Papers in Innovation Studies

Paper no. 2015/27

The Innovation Union Scoreboard is flawed: The Case of Sweden – not the innovation leader of the EU – updated version

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This paper is a supplement and an updating of a previous version published in CIRCLE Papers in Innovation Studies 2015/16 in April 2015, with the title “The Innovation Union Scoreboard is flawed: The Case of Sweden – not being the innovation leader of the EU”. The previous version was based on the Innovation Union Scoreboard 2014. However, the Innovation Union Scoreboard 2015 was published two weeks after our previous version. This made this updated paper, based on both scoreboard versions, necessary. In this paper we follow exactly the same structure as in the previous CIRCLE WP 2015/16 (see Edquist and Zabala-Iturriagagoitia, 2015), but here we also introduce the new data provided by the Innovation Union Scoreboard 2015.

This version: August 2015

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WP 2015/27

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Charles Edquist and Jon Mikel Zabala-Iturriagagoitia

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According to the Innovation Union Scoreboard published by the European Commission, Sweden has been, and still is, an innovation leader within the EU and one of the most innovative countries in Europe. In this paper, the performance of the Swedish national innovation system is analyzed using exactly the same data as those employed by the Innovation Union Scoreboard for the years 2014 and 2015.

We argue that the Summary Innovation Index provided by the Innovation Union Scoreboard is highly misleading. Instead of merely calculating this Summary Innovation Index, the individual indicators that constitute this composite innovation indicator need to be analyzed in much greater depth in order to reach a correct measure of the performance of innovation systems. We argue that input and output indicators need to be considered as two separate types of indicators and each type should then be measured individually. Thereafter the input and output indicators should be compared to one another, as is normally done in productivity and efficiency measurements.

To check whether our approach provides results similar to those of the Innovation Union Scoreboard (or not), we apply it and analyze the relative position of Sweden - appointed the innovation leader of the EU, by the EU. A theoretical background and reasons for selecting the indicators used are also given and a new position regarding Sweden's innovation performance compared to the other EU countries is calculated.

Our conclusion is that Sweden cannot be seen as an innovation leader in the EU. This means in turn that the Innovation Union Scoreboard is flawed and may therefore mislead researchers, policy-makers, politicians as well as the general public – since it is widely reported in the media.

JEL codes: O30, O38, O49, O52

Keywords: Innovation system, innovation policy, innovation performance, Sweden, indicators, input, output

The Innovation Union Scoreboard is flawed: The Case of Sweden – not the innovation leader of the EU – updated version [1]

By

Charles Edquist and Jon Mikel Zabala-Iturriagagoitia

Version 2015-08-09

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1. Introduction

The European Commission has often highlighted that Europe is one of the most innovation intensive regions in the world (European Commission, 2013a). With the recent strategy "Europe 2020", the European Commission has outlined its intention to focus on today's challenges in a changing world and stated its desire to become "a smart, sustainable and inclusive economy" (European Commission, 2013b: 1). The European Union has therefore set ambitious objectives in five areas to be reached by 2020. In addition to climate and energy, education, employment and social inclusion, innovation is one of the five pillars to form a so-called "Innovation Union" (European Commission, 2013a).

To support the establishment of an Innovation Union, the European Commission is using the Innovation Union Scoreboard (IUS) as a tool to monitor the implementation of and to examine and illustrate the "innovation performance" of European Member States (European Commission, 2011).[2] This suggests that the IUS is meant to have a real impact on the evaluation of the policies of the Member States, on the allocation of resources, and – supposedly – on the design of innovation policies at the European, national and regional levels. In other words, the results provided by the IUS have a significant (political) impact.

One of the key findings of the IUS is that Sweden holds the position of innovation leader in the EU, and that its ranking remains stable over time (European Union, 2013, 2014, 2015). Sweden has the top position (ranked number 1) of all EU28 Member States in what is called "EU Member States' Innovation Performance" (European Union, 2014: 5). This has been reported in the media and also reached high-level politicians and policy-makers in Sweden. For example Sweden's former foreign minister Carl Bildt tweeted from his official account that it is "Nice to see that Sweden is ranked as the No 1 innovation country in the EU"[3], echoing the results of the IUS report. The Swedish Innovation Policy Agency (VINNOVA) also concluded in a newsletter that "Sweden leads the EU innovation league.". The Minister of Industries at that time, Annie Lööf, commented on Sweden's standing, saying that "the fact that

[2] The IUS is published by the DG for Internal Market, Industry, Entrepreneurship and SMEs, Unit J3 – Innovation Policy for Growth. The 2015 edition was prepared by Hugo Hollanders, Nordine Es-Sadki and Minna Kanerva from the Maastricht Economic and Social Research Institute of Innovation and Technology (UNU-MERIT).

[3] https://twitter.com/carlbildt/status/316807766700351488, 27/03/2013, 12:03am.

Sweden again tops the innovation league in the EU and draws away from other countries shows that our efforts to increase our innovation power give results".[4] We will show below that these statements are based on a weak flawed analysis.

To assess the "innovation performance" of the Member States, a Summary Innovation Index (SII) is provided by the IUS. The SII includes 25 indicators,[5] which are divided into three main categories (i.e. enablers, firm activities and outputs) and eight dimensions (i.e. human resources, excellent research systems, finance and support, firm investments, linkages and entrepreneurship, intellectual assets, innovators, economic effects). However, in its successive reports, IUS does not provide any conceptual or theoretical discussion of these categories and dimensions, nor of the specific indicators and the relations among them. The reports limit themselves to briefly describing the indicators considered.

The purposes of this paper are the following. We question whether Sweden can be considered to be the top position holder within the EU with regard to "innovation performance" in any meaningful use of this term. In doing so, we employ exclusively the data provided by the IUS 2014 and 2015 to assess the performance of the Swedish innovation system and discuss whether or not Sweden can be regarded as the innovation leader in Europe. On a theoretical basis, we single out a number of input (n=4) and output (n=8) innovation indicators from the 25 employed by the IUS. We then compare Sweden's position to those of the other EU28 Member States according to the data provided by the IUS for the years 2014 and 2015 (see also Edquist and Zabala-Iturriagagoitia, 2015). Finally, we compare the measures of innovation outputs and inputs of each of the EU28 countries.[6] This measure of productivity (or efficiency) of innovation systems (i.e., the relationship between the innovation inputs and outputs) is then also used to compare the performance of Sweden's innovation system with those of the other 28 EU member countries.

With this paper we do *not* intend to discuss the quality and accuracy of the IUS data, this will be a future endeavor. We merely use exactly the same data provided by the IUS. However, as a consequence of adding some conceptual and theoretically informed considerations to the IUS analysis, we obtain quite different results.

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[4] In newsletter from VINNOVA of March 14, 2014.

[5] For the definitions of each of these 25 indicators, see European Union (2014, 2015).

[6] Our aggregated output indicator measures innovations as such, and not their determinants or consequences.

Our analysis shows not only why and how Sweden's status as an innovation leader needs to be revised but also that the IUS analysis is flawed in respect to assessing innovation performance. The IUS mode of measuring innovation performance is outright incorrect and highly misleading, not only for analysts/researchers but also for policy-makers/politicians. Lack of theoretical awareness among EU administrators and their advisors is the probable explanation for this problem.

The paper is organized as follows. Section 2 provides an overview of the research methodology applied. Section 3 presents the rationale and theoretical basis for the selection of certain indicators. The analysis of the relative position of Sweden in the European context is developed in Section 4. There, we use the normalized IUS scores for each of the selected indicators and provide new rankings for both the innovation inputs and the innovation outputs. We also calculate the ranking of the efficiency of the Swedish innovations system by relating the innovation outputs and inputs to each other (thus calculating innovation performance). Finally, Section 5 concludes with a discussion of the main findings of the research and its relevance for the practice of innovation policy making.

2. Methodology

This paper begins with a brief presentation of the 25 IUS indicators included in the IUS (2014, 2015) and a discussion of which of these that best measure innovation input and output, respectively. The recent and current literature on the innovation systems approach, has demonstrated that not all the indicators included in the IUS are adequate for measuring either input or output. Based on these findings, we use only 12 of the IUS indicators, selecting eight output indicators and four input indicators.[7]

After selecting the indicators that we deemed most relevant for the purposes of this research, we gathered all the data from the IUS 2014 and 2015, all with normalized scores for each indicator chosen and for all EU28 countries. We then ranked all EU28 countries for each indicator. This provided a basis for making a comprehensive and in-depth analysis of the relative position of Sweden for a diverse set of measures.

By categorizing the indicators as inputs and outputs, we are able to see the extent to which innovation inputs are transformed into or materialize as innovation outputs.

[7] The definition of all the indicators considered and the rationale for their selection are provided in section 3.

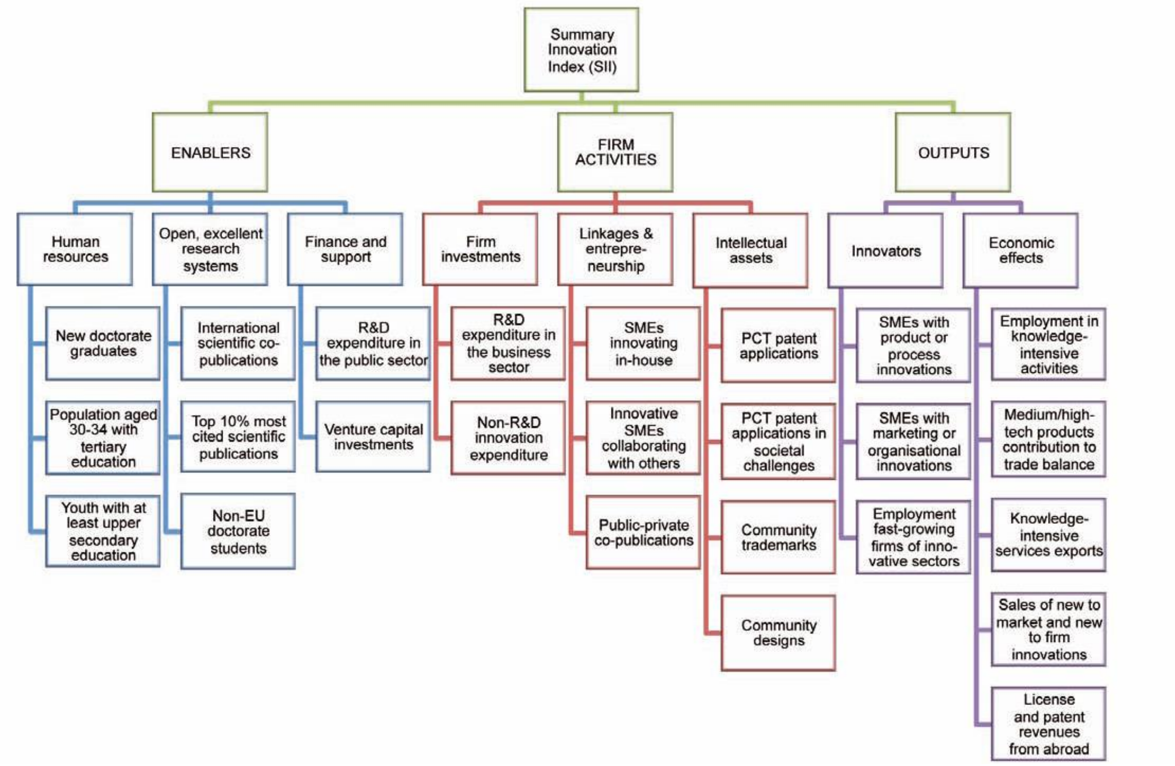
Innovation performance in terms of efficiency is calculated as the ratio between the eight innovation output indicators and the four innovation input indicators. A high score for the input indicators means that a great deal of effort and a great many resources have been devoted to stimulating innovation. Similarly, a high score for the output indicators shows that a country has a high production of innovations. However, if the input side is, relatively speaking, much larger than the output side, the efficiency of the system as a whole is low.

3. Theoretical background and relevant indicators

The IUS (until 2009 called the European Innovation Scoreboard) provides a comparative assessment of the research and innovation performance of the EU Member States (currently 28) as well as Iceland, the Former Yugoslav Republic of Macedonia, Norway, Serbia, Switzerland and Turkey,) and the relative strengths and weaknesses of their research and innovation systems (European Union, 2014: 8). It uses the most recent data available from a variety of sources (e.g. Eurostat, Scopus, Thomson Reuters, OECD, the Office for Harmonization in the Internal Market, the United Nations). In this paper we compare the performance of Sweden with that of the other EU28 member states using only the data provided by the IUS 2014 and 2015. However, as described below, a different approach is applied to analyze the data (see Section 2).

