PolicsLab: insights for supporting innovation policies

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Abstract: When defining and updating the Smart Specialisation Strategy, regional policy-makers are called upon to identify territorial avant-gardes and its growth potential through a continuous technological foresight exercise, which takes into account the entire panorama of local research and innovation. Data from official statistics based on international classifications, although very useful, is not sufficient to keep pace with sudden changes affecting local territories as well as external factors that may influence a given territorial policy. Furthermore, the use of new data sources, far from being a simple solution to the need of fresh and granular data, implies tackling numerous methodological challenges. The paper presents the rationality of an information system able to support policy-makers in technological foresight. The model is based on the valorisation of data available from traditional and non-traditional sources as well as the construction of simple and intuitive interpretative tools to measure and predict territorial changes and transformations, which are related to the innovation system of Italian regions.

1 INTRODUCTION

Investments in research and innovation play a key role within the "Europe 2020" Strategy for smart, sustainable and inclusive growth. In this context, the Smart Specialisation Strategy is identified as a new paradigm to spread place-based policies at EU, national, and regional level.

The Smart Specialisation concept describes the capability of an economic system to generate new specialisations through the discovery of new fields of opportunities. The underlying rationale is that countries and regions can become - and remain - competitive in the global scenario and trigger structural changes within their economic systems by concentrating knowledge, resources and expertise in a limited number of priority economic activities and by exploiting the benefits of agglomeration, scope and spillover effects. In short, the smart specialisation concept refers to the ability of developing unique assets and capabilities based on the distinctive entrepreneurial strenghts of each region (Foray, 2015).

The identification of priorities in the context of smart specialisation involves a combination of a top-down process of identifying general objectives aligned with EU policies and an emergency of a bottom-up process of areas of experimentation deriving from the discovery of entrepreneurial actors.

Most of the structural changes generated by Smart Specialisation Strategies (S3) imply the creation of related variety by recombining existing sectors into new forms or by developing new activities. Modernisation, diversification and transition are transformation processes that link existing production capacities to new areas of potential competitive advantage (Frenken et al., 2007; Aghion et al., 2009; Neffke et al., 2009; Boschma and Frenken, 2011).

In addition to the related variety, an alternative approach is mentioned in the selection of intervention priorities: the entrepreneurial discovery process. This precedes the innovation stage and consists in exploring and creating a new field of opportunities (technological and market opportunities), potentially rich in numerous innovations that will occur later. Entrepreneurs must therefore be broadly understood to include, among others: enterprises, higher education institutions, public research centres, independent innovators; whoever is in the best postion to discover those R&D&I domains where a

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region is likely to excel (Hausmann and Rodrik, 2003).

Considering that the process of entrepreneurial discovery is totally bottom-up, this vision seems to contrast the related variety approach that aims to identify, a priori, which regional potentials and intersectoral crossovers could be stimulated. One way to effectively combine related variety and entrepreneurial discovery is to adopt a sequential approach to priority setting in which economic activities, with greater potential, are identified by the related variety method and, subsequently, the entrepreneurial discovery process is activated within the boundaries of these predefined areas. Analysis carried out using the related variety approach, limit the scope of entrepreneurial discovery only to those areas where there is strong emerging evidence of innovation and growth potential. Entrepreneurial discovery helps to identify current growth bottlenecks and knowledge-driven development opportunities (Boschma and Gianelle, 2014).

Based on these assumptions, the paper presents the rationality of an information system able to support policy-makers in technological foresight. The model is based on the valorisation of data available from traditional and non-traditional sources as well as the construction of simple and intuitive interpretative tools to measure and predict territorial changes and transformations, which are related to the innovation system. The first test of the platform has been carried out in the context of Italian regions.

2 THE INFORMATION NEEDS OF POLICY-MAKERS

When defining and updating the S3, regional policy-makers are called upon to identify territorial avant-gardes through the process of entrepreneurial discovery. They also need to identify its growth potential through a continuous technological foresight exercise, which takes into account the entire panorama of local research and innovation. This requires policy-makers to make a non-trivial strategic effort.

Initial analysis carried out on approved Strategies, show a substantial continuity with the outline of previous research and innovation policies and a choice of investment priorities that are weakly linked to the specific characteristics of local production facilities.

