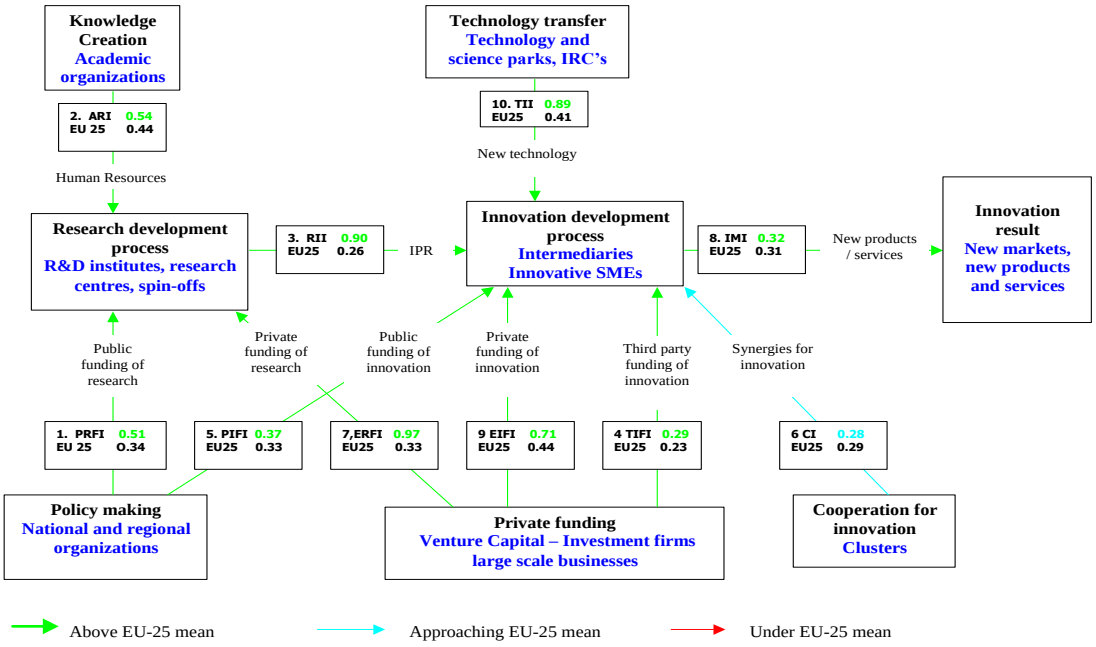
Figure 5: Geographical representation for the clusters of regions



Another important innovation deployment pattern concerns mainly the "research oriented" industrial regions that have developed strong research ties and infrastructure. These research oriented regions, which are also identified by Swann and Birke (2005) mostly follow a linear innovation development process, as stated by 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* by Doloreux & Parto (2004). An example of a research oriented region, Baden-Wurttemberg, is presented in Figure 6.

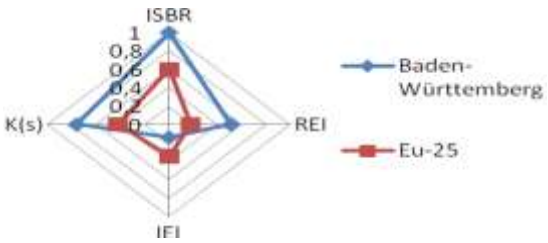
These research oriented regions present a cohesive innovation system, although the research orientation weakens the ability for the interactive monitoring of innovation process with the market needs argues Adams and Jaffe (2002). In Figure 7, the excellent level of the research subsystem is undermined with relatively lower efficiency of the innovation subsystem.

Figure 6: The 3I framework the Baden-Wurttemberg region.



While the efficiency indicator is above EU-mean, along with cost of the system the innovation efficiency indicator presents a relatively low value.

