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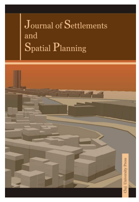

Indexing the Innovative Capability of Romanian NUTS 3 Subdivisions (Counties)

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A B S T R A C T

Creating an innovation aggregate index for Romania is a challenging task, partly due to the lack of the necessary statistical data, but also due to the absence of officially registered data at local administrative unit level. In spite of this deficiency, we will put forward an innovation index comprised of several indicators originating from the data banks of the National Institute of Statistics and the State Office for Inventions and Trademarks, for the county subdivisions of the Romanian territory. Our results point out, as expected, to an extremely heterogeneous and unequal situation, with only a handful of counties above the national average and thus presenting a positive skew ness of the aggregate data.

1. INTRODUCTION

The basic objectives of this paper are threefold. First of all, we intend to aggregate a general innovation index by using the existing methodologies and the available statistical data at county level, the equivalent of NUTS 3 (Nomenclature of Territorial Units for Statistics) in Romania.

Secondly, we aim to apply and map the above mentioned index for the 41 NUTS 3 subdivisions of the Romanian territory (counties [*"judeţe"* in Ro], plus the Municipality of Bucharest).

Thirdly, and the most important, our aim is to reveal whether innovation is homogenous or heterogeneous across Romania as well as find symmetry or asymmetry in its distribution. These three goals arise from innovation's highly geographically peaky nature, from the lack of a standard innovation aggregate for Romania as well as from the availability of certain statistical indicators that, in conjunction and more thoroughly than separate, can exhibit a proper picture of innovation in the 21st century Romania.

2. THEORY AND METHODOLOGY

Innovation is, beyond a shadow of a doubt, one of the most crucial elements, but also one of the least understood aspects of *spatially unbalanced* growth and development.

As Tinguely (2013) stated, while it is beyond dispute that innovation is the main driver of the continual increase in the standards of living, its research and measurement is complicated by the fact that it is a continuous process, involving novelty and qualitative changes and generating positive spillovers well beyond its industry or sector of origin [1]. Thus, a major problem lies here, in defining and measuring this concept as innovation is a continual, far-reaching and all-encompassing process and phenomenon and cannot be quantified efficiently.

More evidence for the above comes from Manoochehri (2010), who stated that measuring innovation has proved to be extremely challenging [2]. While some organizations might ignore measurement, or do not want to spend time and resources, or even because they are afraid of discovering any problems, most of them ignore it because they do not know what and how to measure it. It is like *measuring the immeasurable*. Brenner and Broekel (2011) also concluded that there is no general best way of measuring the innovation performance of spatial units (states, regions, counties etc.) [3]. Gault (2013) determined that innovation is a complex phenomenon and the implementation of an innovation policy, including a measurement system, is not straightforward [4]. More needs to be known about innovation and how it connects to the economy and the society. Further inability in constructing some sort of universal measurement for innovation or reaching a consensus in terms of innovation theory and aggregation was mentioned by Polenske in 2007 and Aoyama et al. (2011), and also by Matthews and Brueggemann (2015) who introduced innovation as a difficult to count or measure concept and lacking any valid way of quantification, despite its crucial importance in social-economic growth and development. Despite this, Matthews and Brueggemann (2015) proposed nine indirect measures or proxies to measure innovation: patents, expenditures in research and development, government investment, country culture, value of leading universities, and company culture and structure [7]. Other similar measurement elements include Crescenzi and Rodriguez-Pose's 2011 index that includes research and development expenditure as percent of Gross Domestic Product, research and development personnel as percent of total labour force, and number of high tech patents / million in the labour force [8].

This deficiency in assigning a standard of measurement to the concept of innovation, despite being one of the most significant starting points for this paper, is not the point of origin of our endeavour. It all started for us with the study published by Jamrisko and Lu (2016), containing an *innovation score* and a cartographic representation of said score for the United States of America [9]. They ranked the states from most to least innovative by employing a score composed of R&D intensity (research and development spending), productivity (GSP or gross state product per employed person), high-tech density (number of highly technologically intensive public companies), STEM concentration (Science, Technology, Engineering and Mathematics professionals), science and engineering degree holders (% state population), and patent activity (utility patents granted by the state of origin). Though not the first, this index is one of the most complex and we decided to use it as a basis for our scientific inquiry.