The IUS identifies 25 indicators, which are divided into three categories and eight dimensions (see Figure 1). Unfortunately, there is no conceptual or theoretical discussion of how and why these indicators were selected. The three categories considered consist of *Enablers*, *Firm activities* and *Outputs.* According to the IUS report, the Enablers "capture the main drivers of innovation performance external to the firm" (European Union, 2014: 4) and cover three innovation dimensions: human resources, open, excellent and attractive research systems, and finance and support. Firm activities "capture the innovation efforts at the level of the firm" (ibid) and are also grouped in three innovation dimensions: firm investments, linkages and entrepreneurship, and intellectual assets. Finally, outputs cover "the effects of firms' innovation activities" (ibid) in two innovation dimensions: innovators and economic effects.

Figure 1. - Measurement framework of the Innovation Union Scoreboard



Source: European Union (2014: 8).

Based on the indicators included in these categories and dimensions, the IUS provides a Summary Innovation Index (SII). For each year, each indicator has a normalized score that varies from a minimum performance of 0 up to a maximum of 1. In the SII all indicators are given the same weight.[8]

The IUS draws the conclusion that the country with the highest average score for the 25 indicators is also the best "innovation performer," regardless of whether the indicators used measure the input or output side of innovation or something else. In addition, the IUS provides no explicit definition of "innovation performance," which is quite surprising since this is the most central concept in the scoreboard reports. However, implicitly the SII score is the IUS definition of "innovation performance".

Countries are ranked according to the SII in the following groups: *innovation leaders* (more than 20% above EU average),[9] *innovation followers* (less than 20% above, or

[8] For a discussion on the adequacy of weighting indicators when elaborating composite measures see Grupp and Schubert (2010).
[9] In the IUS 2014 and in the IUS 2015, the EU28 countries regarded as innovation leaders are: Denmark, Finland, Germany and Sweden.

more than 90% of the EU average),[10] *moderate innovators* (relative performance rates between 50% and 90% of the EU average)[11] and *modest innovators* (less than 50% of the EU average) (European Union 2014: 11).[12]

One could expect that a category designated to "*outputs*" (see figure 1) would include mainly indicators of innovation output in the sense of innovations as such. This "outputs" category includes three indicators related to the behavior of "innovators" and five indicators related to the "economic effects" of innovations. The indicators under the "innovators" heading are 'SMEs introducing product or process innovations as % of SMEs', 'SMEs introducing marketing or organizational innovations as % of SMEs' and 'Employment in fast-growing firms of innovative sectors.' The "economic effects" category includes five indicators: those related to employment in knowledge-intensive activities, to exports of medium and high-tech industries, to knowledge-intensive services, to sales of new to market and new to firm innovations and to license and patent revenues. Accordingly and surprisingly, however, the IUS category of "outputs" includes diverse types of indicators, some of which can be regarded as actual outputs or results of innovation activities, but at the same time, it also includes indicators that refer to the consequences (i.e. the impact) of these innovations (see Figure 1).

Productivity is a measure of the efficiency of a person, company, system, country, etc. in converting inputs into outputs. Productivity or efficiency is the ratio between outputs (nominator) and inputs (denominator), or output per unit of input. Hence, (innovation) output is, of course, a part of any productivity measure. When measuring innovation productivity, some sort of input and some sort of output must be compared to determine the performance of a given unit. Therefore it is quite surprising that the IUS estimates the "innovation performance" without making any distinction between inputs and outputs. It is simply methodologically incorrect to speak of "performance" in the sense of productivity or efficiency and, at the same time, mix inputs and outputs.

[10] In the IUS 2014, the EU28 countries regarded as innovation followers are: Austria, Belgium, Cyprus, Estonia, France, Ireland, Luxembourg, Netherlands, Slovenia and the UK. In the IUS 2015, the EU28 countries regarded as innovation followers are: Austria, Belgium, France, Ireland, Luxembourg, Netherlands, Slovenia and the UK.
[11] In the IUS 2014, the EU28 countries regarded as moderate innovators are: Croatia, Czech Republic, Greece, Hungary, Italy, Lithuania, Malta, Poland, Portugal, Slovakia and Spain. In the IUS 2015, the EU28 countries regarded as moderate innovators are: Cyprus, Czech Republic, Estonia, Greece, Hungary, Italy, Lithuania, Malta, Poland, Portugal, Slovakia and Spain.
[12] In the IUS 2014 and in the IUS 2015, the EU28 countries regarded as modest innovators are: Bulgaria, Latvia, and Romania.

To measure the performance of an innovation system in terms of productivity/efficiency, the indicators must, in some way, be separated into indicators that reflect the input character of innovation (causes, determinants) on the one hand, and other measures which reflect the outputs of the innovative action (actual innovations) (Mahroum and Al-Saleh, 2013; Zabala-Iturriagagoitia et al., 2007a). Both sides need to be considered separately, and then related to each other. Neither input nor output indicators themselves can measure the innovation performance of a country. It is the relation between them which measures innovation performance. To be able to assess which of the indicators provided by the IUS are inputs and which are output indicators, we thus define inputs and outputs as follows:

Innovation input indicators *refer to the resources (human, material and financial; private as well as governmental) which are used to create innovations, including bringing them to the market.*

Innovation output indicators *refer to new products and processes, new designs and community trademarks as well as marketing and organizational innovations, which are new to the market and/or new to the firm and are adopted by users.*

Based on the definitions provided by the IUS for each of the 25 indicators, we identify eight indicators as measuring innovation output and four as measuring innovation input. Table 1 below shows the definition of each of the eight output indicators considered and the data sources according to the IUS.

Table 1. - Indicators proposed as innovation output indicators by us

	Indicator	**Interpretation**	**Data source**
2.2.1	SMEs innovating in-house (% of SMEs)	This indicator measures the degree to which SMEs that have introduced any new or significantly improved products or production processes have been innovated in-house.	Eurostat (CIS)
2.3.3	Community trademarks per billion GDP (in PPP€)	Trademarks are an important innovation indicator, especially for the service sector. It fulfils the three essential functions of a trademark: it identifies the origin of goods and services, guarantees consistent quality through evidence of the company's commitment vis-à-vis the consumer, and is a form of communication, a basis for publicity and	Office for Harmonization in the Internal Market and Eurostat

		advertising.	
2.3.4	Community designs per billion GDP (in PPP€)	A design is the outward appearance of a product or part of it resulting from the lines, contours, colours, shape, texture, materials and/or its ornamentation.	Office for Harmonization in the Internal Market and Eurostat
3.1.1	SMEs introducing product or process innovations (% of SMEs)	Technological innovation, as measured by the introduction of new products (goods or services) and processes, is a key ingredient to innovation in manufacturing activities.	Eurostat (CIS)
3.1.2	SMEs introducing marketing or organizational innovations (% of SMEs)	This indicator tries to capture the extent that SMEs innovate through non-technological innovation.	Eurostat (CIS)
3.2.2	Contribution of medium and high-tech products exports to the trade balance	The manufacturing trade balance reveals an economy's structural strengths and weaknesses in terms of technological intensity. It indicates whether an industry performs relatively better (or worse) than total manufacturing and can be interpreted as an indicator of revealed comparative advantage that is based on a country's trade specialisation.	UN Comtrade
3.2.3	Knowledge-intensive services exports (as % of total services	This indicator measures the competitiveness of the knowledge-intensive services sector.	Eurostat
3.2.4	Sales of new to market and new to firm innovations (as % of turnover)	This indicator measures the turnover of new or significantly improved products and includes both products which are only new to the firm and products which are also new to the market. The indicator thus captures both the creation of state-of-the-art technologies (new to market products) and the diffusion of these technologies (new to firm products).	Eurostat (CIS)

Source: European Union (2014: 86-90).

The above 8 indicators provided by the IUS[13] help identify the outputs of an innovation system. Five of them are also listed as outputs in the IUS (i.e. indicators 3.1.1, 3.1.2, 3.2.2, 3.2.3 and 3.2.4). The three indicators which we, but not the IUS, consider to be

[13] We acknowledge that other output indicators may also be available and used by other statistical offices and methodologies (e.g. Global Innovation Index). However, in this paper we limit the scope of our analysis to the indicators and data provided by the IUS.

output measures are listed in the IUS as 2.2.1, 2.3.3 and 2.3.4. In the following we justify our reasons for considering these three additional indicators to be innovation output indicators. We also argue that three of the indicators that the IUS lists as outputs (3.1.3, 3.2.1 and 3.2.5) should not be considered as measures of innovation output.

As stated above, we are looking for *output indicators* that, to the largest extent possible, measure innovations as such. The notion of innovation output, according to the definition that we provided above, is partly different than the IUS category of "outputs," which is defined as "the effects of firm's innovation activities" (European Union, 2014: 4). For us, however, the term innovation output indicators refers to new products and processes, new designs and community trademarks as well as marketing and organizational innovations which are either new to the market and/or new to the firm and are adopted by users (see the definition above).

In the IUS, the category of "outputs" thus places more emphasis on the consequences (i.e., impacts or results) of innovations than on the actual production of innovations (i.e., what we call "outputs"). In passing, we want to mention that in this paper we are not at all interested in the consequences of innovations, such as economic growth or employment. Rather, we are interested in actual innovations and the determinants of innovations – which we call "input indicators," which will be discussed later in this section.

As stated above, we contend that indicators 2.2.1, 2.3.3 and 2.3.4 should be categorized as output indicators, despite the fact that they are classified in the IUS as "firm activities" rather than "outputs". Let us present our reasons for classifying them as innovation output indicators.

The IUS indicator 2.2.1, '*SMEs innovating in-house'*, is classified under the category firm activities. However, we believe that this indicator needs to be seen as an innovation output indicator. According to the definition provided by the IUS, it refers to the degree to which SMEs have succeeded with the introduction of new or significantly improved products and/or processes which may have been innovated inside the company. In other words, it identifies the firms where innovation processes have been completed and led to an actual new product or process. Therefore, this indicator measures in fact outputs of an innovation system.

Similar arguments hold for indicators 2.3.3, '*Community trademarks per billion GDP'*, and 2.3.4, '*Community designs per billion GDP'*, which are also included in the IUS under the category of firm activities. Community trademarks, as well as community designs, are significant aspects of product innovations, since they help to label a specific brand or design. Since the number of community trademarks and community designs (related to GDP in each country) provide a measure of innovations which are already on the market, these two indicators should be seen as innovation output indicators. It should also be highlighted that the IUS explicitly lists indicator 2.3.3 (trademarks) as an "innovation indicator" (see Table 1).

The five indicators 3.1.1 through 3.2.4 in Table 1, are considered to be "outputs," both by the IUS and by us. However, a conceptual difference exists between the label "outputs" as used in the IUS and the concept of "innovation output" used in this paper. It is for this reason that we do not classify as "innovation output indicators" the following three indicators referred to in the IUS as "outputs": 3.1.3, '*Employment in fast-growing firms of innovative sectors*'; 3.2.1, '*Employment in knowledge-intensive activities*' and 3.2.5, '*License and patent revenues from abroad*'.

The rationales for not considering the above three indicators as measures of innovation output are the following. Indicators 3.1.3 and 3.2.1 measure employment. Employment may be an outcome of innovation but it may also be a result of other forces. Some kinds of innovations (e.g. product innovation) often result in increased employment while other kinds (e.g. process innovations) normally result in decreasing employment per unit of output. These two indicators can therefore not be considered innovation output indicators (Edquist et al., 2001). Employment should be considered a consequence of innovations rather than an innovation as such – just as in the case of economic growth.

The third indicator listed in IUS as an output, 3.2.5, licenses and patents, refers to sales of intellectual property rights. Although patents may form the basis for innovations, they are certainly not innovations, although this is a common misunderstanding. As long as a product or a process has not been commercialized and adopted by users (user firms or consumers) it cannot be considered to be an innovation. There are, for example, many inventions which are patented but never reach the market and therefore never become innovations.

Looking further at the measurement framework of the IUS, it also becomes clear that while one of the main categories of indicators is considered to be a measure of innovation output, there is no category explicitly referring to innovation inputs (determinants of innovation) or providing a clear specification of what such inputs would be. Instead, the IUS defines two other main types of innovation indicators: *Enablers*, innovation drivers which are outside the firm, and *Firm activities*, indicators which capture the innovation efforts undertaken by firms. However, it seems that some of the *Enablers* and *Firm activities* have characteristics which motivate classifying them as innovation input indicators, as we now discuss below.