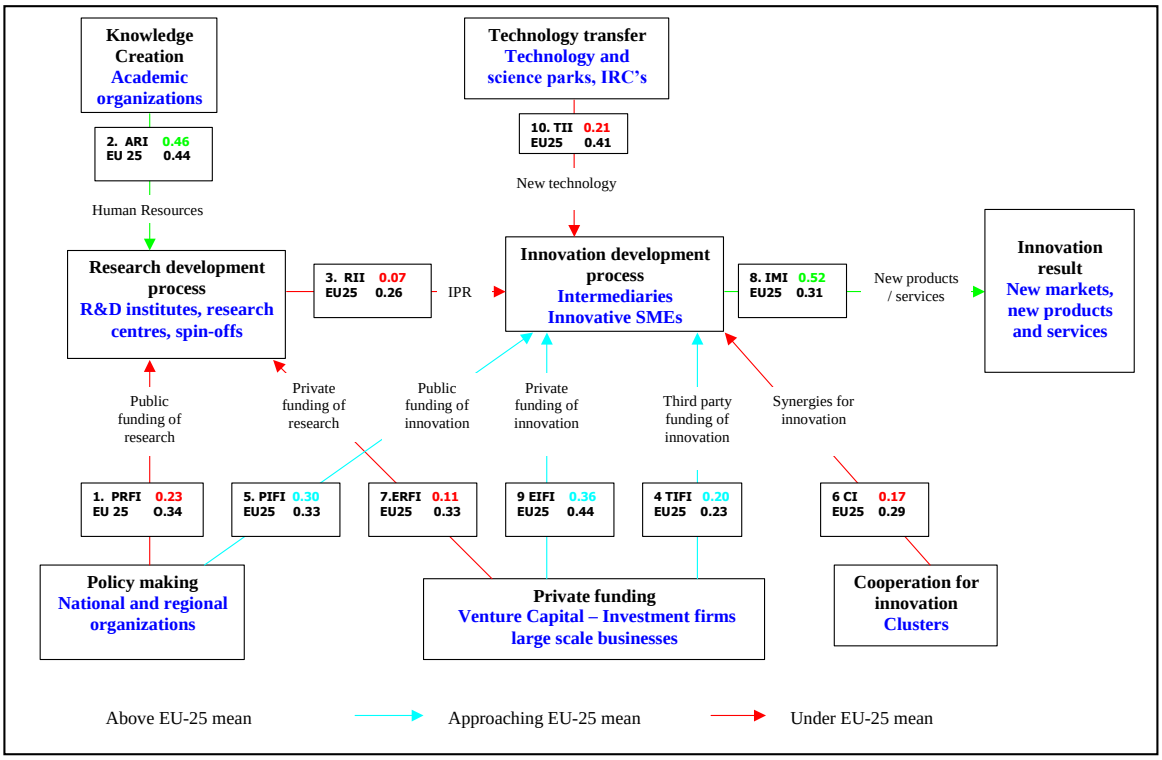
Figure 7: Systemic performance failure for the Baden-Wurttemberg region



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 need, as it is stated by Rodriguez and Crescenzi (2006). While the Baden-Wurttemberg region is an example of excellence regions in mostly all metric reports, the systemic approach reveals an important system failure. Crevoisier (2004) concluded that the innovation deficiency calls for networking actions that will improve the research target areas with market needs. The forty-three European research oriented regions belong mainly to Germany, Holland, Austria and France, as it is presented in Figure 5.

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. The "dynamic" regions have managed to develop innovation results by having developed reflective processes to the global market needs, as it was concluded by Arundel et al. (2007). These "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, indicated by Neely and Hii (1998). An example of a dynamic region the region of Valenthia is presented in Figure 8.

Figure 8: The 3I framework the Valenthia region.

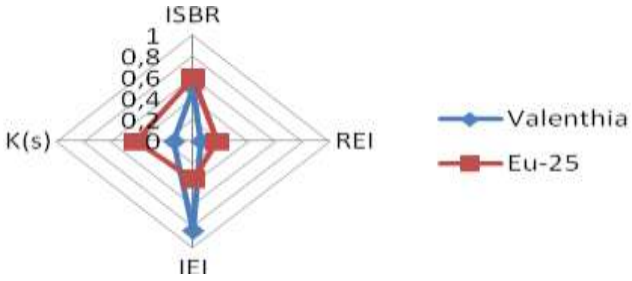


These regions have very low performance of the research subsystem, while present high efficiency in the innovation subsystem, as it is shown in Figure 9. These dynamic regions have been described by the European region as process innovation regions since they have develop special global networking capabilities 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*.** In Figure 5, 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, Střední Cechy, Střední Eastern, Border, Midlands and Western and Ireland. Some twenty two dynamic regions in Europe belong mainly to Spain, Czech Republic and Scotland.

Figure 9: Systemic outperformance for the Valenthia region



The majority of European Regions belong to the fourth group of "converging regions" that their research and innovation performance converges to the European average performance. These 89 converging regions are diffused throughout the European terrain and do not present any particular geographical agglomeration as they are presented in Figure 5.