However, we decided not to include STEM concentration nor science and engineering degree holders due to what Chan and Mann stated in 2011. According to them, the terms 'innovation' and 'creativity' traditionally referred to separate spheres of social life [10]. The situation changed dramatically around the beginning of the 21st century. Creativity is now increasingly twinned with innovation and mentioned in association with the economy. The notion of a creative economy has come to the forefront of the public policy. As Florida (2002, 2005) argued, the decline of the industrial economy has highlighted the importance of knowledge economy and, more recently, of the creative class [11], [12]. According to him, every man can be and is creative and innovative at the same time, so we believe it is erroneous to include solely engineering, IT, mathematics, or other sciences in our aggregate innovation score. Also, the inclusion of higher education degree holders is erroneous in our view.

Using the available data, provided by the Romanian National Institute of Statistics (TEMPO-online) and the Romanian State Office for Inventions and Trademarks, we set out to compose an innovation score and apply it to the NUTS 3 regions of Romania (counties).

Unfortunately, the range of obtainable data is extremely limited when it comes to county level, forcing us to rely solely on five proxy statistical indicators: *1) number of employees in research & development at the end of 2014; 2) number of employees in research & development (full time equivalent) at the end of 2014; 3) total expenditure in research & development in 2014; 4) the average number of patent applications filed by residents per 100,000 inhabitants (average 2001-2014)*, and *5) the average number of trademark registration applications filed by residents per 100,000 inhabitants (average 2001-2014)*. The first three indicators were developed by the National Institute of Statistics, while the last three were taken from the data banks of the State Office for Inventions and Trademarks (Fig. 1).

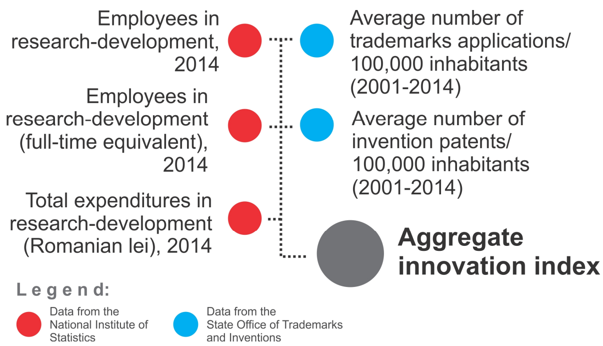

Fig. 1. The indicators used for aggregating an innovation score.

As an additional note, according to the National Institute of Statistics, the number of employees in research & development units is the total number of employees who, at a certain point, directly or indirectly participate in the solving of problems which represent the activity of the unit, being paid for the services performed, while the employees from research

& development units (full-time equivalent) are expressed not only as a physical number of persons, but also in a conventional measurement unit called full-time equivalent, which is based on the evaluation unit representing a person who works full-time during a certain period and on the conversion of the number of part-time workers in a full-time workers equivalent, taking into account the hours of work dedicated to research & development activity. Expenditures in the research & development sector refer to the current and capital expenditures for the research objectives of R&D units. Expenditures by destination include:

a). Current expenditures, that is payments made within units during a certain period of time, representing labour cost, the cost of materials and other running expenses.

b). Capital expenditures (investments) or payments made during a certain period of time for the execution of construction works, the purchase of apparatus, tools, machinery and equipment or other expenses of this type, meant to contribute to the increase in the unit's volume of fixed assets.

The difference between invention and innovation is that the latter means the first attempt to carry the former into practice [15], thus making patent applications and final patents extremely useful measurement proxies for innovation, fact also supported by Tinguely (2013), Manoochehri (2010), and Hong et al. (2012), while trademarks can convey important information not only on product innovation, but also on marketing innovations and innovations in the services sector, as their perimeter of application is considerably broad [17]. Creating our innovation score involved placing each value of the five already mentioned indicators into four categories, which have the following configuration and grading: 2.5 or low innovation, 5 or medium innovation, 7.5 or high innovation, and lastly 10 or very high innovation. To achieve this, we used the VLOOKUP function in Microsoft Office Excel. Next, we averaged (with the AVERAGE function in Excel, which returns the arithmetic mean of its arguments) all these figures for each separate county, thus ending with an innovation score for each region. We then introduced the data into ArcMap 10.2.2. GIS software and finally laid out a map presenting the distribution of our innovation index across Romania.

Our final test involved running a descriptive frequency analysis for the data, executed in IBM SPSS 18, involving data skewness, which calculated the degree of asymmetry of the innovation data's distribution around its mean.