We propose four indicators (see Table 2), that fulfill the requirements for innovation inputs according to the definition presented above. Two of the indicators are categorized in the IUS conceptual structure as "enablers" and two as "firm activities". Two of those indicators measure R&D expenditures from the public and private sector, both important determinants of innovation.[14] Venture capital, which is important "for the relative dynamism of new business creation" (European Union, 2014: 87), is especially needed for risk and cost intensive innovation and is also required to enhance innovation by commercialization of R&D results. In addition to R&D intensive investments, companies need to invest in non-R&D innovation expenditures as well.

Table 2. - Indicators proposed as innovation input indicators by us

	Indicator	**Interpretation**	**Data source**
1.3.1	R&D expenditure in the public sector (% of GDP)	Trends in the R&D expenditure indicator provide key indications of the future competitiveness and wealth of the EU.	Eurostat
1.3.2	Venture capital (% of GDP)	The amount of venture capital is a proxy for the relative dynamism of new business creation. In particular for enterprises using or developing new (risky) technologies; venture capital is often the only available means of financing their (expanding) business.	Eurostat
2.1.1	R&D expenditure in the business sector (% of GDP)	This indicator captures the formal creation of new knowledge within firms.	Eurostat
2.1.2	Non-R&D	This indicator measures non-R&D innovation	Eurostat

[14] Of these two indicators, R&D expenditures in the business sector are certainly to a very large extent directly undertaken to enhance innovation. R&D expenditures in the public sector are to a lesser extent undertaken directly for this purpose, since a substantial proportion is pursued to result in scientific knowledge, part of which may, in turn, result in innovations. In spite of this, we include both of these indicators in the category of input indicators, although a part of the public sector R&D expenditures may result in innovations after a substantial time lag.

	innovation expenditures (% of turnover)	as percentage of total turnover. Several of the components of innovation expenditure, such as investment in equipment and machinery and the acquisition of patents and licenses, measure the diffusion of new production technology and ideas.	(CIS)

Source: European Union (2014: 86-90).

The four input indicators proposed above are linked to innovation activities and are typically undertaken to enhance innovation, at least in part. There are, of course, other determinants of innovation processes (Furman et al., 2002). Ideally we should include *all such determinants* as input indicators. However, we would then need a holistic theory of all determinants of innovation processes and their relative importance (Samara et al., 2012). That we do not have. Admittedly, this is unsatisfactory – but a fact. For example, in the IUS (and in this paper) no account is taken of determinants of innovation processes operating from the demand side.[15]

In other contexts we do, however, argue in a more holistic way in terms of ten activities in innovations systems (sometimes called functions) that influence innovation processes and cover a wide range of determinants of innovation, if not all (Edquist, 2005, 2011). However, given the purposes of this paper, we have chosen to include only these four since they are clearly input indicators and, in addition, data for these indicators are also found in the data provided by the IUS.[16] As indicated above, we choose here to use only the IUS data, although with a different approach than the IUS.[17] In addition, using data from the IUS database makes it possible to compare the two approaches to measuring performance of innovation systems independent of the availability and quality of the data used (Zabala-Iturriagagoitia et al., 2007a).[18]

[15] Demand side determinants are addressed in Edquist and Zabala-Iturriagagoitia (2012) and in Edquist et al. 2015).

[16] If all innovation input and all innovation output indicators were included, we would be able to calculate total productivity. As indicated, we will be satisfied here with a limited number of indicators on both sides, i.e., we will only be able to provide a partial measure of productivity (efficiency, innovation performance). At least we make *some* distinction between input and output indicators – which the IUS does not do, when calculating "EU Member States innovation performance".

[17] There will, of course, be reasons to include non-IUS indicators if a holistic approach is pursued. But this would be a different exercise.

[18] The sources of the IUS data were briefly mentioned in the beginning of section 3. However, we here make no attempt to evaluate the quality of these data – simply since it is not the purpose of this paper. This does not exclude the fact that we are aware of the discussion of the problems with regard to quality of, for example, the Community Innovation Survey data. Examples of contributions to this discussion are Evangelista et al. (1998), Mairesse and Mohnen (2002), Laursen and Salter (2006), Arundel et al. (2009) and Heidenreich (2009) to mention a few.

Our main goal here is to begin to consider some indicators as inputs and others as outputs, and in so doing to provide a starting point that could be generalized into a more holistic and less partial approach in future work. Admittedly, the analysis pursued here - partially comparing rankings between output and input indicators - follows a linear logic (as opposed to a systemic or holistic one). This is not supported by the scholars in the innovation systems approach, not even by us (Edquist, 2014a, 2014b, 2014c).

Based on the arguments outlined in this section, the eight output indicators and the four input indicators will next be used to assess the innovation performance of the Swedish national innovation system in relation to the rest of the EU28 Member States and also to analyze the viability of the proposed approach.

4. Analysis

After discussing the rationales for the selection of certain input and output indicators, this section analyzes the performance and relative position of Sweden for each of the proposed indicators within the EU. In this paper, following Frane (2014), we limit the analysis to the data provided by the IUS 2014 and 2015. We make some comparisons between the data provided in these two editions of the IUS. Except for such limited comparisons we do not analyze the development over time, which is a matter for further work.

4.1. Output orientation

We begin the analysis of the Swedish innovation system from the perspective of the production of innovation outputs, first looking at the three indicators that are not explicitly regarded as output indicators by the IUS, but which we consider to be such (see Section 3). Starting with indicator 2.2.1, *'SMEs innovating in-house'*, the data provided by the IUS 2014 and 2015 show that the normalized score for Sweden is higher than the EU28 average. While the EU28 average reaches 0.570 points in 2011 (0.513 in 2012), the latest year for which data is available for this indicator, Sweden has a normalized score of 0.729 in year 2011 (0.779 in year 2012).[19] Sweden thereby holds the 8th position for this indicator in the IUS 2014 (4th position in the IUS 2015), the

[19] Note that most of the indicators provided by the IUS 2014 refer to years 2011 and 2012, while those included in the IUS 2015 refer to years 2012 and 2013.

leading countries in the IUS 2014 being Germany (0.933), Cyprus (0.833) and Denmark (0.813) (see Table 3).[20]

Indicator 2.3.3, on *'Community trademarks,'* shows a similar picture for Sweden, with 0.573 points as the normalized score in 2012 (i.e., IUS 2014) and 0.661 points in 2013 (i.e., IUS 2015). Although Sweden is above the EU28 average (0.444 in the IUS 2014 and 0.580 in the IUS 2015), the country is not part of the group of countries leading this indicator, as it holds the 7th position in 2012 and the 8th in 2013. Three countries (Cyprus, Luxembourg, and Malta) reach the highest normalized score of 1.0 in both years, while Sweden achieves just over half of that.[21]

Taking a closer look at *community designs*, as measured by indicator 2.3.4, Sweden's score of 0.574 is almost the same as the average for the EU28 countries for 2012, which is about 0.566. Sweden holds the 8th position in the European context, which is led by Luxembourg and Austria (1.0 normalized score), Denmark being in the third position (0.971). This is one of the indicators where a larger difference is observed between the outputs in Sweden according to the IUS 2014 and the IUS 2015. In year 2013 (i.e., IUS 2015), the indicator 2.3.4 on community designs amounts to 0.999, Sweden being ranked 3th in the context of the EU28.

Hereafter we analyze those indicators which are classified as "outputs" by the IUS and as innovation output indicators by us. According to IUS indicator 3.1.1, *'SMEs introducing product or process innovations,'* Sweden reached a normalized score of 0.781 in 2011 (4th position), and 0.656 in 2012 (6th position), which is the latest data offered by the IUS. This is significantly higher than the EU average (0.577 in 2011 and 0.432 in 2012), but also below the top ranked countries, which are Germany, Belgium and Luxembourg.

The normalized score for Sweden for indicator 3.1.2, *'SMEs introducing marketing or organizational innovations'* (0.605 in year 2011 and 0.540 in year 2012*)*, also shows a score above the EU28 average (0.566 in 2011 and 0.495 in 2012). Nevertheless Sweden

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[20] The leading countries in the IUS 2015 are the Netherlands (0.797), Ireland (0.792) and Germany (0.787).

[21] It seems quiet unclear, why especially Cyprus and Malta are top ranked for indicator 2.3.3, well above other European countries such as Germany (0.595 – 6th position in 2012, 0.670 – 6th position in 2013), France (0.308 – 19th in 2012, 0.462 – 20th in 2013), Italy (0.396 – 16th in 2012, 0.545 – 15th in 2013), United Kingdom (0.419 – 12th in 2012, 0.578 – 13th in 2013) or the Netherlands (0.541 – 9th in 2012, 0.631 – 10th in 2013).

is still in the 10th (2011) and 12th (2012) position, respectively, and miles behind the innovation leaders, Germany, Luxembourg, Ireland and Greece.

For indicator 3.2.2, *'Contribution of medium and high-tech product exports to trade balance'*, the distance between Sweden and the top-ranked countries is substantial. Sweden has a normalized score of 0.579 for 2012 (0.648 in 2013), which is slightly above the EU average (0.553 in 2012, 0.658 in 2013). However, this should not obscure the fact that Sweden is behind 14 other EU countries (i.e., in year 2013 Sweden ranks 9th). This means that half of the countries analyzed in the context of the EU28 show a better result than Sweden did in 2012 for this particular measure. Germany (0.930) leads the group once more in 2012, Slovenia (0.802) and Hungary (0.756) being second and third respectively.[22]

For 3.2.3, *'Knowledge-intensive services exports'*, the EU28 average showed a normalized score of 0.606 in 2011 (0.665 in 2012), while Sweden reached 0.510 points (0.524 in 2012), which is below the EU average and places the country in the 10th position (11th in 2012). Ireland and Luxembourg lead the ranking for indicator 3.2.3, while Denmark holds the third position.

Finally, the result observed in relation to indicator 3.2.4, *'Sales of new to the market and new to the firm innovations,'* is even worse, as Sweden falls down to position 21 in 2011 (24th in 2012), with a normalized score of 0.248 (0.156 in 2012). Sweden is far behind the European average (0.664 in 2011, 0.488 in 2012) and only a few countries show a poorer result. Greece and Slovakia (1.0) are the best performers among the EU28 in 2011, Spain (0.982) being third.[23] Given the fact that this indicator measures the share of the turnover due to the sales of significantly improved products, new to the firm, or new to the market innovations, this indicator is, in our view, one of the most important and basic output indicators of all. Sweden's poor result for this indicator should therefore be seen as a serious weakness in the Swedish innovation system.

Table 3 summarizes the normalized scores for the eight output indicators and the relative position Sweden holds in relation to the EU28 countries for the latest year for which data are available for each indicator. It also gives an average ranking and normalized score for Sweden for all output indicators.

[22] In year 2013 (i.e. IUS 2015), Hungary is the leading country for this particular indicator (0.899), Germany being second (0.892) and Slovakia (0.850) being third respectively.
[23] In year 2012 (i.e. IUS 2015), Denmark is the leading country for this particular indicator (1.000), Slovakia being second (0.869) and Spain (0.590) being third respectively.

Table 3. - The innovation output indicators of the Swedish national innovation systems[24]

Indicator	Score in 2014 [2015]	Ranking (out of 28) in 2014	Ranking (out of 28) in 2015	EU 28 average in 2014 [2015]	Leading countries (top 3) in 2014	Leading countries (top 3) in 2015
2.2.1 SMEs innovating in-house as % of SMEs	0.729 [0.779]	8	4	0.570 [0.513]	Germany (0.933) Cyprus (0.833) Denmark (0.813)	Netherlands (0.797) Ireland (0.792) Germany (0.787)
2.3.3 Community trademarks per billion GDP (in PPP-€)	0.573 [0.661]	7	8	0.444 [0.580]	Luxembourg (1.0) Cyprus (1.0) Malta (1.0)	Cyprus (1.000) Luxembourg (1.000) Malta (1.000)
2.3.4 Community designs per billion GDP (in PPP-€)	0.574 [0.999]	8	3	0.566 [0.569]	Luxembourg (1.0) Austria (1.0) Denmark (0.971)	Denmark (1.000) Luxembourg (1.000) Sweden (0.999)
3.1.1 SMEs introducing product or process innovations as % of SMEs	0.781 [0.656]	4	6	0.577 [0.432]	Germany (1.0) Belgium (0.848) Luxembourg (0.792)	Luxembourg (0.732) Germany (0.717) Belgium (0.713)
3.1.2 SMEs introducing marketing or organizational	0.605	10	12	0.566	Germany (1.0)	Luxembourg (0.851)

[24] The data and rankings for the innovation outputs of all EU28 Member Countries are presented in Annex 1.

innovations as % of SMEs	[0.540]			[0.495]	Luxembourg (0.960) Greece (0.801)	Ireland (0.797) Germany (0.720)
3.2.2 Contribution of medium and high-tech product exports to trade balance	0.579 [0.648]	15	9	0.553 [0.658]	Germany (0.930) Slovenia (0.802) Hungary (0.756)	Hungary (0.899) Germany (0.892) Slovakia (0.850)
3.2.3 Knowledge-intensive services exports as % total service exports	0.510 [0.524]	10	11	0.606 [0.665]	Ireland (1.0) Luxembourg (1.0) Denmark (0.959)	Ireland (1.000) Luxembourg (1.000) Denmark (1.000)
3.2.4 Sales of new to market and new to firm innovations as % of turnover	0.248 [0.156]	21	24	0.664 [0.488]	Greece (1.0) Slovakia (1.0) Spain (0.982)	Denmark (1.000) Slovakia (0.869) Spain (0.590)
Average output result[25]	0.575 [0.620]	10	4	0.568 [0.550]	Germany (0.859) Luxembourg (0.754) Denmark (0.701)	Luxembourg (0.772) Denmark (0.728) Germany (0.723)

Source: own elaboration based on the European Union (2014 and 2015) data.