On the basis of the Eye@RIS database, the JRC has carried out a mapping exercise of the priority activities identified by the S3, in the Member States and regions, aimed at verifying to what extent policy-makers are actually creating a unique portfolio of priorities or simply imitating each other. It seems like only a few regions have developed a similar combination of priorities, even if there is still a number of sectors that appear in many national and regional strategies. However, by comparing main investment areas identified through sector-specific data on enterprises, employment and patents, the overall link between priorities and economic and innovation structures appears weak. One of the reasons is the lack of relevant data or the inadequacy of economic classifications used to read changes in the innovation system (Kleibrink and Sörvik, 2015).

When focusing the analysis on Italy, it is not clear how regions have carried out the entrepreneurial discovery process, with reference to both new areas of specialisation and innovation leading actors. Regions are most likely to have had difficulties in making the concept operational and, therefore, in putting it into practice. Moreover, there have been few attempts to develop observable dimensions and indicators of entrepreneurial discovery. One of the main consequences of relatively low attention to entrepreneurial discovery process and a governance not very open to the "quadruple helix", is the development of Strategies that basically follow a path marked by pre-existing regional innovation policies (Caramis and Lucianetti, 2014).

A critical issue is linked to the availability of data and information referring to:

- the analysis of the regional innovation context;
- the identification of areas of specialisation and technological trajectories to invest in;
- the continuous verification of investment priorities defined in the light of technological and international market scenarios and the effects of already implemented interventions.

Analysis of the regional context should cover three main dimensions: (i) regional assets, such as technological infrastructures; (ii) dynamics of the business system; (iii) links with the outside world and the region position within the European economy and global value chains.

The definition of vertical priorities is difficult, which is why smart specialisation is about defining a method to help policy-makers identify desirable areas of intervention suitable for innovation policy. The capability of policy-makers to observe and detect at a fine-grained level is emerging as a critical condition for the success of a smart specialisation strategy.

"There is therefore a pressing need for further research and development in this area to build a

collection of statistics on several dimensions of smart specialisation and produce new ways of measuring emerging trends regarding entrepreneurial discoveries, the development of new activities, diversification of the system and the generation of critical clusters; in other words, measuring progress towards the different goals of smart specialisation. This effort is essential if the economics of smart specialisation is to progress beyond the purely abstract, and allow theory to be linked to practice." (Foray, 2015 pp. 106).

In general, indicators must be a little "eclectic, since the trends and evolutions underlying the fundamental logic of developing new skills are often not captured by the standard knowledge and innovation indicator framework. […] Smart specialisation does not refer to the fact that a region is specialised relative to other regions in a passive sense, but to the development of new activities and specialities based on regional concentration of resources and competences. Thus, the existing indicator framework that provides specialisation metrics and thus profiles of regions – while very useful for a wide range of assessment purposes – does not capture the localisation and concentration of activities" (Foray, 2015, p.107).

However, "without metrics and indicators, as well as regular data collection, the patterns of smart specialisation strategies will not be discernible and policy-makers will be unable to track progress, assess structural transformations and compare strategies." (Foray, 2015 pp. 107).

2.1 The use of new data sources to fill the knowledge gap

The Smart Specialisation approach requires national and regional policy-makers to develop evidence-based policies and innovation strategies based on a detailed analysis of socio-economic conditions with indicators reflecting the strengths and weaknesses of the innovation system (Kleibrink, 2016).

The advent of data revolution has generated, in fact, an overwhelming increase in the amount of data available, also outlining new opportunities for policy-makers to use a data-informed approach in defining policies and actions supporting innovation. In other words, the possibility of designing evidence-based frameworks for policy interventions is being envisaged.

In this regard, there are two main types of data:

- open data (e.g. administrative data, demographic data and population statistics, economic indicators, etc.) currently used more intensively and linked together;
- data from social media, sensors and smartphones, which are entirely new sources for policymaking, analysed with innovative methods such as sentiment analysis, location mapping or advanced social network analysis (Poel et al., 2015).

The use of data from official statistics based on international classifications, although very useful, is not sufficient to keep pace with sudden changes affecting local territories as well as external factors that may influence a given territorial policy. These datasets are limited in identifying innovative sectors, mapping innovation networks and characterising complex ecosystems, targets for possible innovation interventions (Crick et al., 2016).

