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The Innovation Union Scoreboard is Flawed: The case of Sweden – not being the innovation leader of the EU

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Charles Edquist and Jon Mikel Zabala-Iturriagagoitia

Abstract

According to the Innovation Union Scoreboard, published by the European Commission every year, Sweden has been, and still is, an innovation leader within the EU and one of the most innovative countries in Europe. In the Innovation Union Scoreboard 2014 (European Union, 2014: 5), Sweden has the top position (ranked number 1) of all EU28 Member States in what is called "EU Member States' Innovation Performance". In the ranking there are 10 countries between Sweden and the EU average. This analysis is based on the ranking provided by one single composite indicator (SII or Summary Innovation Index), based on 25 separate indicators.

In this paper we argue that the SII provided by the Innovation Union Scoreboard is highly misleading. The data (the 25 separate indicators) that constitute this composite innovation indicator need to be analyzed much more in depth in order to reach a correct measure of the performance of an innovation system. We argue that input and output indicators need to be considered separately and measured individually and as two groups of indicators. Thereafter we compare the input and output indicators with one another (as is normally done in productivity and efficiency measurements). The outcome of this is a relevant and better measure of innovation performance.

In this paper, the performance of the Swedish national innovation system is analyzed by using exactly the same data as is used by the Innovation Union Scoreboard 2014. We analyze the relative position of Sweden regarding both input and output indicators, concluding that Sweden's position as an innovation leader within the EU must be reconsidered. A theoretical background and reasons for selecting the indicators used is given and a new position regarding Sweden's innovation performance compared to the other countries is calculated.

Our findings show, that Sweden remains in a high position for the innovation input indicators, ranked number 1. However, with regard to innovation output, Sweden is ranked number 10. In other words, about a third of all European Union 28 Member States have a higher innovation output than Sweden. To estimate the efficiency or productivity of the Swedish innovation system, inputs and outputs must be related to each other. When doing so, we reach the conclusion that Sweden is ranked number 24 of EU28 Member States. This finding is then discussed and we also discuss which countries would be relevant for Sweden to compare (benchmark) its innovation system with.

The conclusion is that Sweden, based on our calculations, can certainly not be seen as an innovation leader in Europe. This means 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

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1. Introduction

The European Commission (2013a) highlights that Europe is one of the most innovation intensive regions in the world. Furthermore, in the same report the Commission declares that "since 2008, the EU has improved its innovation performance and it closed almost half of the innovation gap with the US and Japan. The EU is also keeping its strong innovation lead over Brazil, India, Russia, and China, although the latter is most markedly catching up" (European Commission, 2013a: 4).[1]

With the recent strategy "Europe 2020", Europe is focusing on today's challenges in a changing world and wants to become "a smart, sustainable and inclusive economy" (European Commission, 2013b: 1). Thereby the European Union has set ambitious objectives in five areas to be reached by 2020. Besides climate and energy, education, employment and social inclusion, innovation is one of these five pillars to form a so called "Innovation Union" (European Commission, 2013a).

To support the establishment of the Innovation Union, the European Commission is using the Innovation Union Scoreboard (IUS) as a tool to monitor the implementation and to examine and illustrate the innovation performance of European member states and evaluate (and rank) their research and innovation systems (European Commission, 2011). This means that the IUS is intended to have a real impact on the evaluation of the policies of the Member States, the allocation of resources ("European instruments for structural changes") and – supposedly – for the design of innovation policies at the European, national and regional levels. Hence, the design of the IUS and its results are supposed to have real impact.

One of the key findings of the IUS is that Sweden holds the innovation leadership in the European Union (European Union, 2013, 2014), its ranking remaining stable over time. 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

[1] Note that the European Commission uses terms such as "innovation performance", "innovation gap" and "innovation lead", rather than referring to "innovation outputs". However, it is not clear what is meant by the previous terms.

innovation country in the EU"[2], absorbing 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 there that "the fact that 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".[3] We will below show that these statements are based on a fragile analysis.

To assess the innovation performance of the member states, a Summary Innovation Index (SII) is provided by the IUS. In 2014, the SII included 25 indicators, which are equally weighted.[4] These indicators 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, the European Union (2014) report does not provide any conceptual or theoretical discussion about all these categories, the specific indicators and the relations between them. The report only briefly describes the indicators.

