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Increasing the national innovative capacity: Identifying the pathways to success using a comparative method

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ABSTRACT

As national innovative capacity is one of the main drivers for long-term economic growth, several countries have tried to increase their capacity by applying a high-tech strategy and supporting this strategy with policies. A better knowledge of successful strategies could support these processes. Previous studies have identified various determinants for a high capacity, but have failed to analyze their interconnections and therefore to derive comprehensive strategies. Applying fuzzy-set qualitative comparative analysis to 17 European countries, we identified different paths leading to a high innovative capacity by combining various determinants. The paths were translated into innovation strategies. Rather than a single strategy, different strategies with the same outcome exist, thus allowing countries to choose the appropriate strategies on the basis of their preconditions. Applying the identified strategies to countries with a low innovative capacity, we found that the UK is strong in all areas except high-tech specialization. Ireland lacks a high share on education spending and venture capital, as do Italy and Spain, which also lack private R&D funding and a high base of journal publications. The Czech Republic, Hungary, Romania, Poland, and Portugal have only a few preconditions for raising their innovative capacity.

1. Introduction

1.1. Research motivation

National innovative capacity (NIC) describes "the ability of a country to produce and commercialize a flow of innovative technology over the long term" (Furman et al., 2002). Consequently, the notion of NIC goes beyond "the realized level of innovative output per se" and claims to reflect "more fundamental determinants of the innovation process" (Furman et al., 2002). In more practical terms, NIC might answer the question of why innovation capabilities on a national level differ from country to country.

In fact, natural imbalances of NIC also apply to the member states of the European Union (European Commission, 2013; Faber and Hesen, 2004). Empirical data on patent volume, a widely accepted proxy for measuring innovative performances (Archibugi and Coco, 2005), show a growing imbalance in countries' innovative outcome, with its "innovation leaders," "innovation followers," "moderate innovators," and "modest innovators" as protagonists in this race (Wohlmuth, 2013). Countries like Germany, Sweden, Denmark, and Finland consistently manage to retain and expand their leadership position in this competition, whereas the remaining countries fail to catch up (European Commission, 2013). Researching EU member states' individual approaches to facilitating innovation – in other words, their national innovation strategies – might provide an answer to the why and also attempt to explain the how, the "hierarchy" within this four-pronged taxonomy.

Much research has already been done on this case (Krammer, 2009) and in summary, no one-fits-all-strategy has emerged. Instead, a certain path dependency among the strategies is observable (Varblane, 2012). The identification of the key success paths leading to high innovation capacity, thus helping stragglers to catch up (Varblane et al., 2007), might be generally useful for both academia and practice. We present a relatively new approach and new results appropriate for many purposes of economic governance, derived from proven concepts, enhanced by fuzzy-set qualitative comparative analysis (fsQCA) as a new but suitable method for innovation research, and grounded on a robust European data set.

1.2. The emergence of NIC research

The roots of this field of study lie in the 1950s, in research contributing to the so-called growth theory. Seminal work paved the way for the contemporary discourse on nations' long-run growth and competitive advantages (Freeman, 1989, 2002; Porter, 1998; Romer, 1986, 1990; Solow, 1956, 1994). These studies pointed out that science, technology, and innovation are the building blocks of economic growth and thereby laid the foundation for three interconnected streams of research and

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literature. As the innovation branch of this taxonomy has evolved toward a consolidated field of research known as the theory of national innovation systems (NIS), some works are positioned in between, bridging modern NIS research, growth theory, and the so-called Schumpeterian school of thought with regard to innovation research (Fagerberg and Srholec, 2008; Fagerberg et al., 2007; Hozumi, 2000; Jungmittag, 2011; Lee and Kim, 2009; Zalewski and Skawińska, 2009).

The term NIS became academically perceptible in the early 1990s. Most of the surveying literature deals with questions of positioning, purpose, and trends (Balzat and Hanusch, 2004; Edquist, 2001; Fagerberg and Sapprasert, 2011; Lundvall, 2007; Niosi et al., 1993; Patel and Pavitt, 1994; Porter and Stern, 2001; Sharif, 2006), and more recent work contributes bibliometric retrospectives on NIS studies (Sun and Grimes, 2016; Teixeira, 2014). Closely linked to these studies and other comprehensive materials (Ács, 2000; Hall, 2010; Lundvall, 2010; Seliger, 2014), another rather small body of literature offers a rigorous attempt at systemic interpretation, aiming for the translation of NIS "from a conceptual framework to theory that feeds a concrete practice" (Edquist, 2009), presenting some sort of innovational ecosystem as a result (OECD, 1997; Oh et al., 2016).