3. RESULTS AND DISCUSSION

The results of this study can be divided into two basic categories.

Firstly, the high degree of innovation spatial concentration based on the aggregate innovation score can be seen in the following table (Table 1) and map (Fig. 2).

Table 1. The classification of Romanian counties based on aggregate innovation score.

County	1	2	3	4	5	6
București	10.0	10.0	10.0	10.0	10.0	10.0
Ilfov	10.0	10.0	10.0	10.0	10.0	10.0
Iași	7.5	7.5	7.5	10.0	10.0	8.5
Cluj	7.5	7.5	7.5	7.5	7.5	7.5
Argeș	7.5	5.0	7.5	7.5	2.5	6.0
Timiș	5.0	5.0	5.0	5.0	5.0	5.0
Brașov	5.0	5.0	5.0	5.0	5.0	5.0
Sibiu	5.0	5.0	5.0	5.0	5.0	5.0
Suceava	5.0	2.5	2.5	2.5	7.5	4.0
Dolj	5.0	5.0	2.5	2.5	5.0	4.0
Neamț	5.0	2.5	2.5	2.5	5.0	3.5
Maramureș	2.5	2.5	2.5	5.0	5.0	3.5
Galați	2.5	2.5	2.5	5.0	5.0	3.5
Prahova	5.0	2.5	2.5	2.5	2.5	3.0
Constanța	5.0	2.5	2.5	2.5	2.5	3.0
Vâlcea	5.0	2.5	2.5	2.5	2.5	3.0
Bistrița-Năsăud	5.0	2.5	2.5	2.5	2.5	3.0
Mureș	5.0	2.5	2.5	2.5	2.5	3.0
Hunedoara	5.0	2.5	2.5	2.5	2.5	3.0
Dâmbovița	5.0	2.5	2.5	2.5	2.5	3.0
Arad	5.0	2.5	2.5	2.5	2.5	3.0
Bacău	2.5	2.5	2.5	2.5	2.5	2.5
Gorj	2.5	2.5	2.5	2.5	2.5	2.5
Alba	2.5	2.5	2.5	2.5	2.5	2.5
Bihor	2.5	2.5	2.5	2.5	2.5	2.5
Vaslui	2.5	2.5	2.5	2.5	2.5	2.5
Buzău	2.5	2.5	2.5	2.5	2.5	2.5
Giurgiu	2.5	2.5	2.5	2.5	2.5	2.5
Botoșani	2.5	2.5	2.5	2.5	2.5	2.5
Vrancea	2.5	2.5	2.5	2.5	2.5	2.5
Călărași	2.5	2.5	2.5	2.5	2.5	2.5
Mehedinți	2.5	2.5	2.5	2.5	2.5	2.5
Covasna	2.5	2.5	2.5	2.5	2.5	2.5
Ialomița	2.5	2.5	2.5	2.5	2.5	2.5
Brăila	2.5	2.5	2.5	2.5	2.5	2.5
Tulcea	2.5	2.5	2.5	2.5	2.5	2.5
Satu Mare	2.5	2.5	2.5	2.5	2.5	2.5
Sălaj	2.5	2.5	2.5	2.5	2.5	2.5
Caraș-Severin	2.5	2.5	2.5	2.5	2.5	2.5
Harghita	2.5	2.5	2.5	2.5	2.5	2.5
Olt	2.5	2.5	2.5	2.5	2.5	2.5
Teleorman	2.5	2.5	2.5	2.5	2.5	2.5

Legend:

1. Expenditures in research and development in 2014.
2. Employees in research and development in 2014.
3. Employees in research and development (full-time equivalent) in 2014.
4. Average number of trademark applications 2001-2014.
5. Average number of patent applications 2001-2014.
6. Innovation score (aggregate).

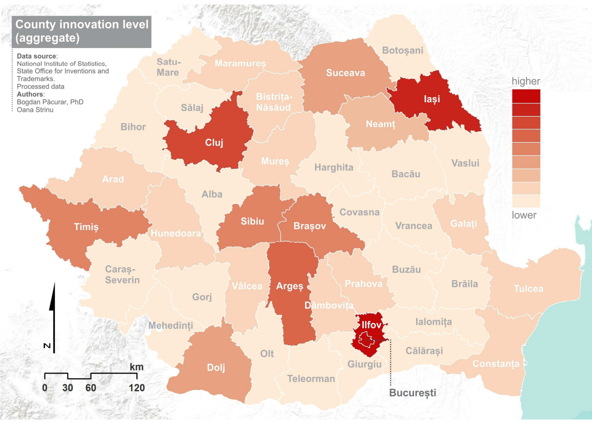

Fig. 2. Innovation score aggregate distribution at county level, Romania.