The purposes of this paper are as follows. We use the data provided by the IUS 2014 in order to assess the performance of the Swedish innovation system and discuss whether Sweden can be regarded as the innovation leader in Europe or not. We single out a number of input (n=4) and output (n=8) innovation indicators from the 25 indicators provided by the IUS 2014, and compare Sweden's position in relation to that of the other EU 28 Member States. The aggregated output indicator measures innovations as such (and not their determinants or consequences). Finally we compare the innovation outputs and the inputs of each of the EU28 countries and compare Sweden's ranking with regard to this measure of efficiency or productivity with that of the other EU28 Member States. This productivity indicator (i.e. the relationship and balance between the innovation inputs and outputs) is the way in which we measure the performance of Sweden's innovation system.

The analysis shows why and how Sweden's status as an innovation leader needs to be revised and that the IUS is flawed in this respect. The IUS mode of measuring

[2] https://twitter.com/carlbildt/status/316807766700351488, 27/03/2013, 12:03am.
[3] In newsletter from VINNOVA of March 14, 2014.
[4] For the definitions of each of these 25 indicators see Annex I.

innovation performance is outright incorrect and highly misleading – both for analysts/researchers, policy-makers and politicians. Lack of theoretical awareness among EU administrators and their advisors is the probable explanation to this.

The paper is organized as follows. Section 2 provides an overview of the research methodology followed. 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 score for each of the selected indicators and provide new rankings for the innovation inputs as well as for 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 (i.e. innovation performance). Finally, section 5 concludes the paper with a discussion of the main findings of the paper and its relevance for the practice of innovation policy making.

2. Methodology

This research started by analyzing the 25 indicators included in the IUS 2014 (see Figure 1) and discussing which indicators may best measure innovation input and innovation output and therefore, help assess innovation performance. The analysis and further discussion was based on the definition that the IUS 2014 provides for each indicator (see Annex I) and on innovation theory. From our point of view, not all the indicators included in the IUS 2014 are adequate for measuring either innovation input or output. As a result, we base our analysis on eight output and four input indicators.[5]

After selecting the indicators we deemed as most relevant for the purposes of this paper, we gathered all the data from the IUS 2014, all with normalized scores for each indicator chosen and for all EU28 countries.[6] We then ranked all EU28 countries for each indicator (Annex 6). This provides a basis for making a comprehensive and in-depth analysis of the relative position of Sweden in a diverse set of measures.

The innovation performance in efficiency terms is measured as the relation between the four input indicators and the eight output indicators. By grouping the indicators in inputs and outputs, we are able to see the extent at which innovation inputs are

[5] The definition of all the indicators considered and the rationale for their selection is provided in section 3.
[6] For interpretation and measurement of the normalized scores see European Union 2013(65-66) and Hollanders and Tarantola (2011).

transformed into or materialize into innovation outputs. From our point of view it is important to see the relationship between the input and the output side and assess their balance. A high score for the input indicators means that large efforts and resources are devoted to stimulate 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. This implies that the efforts for stimulating innovation do not lead to the actual production of innovations.