The fifth group of regions belongs to the "weak regions" that present a significant rate of under investment in innovation and weak performance throughout their innovation system. These 22 regions are located in the periphery of Europe favored less from the agglomeration of regional innovation resources. These knowledge isolated regions should be enforced with differentiated policies to eliminate the profound ***knowledge deficit*** in the periphery of Europe.

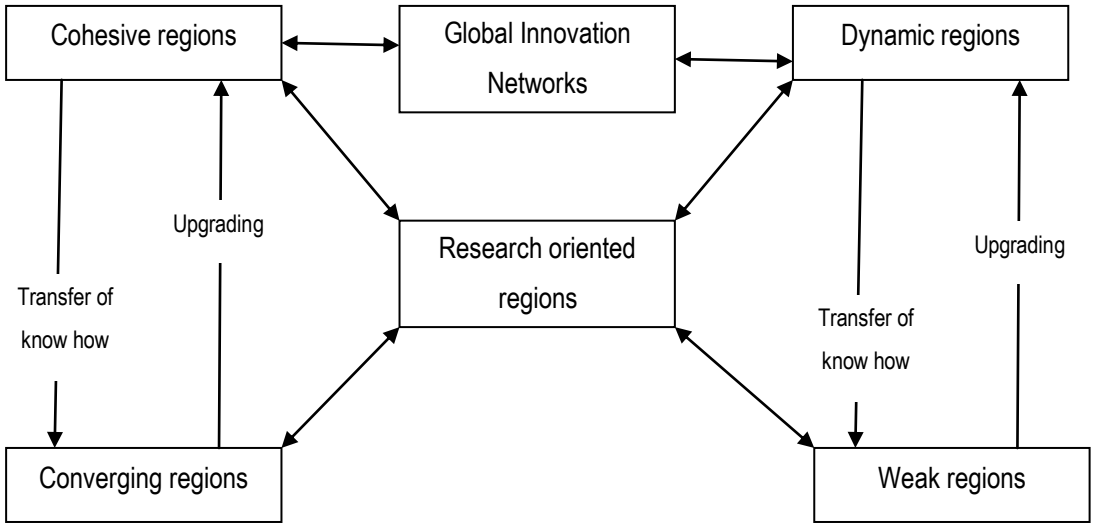
Dynamizing the innovative capacity of less favoured regions

A policy framework for dynamizing the innovative capacity of less favored regions can take the form of an integrated regional cooperative model aiming to build flows of knowledge upgrading the converging regions into cohesive regions and the weak regions into dynamic regions. Converging regions that are usually isolated in the metropolitan areas process the necessary resources to be upgraded into cohesive regions.

The agglomeration of weak regions in the periphery of Europe is highlighted with examples of dynamic regions. These weak regions could be upgraded easier to dynamic regions than to converging regions since they are mostly under resourced.

This policy framework could be a valuable orientation guide regarding the types of interregional cooperative models in the periphery of Europe. Especially, for the weak peripheral regions the upgrade to dynamic regions commands in the creation of new dynamic sectors capitalizing on the R&D results of research oriented regions. The upgrade to dynamic regional features requires collaboration with global innovative networks and market pull strategies in emerging innovation areas such as green technologies, service and social innovation.

Figure 10: A policy framework for regional innovation uptake in the periphery of Europe



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 used the 3I analytical framework to identify the dynamic regional innovative features in the periphery of Europe that are hidden from the current "market failure" oriented regional benchmarking practices and propose differentiated policy lines that will capitalize on these hidden strengths. The study adds new modes of regional innovation capacity build-up to the existing conventional and mostly linear policy implementation practices and benefits policy designers in the periphery of Europe to reform their innovation policies to more effective result oriented actions.

Thus the weak regions resource gap will never "catch up" to the level of resources allocated to the cohesive regions. Thus just increasing the level of R&D spending will create minimal benefits to the region's innovation systems. More radical and well targeted approaches must be taken place in order to maximize results and speed the converging process. The rapid uptake of regional innovation systems in the periphery of Europe demands the adaptation of market opportunistic development methods, such as those developments by the dynamic regions.

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Dr. Sotiris Zygiaris is a senior researcher at the Urban and Regional Innovation Center of Aristotle University in Greece. His Ph.D. work was about analysis of regional innovation systems and policies. His research focus is on smart cities, intelligent web and innovation ecosystems. He is a European Union expert in issues related to smart growth and has participated in various regional development projects globally. Currently, he is formulating the curriculum for a post-graduate course in smart city planning.

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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. Third 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. Enterprise 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).