The main reasons that imply the use of new data sources are linked to the very nature of the concept of innovation. In particular:

- it involves novelties in terms of production factors, processes and results: new capacities, organisational forms and industries, by definition, are not included in the classifications of existing economic activities which are not able to provide a detailed and precise picture of innovative activities in the business world and thus serve as a conceptual basis for effective analysis and evaluation on the part of public decision-makers (Crick et al., 2016);
- it is not limited to science and technology: it may reflect changes in business model or marketing, always captured by traditional metrics such as academic documents and patents;
- it is a complex network process: it is in fact related to a dynamic combination of resources and capabilities of different agents and institutions. Those who benefit from access to innovation data are not only policy-makers and may include investors, entrepreneurs and businesses, so most innovation data from traditional sources is of little relevance.

The unstructured data sources can offer an increasingly necessary enrichment of structured sources in order to calibrate policies and strategies in an informed manner. The precondition for using these sources lies in a high qualitative level of data which, given the more granular and comprehensive nature, would help to ask new types of questions and enable new research lines useful to assess the consequences of policy interventions (Einav et al., 2014).

New data sources are not, however, a panacea for policy-makers who have to tackle numerous methodological and ethical challenges (Einav et al., 2014), recognising how they integrate rather than

replace traditional methods (Boyd et al., 2012). It is evident that in order to make the best use of the opportunities represented by these sources, it is necessary to fill, first of all, the gap in the competences of policy-makers towards an increase in data literacy.

Hence the intuition to offer them a concrete support in the definition of innovation policies, through the creation of a tool that allows to integrate the various data sources useful for the adoption of an evidence-based approach.

In the last period, support for the implementation of innovation policies has become fertile ground for many initiatives similar to the one described in this document. In particular, the tool "Arloesiadur" developed by the Nesta Foundation, on behalf of the Government of Wales, aims of creating a data platform that collects and evaluates information on innovation activities and the interconnection between people and organisations. The system automatically integrates data from very different sources, combining consolidated statistics and web data (company web sites, software development or professional meeting platforms, Twitter accounts, etc.). Understanding how to treat and value these unconventional data sources in order to improve innovation policies is part of the entrepreneurial discovery process. This exercise provides valuable lessons on monitoring developments in the priority areas of Smart Specialisation and effective management of the lack of regionalised data from official sources, which are the common challenges facing national and regional authorities across Europe (Gianelle et al., 2016).

Table 1: The Innovation System Module. Questions, possible indicators and sources.

Question	Possible indicator	Source
What are the characteristics of the regional innovation system? What are its recent developments, also in relation to the other Italian regions? What are the most dynamic sectors? What is the propensity for innovation in the entrepreneurial system? What is the vitality of the high-tech sectors? How is the region positioned in relation to other European regions in relation to the key factors of innovation?	R&D expenditure as a % of GDP	Istat
	Human capital - e.g. Graduates in science and technology	Istat
	Enterprise demography in knowledge-intensive sectors	Istat
	Innovative enterprises profile	Eurostat - CIS
	Researchers in regional unisversity system by disciplinary area/scientific sector	Miur
	Regional Innovation Scoreboard	Eurostat

Source: our analysis

3 POLICSLAB, A SMART PLATFORM FOR TECHNOLOGICAL FORESIGHT

The fundamental intuition is that today, economists and scholars of regional sciences, in order to analyse rapidly evolving research and innovation domains and to grasp the sudden changes that are going through them, have to make an additional analytical effort aimed at: i) mapping the new data sources and studying their potentialities and limits in order to integrate them with traditional sources; (ii) developing rigorous scientific methodologies to extract knowledge from this surplus of information, (iii) continuously verifying the robustness of the evidence produced.

Starting from the analysis of S3 approach and related information needs of the policy-maker, an interdisciplinary working group has started experimenting to develop an "intelligent" platform for technological foresight, based on already gained research experience in integration of structured and non-structured sources and the study of similar solutions at European level. Known as PolicsLab, this platform offers an integrated overview of all relevant data and indicators in the domain of research and innovation policies in Italian regions.

The web platform consists of an integrated base of data containing information from traditional sources, represented by official statistics (such as Eurostat, Istat, Ministry of Universities, Education and Research, etc.), many of which are now available in open or linked open data format (e.g. indicators relating to R&D in the private sector, statistics on employment in knowledge-intensive sectors, etc.). The platform also includes information from sources, which were previously rarely considered if not considered at all such as thematic platforms used in

the definition of S3, dedicated portals and thematic blogs, patents, projects and scientific publications as well as data from social media.

PolicsLab is:

- a foresight-based policy system that supports policy-makers in creating medium and long-term visions/scenarios for the future. In particular, the system enables to define investment priorities on the basis of interconnections between the specific nature of research and business worlds, by also facilitating the process of entrepreneurial discovery;
- a horizon scanning tool, which allows policy-makers to have information on innovation paths defined in the light of technological trajectories and emerging markets worldwide.