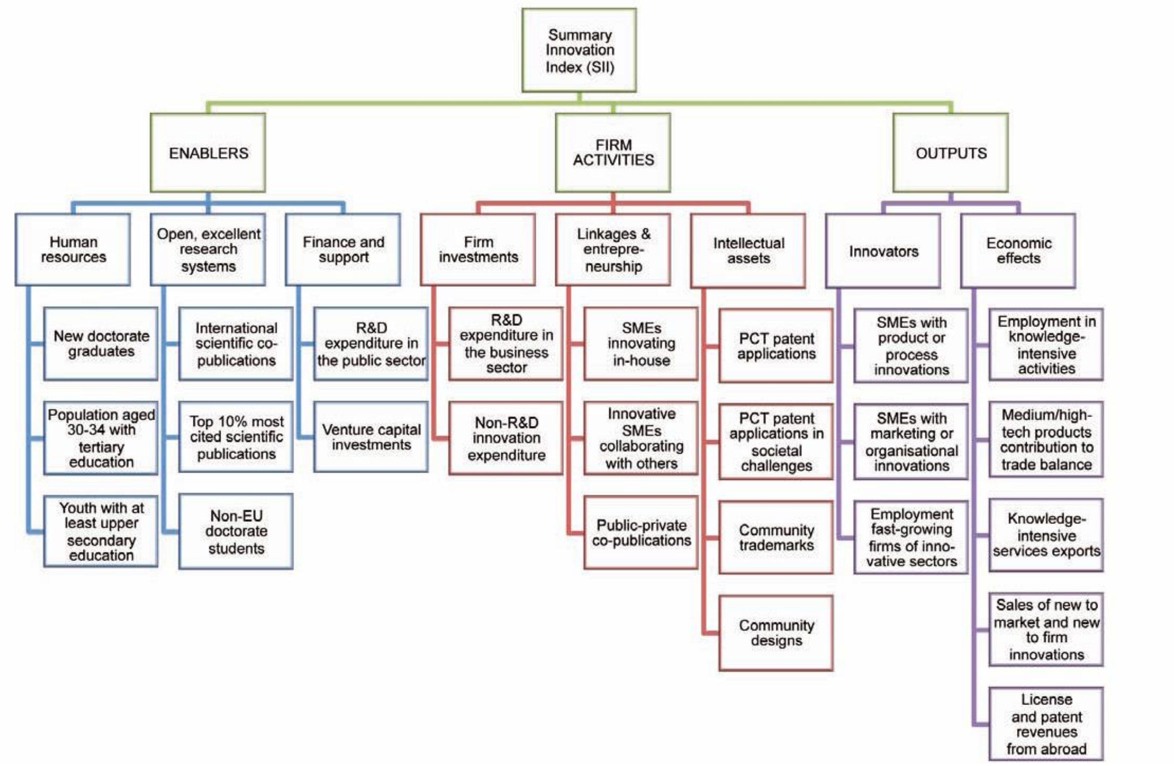
The rationale for using efficiency to complement the conclusions obtained through the IUS lies in the fact that the latter follows a "the more the better" logic. Namely, the more resources (inputs) a country puts into the system, the more competitive it will be – more innovations (outputs) obtained. This on the one hand follows a very linear logic, which is not supported by the scholars in the innovation systems approach (e.g. Edquist, 2014a). On the other hand, the underlying foundation behind this linear logic lies in the amount of resources employed, rather than how they are used. The efficiency measurement approach aims at providing information about the use (misuse) of these resources (Castro-Martínez et al., 2009).

3. Theoretical background and relevant indicators

The IUS (until 2009 called 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 available data from a variety of sources (e.g. Eurostat, Scopus, Thomson Reuters, OECD, Office for Harmonization in the Internal Market, United Nations). In this paper we compare the relative performance of Sweden with that of the EU28 member states.

The IUS 2014 identifies 25 indicators which are divided into three categories and eight dimensions (see Figure 1). The three categories considered by the IUS include *Enablers*, *Firm activities* and *Outputs.* 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). In the SII all indicators are given the same weight. The SII has been calculated for each year from 2008 to 2013.[7] For each year, each indicator has a normalized score that varies from a minimum performance of 0 up to maximum of 1. The normalized scores are added to each other and divided by the number of indicators within each of the eight dimensions. Afterwards, the indices of each of the dimensions form the SII by calculating the average among all eight dimensions.

The IUS draws the conclusion that resulting from an average score among 25 indicators, the country with the highest score is also the best innovation performer, regardless if the indicators used are measuring the input or output side of innovation or something else.

[7] However, sometimes data is missing and available only for 2009 - 2012

Countries are ranked according to the SII in the following groups (European Union 2014: 11): *innovation leaders* (more than 20% above EU average),[8] *innovation followers* (less than 20% above, or more than 90% of the EU average),[9] *moderate innovators* (relative performance rates between 50% and 90% of the EU average)[10] and *modest innovators* (less than 50% of the EU average).[11]

As mentioned, the IUS 2014 measures the innovation performance for each country by summarizing all 25 indicators into a single SII, irrespective of whether the indicators are presenting innovation outputs or innovation inputs – or something else. The category of IUS *outputs* can, at least partly, be expected to include the innovation output or innovations as such. As discussed above, the category of outputs includes three indicators related to the behavior of "innovators" and five indicators related to the "economic effects" of innovation. The indicators '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' are the ones included under the "innovators" heading.

