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Measuring regional innovation: A critical inspection of the ability of single indicators to shape technological change

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ABSTRACT

The disparities in regional innovation are often illustrated in both scientific research and politics by a single innovation indicator or a composite index. Do such undeniably catchy approaches really convey a better understanding of regional innovation? A composite index can only be employed for an effective innovation policy if the various innovation indicators are highly correlated and affected similarly by the same drivers. The paper investigates driving forces for three composite innovation indices and six innovation indicators covering various aspects of innovation. The analyses demonstrate that the effects of the drivers differ substantially with regard to the investigated aspects of innovation. Knowledge about relevant drivers of innovation is indispensable for the design of an efficient innovation policy. Therefore using only a composite index in order to predict or to influence the innovation dynamic of a territory is highly problematic because of the loss of important parts of the underlying transmission mechanism from innovation policies to innovation outcome. Concentrating on one innovation indicator signifies investigating a specific aspect of regional innovation. Provided these limitations are intended the application of a single indicator may be more appropriate.

1. Introduction

Although innovation is a key subject in regional economics (Asheim et al., 2011; Cooke et al., 1997; Doloreux and Porto Gomez, 2017) and at the center of attention in current discussions of economic policy (European Commission, 2016, 2010; European Council, 2015), there is no standard method for operationalizing and measuring regional innovation performance. This is even more surprising given the extensive scientific debate on suitable innovation indicators at various observational levels (Archibugi, 1988; Becheikh et al., 2006; Griliches, 1990; Janger et al., 2017; Kleinknecht et al., 2002; Smith, 2005).

The importance of the regional dimension in innovation economics is widely acknowledged (Asheim et al., 2011; Carayannis et al., 2017; Cooke, 1992; Crevoisier, 2004; Morgan, 1997; Tödtling and Trippl, 2005). Reasoning is diverse. Firstly, regional differences with regard to innovation patterns and performance in an industrialized area such as the EU are sizeable and potential pitfalls on the road to further economic cohesion (Beugelsdijk et al., 2017; Camagni and Capello, 2013). Secondly, although knowledge spillovers are present, there is evidence that these spillovers are spatially bounded (Bottazzi and Peri, 2003), and, thirdly, an effective innovation policy necessitates an institutional carrier, which is typically a politically delimited region (OECD, 2011).

Considerable research has been devoted to identify political channels for bridging the gap in innovation differentials between European regions. However, clear conceptualization of innovation and identification of the related driving forces is essential in order to design a regional innovation policy and to assess its impact. Accordingly, appropriate innovation indicators are needed. It is of paramount importance to understand the basic relationships between driving forces and outcomes in regional innovation processes in order to highlight best practice approaches and illustrate effective measures for lagging regions.

Current empirical literature on regional innovation intensity primarily focuses on three measurement approaches. The first and probably most frequently applied method is to quantify innovation using a single indicator. Patent statistics (Bilbao-Osorio and Rodríguez-Pose, 2004; Bottazzi and Peri, 2003; Di Cagno et al., 2016; Hauser et al., 2007; Moreno et al., 2006, 2005) and indicators derived from such data, e.g. patent citations (Maurseth and Verspagen, 2002; Paci and Usai, 2009), dominate this group.

The second approach to analyze regional innovation employs an extensive set of indicators. Countries or regions are clustered based on

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these indicators with the aim to identify various types of innovation systems (Capello and Lenzi, 2013; Navarro et al., 2009; Pinto, 2009). Accordingly, these studies emanate from a multidimensional innovation design allowing different typologies of innovation processes (for details on territorial innovation approaches, see Asheim et al., 2011; Camagni, 1995; Cooke et al., 1997; Crevoisier, 2004).

The third approach combines a multitude of innovation indicators directly or stepwise to form a composite index. There are various examples for composite innovation indices. The best known examples of national innovation indices are the Bloomberg Innovation Index,[1] the Global Innovation Index (Dutta et al., 2015) and the European Innovation Scoreboard (Hollanders et al., 2016a). The Statsamerica Innovation Index[2] compares rates of innovation activities in US states. The most important innovation index at the regional level is the European Regional Innovation Scoreboard (RIS) whose 7th edition was released in summer 2016 (Hollanders et al., 2016b). This periodic exercise comparatively assesses the innovation performance of European regions through the RIS regional innovation index (RII) based on indicators referring to three pillars: enablers, firm activities and outputs. The main objective is to provide a monitoring system tracking regional innovation results. Due to the high attention the European Regional Innovation Scoreboard gets at various levels (EU Commission, national institutions, and media), political decision makers may rely on this tool to evaluate the position of their respective territory as well as to deduce potential pathways to get a higher ranking with respect to RII.

