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Inside the ‘Black-Box of Innovation’: Translating R & D outlays into economic and employment growth



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ABSTRACT

The purpose of this study is to cast light on the complexity of innovation by describing Regional Innovation Systems (RIS) architecture and by reducing the uncertainty that surrounds Governmental R & D Investment effectiveness. Empirical evidence demonstrates that the RIS subsystems are not homogenous, and most have negative side-effects. Our results suggest that the ‘quality’ of economic agents cannot be successfully replaced by ‘Keynesian policies’ focused on enhancing Market Potential, Demand Sophistication and Governmental R & D Investment. Investing in developing Absorptive Capacity is the most balanced and short-term development strategy for regions averse to innovation and characterised by low industrialization and income levels.

1. Introduction

Over the last three decades, following the mandate for ever faster growth supported by innovation (Christensen and Raynor, 2003), European regions have experienced considerable industrial restructuring towards a more decentralised and flexible industry structure in order to harness the forces of technology and globalization (Audretsch et al., 2012). Given our limited systematic knowledge about determinants of innovation, case studies comparing innovation systems of various kinds, as well as the determinants of innovation processes within them, have great potential (Edquist, 2005). Consequently, these case studies have particularly captured the attention of academic researchers and those with political responsibilities (European Commission, 2012; Landabaso, 2014; Maassen and Stensaker, 2011; OECD, 2013). This has given rise to a series of important studies, both theoretical and empirical (e.g., Audretsch et al., 2012; Audretsch and Weigand, 2005; Auerswald, 2010; Brown and Petersen, 2010; Eckhardt and Shane, 2011; Gilbert et al., 2008; Kilpatrick and Wilson, 2013; Lee, 2010; Pe’er and Vertinsky, 2008; Ranga and Etkowitz, 2013). Thus, it is especially important to find out what components of an R & D system are most decisive as engines of economic growth (Audretsch and Thurik, 2001a; Eckhardt and Shane, 2011; Gilbert et al., 2008) and what are the key factors determining systems’ innovative capacity (Asheim and Coenen, 2005; Audretsch and Keilbach, 2008; Audretsch and Lehmann, 2005a). It is to these topics that we turn our attention, in this study, involving, as in Furman and Hayes’s approach (2004), the following:

- the core ideas-driven New Growth Theory (e.g., Krugman, 1991, 2013; Pires 2005; Romer, 1986, 1990);
- the competitive advantages perspective (e.g., Furman et al., 2002; Lindic et al., 2012; Porter, 2003);
- the Triple Helix dynamics (e.g., Leydesdorff and Fritsch, 2006; Leydesdorff and Meyer, 2007; Ranga and Etkowitz, 2013); and
- the concept of RIS (e.g., Asheim and Coenen, 2005; Cooke, 2001; Doloreux and Parto, 2005).

Previous studies have determined that certain effective ecosystems, at the regional level, need to be promoted and which involve