In turn, the "economic effects" dimension includes indicators related to employment in knowledge-intensive activities, exports of medium and high-tech industries and knowledge-intensive services, sales of new to market and new to firm innovations and license and patent revenues. As Figure 1 illustrates, the category of outputs includes different 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.

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.[12] When measuring productivity some sort of input and some sort of output must be compared. It is a matter of performance of some unit. Therefore it is quite surprising that the IUS estimates the

[8] In the IUS 2014, the EU28 countries regarded as innovation leaders are: Denmark, Finland, Germany and Sweden.

[9] In the IUS 2014, the EU28 countries regarded as innovation followers are: Austria, Belgium, Cyprus, Estonia, France, Ireland, Luxembourg, Netherlands, Slovenia and the UK.

[10] 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.

[11] In the IUS 2014, the EU28 countries regarded as modest innovators are: Bulgaria, Latvia, and Romania.

[12] For example, labor productivity is (often) defined as GDP per hour worked.

“innovation performance” of the EU countries without making any distinction between inputs and outputs. It is flawed to talk about “performance” in the sense of productivity or efficiency and, at the same time, mix inputs and outputs.

To measure the performance of an innovation system in terms of productivity/efficiency (Mahroum and Al-Saleh, 2013; Zabala-Iturriagagoitia et al., 2007a), the indicators need to, in some way, be split up 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 (innovations). 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 rather the relation between them which measures innovation performance. To be able to assess which of the indicators provided by the IUS 2014 that are input and output indicators respectively, we 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 either new to the market and/or new to the firm and are adopted by users.*

Based on the definition of each of the 25 indicators, which is provided by the IUS (see Annex I), we classify eight indicators as measuring innovation output and four indicators 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 2014.

Table 1. - Indicators classified as output indicators

	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 innovated in-house. The indicator is limited to SMEs because almost all large firms innovate and because countries with an industrial structure weighted towards larger firms tend to do better.	Eurostat (CIS)

2.3.3	Community trademarks per billion GDP (in PPP€)	Trademarks are an important innovation indicator, especially for the service sector. The Community trademark gives its proprietor a uniform right applicable in all Member States of the European Union through a single procedure which simplifies trademark policies at European level. 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 advertising.	Office for Harmonization in the Internal Market and Eurostat
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. A product can be any industrial or handicraft item including packaging, graphic symbols and typographic typefaces but excluding computer programs. It also includes products that are composed of multiple components, which may be disassembled and reassembled. Community design protection is directly enforceable in each Member State and it provides both the option of an unregistered and a registered Community design right for one area encompassing all Member States.	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. Higher shares of technological innovators should reflect a higher level of innovation activities.	Eurostat (CIS)
3.1.2	SMEs introducing marketing or organizational innovations (% of SMEs)	The Community Innovation Survey mainly asks firms about their technological innovation. Many firms, in particular in the services sectors, innovate through other non-technological forms of innovation. Examples of these are marketing and organizational innovations. This indicator tries to capture the extent that SMEs innovate	Eurostat (CIS)

		through non-technological innovation.	
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 countries' trade specialisation. A positive value indicates a structural surplus, while a negative value indicates a structural deficit. The indicator is expressed as a percentage of total trade in order to eliminate business cycle variations.	UN Comtrade
3.2.3	Knowledge-intensive services exports as % of total services exports	The indicator measures the competitiveness of the knowledge-intensive services sector. Knowledge-intensive services are defined as NACE classes 61-62 and 64-72. These can be related to the above-mentioned EBOPS classes using the correspondence table between NACE, ISIC and EBOPS as provided in the UN Manual on Statistics of International Trade in Services (UN, 2002).	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).