[25] Calculation based on the sum of the average normalized score for each output indicator and divided by the number of output indicators.

According to the IUS 2014 and 2015, the results for Denmark, Finland, Germany and Sweden are well above those of the EU average. These countries are labelled the '*innovation leaders*'. According to the IUS, "in all dimensions the performance of the innovation leaders, Sweden, Denmark, Germany and Finland is not too different" (European Union, 2014: 4-5). Table 3 gives a sharply different picture, however. Taking into account the normalized values observed for the eight output indicators discussed above, and according to the IUS 2014 data, Sweden has an average normalized score of 0.575 for the innovation output indicators (0.620 for the IUS 2015), which is very close to the EU28 average of 0.568 (0.550 for the IUS 2015). Sweden thereby holds the 10th position among the EU28 (4th in the IUS 2015).[26]

This result means that nearly a third of all EU countries have higher innovation outputs than Sweden based on the IUS 2014 data. The best performing countries, based on the IUS 2014 data, and with regard to innovation output are Germany (0.859), Luxembourg (0.754) and Denmark (0.701). As shown by Table 3, Sweden (ranked 10th) is thus far behind Germany and considerably behind Luxembourg and Denmark. In turn, the best performing countries, based on the IUS 2015, are Luxembourg (0.772), Denmark (0.728) and Germany (0.723), Sweden being ranked 4th with a normalized value of 0.620.

The main indicators explaining the change in the relative position of Sweden when using IUS 2014 and IUS 2015 data are 2.2.1 "SMEs innovating in-house" (change from 0.729 – 8th - in 2010 to 0.779 – 4th in 2013), 2.3.4 "Community designs" (change from

[26] We have also made a limited sensitivity analysis by replicating the above analysis of the innovation outputs including 12 indicators (2.2.1, 2.3.1, 2.3.3, 2.3.4, 3.1.1, 3.1.2, 3.1.3, 3.2.1, 3.2.2, 3.2.3, 3.2.4, 3.2.5). As was the case with the average output results included in Table 3, the calculation of the average output results in this case is based on the sum of the average normalized score for these output indicators, which are then divided by the number of output indicators (n=12). Using this procedure with the IUS 2014 data, the ranking is led by Germany with a normalized score of 0.809, followed by Luxembourg with 0.746 and Denmark with 0.720. Sweden ranks 4th with a normalized value of 0.686. When comparing the average values and rankings with both approaches (12 outputs as compared to 8 outputs) we get a correlation of R^2=0.85. This implies that the average output results and the subsequent rankings with 8 and 12 outputs show very similar values for the EU28 countries. When using the IUS 2015 data, the ranking is led by Luxembourg with a normalized score of 0.765, followed by Germany with 0.725 and Denmark with 0.724. Sweden ranks 5th with a normalized value of 0.690. When comparing the average values and rankings with both approaches (12 outputs as compared to 8 outputs) we get a correlation of R^2=0.92 in 2015. As was the case with the R^2 value for the IUS 2014, this high correlation implies that the results we obtain as regards the low output performance of Sweden is not dependent on the number of indicators considered, but rather on the low outputs achieved by Sweden in comparison with the results obtained in the other EU28 countries.

0.574 – 8th – in 2012 to 0.999 – 3rd – in 2012), and 3.2.2 "Medium and high-tech product exports" (change from 0.579 – 15th in 2012 to 0.648 – 9th – in 2013).[27]

The results above should call for a serious reconsideration of who the real European "innovation leaders" may be, and in what sense they are leaders. These findings also call into question the way that the European Commission analyzes the innovation data presented in the IUS. Using the data from the IUS 2014 to assess the production of innovation outputs, we have concluded that Sweden does not possess one of the best performing innovation systems in the EU28, as it ends up ranked number ten out of 28 in our analysis (4th when using the IUS 2015 data). Admittedly, the method described in this subsection is quite partial, only measuring innovation outputs. To make the method less partial, in section 4.3 we will compare these outputs to some inputs that have been available for developing and commercializing innovations. However, we will first discuss our selection of the indicators and data of relevance for innovation input in section 4.2.

4.2. Input orientation

The four IUS indicators which we consider here as being important for the input side of innovation processes are listed in Table 4, where we also summarize Sweden's normalized scores and rankings for the input indicators we selected. A high position and ranking here means that innovation efforts (often investments) to enhance innovation output are high. Thus, when a country has a high normalized score and ranking on the input side but a low one on the output side, the country has a low efficiency in the translation of inputs into outputs, i.e., a low productivity of the innovation system – as we will later discuss in section 4.3.

Looking at the IUS scores for indicator 1.3.1, *'Public R&D expenditures',* we see that Sweden had a normalized score of 0.979 in 2012 (0.957 in 2013), which is close to the highest result (Finland, 0.990 in 2012 and Denmark 0.989 in 2013), while the EU28 average was 0.639 in 2012 (0.641 in 2013).

The score for private R&D expenditures in 2012, indicator 2.1.1 *(Business R&D expenditures as % of turnover),* was even higher (a normalized score of 0.991 in 2012 and 0.956 in 2013), with Sweden being again ranked second only after Finland.

[27] See Edquist and Zabala-Iturriagagoitia (2015) for a more detailed analysis of the IUS 2014 data in the case of Sweden.

Table 4.- The innovation input indicators of the Swedish national innovation systems[28]

Indicator	Score in 2014 [2015]	Ranking (out of 28) in 2014	Ranking (out of 28) in 2015	EU28 average in 2014 [2015]	Leading countries (top 3) in 2014	Leading countries (top 3) in 2015
1.3.1 Public R&D expenditures as % of GDP	0.979 [0.957]	2	3	0.639 [0.641]	Finland (0.990) Sweden (0.979) Denmark (0.918)	Denmark (0.989) Finland (0.957) Sweden (0.957)
1.3.2 Venture Capital investments	0.503 [0.536]	8	7	0.478 [0.472]	Luxembourg (1.0) UK (0.762) Finland (0.544)	Luxembourg (0.858) UK (0.672) Denmark (0.604)
2.1.1 Business R&D expenditures as % of GDP	0.991 [0.956]	2	2	0.558 [0.559]	Finland (1.0) Sweden (0.991) Slovenia (0.926)	Finland (1.000) Sweden (0.956) Denmark (0.868)
2.1.2 Non-R&D innovation expenditures as % of turnover	0.319 [0.412]	10	10	0.275 [0.349]	Cyprus (0.936) Lithuania (0.701) Estonia (0.557)	Estonia (0.871) Latvia (0.764) Germany (0.746)
Average input result[29]	0.698 [0.775]	1	1	0.488 [0.505]	Sweden (0.698) Finland (0.694) Germany (0.631)	Sweden (0.775) Germany (0.718) Denmark (0.672)

Source: own elaboration based on the European Union (2014 and 2015) data.

[28] The data and rankings for the innovation inputs of all EU28 Member Countries are presented in Annex 2.
[29] Calculation based on the sum of the average normalized scores for each input indicator divided by the number of input indicators.

Regarding Venture Capital investments, indicator 1.3.2, in 2012 Sweden shows a normalized score of 0.503 in 2012 (0.536 in 2013), the 8th position in the EU context in 2012 (7th in 2013) and slightly above the EU28 average (0.478 in 2012, 0.472) in 2013.

Finally, for indicator 2.1.2, *'Non-R&D innovation as % of turnover,'* Sweden shows a normalized score of 0.319 in 2010 (0.412 in 2012), which positions the country 10th in 2010 and 2012. This means, regarding the IUS definition of the indicator, that investments in "equipment and machinery and the acquisition of patents and licenses" (European Union, 2014: 87) are low and that more than a third of all European countries are investing more in order to spread new production technologies and inventions.

Looking at all four input indicators that we selected as important for innovation, it becomes evident, that Sweden is at the very top with regard to its average ranking (ranking number one based on both in 2014 and 2015 IUS data, 0.698 and 0.775, respectively) among the other EU 28 Member States.[30] According to the IUS 2014 data, Finland has ranking number 2 (0.694) and Germany has ranking number 3 (0.631).[31] Using the IUS 2015 data, Germany has ranking number 2 (0.718) and Denmark has ranking number 3 (0.672). It should be pointed out that the differences between the normalized scores of the inputs for these countries are quite small. In section 4.3, we will now compare output and input indicators with each other in order to discuss the efficiency or performance of the Swedish national innovation system as a whole.

[30] As we discussed in Section 3, a considerable part of public R&D has other objectives than innovation. Therefore, we have also made a limited sensitivity analysis to check whether the average input result for Sweden shows a similar or a different pattern when indicator 1.3.1, 'Public R&D expenditures 'is included or excluded. As was the case with the average output results included in Table 3, the calculation of the average output results in this case is based on the sum of the average normalized score for the input indicators considered, which are then divided by the number of input indicators (n=3). When excluding indicator 1.3.1, and using this procedure with the IUS 2014 data, the ranking is also led by Sweden with a normalized score of 0.604, followed by Finland with 0.595 and Germany with 0.556. When comparing the average values and rankings with both approaches (4 inputs as compared to 3 inputs) we get a correlation of R^2=0.85. This implies that the average input results and the subsequent rankings whether with 3 or 4 inputs show very similar values for the EU28 countries. When using the IUS 2015 data, the ranking is led by Germany with a normalized score of 0.664, followed by Sweden with 0.635 and Finland with 0.573. When comparing the average values and rankings with both approaches (4 outputs as compared to 3 outputs) we get a correlation of R^2=0.87. As was the case with the R^2 value for the IUS 2014, this high correlation implies that the results we obtain as regards the high input performance of Sweden is not dependent on whether "Public R&D expenditures" are included or not.

[31] We have also replicated the above analysis of the innovation inputs considering 7 input indicators (1.1.1, 1.1.2, 1.1.3, 1.3.1, 1.3.2, 2.1.1, 2.1.2). The ranking is still led by Sweden with a score of 0.771 in 2014 and a score of 0.810 in 2015. When comparing the average values and rankings with both approaches (7 inputs as compared to 4 inputs) we get a correlation of R^2=0.86 in 2014 and an R^2=0.83 in 2015.

4.3. The performance of the Swedish national innovation system

So far we have seen that our analysis of the IUS data shows that Sweden is not in a top position on the output side, while the input side shows that there is a high inflow of resources into the national innovation system - both positions in relation to the other EU member states. Together these results indicate that Sweden is not the leading country in terms of innovation performance in the EU – according to our approach to analyzing the IUS data.

In this subsection we focus further on the relation between the input and the output sides, since this relation provides a measure of the innovation performance of the Swedish national innovation system in terms of its efficiency, or productivity. We will also rank the productivity or efficiency of Sweden's innovation system in relation to the other EU28 countries. In what follows, we will discuss – and qualify - the interpretation of this ranking.

What then can be concluded about a country's performance on the basis of the 25 IUS indicators? The IUS calculates a Summary Innovation Index (SII) from them in which it gives the same weight to all indicators. In addition, it makes no distinction whatsoever to show whether indicators reflect (a) innovations as such, (b) determinants or inputs of innovation processes, or (c) consequences of innovations. After using these indicators to calculate what is called the "EU Member States' innovation performance," an IUS ranking for the EU28 Member States is calculated. Sweden has, for several years, emerged as number one in this ranking. This has often been interpreted as meaning that Sweden is the top ranked country in the EU with regard to innovation performance. That this interpretation is common was documented in section 1.