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successful enterprises, higher education institutions and research bodies (Acs et al., 2009; Fritsch and Mueller, 2004a, 2004b; Griliches, 1979; Sternberg and Litzenger, 2004). Additionally, regions that include highly qualified personnel and knowledge intensive services are an important basis on which industries may develop (Eckhardt and Shane, 2011; Gilbert et al., 2008; Leydesdorff and Fritsch, 2006; Tappeiner et al., 2008). The innovation evolutionary approach underpins – besides the regional context – the institutional framework (Breznitz and Zehavi, 2010; Hewitt-Dundas and Roper, 2011; Ranga and Etzkowitz, 2013) and the fact that its outcomes depend on a broad heterogeneous number of constructs (Audretsch and Keilbach, 2004, 2008; North, 1990, 2005). It is precisely these differential effects of specific RIS ‘subsystems’ that make it difficult to operationalise for policy purposes, as noted by Uyarra (2010, p. 116). Therefore, the evolutionary perspective induces us to work with a Factor Analysis that permits the use of a broad number of interdependent correlated explanatory variables (Manso and Simões, 2009; Pestana and Gageiro, 2008). On the other hand, the Artificial Neural Networks (ANN) methodology considers the determinants as interdependent and highlights the difficulty of classifying them between causes and consequences (Detienne et al., 2003), in terms of employment and economic growth. For instance, successful companies, universities and other research institutions do coincide normally in the same regions (Acs et al., 2008, 2009; Fritsch and Mueller, 2004a, 2004b; Sternberg and Litzenger, 2004). Furthermore, industries develop in regions that offer highly qualified human capital and knowledge intensive services (Eckhardt and Shane, 2011; Gilbert et al., 2008; Leydesdorff and Fritsch, 2006; Tappeiner et al., 2008). However, it is not clear who induces who (Pessoa, 2010; Teixeira and Fortuna, 2010; Thurik et al., 2008). In such a dynamic system in which all factors do influence each other (Cooke, 2001; Rosenberg, 1982; Uyarra, 2010) it is impossible to use the traditional econometric methods based on individual variables (West et al., 1997). For all these reasons, we developed a new procedure in this type of research, by combining Factor Analysis with ANN modelling. The aim of this paper is the development of a new more holistic approach using a broad set of variables to analyse the core constructs of innovative activity, that helps us to demonstrate empirically that a RIS consists of multiple, interrelated elements and each of them have a certain impact on the macro-economic performance of the region. This approach is inherent to the evolutionary theory that underpins that innovation has to be considered as a multidimensional activity (Furman et al., 2002; Leydesdorff and Fritsch, 2006). The literature also emphasizes the difficulty and the weaknesses of the use of individual indicators to measure the macro-economic results of innovation (Somers and Casal, 2009; Wilson and Sharda, 1994). In light of the above considerations, the main purpose of this study is to fill in the gap between R & D efforts and the attainment of measurable, sustained and sustainable outcomes in terms of employment and economic growth. Based on the assumption that innovation is a “place-based phenomenon”, where specific investments pay off in the form of specific outcomes (Audretsch et al., 2012; Landabaso, 2014; OECD, 2013; Ranga and Etzkowitz, 2013), this study seeks to address the following research questions: 1) At a time of much debate with regards to the future of entities such as the EU, what factors determine employment and economic growth among innovation drivers? 2) Is current mainstream economic theory sufficient to point a way forward to increased employment and growth, at the regional level, or is new theory necessary to map out the overall RIS architecture? 3) What underlying relevant mediating variables exist and how should we measure their influence on the attainment of statistically significant outcomes at the macro-economic level (i.e., Youth-Unemployment, Unemployment, Gross Value Added and Gross Domestic Product)? The paper proceeds as follows: In Section 2 we provide a review of the literature. Section 3 illustrates the formulation of the dataset and methodology used in the study. Section 4 documents the methods applied for the analysis of innovation strategies as economic policies. Section 5 follows up with the presentation of the neural model of RIS. Section 6 provides an interpretation of the results according the literature framework. Section 7 presents the major theoretical and policy conclusions. This article thus provides a platform for the discussion of investments and capital outlays at the European level.

2. Literature review

The microeconomics of innovation has experienced a significant change with the introduction of the so called “chain linked model” of innovation proposed by Kline and Rosenberg (1986). Instead of a linear process unfolding sequentially through a series of stages (i.e., research, development, production, marketing) they emphasize the ‘feedback loops’ between the different stages and also the connections with knowledge sources internal and external to the firm. These ‘feedback loops’ are seen as fundamental in order to compensate for the inherent uncertainty in innovation processes (Moutinho et al., 2014). The final outcome is considered a result of a complex interplay between various actors rather than a planned endeavour (Lau and Lo, 2015). Hence, innovation is highly dependent on the way the different participants interact and the notions of ‘relationship’ and ‘interaction’ become central to the study of the subject. The particular institutional setup of the environment in which innovation takes place determines the rates and forms of knowledge exchange and thus has a decisive impact on the evolution of a RIS (Salerno et al., 2015). It has been found that firms located in research-driven clusters tend to exhibit greater innovation, higher rates of growth and higher survival rates than firms not located within such geographical boundaries (Gilbert et al., 2008; Friedman, 2005). Empirical evidence suggesting that University-Industry-Government pathways have a regional scope (e.g., Maassen and Stensaker, 2011; Sternberg and Litzenger, 2004) can also be found in the Knowledge Spillover Theory of Entrepreneurship literature. Regions characterised by higher R & D investment also tend to experience greater knowledge spillover (e.g., Audretsch and Feldman, 1996; Audretsch and Lehmann, 2005b; Audretsch and Keilbach, 2004, 2008), and venture sustainability is influenced not only by traditional economic factors, such as Market Potential (e.g., Knoblen et al., 2011; Pires, 2005) or Demand Sophistication (e.g., Buesa et al., 2010; Kim and Mauborgne, 2005; Lindic et al., 2012), but also by the opportunity to access the knowledge and technology generated by surrounding universities (Audretsch et al., 2005). Thus, the knowledge contexts can be a source of regional competitive advantage (e.g., Fritsch, 2008; Pe’er and Vertinsky, 2008; Tappeiner et al., 2008). As described by Audretsch et al. (2012), globalization is shifting the ‘comparative advantage’ in the advanced economies away from being based on traditional inputs of production toward knowledge. As the ‘comparative advantage’

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