As shown in Table 1, we have classified 8 indicators as measures that identify the outputs of an innovation system. Five of these indicators are also regarded as outputs by the IUS (i.e. indicators 3.1.1, 3.1.2, 3.2.2, 3.2.3 and 3.2.4). In addition, there are three other indicators which we, but not the IUS, regard as output measures (2.2.1, 2.3.3 and 2.3.4). In the following lines we justify our reasons for considering these three additional indicators as innovation outputs. We also present the arguments according to which three of the indicators that the IUS regards as outputs should not be considered as innovation output measures (3.1.3, 3.2.1 and 3.2.5).

As indicated we are looking for *output indicators* that, to the largest extent possible, measure innovations as such. The notion of innovation output is actually partly different from the IUS category of "outputs" that is specified as "the effects of firm's innovation activities" (European Union, 2014: 4). As discussed above, in the IUS 2014, the category of "Outputs" emphases more the consequences (i.e. outcomes) of innovations than the actual production of innovations (i.e. outputs). Judging from these explanations, the IUS does not seem to include any label that covers innovations as such, although we will see that some of the indicators measuring innovations as such are actually included under "outputs". In passing, we want to mention that we are, in this paper, not at all interested in consequences of innovations such as economic growth or employment. However we are interested in the determinants of innovations – which we call "input indicators", and which will be discussed later in this section.

Based on the above, indicators 2.2.1, 2.3.3 and 2.3.4 should be categorized as output indicators. However, they are, by IUS, classified as "firm activities" rather than "outputs". Let us present our reasons for classifying them as innovation output indicators.

The IUS categorizes the indicator 2.2.1 '*SMEs innovating in-house'* under 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 that 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 the innovation processes have been completed. Therefore, the indicator 2.2.1 is itself an output of an innovation system, and the result of different input indicators (e.g. R&D expenditures, venture capital or public R&D financial and non-financial support).

Similar arguments hold for indicators 2.3.3 '*Community trademarks per billion GDP'* and 2.3.4 '*Community designs per billion GDP'*. They are also, in the IUS, included 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. The number of community trademarks and community designs (related to GDP in each country), identify innovations which are already on the market, and these two indicators should therefore be seen as innovation output indicators. It should also be highlighted that the IUS 2014 explicitly calls indicator 2.3.3 (trademarks) an “innovation indicator” (see Table 1).

Indicators 3.1.1 – 3.2.4 in Table 1 are considered to be “outputs” both by the IUS and by us. However, the conceptual difference between the label “outputs” used in the IUS and the definition of “innovation output” introduced in this paper is the reason why three indicators called “outputs” by IUS are not classified as “innovation output indicators” by us. These three indicators are: 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 description provided by the IUS of these indicators is given in Table 2.

Table 2. - Indicators classified as outputs by the IUS but not considered as innovation outputs

	Indicator	**Interpretation**	**Data source**
3.1.3	Employment in fast-growing enterprises in innovative sectors (% of total employment)	The indicator shows the degree of innovativeness of successful entrepreneurial activities. It captures the sum of sectoral results for the employment in fast-growing enterprises by economic sector multiplied by the innovation coefficients of these sectors. Fast-growing enterprises are defined as firms with average annualised growth in employees of more than 10% a year, over a three-year period, and with 10 or more employees at the beginning of the observation period.	Eurostat
3.2.1	Employment in knowledge-intensive activities (as % of total employment)	It refers to the number of employed persons in knowledge-intensive activities in business industries. Knowledge-intensive activities are defined, based on EU Labour Force Survey data, as all NACE Rev.2 industries at 2-digit level where at least 33% of employment has a higher education degree (ISCED5 or ISCED6).	Eurostat
3.2.5	License and patent revenues from abroad as % of GDP	It refers to the export part of the international transactions in royalties and license fees.	Eurostat

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

The rationales for us not to consider 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 or it may be the result of other forces. Some kinds of innovations (e.g. product innovation) often result in increased employment while other kinds of innovations (e.g. process innovations) normally result in decreasing employment, per unit of output. These two indicators can therefore not be considered to be innovation output indicators (Edquist et al., 2001). Employment should rather be considered to be a consequence of innovations than innovation as such – just like economic growth.