In summary, an NIS can be regarded as a historically grown set of components of the national ecosystem that encourages and supports a country's innovational output. An EU member state's NIS is embedded in an overarching and continuously emerging European innovation system with links to both global and regional innovation systems. Below the national level, sectoral, sub-regional, and local innovation systems have to be distinguished. The NIS is an analytical framework that serves as both model and tool, emphasizing the importance of the system's openness and linkage of different layers as well as coherence and dynamics (Staroske et al., 2000; Sun and Liu, 2010; Wohlmuth, 2013). NISs can be considered as networks with certain characteristics and functions (Wohlmuth, 2013):

- NISs determine the yield, quality, and kind of an economy's innovational activities (Arundel et al., 2007; Ebersberger et al., 2011; Tsai et al., 2009; van de Vrande et al., 2010; Wang et al., 2012; Wonglimpiyarat, 2013; Yoon et al., 2015)
- NISs guide the direction and define the intensity of (cross-border) knowledge flows, technology transfer, commercialization of knowledge, and economic incentives (Etzkowitz and Leydesdorff, 2000; Gomez et al., 2014; Lundvall, 1998; Mowery and Oxley, 1995; Niu, 2014; Paik et al., 2009)
- NISs uncover the linkage between institutions and economic entities and secure a balance between them (Bartels et al., 2012; Djeflat, 2009; Ivanova and Leydesdorff, 2014; Lai et al., 2014; Lee and Park, 2006; Varsakelis, 2006)
- NISs point out starting points for state intervention and policy optimization (Furman and Hayes, 2004; Samara et al., 2012; Schmoch et al., 2006; Solleiro and Castañón, 2005)
- NISs absorb structural and technological change (Antonelli, 2008; Castellacci and Natera, 2013; Hekkert et al., 2007; Schmoch et al., 2006)
- NISs unfold their effects across levels (global, national, regional, sub-regional, local) (Asheim and Coenen, 2006; Hsu et al., 2014; Jiao et al., 2016; Kenney, 2011; Kwakkel et al., 2014; Nill and Kemp, 2009; Niosi and Bellon, 1994; Spielkamp, 1997; Sun and Liu, 2010; van Lancker et al., 2015)

1.3. Practical use of NIC research: turning innovation strategy into reality

As innovative capacity plays an important role for long-run economic growth (Fagerberg and Srholec, 2008), countries have adopted their innovation strategies accordingly.

For example, Germany, indisputably one of the world's leading economies, possesses and pursues comprehensive strategic agendas dedicated to the technological and scientific development of its economy. The "High-Tech Strategy 2020" of Germany aims for both the retention of its leading position and the securing of global competitiveness and transition into a knowledge-based society on a sustainable basis (Federal Ministry of Education and Research, 2014). The networking of the so-called Triple Helix, consisting of politics, business and science, is at the center of this strategy. In addition, the promotion of SMEs' R&D activities plays a major role (Wohlmuth, 2013).

Importantly, however, the strategy itself should be incorporated into the NIS, particularly in the areas addressed in innovation strategies. Research on the development of NISs shows that continuous monitoring, evaluation, and revision of the NIS are essential to enable intervention by adjusting its cornerstones and interconnections (Edquist, 2009; Wohlmuth, 2013). To this end, new approaches are needed to analyze future trends so as to translate long-term perspectives into institutional arrangements that reflect necessary policy changes and to utilize the NIS for a global competitive strategy (Wohlmuth, 2013). Certain institutional changes and changes in economic incentives as well as the setting of new quantified targets have prerequisites that depend on support from appropriate policies. All levels of government and the parliaments must be fully involved. But how can all relevant policy areas be perfectly matched? How can knowledge demand and supply be optimally organized? Which authorities, companies, and other institutions need to cooperate, and how can they be optimally orchestrated? What weaknesses reside within the linkage of crucial players? (Wohlmuth, 2013).

2. NIC as an analytical framework

2.1. From theory to practice

To provide suitable answers to the above questions, and as a consequence to improve countries' innovation strategies with the help of in-depth knowledge on determinants of innovative capacity, an analytic framework based on NIS research has been developed in parallel to the theoretical principles. Initially, the concept was proposed as an index that could provide regular diagnostics of national performance in invention over time (Romer, 1990; Villa, 1990). The intention was to show the influence of technological change on economic growth. Early research introduced a novel framework called "national innovation capacity" (Furman et al., 2002; Porter and Stern, 2000, 2001, 2004) – a framework that draws on three distinct areas of prior research: ideas-driven endogenous growth theory (Romer, 1990), the cluster-based theory of national industrial competitive advantage (Porter, 1998), and research on NIS that was done in the course of country comparison (Nelson, 1992, 1993). These studies hold that the innovation capacity of countries can be measured by three aspects: the common innovation infrastructure, the cluster-specific environment for innovation, and the quality of their linkage. Since the earlier studies, researchers world-wide have used, enhanced, and adopted the framework for various contexts.

A major field of the framework's application is country development or comparison (Marxt and Brunner, 2013), with a special focus on emerging countries, the so-called catch-up economies (Hu and Mathews, 2005; Liu and White, 2001). In addition, the logics of the NIC framework can be found in various economic studies, such as those that examine the learning and information processes of an economy (Guan and Chen, 2012) or that aim for policy optimization (Herstad et al., 2010; Nill and Kemp, 2009) as well as studies dealing with the efficiency and forecasting of R&D activities (Cullmann et al., 2009; Johansson et al., 2014; Moon and Lee, 2005; Wang and Huang, 2007). Further fields of application are sectoral innovation systems, primarily within the so-called NBIC-cluster (nanotechnology, biotechnology, information and communication technologies, cognitive sciences, and neurosciences) as it gains increasing significance for the global competition of innovative leadership (Chen, 2007; Dodgson et al., 2008; Hu and Phillips, 2011; Kaiser and Prange, 2004; Lo et al., 2013;

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