However, all three employed approaches show clear shortcomings. In the literature these issues are particularly discussed for patent statistics. A key limitation of patent statistics is that they primarily cover inventions and not commercial innovations (Smith, 2005), while reflecting innovative activities of various sectors very differently (Brouwer and Kleinknecht, 1999; Cohen et al., 2000). The ability of patent data to reflect service innovations (Blind et al., 2003; Hipp and Grupp, 2005) and process innovations (Arundel and Kabla, 1998; Blind et al., 2003; Brouwer and Kleinknecht, 1999) is also limited.

In contrast, identification of innovation regimes attempts to do justice to the variety and complexity of innovation activities in different sectors and territories. These analyses take a very broad view of innovation processes and mostly do not distinguish between innovation drivers and outcomes of such processes. Such a mixture of cause and effect prohibits that the approach is suitable for foresighted policy recommendations, it is rather appropriate to depict the current situation.

An index such as the RII attempts to combine the informational density of a single indicator with the broad coverage of regime patterns by subsuming data from a multitude of different sources. However, considering the multidimensionality of the innovation concept via an index requires at least two prerequisites: High correlation of the adopted indicators and similar drivers affecting innovation outcomes. The aggregation of different, not highly correlated innovation indicators blurs or rather eliminates information. Even if the innovation indicators highly correlate they may not be influenced by the same driving forces and therefore the analysis may lead to distorted results. Such a misleading finding is illustrated using two regional innovation indicators, namely the percentage of firms with goods innovations and with service innovations respectively, and the RII. The RII comprises the regional share of technological innovators, a combination of the two aforementioned innovation indicators, and also the introduction of process innovations. The left panel of Fig. 1 clearly shows that, although the two innovation indicators show a coefficient of determination of 0.46, several regions score high only on either one of the innovation indicators. Examples are the metropolitan centers of London and Prague with high values on service innovations and below average scores on goods innovations, while the Austrian region Burgenland or Thüringen in Germany show the reverse picture. The right panel of Fig. 1 compares the indicator for service innovations with the RII. Looking on service innovative regions like Northern Ireland or Alentejo (Portugal) both have above average values, however, with respect to the RII both regions are clearly below the average. On the other hand, the regions Sjælland (Denmark) and Bremen (Germany) show below average values for service innovation but score above average on the RII.

The figure shows that regions can be identified that score high on ‘service innovation’ and distinctively lower on ‘goods innovation’ and vice versa. Consequently, focusing only on one of the innovation indicators does not reveal the entire picture of innovative performance of a region. The figure also shows that the regional performance on ‘service innovations’ is not necessarily reflected in the composite index, and thus even the RII, comprising these two highly correlated indicators, is not capable to capture the above feature of innovation.

In this paper we focus on three potential problems of using a composite index:

- A mix of drivers and outcomes of innovation activities in one index impedes the prediction and analysis of effects of driving forces on outcomes and thereby complicates or impedes the identification of effective policy measures.
  For example, one prominent driver of innovation namely ‘Non R&D innovation expenditures’ is included in the RII. If policy programs want to evaluate whether this innovation driver influences the degree of innovation as measured by the innovation index RII, such a practice is precluded because via definition ‘Non R&D innovation expenditure’ affects the innovation index RII. However, if innovation drivers and innovation outcome indicators are clearly separated from each other one can attempt to answer that question. One of our (preliminary) results demonstrates that especially for this driver no evidence was found for a statistical significant impact on various innovation indicators and indices, except of course for RII.
- The selection of indicators and the adopted weights strongly affect the ultimate value of an innovation index without being yet stringently established by theoretical considerations from innovation economics.
  The index value of a region (and consequently also the size and significance of drivers) is the end product of a selection of different aspects of innovation and their combination via a specific weighting scheme. Without being aware of the specific composition of the index, a rank of a region with respect to such an index is not interpretable (and is often not interpretable even with a profound knowledge of the composition of the index) and therefore useless for policy recommendations. This problem is demonstrated using innovation indices with differently obtained aggregation weights (by experts or by a data driven method) and showing the consequences thereof for example with respect to innovation driving forces.
- Even very sophisticated indices based on multiple aspects of innovation could enable or even induce policy makers to focus on positions in the final or subordinated rankings and thereby transform the analysis into a beauty contest or a pretext for advancing a political agenda.
  Adopting data of appropriate innovation indicators for various aspects of innovation may prevent political decision-makers from over-simplifying and may draw a more accurate picture of a region's innovation performance.

These problems are investigated by analyzing the effects of a comprehensive set of innovation drivers (inferred from literature) on:

- a widely used composite index of regional innovation (RII),
- a modified version of the former, eliminating all components representing innovation drivers,
- a composite index with endogenous weighting obtained by a principal component analysis (PCA),
- a set of single innovation indicators derived from the Community

[1] For Bloomberg Innovation Index, see: http://www.bloomberg.com/graphics/2015-innovative-countries/.

[2] For Statsamerica Innovation Index, see: http://www.statsamerica.org/innovation/innovation_index/region-select.html.