Behind our choice of analysis below is the well-established fact that the only way to measure the efficiency or productivity of a firm, country or system is to compare outputs with inputs, as we have already argued in Section 2. There must be a nominator and a denominator in a productivity ratio. The efficiency or productivity of an innovation system is thus defined by us as the ratio between innovation output and innovation input. Such a ratio shows how efficiently the countries/systems use their innovation inputs. The IUS, on the other hand, simply calculates the average between all the 25 indicators and does not relate them to each other in any other way.

We acknowledge that, as in any process of change, there are time lags between the investments made on the input side and achieving certain outputs (Brenner, 2014;

Brenner and Broekel, 2009; Makkonen and van der Have, 2013). However, in this paper, we have decided not to include any analysis of time gaps in the discussion of the relations between innovation inputs and innovation outputs.[32] We want to stress, however, that time lags between the inputs and outputs should be considered in further analyses of the efficiency of innovation systems, although this this might be difficult to do for all EU28 countries, due to the differences in their innovation profiles, and because, for example, radical innovations may require longer gestation periods than incremental innovations.

The productivity of the Swedish innovation system is shown in Table 5. Applying our method to the data provided by the IUS 2014, Sweden is ranked extremely high with regard to input (ranking number one) and at an intermediate level (ranking number 10) with regard to output. The IUS 2015 data show that Sweden continues to be ranked first with regard to input and 4th with regard to output. As shown in Table 5, this obviously leads to a very low ranking with regard to the productivity or efficiency of the innovation system. Annex 3 provides data showing that Sweden is ranked number 24 among the EU28 Member States with regard to the productivity of the innovation system as we define it here using the IUS 2014 data and number 25 using the IUS 2015 data.[33] Obviously, the national innovation system in Sweden cannot be said to perform well at all from this productivity point of view.

It may be repeated here that Sweden scores very low on output indicator 3.2.4 (*Sales of new to the market and new to the firm innovations*), where Sweden falls down from position 21 in 2011 to position 24 in 2012. This indicator is one of the most important output indicators of all – see section 4.1.

[32] The IUS (2014 and 2015) do not have such an analysis discussion either, and do not even mention the issue.

[33] We have also calculated the productivity of the Swedish innovation system and its relative ranking in the EU28 context with the indexes elaborated with the 7 inputs (input value of 0.771) and the 12 outputs (output value of 0.686). In the IUS 2014, Sweden (with a productivity of 0.89) then holds the 18th position in the EU28. When comparing the average values and rankings with both approaches (4 inputs and 8 outputs compared with 7 inputs and 12 outputs) a correlation of R^2=0.42 is observed. In the IUS 2015, Sweden (with a productivity of 0.852) then holds the 21st position in the EU28. When comparing the average values and rankings with both approaches (4 inputs and 8 outputs compared with 7 inputs and 12 outputs) a correlation of R^2=0.49 is observed.

Table 5: The efficiency and productivity of Sweden's innovation system[34]

	Score in 2014	Score in 2015	Ranking (out of 28) in 2014	Ranking (out of 28) in 2015	Leading countries (top 3) in 2014	Leading countries (top 3) in 2015
Productivity of the innovation system (=innovation output divided by innovation input)	0.82 (0.575/0.698)	0.80 (0.620/0.775)	24	25	Greece (2.52) Bulgaria (2.19) Italy (1.98)	Cyprus (4.053) Luxembourg (3.431) Romania (1.976)

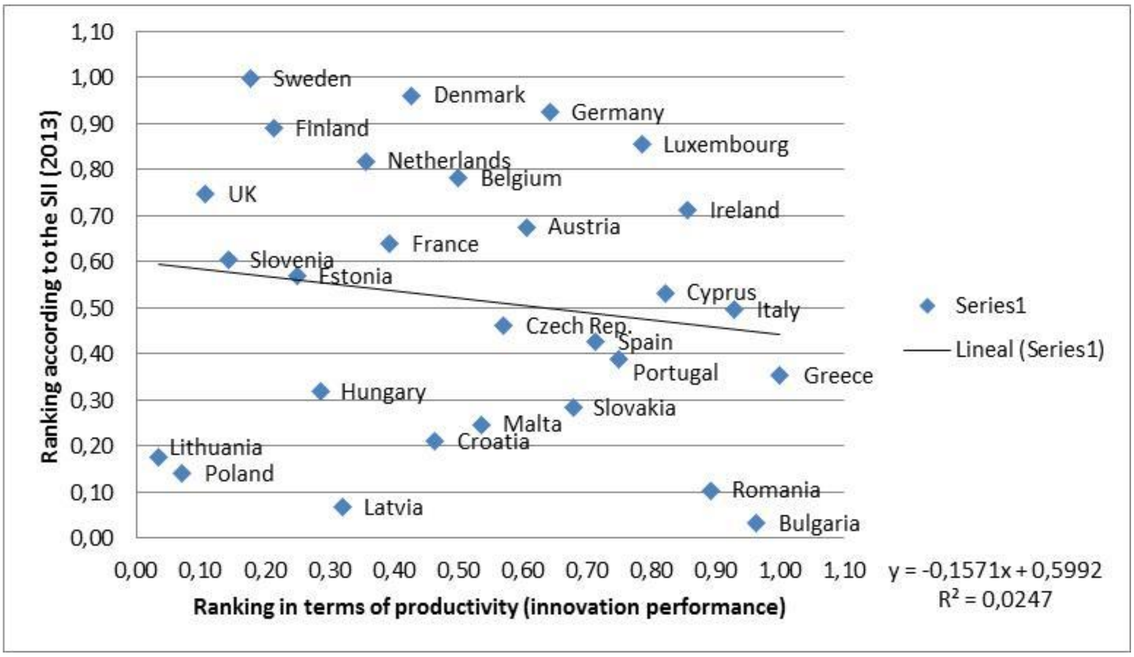
Source: own elaboration based on data from the European Union (2014 and 2015).

[34] The data and rankings for all EU28 Member Countries are presented in Annex 3.

Figure 2 shows the distribution of the ranking scores obtained from the above efficiency estimation (using 4 input and 8 output indicators) for both the IUS 2014 and 2015. This ranking is then compared with the one provided by the SII, which, according to the IUS, measures “EU Member States’ Innovation Performance” (European Union, 2014:5). With this we want to check to what extent the two approaches (i.e., the one followed by the IUS with the SII and our productivity/efficiency approach) provide similar results or not. If the two rankings coincided, one would expect the majority of countries to be distributed along a 45° line. However, this is not the case. The negative relation of these indices must result from their different conceptual frameworks and settings, since the indicator data are the same in both cases. As can be observed, Sweden is not the only country where the two rankings are radically different. In fact, this is the case for most countries, including innovation leaders, innovation followers, moderate innovators and modest innovators.

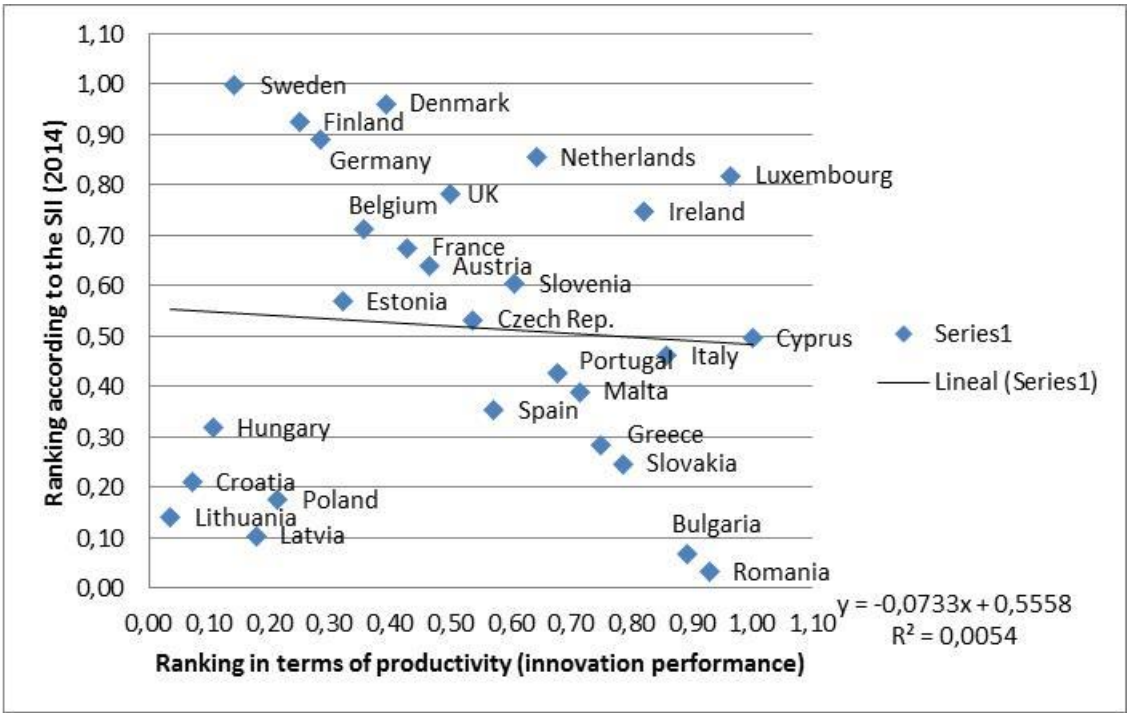
Figure 2. – Comparison of the IUS Summary Innovation Index (SII) and our innovation performance measurement for the EU28

IUS 2014



Source: own elaboration.

IUS 2015



Source: own elaboration.

Our results indicate that the efficiency or productivity of the Swedish national innovation system is far from being adequate. Compared to the resources invested, the Swedish innovation system does not manage to produce a large enough innovation output – given the assumption that the IUS data measures inputs and outputs correctly.

To put these results into perspective, we will now compare them to the results of another innovation index which has been produced for eight years. The latest version has been published as “The Global Innovation Index 2014”and was produced by Cornell University, INSEAD, and WIPO (Cornell University et al., 2014). “The Global Innovation Index” (GII) includes 81 indicators for 143 countries. All indicators are classified as innovation input or innovation output indicators and a sub-index is calculated for each.[35] Sweden is ranked high both with regard to the Innovation Input Sub-Index (6th) and the Innovation Output Sub-Index (3rd) (Cornell University et al., 2014: 16-18). The GII also provides a simple average of the two sub-indexes, i.e., outputs and inputs are not compared in this average. Hence, this GII average is calculated in a way similar to the Summary Innovation Index (SII) of the IUS (2014).

[35] In this paper, we have not evaluated the accuracy of the GII classification into input and output indicators.

According to the GII average index, Sweden was ranked number 3 in 2014, after Switzerland (ranked number 1) and the United Kingdom (ranked number 2). In the GII average indexes for 2011 and 2013, Switzerland was ranked number 1 and Sweden number 2 (Cornell University et al., 2014). Hence the GII Index and the IUS SII index lead to similar results for the case of Sweden.

As mentioned, the IUS does not make any distinction or comparisons at all between innovation input and innovation output indicators. However, in GII a ratio is calculated between the Innovation Output Sub-Index and the Innovation Input Sub-Index for all countries. This is called the “Innovation Efficiency Ratio”. “It shows how much innovation output a given country is receiving from its inputs” (Cornell University et al., 2014: 7). It is therefore, in its basic characteristics, similar to the innovation performance (i.e. efficiency/productivity) measure proposed earlier by us.

The GII “Innovation Efficiency Ratio” shows that, despite Sweden’s very high ranking for inputs (6) and outputs (3), it is ranked number 22 with regard to innovation efficiency. Hence our use of IUS data to calculate efficiency of innovation systems and the calculation of the GII “Innovation Efficiency Ratio” lead to results that point in the same direction: they both indicate that the Swedish innovation system is quite inefficient.

The results presented here should be related to the decades-old discussion of the so-called “Swedish paradox” (Edquist and McKelvey, 1998), a notion still central to innovation policy discussions in Sweden. When first formulated, it was as a reflection of a high research and development (R&D) intensity in Sweden coupled with a low share of high-tech (R&D intensive) products in manufacturing as compared to the OECD (Organization for Economic Co-operation and Development) countries.[36] It was seen as a paradox between a high input and a low output measured by these specific indicators.

