Key Enabling Technologies and Smart Specialization patterns. European evidence from patent data.

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Extended Abstract

The concept of Smart Specialisation (SS) has gained momentum in the policy debate about the efficient use of public investments within well-identified geographical and institutional contexts (Capello et al, 2014; Camagni and Capello, 2013; Foray et al, 2011; OECD, 2013). As discussed by Boschma (2014), the SS concept shares the main principles of the construction of regional advantages (CRA), which requires regions to identify technology based development patterns, drawing upon knowledge, variety and policy platforms (Oughton et al., 2002; Asheim et al., 2011).

The CRA approach identifies related variety as the main driver of diversification and industrial branching at the regional level (Boschma, 2011). Proximity amongst sectors or technologies shapes regional development trajectories in such a way that competences accumulated over time are likely to create dynamic irreversibilities, engendering path-dependent diversification dynamics (Boschma et al., 2013 and 2014; Colombelli et al., 2014; Essletzbichler 2013).

Differently from CRA, the SS concept does not entail explicitly the regional dimension. As McCann and Ortega-Argiles (2011) argue, the geographical dimension should be rather integrated in the SS looking at the effects of regional features on entrepreneurs' ability to engage in successful learning processes. In this respect, SS strategies should stimulate the regional diversification into particular domains yielding economic and technological opportunities.

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The combination of SS and CRA allows to developing a framework in which the regional governance of SS strategies is driven by knowledge accumulated over time by local agents. Regional development emerges out of a process of industrial diversification, in which the introduction of new varieties is constrained by the competencies accumulated at the local level. From the spectrum of possible new activities, the birth of industries that are closely related to already existing local production is more likely. The new activities exploit (at least in part) already developed routines.

The previous conceptual framework is crucially affected by the nature of the technologies that nurture the local production system and the dynamics of its SS-RCA combination. Among these, technologies showing systemic relevance deserve special attention, due to the wide knowledge base they impinge upon, which spans across different technology fields. Their horizontal nature actually makes of them the "technological building blocks" of a large variety of existing and prospective product applications, as well as of process, goods and service innovations throughout national and regional economies. In the literature on economic growth, their search has led to crystallize the notion of "General Purpose Technologies" (GPS), whose identification (typically, steam, electricity, and computers) and actual productivity impact has stimulated a massive amount of studies in the last decades, whose synthesis already represents a classic handbook-chapter (Jovanovic and Rousseau, 2005, 2005; Bresnahan, 2010).

More recently, a renewed interest for the issue has emerged from the European policy makers, in search of technologies that, in addition to their pervasiveness and potential for growth and competitiveness (e.g. via increasing returns-to-scale), could also be the "key-enabler" of the structural transformation towards a "knowledge-based" and "low-carbon" economy (EC, 2014), which the Europe2020 strategy naturally entails (EC, 2012). In the European area, this search has led to the expert-based identification of a number of "Key Enabling Technologies" (KETs), which are generally "knowledge intensive and associated with high R&D intensity, rapid innovation cycles, high capital expenditure and highly skilled employment", and more specifically "embedded at the core of Europe's innovative products and […] underpin[ning] strategic European value chains" (ibidem, p. 8), that is: photonics, industrial biotechnology, nanotechnology, advanced materials, micro-/nanoelectronics and advanced manufacturing systems.

An important aspect for our study on the SS patterns is that each and every of the six KETs has individually a great potential for the exploitation and eventual transformation of the competencies accumulated at the local level over time, given its horizontal and systemic nature. This is even more evident for what the latest EC project on the issue (http://ec.europa.eu/enterprise/sectors/ict/key_technologies/ro-ckets/index_en.htm) has called "cross-cutting KETs activities" (Ro-cKETs), which points to the integration of different KETs, whose complementarity power proves to be superadditive. The local availability of KETs and Ro-cKETs knowledge and applications, as well as of policies for their support, can in fact represent a "second-order" kind of enabler for the development of new varieties of markets and activities starting from those of the CRA, with crucial implications in terms of growth and competitiveness.