Thanks to an intuitive querying mechanisms, PolicsLab will provide the user with data visualisation tools, allowing an easy navigation between data and indicators, and by taking advantage of the available metadatation it will also guide the user in understanding suggested contents by means of digital storytelling. The use of interactive dashboards, dynamic tables and cartographic representations is calibrated according to the availability of data from a territorial and temporal point of view.

Reports reading will be facilitated by a tutoring system able to guide the user in the reasoning process necessary to make "informed" choices and, thanks to the presence of relevant metadatation it will help avoiding running into "data traps" (e. g. how to interpret that given value, what other data should be consulted, etc.).

In brief, the platform enables:

- the guided visualisation, on a territorial basis, of updated data and indicators useful for the analysis of changes affecting the socio-economic and innovation context;
- the construction of scenarios, in the medium-term future, of technological and market developments in areas of interest according to current and expected specialisations in the research and enterprise system;
- the definition of a further set of indicators, thanks to the integration of information coming from unstructured sources, in order to enhance the evidence on territorial contexts and to dynamically grasp those changes taking place in the panorama of regional innovative specialisations.

The beta version of the platform, currently under development and testing stages, is set to provide a three-module structure. Each module will meet a specific information requirement.

Table 2: The Foresight Module. Questions, possible indicators and sources.

Question	Possible indicator	Source
In which research areas is the regional academic system more specialised? In which economic sectors does the region show high levels of specialisation? What is the degree of cooperation and the shape of networks in research and innovation projects? Which are the most relevant actors? What are the emerging sectoral recombinations? Is the focus of the smart specialisation strategy on enterprises and the development of commercial applications? How significant are the priority activities for the regional economy? Do the priority activities open up a new area that is potentially rich in innovation and spin-offs? Can these activities really realistically push the region into a leadership position in the selected niche?	University publications by Web of Science category and by S3 area	Thomson Reuters; Scopus
	Specialisation index (Publications/Researchers) of universities	Miur
	H2020 funding of universities for FP7 projects by topic	Cordis
	Sectoral specialisation index (e.g. ICT, agro-industry, mechanics, etc.)	Istat/ASIA; Infocamere
	PON R&C funding by economic sector of the beneficiary, number and topic of research projects	Open PON R&C; OpenCoesione
	PON R&C funding per beneficiary's economic sector and research porject topics	Open PON R&C; OpenCoesione
	Topic of patent applications filed by regional companies	Thomson Reuters
	Research projects' network	Open data PON R&C; OpenCoesione

Source: our analysis

The Innovation System Module allows the exploration of data and indicators available from official sources, useful to profile the innovation landscape at regional, national and international level. It refers to traditionally used indicators such as: incidence of R&D expenditure on GDP; birth rate of

enterprises in knowledge-intensive sectors; three-year survival rate in knowledge-intensive sectors, etc. or to composite indicators such as Regional Innovation Scoreboard and its components (tertiary education rate, exports in high-tech sectors, registered patents, etc.).

The Foresight Module allows the exploration of data and indicators, both from traditional as well as web and unstructured sources, related to specific regional characteristics of university and research systems (e.g. number of publications by scientific category, specialisation index of the regional research system by scientific area, etc.); to innovative business activity (e.g. innovative startups by specialisation area, patent topics) andcooperation within R&D (e.g. projects funded by Horizon 2020, etc.) enabling technological foresight exercise to define prioritary investment areas.

As highlighted above, during the priority setting stage, the S3 combines related variety and entrepreneurial discovery approaches through a sequential scheme that restricts the entrepreneurial discovery process to priority areas previously identified with the related variety method. The aim is to anchor choices to distinctive existing local entrepreneurship and related sectors. In this context, it is crucial to provide a surplus of information with respect to the related variety approach that can better guide the entrepreneurial discovery process. By analysing research and innovation investment decisions of regional entrepreneurs and sectoral crossovers they also determine, it is possible to create a method of predicting possible future diversifications. Collaborative projects with local companies can help reveal information about the future value of some specialisations.

scraping procedures and elaborated through the use of text mining techniques from blogs, thematic portals, articles and publications of public research institutes. The objective is to assess the consistency of technological trajectories identified by the regional context with recent and future developments on a global scale.