In other words, the Swedish paradox pointed to a low productivity for the Swedish national system of innovation in this specific sense, i.e., on the basis of the scarce data that was available in the 1990’s. Subsequently, the expression has been used widely, but often formulated as a general relation between inputs and outputs – e.g., that the investments in R&D in Sweden are very large, but that the ‘pay-off’ (in terms of, for

[36] The share of high-tech products was seen as a proxy for innovation output intensity.

example, growth and competitiveness) is not particularly impressive (e.g., Andersson et al., 2002). Due to varying uses of the concept, and since many formulations have been based on rather partial data, there has been considerable discussion about to what extent a paradox actually exists.[37]

The analysis presented in this paper indicates that the Swedish paradox, in the original sense of the term, is still in operation, provided that the IUS data correctly measures inputs and outputs and that we are applying them in an appropriate way. The same conclusion is also indicated by the GII data and analysis. The reasonable interpretation is that Sweden invests substantial inputs for the development of innovations, but when it comes to the actual production of innovation outputs, Sweden shows relatively low results.

To understand the current confusion about the innovation performance of Sweden as compared to other EU countries, it is important to note that the meaning of the notion "innovation performance" in the setting "EU Member States' Innovation Performance" is not explicitly defined or specified in the IUS. No theory-based discussion of innovation performance is underpinning it, which makes it hard for the reader of the IUS reports to evaluate the meaning and implications of this concept. "Innovation performance" is only specified implicitly and contextually by the way it is used and measured. This is highly surprising, since "innovation performance" is the absolutely most central concept in the IUS reports. If this vagueness is conscious, it should be severely criticized, since it may lead to – and has led to – many different interpretations. *As it is used* in the IUS, "innovation performance" implicitly means an average obtained by calculating values for 25 indicators measuring the determinants of innovations, innovations as such and the consequences of these innovations (i.e., enablers, firm activities and outputs, in the IUS language).[38] In the IUS, there is no conceptual or theoretical discussion that motivates why the term should have this meaning. No criteria are presented for choosing exactly those 25 indicators. Since it includes determinants,

[37] The "Swedish Paradox" has been intensively discussed (e.g., Jacobsson and Rickne, 2004; Granberg and Jacobsson, 2006; Audretsch, 2009; Ejermo and Kander, 2009; Ejermo et al., 2011). However, most of these authors define the phenomenon in different ways compared to Edquist and McKelvey (1998). Hence the different views on whether there is a paradox or not is dependent on what is meant by the term. This could be analyzed, but it is not within the scope of this paper.

[38] In spite of this very wide use of the concept, the IUS does label it "innovation performance" and not "innovation-related activities", which may sound more sensible.

innovations as such and consequences, the term is useless from an innovation policy point of view.

The use of the term is even counterproductive from a policy point of view. The main reasons for this are the following:

- The objective of innovation policy must be to influence the development and diffusion of innovations as such. Therefore the relative innovation output should be known to policy analysts, policy-makers and politicians. If these innovation intensities are not known, it is hard for policy-makers to motivate why the innovations intensities should be improved by means of policy (Edquist, 2011). The SII is not a measure of innovation output as such, but includes a considerable number of variables in addition to output innovation indicators. We have shown, for example, that the SII includes indicators of *determinants* of innovations (section 4.3). Hence the SII score ("innovation performance") for a country will increase if it puts more (input) resources into its innovation system even if this results in no innovations at all. This confusing "linear logic" means that the "innovation performance" concept of the IUS is more of an obstacle to the development of innovation policy than an asset that facilitates the design and implementation of innovation policy.
- Currently existing innovation intensities have been influenced by a number of forces that affect innovation processes – forces which we call determinants of innovations. Many of these determinants can be influenced by the state. When the state (through its public agencies) influences these determinants in order to increase innovations intensities of certain kinds, it is actually pursuing innovation policy. Therefore, the degree to which public organizations can influence innovations should be known by these organizations. They should be able to know and monitor the evolution of these determinants. The SII does not help them to do so. On the other hand, the group of input indicators that we have singled out from the list of 25 IUS indicators is useful for this purpose (but the number of determinants included in this group should be enlarged. It should include – ideally – all important determinants of innovation processes and describe them using a holistic approach, see Edquist 2014a, 2014c).
- In this context it might also be useful to briefly address the consequences of innovations – consequences for productivity growth, for employment, for environmental conditions, for social conditions, etc. (Gómez Uranga et al.,

2014). It is important for policy-makers and politicians to know these consequences. They are the factors that politicians are *actually* interested in. They are not interested in innovations as such, but in their socioeconomic consequences. Politicians know, though, that they have to achieve certain innovation intensities in order to achieve the socioeconomic benefits of innovations.

We now return to the issue of performance. As stated above, in this paper we understand "innovation performance" to mean either of two things:

- Output of innovations as such, which is here measured by eight innovation output indicators (discussed in section 4.1),[39] and
- The productivity or efficiency of innovation systems, which is here measured as the ratio between the eight innovation output and the four innovation input indicators (discussed in section 4.3).

As can be observed in Annex 3, the EU national innovations systems are ranked in the following order in terms of efficiency: Greece, Bulgaria, Italy, Romania, Ireland, Cyprus, Luxembourg, Portugal, Spain, Slovakia, Germany, Austria, Czech Republic, Malta, Belgium, Croatia, Denmark, France, Netherlands, Latvia, Hungary, Estonia, Finland, *Sweden*, Slovenia, United Kingdom, Poland and Lithuania (European Union 2014). No matter how unbelievable it may appear, this efficiency ranking is correct to the extent that the IUS data are correct and our approach to dealing with them is reasonable. It is still counterintuitive, however, since many of the top ranked countries are less developed and must be considered to have less developed innovation systems.

One possible partial explanation for this seeming contradiction is that many of these less developed EU countries devote very limited resources to inputs, but still manage to obtain a reasonable number of outputs in relation to the inputs they are able to invest. For example, Annex 2 shows that Sweden invested 7.35 times more than Bulgaria in innovation inputs, according to IUS 2014. At the same time Sweden achieved an output figure that is only 2.77 times higher than Bulgaria. The figures are similar for the other EU countries that rank high on productivity, but have low innovation input figures. The

[39] It should be stressed that our notion of "innovation output" is almost identical to the definition of "innovation" in the OECD "Guidelines for collecting and interpreting innovation data", i.e., the so-called "Oslo Manual" (Oslo 2015).

above figures simply imply that the less developed countries manage to use their (more limited) resources in a more productive/efficient way.

How can this higher productivity of less developed national innovation systems be explained? As Zabala-Iturriagagoitia et al. discuss (2007a: 667), countries with more developed and more comprehensive innovation systems are usually more oriented towards radical innovation, the development of new industries, often in knowledge-intensive sectors and in high-tech industries. Such innovation efforts are characterized by uncertainty, high risk, and failures. In contrast, countries with lower innovation capacity and fewer innovation resources tend to absorb and adopt the embodied knowledge and the innovations of others (e.g., from abroad). Such absorption involves lower innovation input costs, but may, at the same time, be more efficient, as they may avoid the inherent risk involved in the development of these innovations, so that the 'new' knowledge is more rapidly and cheaply adapted and adopted than in the country that developed it.

According to Freeman and Soete (1988), the efficient diffusion of innovations is often much more important for development and growth than being the lead innovator. Leading innovation countries may thus be more prone to the creation of new-to-the-world innovations, while follower countries are more prone to the absorption and later diffusion of these innovations (as long as the required levels of absorptive capacity are in place). This is highly relevant from an innovation policy point of view, a partial objective of which may be to catch up with the leading countries by absorbing innovations from abroad. Closing a gap in an existing trajectory of innovation is normally easier and cheaper than opening up a new innovation path.

We have now calculated the differences in the productivities of the EU innovation systems (in one of many possible ways). We have also provided some possible explanations for the fact that many less developed EU countries with fairly underdeveloped national innovation systems score very high with regard to productivity.

Some countries with comprehensive and well-developed innovation systems, and high innovation inputs, score low on the productivity of their innovation systems according to our analysis. Examples are the United Kingdom, Sweden, Finland, the Netherlands, France and Denmark. This may be because these countries are spending too much on innovation inputs, or because these innovation efforts are not well balanced. It might also be because the input resources are not used in an efficient way. A question that may be asked is, for example, whether Sweden (or any of these countries) could or should try to increase the absorption of innovations from abroad? Therefore, there are reasons for policy analysts in these countries to further analyze this question – with the intention of changing innovation policies if the analysis shows that such is called for.

The notion of optimality is irrelevant in an innovation context, and we cannot specify an optimal or ideal innovation system. The only way to identify problems that should be the subject of innovations policy is therefore to compare innovation systems with each other (Edquist, 2012). Unfortunately, the ranking of the efficiency of the EU28 innovation systems in Annex 3 is practically useless from the point of view of innovation policy development. There are no reasons whatsoever to benchmark Sweden's national innovation system with those of Greece, Bulgaria, Romania, and Cyprus in attempting to develop an analysis to form a basis for innovation policy changes.[40] Such comparisons should, instead, be made between innovation systems that are more similar in a structural sense and at a similar level of development. One could try out such comparisons, however, between countries that are at similar development stages, that have the same size, that score similarly on innovation output or innovation input, etc.[41]

Let us, very briefly, mention some countries which have similar innovations inputs and that also manage to achieve a higher innovation output than Sweden. All these countries are also ranked above Sweden with regard to the efficiency of their innovation systems (see Annex 3). Such countries are the Netherlands, Belgium, Luxembourg, Denmark, Germany and France. These countries could serve as benchmarks for Sweden in developing its innovation system through innovation policy, since their structures (i.e., industrial, administrative and political systems) are rather similar to those in Sweden (see Table 6). If we focus on inputs, it can be observed that Denmark and Germany have a level of investment similar to that in Sweden. On the output side, Belgium, France and the Netherlands have output levels similar to those of Sweden.

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[40] This argument is also valid for the GII "Innovation Efficiency Ratio" discussed in section 4.3.

[41] As Navarro et al. illustrate (2009), to foster learning in policy-making processes and to derive sensible policy conclusions, countries need to be compared with others with similar characteristics.

Table 6.- Possible benchmarks for the Swedish innovation system

	Output in 2014 [2015]	Input in 2014 [2015]	Productivity of innovation systems in 2014 [2015]	Ranking in terms of productivity in 2014 [2015]	Summary Innovation Index (SII) 2013 [2014]	Ranking according to the SII (2013) [2014]
Luxembourg	0.754 [0.772]	0.461 [0.225]	1.63 [3.43]	7 [2]	0.646 [0.642]	5 [6]
Germany	0.859 [0.723]	0.631 [0.718]	1.36 [1.007]	11 [21]	0.709 [0.676]	3 [4]
Belgium	0.603 [0.566]	0.507 [0.542]	1.19 [1.043]	15 [19]	0.627 [0.619]	7 [9]
Denmark	0.701 [0.728]	0.630 [0.672]	1.11 [1.084]	17 [18]	0.728 [0.736]	2 [2]
France	0.520 [0.543]	0.479 [0.487]	1.09 [1.116]	18 [17]	0.571 [0.591]	11 [10]
Netherlands	0.538 [0.570]	0.543 [0.437]	0.99 [1.304]	19 [11]	0.629 [0.647]	6 [5]
Sweden	**0.575 [0.620]**	**0.698 [0.775]**	**0.82 [0.80]**	**24 [25]**	**0.750 [0.74]**	**1 [1]**

Source: own elaboration from European Union (2014 and 2015).

Of these countries, we believe that it would be particularly interesting for Sweden to be compared to the German national system of innovation. Such a comparison should include a detailed analysis of innovation output as well as of the determinants of this performance, its consequences, and the productivity of the innovation systems. It should include quantitative analyses based on indicators, but also qualitative analyses of institutions and organizations in the innovations systems.[42]

One conclusion of this as regards Swedish innovation policy is that considerable efforts should be made to identify the sources of the inefficiencies in the Swedish national system of innovation. In addition, existing instruments and mechanisms for innovation policy should be used and new ones created to overcome the inefficiencies identified. This means breaking with the linear model of innovation that still dominates innovation policy in Sweden, a model that is still applied despite the fact that it has been completely rejected in innovation research (Edquist, 2014a). In its place a holistic

[42] We have previously carried out such comparative analyses of ten small national systems of innovations in Edquist and Hommen (2009).

innovation policy should be developed – one that takes into account all the determinants (driving forces as well as obstacles) of innovations (Edquist, 2011).[43]

5. Conclusions

The Innovation Union Scoreboard (IUS) has, for many years, highlighted Sweden as one of the innovation leaders in Europe, with a high "innovation performance" (e.g., European Union 2013, 2014, 2015). For several editions of the IUS, Sweden has been ranked number one with regard to "EU member States' Innovation Performance". However, the IUS does not provide any conceptual or theoretical underpinning for what is meant by "innovation performance" nor is there any discussion of the 25 specific indicators used to calculate such performance or the relations among them. Neither does the IUS provide any discussion about the relations between the inputs and outputs in innovation systems. Hence, it can be concluded that the IUS does not attempt to measure productivity of innovation systems at all.