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

Looking at the measurement framework of the IUS (Figure 1), it becomes clear that while one of the main categories of indicators intends to measure innovation output (in some way), there is no clear classification for what innovation inputs are. The IUS defines the other two main types of innovation indicators, *Enablers*, as innovation drivers which are outside the firm, and *Firm activities*, as indicators which capture the innovation efforts undertaken by firms. Thus, at the first glance, it seems that *Enablers* and *Firm activities* are innovation input indicators.

From our point of view, the four indicators included in Table 3 fulfill the requirements for the definition of innovation input presented earlier in this section. Two of them are "enablers" and two of them are "firm activities" in the IUS conceptual structure. Two of the chosen indicators measure R&D expenditures from the public and private sector, which are important determinants of innovation. 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 means of commercialization of R&D results. Besides R&D intensive investments, companies need to invest in non-R&D innovation expenditures as well.

Table 3. - Indicators considered as innovation input indicators

	Indicator	Interpretation	Data source
1.3.1	R&D expenditure in the public sector (% of GDP)	R&D expenditure represents one of the major drivers of economic growth in a knowledge-based economy. As such, trends in the R&D expenditure indicator provide key indications of the future competitiveness and wealth of the EU. Research and development spending is essential for making the transition to a knowledge-based economy as well as for improving production technologies and stimulating growth.	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)	The indicator captures the formal creation of new knowledge within firms. It is particularly important in the science-based sector (pharmaceuticals, chemicals and some areas of electronics) where most new knowledge is created in or near R&D laboratories.	Eurostat
2.1.2	Non-R&D innovation expenditures (% of turnover)	This indicator measures non-R&D innovation expenditure 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.	Eurostat (CIS)

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

These four input indicators are directly linked to innovation activities and are undertaken to enhance innovation. There are, of course, other determinants of innovation processes. Ideally we should include *all determinants* of innovation processes as input indicators. 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. This is unsatisfactory – but a fact. For example, in the IUS (and in this paper) there is no account taken of determinants of innovation processes operating from the demand side.

In other contexts we 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).[13] However, given the purposes of this paper, we have chosen to include only these four indicators that are clearly input indicators and for which data is also provided in the IUS data base and analysis.[14] As indicated before, we here choose to use only the IUS data, but in a different way than the IUS does. This makes it possible to compare the two approaches to measuring performance of innovation systems independently of the availability and quality of the data used (Zabala-Iturriagagoitia et al., 2007a).[15]

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, such as us (Edquist, 2014a). The important thing here is, however, to consider some indicators to be input ones and others to be output indicators, and provide reasons for that. This may be generalized into a more holistic and less partial approach in future work.

Based on the arguments outlined in this section, the eight output indicators and the four input indicators will next be analyzed in order to assess the innovation performance of the Swedish national innovation system and Sweden's relative position in relation to the rest of the EU28 Member States.

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 chosen indicator. In this paper we limit the analysis to the data provided by the IUS 2014, so we do not identify the evolution observed over time, which is a matter of further work.

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[13] A list of the ten activities is provided in Annex 2 of this paper. To develop this theory and test it empirically is a tremendously large task. We will not pursue this discussion here – although it is a very important task as such.

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

[15] 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 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) or Heidenreich (2009) to mention a few.

4.1. Output orientation

The analysis of the Swedish innovation system from the perspective of the production of outputs starts with the three indicators, that are not explicitly regarded as output indicators by the IUS, but which are considered as such by us (see section 3). Starting with the indicator 2.2.1 *'SMEs innovating in-house'*, the data provided by the IUS 2014 shows that the normalized score for Sweden is higher than the EU28 average. While the EU28 average reaches 0,570 points, Sweden has a normalized score of 0,729 in year 2011, the latest year for which data is available for this indicator. Sweden holds the 8th position for this indicator; the leading countries being Germany (0.933), Cyprus (0.833) and Denmark (0.813) (see Table 4).[16]

The indicator 2.3.3 on *'Community trademarks'* shows a similar picture for Sweden with 0.573 points as the normalized score in year 2012. Although Sweden is above the EU28 average (0.444), the country is not part of the group of countries leading this indicator, as it holds the 7th position. Three countries (Cyprus, Luxembourg, Malta) reach the highest normalized score of 1.0, while Sweden achieves just over half of that.[17]

Taking a closer look on the *community designs*, as measured by the indicator 2.3.4, Sweden's score of 0.574 is almost the same as the average of the EU28 countries for year 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).