3.1 The experimental use of new data sources

One of the main challenges the system aims to tackle is related to the priority economic activity concept, which differs from the economic sector notion and mainly refers to application domains of specific technologies and/or inventions. The traditional classification of economic activities loses of significance because, it does not allow the identification of priority application domains, even at the highest level of detail. For this purpose, the integration of sources, such as the textual corpus of patent databases or business websites, which so far have been majorly undervalued, is essential. To understand what companies are really specialised or investing in, we used the information kit on their portals, in order to enrich the analysis of sectoral crossovers emerging from collaborative projects funded by cohesion policy.

We assumed that companies share information about their specialisation and investment areas in the About section of their portal. So we scraped the web sites of all the beneficiaries of the National Operational Programme on Research and Competitiveness 2007-2013 located in Calabria.

During our analysis aimed to define an appropriate corpus for applying text analysis

Table 3: The Horizon Scanning Module. Questions, possible indicators and sources.

Question	Possible indicator	Source
What are the trends in digital technologies? What are the investment trends? What are the areas of investment that are of greatest interest to VCs? What are the emerging trends in the world of innovation? Are the selected priorities consistent with emerging topics in the global innovation landscape? And with its market opportunities?	Market size of digital technology drivers	Statista
	Investments and average number of private operator deals in innovative sectors	CB Insights
	Emerging Innovation Topics	OECD, Gartner, etc.

Source: our analysis

The Horizon Scanning Module enables the consultation of structured forecast information on trends and market trends from main international sources (e.g. market size forecasts for specific technologies, VC investment trends by segment, etc.) combined with textual data derived from web

techniques, we come up with three important findings: (i) The universities About section was too generic and not very informative for our analysis purpose, so we have excluded them from the analysis. (ii) Many beneficiaries, in general small companies, presented a very short and About with respect to other

with a very detailed list of specialisations and activities. (iii) For several Ateco (Italian classification of economic activities derived directly from NACE Rev.2) subcategories the number of beneficiaries was not sufficient for granting an adequate significance level of the results

As a consequence, we performed traditional cleaning and processing analysis on a corpus composed by the beneficiaries belonging to the J-62.01.00 – Computer programming activities and M-72.19.09- Other research and experimental development on natural sciences and engineering for a total of 32 documents (i.e. lowering cases, removing stopwords, etc.). Since we were interested in analysing not only single words but also more complex verbal expression, we tokenized the text in unigram (single words) and bigram (pairs of words). Consequently we realised a Document Term Matrix and performed a topic modelling algorithm, in order to find more detailed specialisation in the companies' activities, which led us to associate to predefined Ateco subcategories the following priority domains.

Starting from the results of our analysis we managed to detail the network of cooperation in R&D projects among the beneficiaries pertaining to the selected Ateco subcategories.

Table 4: Experimental web scraping: Economic activities and Priority domains.

Economic activities	Priority domains
J-62.01.00 Computer programming activities	Big data; Internet of Things; e-commerce; data analytics; business intelligence; smart home
M-72.19.09 Other research and experimental development on natural sciences and engineering	Manufacturing; billing systems; healthcare; biomedical field; agrifood; cybersecurity; fashion; e-payments; security management; systems integration

Source: our analys on webscraped data

This exercise aimed to define cross sectoral priority domains in order to highlight the regional specificities concerning with the innovation ecosystem. Possible emerging models of recombination and diversification refer to:

- Manufacturing and smart home
- Biomedical field/health care and big data/IoT
- Agrifood and data analytics/big data/e-commerce
- e-commerce and e-payments/billing systems/cyber security.

4 CONCLUSIONS

This paper aimed to represent the first research results for defining an informative system to support policy makers in the definition and revision of Smart Specialisation Strategy. Regional policy makers are called to identify some priority domains which could determine important structural changes in the whole business ecosystem. The first analysis on some of the regional strategies shows a substantial continuity with previous policies, with a lack of metrics, indicators and appropriate data and classifications, policy makers are not able to assess the innovation progress and evaluate transformations.

PolicsLab represents a first attempt of answering to policy makers' needs, integrating traditional and non-traditional sources and implementing interactive features useful for measuring and forecasting regional developments related to innovation.

In the coming months, with regards to the experimentation on new data sources, the working group's efforts will focus on improving current research output through the analysis of research projects abstracts in order to enrich the information derived from the companies' About sections, validating the results on a wider sample of companies, and defining a classification algorithm in order to associate each beneficiary to a specific priority applications domain.

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