In this study we have questioned whether Sweden holds the top position within the EU with regard to "innovation performance" in any meaningful sense of this term. From our point of view, the "innovation performance" of an innovation system should be understood from two perspectives: (i) the production of innovation outputs; and (ii) the productivity/efficiency of the system as a whole.

On this basis, we have first identified a set of indicators that can be used to measure the input and output sides of the national innovation system. Second, we have related the levels of inputs and outputs to each other in order to reach a conclusion about the performance of the Swedish innovation system in terms of its efficiency or productivity in relation to the other EU Member States. Using the data presented in the IUS 2014 and 2015 reports (which, in most cases, refers to the years 2012 and 2013), we divide the analysis into innovation inputs (i.e., four input indicators) and outputs (i.e., eight output indicators). We have exclusively used the data from IUS 2014 and 2015. It has not been our purpose to evaluate the quality of the IUS data, but rather to assess the methodology used in it by comparing the results of the IUS analysis to those achieved using our approach.

The IUS appoints Sweden to the top position (ranked number 1 of the 28 European Member States) in terms of what they call "EU Member States' Innovation

[43] How such a holistic policy could be developed is outlined in Edquist (2014b, 2014c).

Performance". Our analysis demonstrates that the results based on an alternative methodology that separates inputs and outputs provide a quite different picture. Based on the results obtained applying our approach, it can be questioned whether Sweden can be regarded as the innovation leader of Europe. Based on the data provided by the IUS, our analysis shows that Sweden is number 1 (within the EU28) in terms of innovation input, number 10 in terms of innovation output for year 2014 (number 4 for year 2015), and number 24 out of 28 for year 2014 (number 25 for year 2015) with regard to the efficiency or productivity of its innovation system.

Hence, we have shown that many countries which devote a smaller number of resources to innovation than Sweden achieve outstanding levels of efficiency. We have also shown that a country with a comprehensive innovation system such as Sweden's does not necessarily show efficiency levels commensurate with its innovation efforts (i.e., inputs).

We very much agree with Foray and Hollanders (2015) that the statistical information provided by the IUS needs to be supplemented with other more contextual and qualitative information regarding the innovation system under study. Following Frane (2014), a goal of this paper was to analyze and discuss the misinterpretations that the IUS is making of the data, and therefore we have not engaged into the elaboration of this more contextual and qualitative information. However, Edquist and Hommen (2009) have studied details of the structural characteristics of the Swedish innovation system (and nine more small innovation systems in Asia and Europe).

In summary, the approach applied in the IUS offers an incorrect interpretation of the actual state of the EU national innovation systems. The lack of conceptual and theoretical discussions in the IUS approach is a major explanation of the flaws in the interpretation of the results and in the Summary Innovation Index included in their report. Dealing with these flaws is particularly relevant since they could lead to faulty and ineffective (innovation) policy decisions.

From our point of view, the individual indicators that constitute the composite indicator called the Summary Innovation Index need to be analyzed in much more depth in order to reach a correct measure of the performance of an innovation system (Grupp and Mogee, 2004; Archibugi et al., 2009; Zabala-Iturriagagoitia et al., 2007b). In addition, policy makers need to consider the results of different and complementary analyses to obtain a correct picture of their respective innovation systems (Hagedoorn and Cloodt, 2003). In our view, the combination of several partial views will provide a clearer picture than that provided by each in isolation.

Acknowledgements

An earlier version of this paper, only referring to the data from the IUS 2014, was published as a CIRCLE Paper in Innovation Studies 2015/16, under the title "The Innovation Union Scoreboard is Flawed: The case of Sweden – not being the innovation leader of the EU". A version of this paper has also been presented at the EU-SPRI 2015 conference in Helsinki, 10-12 June 2015. The authors are grateful to Jordi Molas, Hannes Toivanen, Jakob Edler, Nick Vonortas, Olof Ejermo, Martin Andersson, Sylvia Schwaag Serger and Lennart Stenberg for their comments on the earlier version. Finally we are very grateful to Michael Nauruschat for his assistance with the data collection during the early stages of the work with this paper. Jon Mikel Zabala-Iturriagagoitia wishes to acknowledge the financial support from the Basque Government Department of Education, Language Policy and Culture and Charles Edquist would like to acknowledge support from the Rausing Foundation.

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Annex 1: Innovation outputs of the national innovations systems of the EU28 member states

Year 2014

	Latest data year		2010		2012		2012		2011		2010		2012		2011		2010			
	SII 2013		2.2.1		2.3.3		2.3.4		3.1.1		3.1.2		3.2.2		3.2.3		3.2.4		Innovation Output and ranking	
Germany	0,709	3	0,933	1	0,595	6	0,884	4	1,000	1	1,000	1	0,930	1	0,790	5	0,742	4	0,859	1
Luxembourg	0,646	5	0,806	4	1,000	1	1,000	1	0,792	3	0,960	2	0,285	25	1,000	2	0,241	22	0,754	2
Denmark	0,728	2	0,813	3	0,561	8	0,971	3	0,649	11	0,616	8	0,336	24	0,959	3	0,704	7	0,701	3
Cyprus	0,501	14	0,833	2	1,000	2	0,605	6	0,493	14	0,494	15	0,606	12	0,564	8	0,687	10	0,660	4
Austria	0,599	10	0,692	9	0,756	4	1,000	2	0,662	10	0,609	9	0,661	9	0,225	22	0,494	16	0,637	5
Belgium	0,627	7	0,786	5	0,398	14	0,515	12	0,848	2	0,596	11	0,601	13	0,553	9	0,525	14	0,603	6
Italy	0,443	15	0,650	10	0,396	16	0,743	5	0,608	12	0,624	6	0,721	5	0,291	19	0,697	8	0,591	7
Finland	0,684	4	0,607	13	0,497	11	0,569	9	0,721	9	0,535	13	0,552	16	0,421	12	0,727	5	0,579	8
Ireland	0,606	9	0,758	7	0,409	13	0,152	23	0,738	8	0,667	5	0,587	14	1,000	1	0,314	20	0,578	9
Sweden	**0,750**	**1**	**0,729**	**8**	**0,573**	**7**	**0,574**	**8**	**0,781**	**4**	**0,605**	**10**	**0,579**	**15**	**0,510**	**10**	**0,248**	**21**	**0,575**	**10**
Portugal	0,410	18	0,632	11	0,364	17	0,600	7	0,739	6	0,717	4	0,481	21	0,336	15	0,659	11	0,566	11
Estonia	0,502	13	0,617	12	0,678	5	0,521	11	0,739	7	0,473	17	0,355	23	0,448	11	0,521	15	0,544	12
Netherlands	0,629	6	0,767	6	0,541	9	0,514	13	0,749	5	0,493	16	0,535	18	0,313	17	0,392	19	0,538	13
France	0,571	11	0,519	15	0,308	19	0,441	15	0,445	16	0,619	7	0,741	4	0,400	13	0,689	9	0,520	14
Greece	0,384	19	0,594	14	0,147	27	0,052	27	0,551	13	0,801	3	0,238	28	0,744	6	1,000	1	0,516	15
Czech Republic	0,422	16	0,445	16	0,290	20	0,486	14	0,453	15	0,583	12	0,672	8	0,320	16	0,725	6	0,497	16
Spain	0,414	17	0,306	19	0,537	10	0,416	17	0,340	20	0,296	21	0,650	11	0,186	24	0,982	3	0,464	17
Slovenia	0,513	12	n/a	-	0,312	18	0,423	16	0,443	17	0,509	14	0,802	2	0,181	25	0,406	17	0,440	18

Slovakia	0,328	21	0,300	20	0,196	24	0,183	22	0,293	21	0,286	22	0,677	7	0,194	23	1,000	2	0,391	19
Malta	0,319	22	0,318	18	1,000	3	0,246	21	0,360	19	0,365	19	0,655	10	0,000	28	0,182	25	0,391	20
UK	0,613	8	n/a	-	0,419	12	0,352	19	0,184	23	0,358	20	0,694	6	0,889	4	0,174	26	0,384	21
Romania	0,237	26	0,000	26	0,171	25	0,070	26	0,000	28	0,249	24	0,512	20	0,605	7	0,658	12	0,283	22
Croatia	0,306	23	0,388	17	0,035	28	0,000	28	0,393	18	0,385	18	0,542	17	0,109	26	0,398	18	0,281	23
Hungary	0,351	20	0,018	24	0,161	26	0,104	25	0,082	24	0,180	26	0,756	3	0,268	20	0,616	13	0,273	24
Poland	0,279	25	0,016	25	0,238	23	0,567	10	0,027	27	0,129	27	0,521	19	0,304	18	0,223	23	0,253	25
Bulgaria	0,188	28	0,060	23	0,398	15	0,379	18	0,078	25	0,051	28	0,247	27	0,254	21	0,193	24	0,207	26
Lithuania	0,289	24	0,133	21	0,248	22	0,107	24	0,187	22	0,267	23	0,454	22	0,024	27	0,128	27	0,193	27
Latvia	0,221	27	0,100	22	0,261	21	0,260	20	0,059	26	0,187	25	0,263	26	0,385	14	0,000	28	0,190	28

Source: Own elaboration from European Union (2014).

Year 2015

	Latest data year		2012		2013		2013		2012		2012		2013		2012		2012			
	SII 2014		2.2.1		2.3.3		2.3.4		3.1.1		3.1.2		3.2.2		3.2.3		3.2.4		Innovation Output and ranking	
Luxembourg	**0,642**	**6**	0,749	6	1,000	2	1,000	2	0,732	1	0,851	1	0,591	12	1,000	2	0,252	21	**0,772**	1
Denmark	**0,736**	**2**	0,561	11	0,669	7	1,000	1	0,512	11	0,590	10	0,492	18	1,000	3	1,000	1	**0,728**	2
Germany	**0,676**	**4**	0,787	3	0,670	6	0,662	11	0,717	2	0,720	3	0,892	2	0,820	5	0,518	7	**0,723**	3
Sweden	**0,740**	**1**	**0,779**	**4**	**0,661**	**8**	**0,999**	**3**	**0,656**	**6**	**0,540**	**12**	**0,648**	**9**	**0,524**	**11**	**0,156**	**24**	**0,620**	**4**
Ireland	**0,628**	**8**	0,792	2	0,581	12	0,251	23	0,554	10	0,797	2	0,549	15	1,000	1	0,326	20	**0,606**	5
Finland	**0,676**	**3**	0,728	8	0,622	11	0,918	4	0,660	5	0,513	13	0,398	22	0,563	8	0,422	13	**0,603**	6
Austria	**0,585**	**11**	0,600	10	0,792	4	0,830	7	0,555	9	0,686	6	0,723	6	0,250	24	0,354	18	**0,599**	7
Malta	**0,397**	**18**	0,521	12	1,000	3	0,868	6	0,467	15	0,653	7	0,705	7	0,124	26	0,371	16	**0,589**	8
Italy	**0,439**	**16**	0,733	7	0,545	15	0,583	13	0,630	7	0,687	5	0,611	11	0,372	18	0,414	14	**0,572**	9
Netherlands	**0,647**	**5**	0,797	1	0,631	10	0,744	10	0,679	4	0,471	17	0,460	21	0,322	20	0,459	9	**0,570**	10
Belgium	**0,619**	**9**	0,753	5	0,542	17	0,516	16	0,713	3	0,505	14	0,529	17	0,546	9	0,426	12	**0,566**	11
France	**0,591**	**10**	0,516	13	0,462	20	0,506	17	0,474	14	0,607	9	0,725	5	0,513	12	0,545	5	**0,544**	12
Cyprus	**0,445**	**15**	0,492	14	1,000	1	0,541	15	0,398	18	0,481	16	0,477	19	0,496	13	0,436	11	**0,540**	13
Estonia	**0,489**	**13**	0,479	15	0,782	5	0,823	8	0,490	12	0,382	18	0,471	20	0,538	10	0,246	22	**0,526**	14
Slovenia	**0,534**	**12**	0,433	18	0,555	14	0,914	5	0,480	13	0,488	15	0,686	8	0,234	25	0,390	15	**0,523**	15
United Kingdom	**0,636**	**7**	n/a	-	0,578	13	0,486	18	0,364	19	0,560	11	0,564	14	0,971	4	0,579	4	**0,513**	16
Portugal	**0,403**	**17**	0,654	9	0,529	18	0,439	19	0,617	8	0,643	8	0,335	24	0,374	17	0,489	8	**0,510**	17
Czech Republic	**0,447**	**14**	0,476	16	0,456	21	0,571	14	0,438	16	0,360	20	0,830	4	0,405	15	0,541	6	**0,510**	18
Greece	**0,365**	**21**	0,456	17	0,367	24	0,121	26	0,409	17	0,693	4	0,023	28	0,744	6	0,454	10	**0,408**	19