Very high levels of innovation, according to our aggregate, can be found exclusively in the Municipality of Bucureşti, the capital city of Romania, and in the surrounding county of Ilfov (both with an index of 10). *High* innovation scores were identified only in the counties of Iaşi (8.5), Cluj (7.50) and Argeş (6). The counties of Timiş, Braşov and Sibiu *had average or medium* values when it came to innovation (5), while more than two-thirds of the counties scored *low* on the innovation aggregate index scale (less than 5). Looking at our findings, one can say that innovation thrives in regions with high degrees of urbanization, or in regions with larger or more powerful cities. This makes sense as, according to Glaeser (2011) cities have always been engines of innovation [18]. In such places, innovation speeds up because smart people are connected to each other, and because cities are gateways to finance, markets and other elements that spur economic innovative growth. In a similar fashion, Capello and Lenzi (2013) stated that many studies show that innovation was concentrated in central and metropolitan areas [19]. Thus, in a way, size does matter. But such a premise should be left for another time and another paper.

Secondly, the distribution of the aggregate innovation score for the NUTS 3 regions or counties of Romania has a strong positive skew (the distribution line is skewed left, as one can see from the histogram in Figure 3, and has a skewness value of 2.244), meaning that the majority (34 or 81 percent) of counties have a low innovation index. The findings reinforce the already mentioned statement that innovation is spatially compact, dense, unequally distributed, and most of all spiky. Here lie some of the 'mountains in a flat world' that Rodriguez-Pose and Crescenzi (2008) have mentioned in their studies [20]. Moreover, it emphasizes and geographically validates the *Pareto principle* or the *Law of the vital few*, in the sense that most innovation capabilities are concentrated in but a smattering regions, thus becoming a corollary principle in innovation theory.

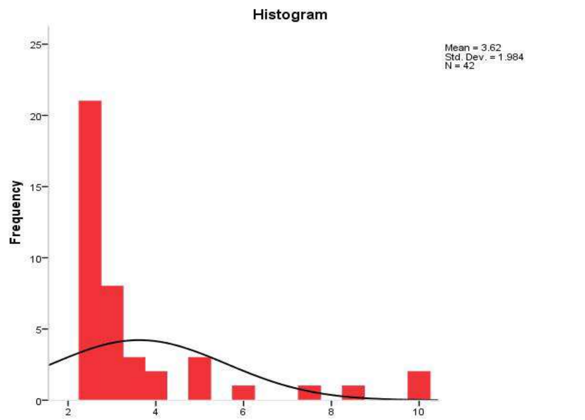

Fig. 3. Histogram presenting the skew ness of innovation score data

Unfortunately, this applies only at national level. If we look beyond our borders, if we compare our innovation capabilities, county or national, to other European countries and regions, we may see an entirely different situation. Even those Romanian counties and regions, which were powerful innovative powerhouses (Bucureşti, Ilfov, Iaşi, Cluj etc.), when put against other regions from the European Union, become nothing more than modest innovators, only Bucureşti being a moderate innovator. Actually, while other European regions advanced and evolved, Romanian regions remained at the same level (see the 2006, 2009 or 2012 regional European innovation scoreboards) [21], [22], [23]. In fact, Romania and its regions and counties (NUTS 2 and 3) still are what we call a 'European innovation periphery'. In conclusion, if betterment is our goal, all innovation stakeholders (public as well as private, local, regional, and national authorities, universities, firms and so on) must extend their reach and try to compete, not only internally, nationally, but at a European level, and why not, at a global level.

4. CONCLUSIONS

As we come to a close to what we hope to be the starting point for future research into innovation geography, it is clear that, though somewhat deficient and crude, the aggregate innovation score (index), concocted from the existing statistical data available at county level, managed to show a true picture of the innovation capability of Romanian counties. Most of them lag behind, stuck in the underfunded and understaffed first gear, while a handful of regions benefit from strong innovation inputs and outputs, helping them usher in a faster and more consistent growth and development.

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