The present paper aims at investigating whether the empirical evidence actually shows a "moderating role" of KETs for the dynamics of SS patterns and, eventually, with which moderating sign. On the one hand, we could expect that, following an "exploration-kind" of SS strategy, KETs make the impact of the current regional knowledge base less binding. On the other hand, KETs might instead be found as functional to an "exploitation-kind" of SS strategy, where the impact of the existing local production system becomes even more compelling.

Far from representing a purely academic exercise, this kind of analysis is of crucial relevance for the sake of regional policy. Indeed, filling a gap that the regions belonging to the S3 Platform have widely expressed (see Sörvik et al., 2014), the results of our analysis would help make more explicit the policy rationale for regions to invest in KETs as part of their policy mix towards strategies for smart specialisation (RIS3).

From a methodological point of view, we will address the previous research question by referring to the notion of "proximity", and by assessing it in relation to an abstract space (Boschma, 2005), and especially the technological space. In particular, following Hidalgo et al.'s (2007), we will build up proximity index within a network-based conceptual representation of the product space of a country, in which each product is a node that is characterized by a specific set of linkages with the other nodes in the network. Some nodes show a high linkage density while others have less dense sets of links. This density of linkages varies across countries, so that the same product can show different values in different contexts. The density of linkages around a product is a proxy of its average proximity level. The authors show that countries are likely to diversify by developing goods that are close to what current production. These dynamics explain persisting divergences between the leading and lagging countries (Hausmann and Klinger, 2007; Hausmann and Hidalgo, 2010).

The proximity index is based on Balassa's revealed comparative advantage (RCA) measure, according to which a country has comparative advantage when the share of a product in its exports is larger than the share of that product in world exports. Since we are interested in the dynamics of technology-based sectors, we implement the Revealed Technological Advantage (RTA) metrics, which provide information on the relative technological strengths (or weaknesses) of a given geographic entity (Soete, 1987).

In order to analyse the effect of the existing production structure on the development of new products, Hidalgo et al. (2007) elaborate a measure of average proximity of the new potential product to the existing productive structure. In our analysis this amounts to deriving an index of average proximity of a given technology to a region's structure of technological activities.

The model which we want to estimate takes the following form:

$$p\,[RTA(i,j,t_1)>1 \mid RTA(i,j,t_0)=0] = f[KETs(t_0),\ \varphi_{j,l},\ KETs(t_0)^*\ \varphi_{j,l},\ \text{controls}] \qquad (1)$$

where proximity φ between technologies *s* and *z* can then be defined as the minimum of the pairwise conditional probability of a region having RTA in a technology given that it has RTA in the other:

$$\varphi_{s,z,t} = \min\{P(RTA_{s,t} \mid RTA_{z,t}), P(RTA_{z,t} \mid RTA_{s,t})\} \qquad (2)$$

In the same model, the focal regressor for our research question, *KETs* is an indicator of region *i*'s technological specialisation in one or more of the six KETs (Ro-cKETS) identified by the expert group appointed by the European Commission (EC, 2013). More precisely, in order to build up this indicator, we follow a "technology-diffusion approach" – addressing the economic sectors in which KETs developing and exploiting organisations are active – and build up a matrix, which cross KETs patent applications and economic sectors. In doing that, we identify KETs patents looking at their IPC codes, using a conversion table put forward by a recent "Feasibility study for an EU Monitoring Mechanism on Key Enabling Technologies" (2012): whose definition is still on-going, but whose application has been already tested though in alternative research realm (Vezzani et al., 2014). As is standard in the extant literature, data for constructing this indicator for European regions are drawn from the PATSTAT database, whose regional location is carried out by using the OECD Reg Pat Database.

As far as the prospected econometric strategy is concerned, a linear probability estimator will be used as a baseline, and its results eventually compared with those obtained with a binomial generalized linear model (GLM) and the GMM system estimator. In doing that, special attention will be paid to the possible spatial correlations of the relative errors and to the possible endogeneity of the regressors.

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