Hereafter we analyze those indicators which are classified as "outputs" by the IUS and as innovation output indicators by us. According to the indicator 3.1.1 *'SMEs introducing product or process innovations'*, Sweden reached a normalized score of 0.781 in year 2011 (4th position), which is the latest data offered by the IUS. This is significantly higher than the EU average (0.577), but also behind the top ranked countries, which are Germany (1.0), Belgium (0.848) and Luxembourg (0.792).

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[16] Even if the focus of the paper lies on Sweden, it is also worth noting the low share of innovative SMEs observed in Finland (0.607), which is also regarded as one of the leading countries, and which with regard to this indicator holds the 13th position in the EU28.

[17] 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), France (0.308 – 19th), Italy (0.396 – 16th), United Kingdom (0.419 – 12th) or the Netherlands (0.541 – 9th).

Also the normalized score for indicator 3.1.2 *'SMEs introducing marketing or organizational innovations'* (0.605, year 2011*)* shows a score above the EU28 average (0.566). Nevertheless Sweden is still on the 10th position and miles away from the innovation leaders, Germany (1.0), Luxembourg (0.960) and Greece (0.801).

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 year 2012, which is slightly above the EU average (0.553). However, this should not obscure the fact that Sweden is behind 14 other EU countries. That 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, Slovenia (0.802) and Hungary (0.756) being second and third respectively.

For 3.2.3 *'Knowledge-intensive services exports'* the EU28 average showed a normalized score of 0.606 in 2011, while Sweden reached 0.510 points, below the EU average and placing the country in the 10th position. Ireland and Luxembourg (1.0) lead the ranking for indicator 3.2.3, while Denmark (0.959) holds the third position.

Finally, the result observed in relation to the 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 year 2011 with a normalized score of 0.248. Sweden is far behind the European average (0.664) and only seven countries show a poorer result. Greece and Slovakia (1.0) are the best performers among the EU28, Spain (0.982) being third. Given the fact that this indicator measures the share of the turnover which is 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.[18] The poor result on this indicator should therefore be seen as a serious weakness in Sweden's innovation system.

Table 4 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.

[18] If different weights were to be given to various indicators, this one should be selected to have a high weight.

Table 4. - The innovation output indicators of the Swedish national innovation system[19]

Indicator	Score	Ranking (out of 28)	EU 28 average	Leading countries (top 3)
2.2.1 SMEs innovating in-house as % of SMEs	0.729	8	0.570	Germany (0.933) Cyprus (0.833) Denmark (0.813)
2.3.3 Community trademarks per billion GDP (in PPP-€)	0.573	7	0.444	Luxembourg (1.0) Cyprus (1.0) Malta (1.0)
2.3.4 Community designs per billion GDP (in PPP-€)	0.574	8	0.566	Luxembourg (1.0) Austria (1.0) Denmark (0.971)
3.1.1 SMEs introducing product or process innovations as % of SMEs	0.781	4	0.577	Germany (1.0) Belgium (0.848) Luxembourg (0.792)
3.1.2 SMEs introducing marketing or organizational innovations as % of SMEs	0.605	10	0.566	Germany (1.0) Luxembourg (0.960) Greece (0.801)

[19] The data and rankings for the innovation outputs of all EU28 Member Countries are presented in Annex 3.

3.2.2 Contribution of medium and high-tech product exports to trade balance	0.579	15	0.553	Germany (0.930) Slovenia (0.802) Hungary (0.756)
3.2.3 Knowledge-intensive services exports as % total service exports	0.510	10	0.606	Ireland (1.0) Luxembourg (1.0) Denmark (0.959)
3.2.4 Sales of new to market and new to firm innovations as % of turnover	0.248	21	0.664	Greece (1.0) Slovakia (1.0) Spain (0.982)
Average output result[20]	0.575	10	0.568	Germany (0.859) Luxembourg (0.754) Denmark (0.701)

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

According to the IUS 2014, the results for Denmark, Finland, Germany and Sweden are well above those of the EU average. These countries are 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).[21]