Slovakia	**0,360**	**22**	0,135	21	0,351	25	0,255	22	0,120	22	0,271	21	0,850	3	0,335	19	0,869	2	**0,398**	20
Spain	**0,385**	**19**	0,149	20	0,653	9	0,398	20	0,139	21	0,188	25	0,532	16	0,312	21	0,590	3	**0,370**	21
Poland	**0,313**	**24**	0,000	27	0,436	22	0,816	9	0,009	26	0,000	28	0,578	13	0,376	16	0,168	23	**0,298**	22
Hungary	**0,369**	**20**	0,012	26	0,340	26	0,169	25	0,003	27	0,251	22	0,899	1	0,290	22	0,348	19	**0,289**	23
Croatia	**0,313**	**23**	0,254	19	0,217	28	0,075	28	0,215	20	0,364	19	0,379	23	0,086	27	0,362	17	**0,244**	24
Latvia	**0,272**	**26**	0,103	22	0,426	23	0,311	21	0,073	24	0,199	24	0,247	26	0,412	14	0,099	26	**0,234**	25
Bulgaria	**0,229**	**27**	0,041	24	0,545	16	0,606	12	0,021	25	0,077	27	0,183	27	0,286	23	0,057	27	**0,227**	26
Romania	**0,204**	**28**	0,012	25	0,285	27	0,098	27	0,000	28	0,088	26	0,616	10	0,658	7	0,029	28	**0,223**	27
Lithuania	**0,283**	**25**	0,102	23	0,473	19	0,234	24	0,082	23	0,247	23	0,261	25	0,026	28	0,123	25	**0,194**	28

Source: own elaboration from European Union (2014).

Annex 2: Innovation inputs of the national innovations system of the EU28 member states

Year 2014

	Latest data year		2012		2012		2012		2010			
	SII 2013		1.3.1		1.3.2		2.1.1		2.1.2		Innovation input and ranking	
Sweden	**0,750**	**1**	**0,979**	**2**	**0,503**	**8**	**0,991**	**2**	**0,319**	**10**	**0,698**	**1**
Finland	0,684	4	0,990	1	0,544	3	1,000	1	0,241	18	0,694	2
Germany	0,709	3	0,856	4	0,369	11	0,835	5	0,464	6	0,631	3
Denmark	0,728	2	0,918	3	0,516	7	0,840	4	0,246	17	0,630	4
Estonia	0,502	13	0,794	6	n/a	-	0,532	9	0,557	3	0,628	5
UK	0,613	8	0,485	15	0,762	2	0,485	12	n/a	-	0,577	6
Slovenia	0,513	12	0,515	13	n/a	-	0,926	3	0,272	14	0,571	7
Netherlands	0,629	6	0,825	5	0,523	6	0,519	10	0,306	11	0,543	8
Belgium	0,627	7	0,588	10	0,538	4	0,649	7	0,253	16	0,507	9
Austria	0,599	10	0,773	7	0,192	17	0,835	6	0,150	23	0,488	10
France	0,571	11	0,670	9	0,537	5	0,619	8	0,088	26	0,479	11
Luxembourg	0,646	5	0,371	20	1,000	1	0,424	14	0,050	27	0,461	12
Lithuania	0,289	24	0,546	12	n/a	-	0,095	24	0,701	2	0,447	13
Czech Republic	0,422	16	0,763	8	0,037	18	0,429	13	0,350	8	0,395	14
Cyprus	0,501	14	0,216	25	n/a	-	0,017	28	0,936	1	0,390	15
Poland	0,279	25	0,443	16	0,392	9	0,134	23	0,551	4	0,380	16
Portugal	0,410	18	0,567	11	0,350	12	0,294	16	0,254	15	0,366	17
Ireland	0,606	9	0,412	17	0,317	13	0,511	11	0,117	24	0,339	18
Spain	0,414	17	0,495	14	0,308	14	0,286	18	0,169	21	0,315	19

Malta	0,319	22	0,206	26	n/a	-	0,208	19	0,513	5	0,309	20
Hungary	0,351	20	0,309	23	0,373	10	0,359	15	0,176	20	0,304	21
Italy	0,443	15	0,412	18	0,200	15	0,290	17	0,293	13	0,299	22
Slovakia	0,328	21	0,361	21	n/a	-	0,139	21	0,326	9	0,275	23
Croatia	0,306	23	0,289	24	n/a	-	0,139	22	0,302	12	0,243	24
Greece	0,384	19	0,330	22	0,014	19	0,095	25	0,379	7	0,205	25
Latvia	0,221	27	0,392	19	n/a	-	0,056	26	0,153	22	0,200	26
Romania	0,237	26	0,175	27	0,199	16	0,043	27	0,213	19	0,157	27
Bulgaria	0,188	28	0,113	28	0,000	20	0,160	20	0,106	25	0,095	28

Source: Own elaboration from European Union (2014).

Year 2015

	Latest data year		2013		2013		2013		2012			
	SII 2014		1.3.1		1.3.2		2.1.1		2.1.2		Innovation input and ranking	
Sweden	0,74	1	0,957	3	0,536	7	0,956	2	0,412	10	0,775	1
Germany	0,676	4	0,88	4	0,378	12	0,868	4	0,746	3	0,718	2
Denmark	0,736	2	0,989	1	0,604	3	0,868	3	0,158	23	0,672	3
Finland	0,676	3	0,957	2	0,555	5	1	1	0,163	21	0,669	4
Belgium	0,619	9	0,609	11	0,574	4	0,687	7	0,3	13	0,543	5
Austria	0,585	11	0,793	7	0,229	15	0,841	6	0,212	19	0,519	6
Estonia	0,489	13	0,837	5	n/a	-	0,357	14	0,871	1	0,516	7
France	0,591	10	0,674	9	0,548	6	0,626	8	0,161	22	0,487	8
Netherlands	0,647	5	0,772	8	0,497	8	0,493	10	0,047	27	0,437	9
United Kingdom	0,636	7	0,457	15	0,672	2	0,454	11	0,12	25	0,426	10
Czech Republic	0,447	14	0,804	6	0,035	19	0,445	12	0,376	11	0,415	11
Slovenia	0,534	12	0,522	12	n/a	-	0,863	5	0,224	18	0,402	12
Malta	0,397	18	0,283	25	n/a	-	0,194	19	0,659	4	0,379	13
Hungary	0,369	20	0,304	24	0,395	10	0,423	13	0,357	12	0,37	14
Portugal	0,403	17	0,5	13	0,382	11	0,278	18	0,298	14	0,365	15
Poland	0,313	24	0,38	18	0,349	13	0,159	22	0,559	6	0,362	16
Lithuania	0,283	25	0,63	10	n/a	-	0,097	25	0,597	5	0,331	17
Ireland	0,628	8	0,326	22	0,417	9	0,493	9	0,173	20	0,331	18
Croatia	0,313	23	0,304	23	n/a	-	0,172	20	0,508	7	0,328	19

Italy	0,439	16	0,446	16	0,21	16	0,286	16	0,279	16	0,305	20
Spain	0,385	19	0,489	14	0,301	14	0,282	17	0,123	24	0,299	21
Latvia	0,272	26	0,326	21	n/a	-	0,066	26	0,764	2	0,289	22
Greece	0,365	21	0,402	17	0	20	0,11	24	0,462	8	0,244	23
Slovakia	0,36	22	0,337	20	n/a	-	0,159	23	0,415	9	0,228	24
Luxembourg	0,642	6	0,348	19	0,858	1	0,304	15	0,023	28	0,225	25
Cyprus	0,445	15	0,228	26	n/a	-	0,022	28	0,283	15	0,133	26
Bulgaria	0,229	27	0,13	28	0,048	18	0,167	21	0,229	17	0,115	27
Romania	0,204	28	0,152	27	0,141	17	0,044	27	0,115	26	0,113	28

Source: Own elaboration from European Union (2015).

Annex 3: The Efficiency of the EU28 Innovation Systems

Year 2014

	Output	Input	Productivity (innovation performance) of innovation system	Ranking in terms of productivity (innovation performance)	Summary Innovation Index (SII) 2013	Ranking according to the SII (2013)
Greece	0.516	0.205	2.52	1	0.384	19
Bulgaria	0.207	0.095	2.19	2	0.188	28
Italy	0.591	0.299	1.98	3	0.443	15
Romania	0.283	0.157	1.80	4	0.237	26
Ireland	0.578	0.339	1.70	5	0.606	9
Cyprus	0.660	0.390	1.69	6	0.501	14
Luxembourg	0.754	0.461	1.63	7	0.646	5
Portugal	0.566	0.366	1.55	8	0.410	18
Spain	0.464	0.315	1.48	9	0.414	17
Slovakia	0.391	0.275	1.42	10	0.318	21
Germany	0.859	0.631	1.36	11	0.709	3
Austria	0.637	0.488	1.31	12	0.599	10

Czech Republic	0.497	0.395	1.26	13	0.422	16
Malta	0.391	0.309	1.26	14	0.319	22
Belgium	0.603	0.507	1.19	15	0.627	7
Croatia	0.281	0.243	1.16	16	0.306	23
Denmark	0.701	0.630	1.11	17	0.728	2
France	0.520	0.479	1.09	18	0.571	11
Netherlands	0.538	0.543	0.99	19	0.629	6
Latvia	0.190	0.200	0.95	20	0.221	27
Hungary	0.273	0.304	0.90	21	0.351	20
Estonia	0.544	0.628	0.87	22	0.502	13
Finland	0.579	0.694	0.83	23	0.684	4
Sweden	**0.575**	**0.698**	**0.82**	**24**	**0.750**	**1**
Slovenia	0.440	0.571	0.77	25	0.513	12
United Kingdom	0.384	0.577	0.67	26	0.613	8
Poland	0.253	0.380	0.67	27	0.279	25
Lithuania	0.193	0.447	0.43	28	0.289	24

Source: Own elaboration from European Union (2014).

Year 2015

	Output	Input	Productivity (innovation performance) of innovation system	Ranking in terms of productivity (innovation performance)	Summary Innovation Index (SII) 2014	Ranking according to the SII (2014)
Cyprus	0,540	0,133	4,053	1	0,445	15
Luxembourg	0,772	0,225	3,431	2	0,642	6
Romania	0,223	0,113	1,976	3	0,204	28
Bulgaria	0,227	0,115	1,974	4	0,229	27
Italy	0,572	0,305	1,873	5	0,439	16
Ireland	0,606	0,331	1,833	6	0,628	8
Slovakia	0,398	0,228	1,749	7	0,360	22
Greece	0,408	0,244	1,677	8	0,365	21
Malta	0,589	0,379	1,554	9	0,397	18
Portugal	0,510	0,365	1,399	10	0,403	17
Netherlands	0,570	0,437	1,304	11	0,647	5
Slovenia	0,523	0,402	1,299	12	0,534	12
Spain	0,370	0,299	1,239	13	0,385	19

Czech Republic	0,510	0,415	1,228	14	0,447	14
United Kingdom	0,513	0,426	1,204	15	0,636	7
Austria	0,599	0,519	1,154	16	0,585	11
France	0,544	0,487	1,116	17	0,591	10
Denmark	0,728	0,672	1,084	18	0,736	2
Belgium	0,566	0,543	1,044	19	0,619	9
Estonia	0,526	0,516	1,020	20	0,489	13
Germany	0,723	0,718	1,007	21	0,676	4
Finland	0,603	0,669	0,902	22	0,676	3
Poland	0,298	0,362	0,823	23	0,313	24
Latvia	0,234	0,289	0,809	24	0,272	26
Sweden	**0,620**	**0,775**	**0,800**	**25**	**0,740**	**1**
Hungary	0,289	0,370	0,782	26	0,369	20
Croatia	0,244	0,328	0,744	27	0,313	23
Lithuania	0,194	0,331	0,585	28	0,283	25

Source: Own elaboration from European Union (2015)