Table 4 gives a sharply different picture. Taking into account the normalized values observed in the eight output indicators discussed above, Sweden has an average

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

[21] Figure 1 in the IUS 2014 report (European Union, 2014: 5) Sweden is shown as being the best performing country (followed by Denmark, Germany and Finland).

normalized score of 0.575 for the innovation output indicators, which is very close to the EU28 average of 0.568. Sweden holds the 10th position among the EU28.[22] This means that nearly a third of all EU countries are having higher innovation outputs than Sweden. The best performing countries with regard to innovation output are Germany (0.859), Luxembourg (0.754) and Denmark (0.701). As shown by Table 4, Sweden is thus far behind Germany and considerably behind Luxembourg and Denmark.

This should call for a serious reconsideration of who the real European "innovation leaders" may be, and in what sense they are leaders. It also questions the way that the European Commission performs the analysis of innovation data as presented in the IUS. Using the data provided by the IUS, we have, in this subsection, assessed the production of outputs of the Swedish innovation system, concluding that it is certainly not one of the best performing countries in the EU28, as it ends up ranked number ten out of 28. However, the method used in this subsection is quite a partial one, only measuring innovation outputs. To make the method less partial, we will later (in section 4.3) compare the outputs to the inputs that have been available to develop and commercialize innovations. However, we will first discuss a measure of innovation inputs in the next section.

4.2. Input orientation

The four indicators which we here see as important for the input side of innovation processes are listed in Table 5. A high position and ranking here means, that the innovation efforts (often investments) in order 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.[23]

Regarding the indicator 1.3.1 *'Public R&D expenditures',* Sweden had in year 2012 a normalized score of 0.979, which is close to the highest result (Finland, 0.990), while the EU28 average was 0.639. The score for the private R&D expenditures in year 2012, indicator 2.1.1 *(Business R&D expenditures as % of turnover)* was even higher (normalized score of 0.991), with Sweden being again ranked second only after Finland.

[22] We have also replicated the above analysis of the innovation outputs considering 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). The ranking is still lead by Germany with a score of 0.809, while 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.

[23] For a further discussion on the relation between input and output indicators, see section 4.3.

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

Finally, for the indicator 2.1.2 *'Non-R&D innovation as % of turnover',* Sweden shows a normalized score of 0.319, which positions the country 10th in 2010. That 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 more than a third of all European countries are investing more in order to spread new production technologies and inventions. Table 5 summarizes Sweden's ranking and normalized scores for the four input indicators selected.

Table 5. - The innovation input indicators of the Swedish national innovation system[24]

Indicator	Score	Ranking (out of 28)	EU28 average	Leading countries (top 3)
1.3.1 Public R&D expenditures as % of GDP	0.979	2	0.639	Finland (0.990) Sweden (0.979) Denmark (0.918)
1.3.2 Venture Capital investments	0.503	8	0.478	Luxembou rg (1.0) UK (0.762) Finland (0.544)
2.1.1 Business R&D expenditures as % of GDP	0.991	2	0.558	Finland (1.0) Sweden (0.991) Slovenia

[24] The data and rankings for the innovation inputs of all EU28 Member Countries are presented in Annex 4,

				(0.926)
2.1.2 Non-R&D innovation expenditures as % of turnover	0.319	10	0.275	Cyprus (0.936) Lithuania (0.701) Estonia (0.557)
Average input result[25]	0.698	1	0.488	Sweden (0.698) Finland (0.694) Germany (0.631)

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

Looking at the four input indicators selected together, it becomes evident, that Sweden is at the top with regard to average ranking (ranking number one, 0.698) among the other EU 28 Member States.[26] Finland has ranking number 2 (0.694) and Germany has ranking number 3 (0.631). 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 compare output and input indicators with each other and discuss the efficiency or performance of the Swedish national innovation system as a whole.

4.3. The efficiency 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 into the national innovation system. In this subsection we focus on the relation between the input and the output sides, in order to measure the innovation performance of the Swedish national innovation system in terms of efficiency or productivity of the system. Based on this, we will also rank Sweden in relation to the other EU28 countries with regard to the productivity or efficiency of the innovation system.

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

[26] We have also replicated the above analysis of the innovation inputs considering 7 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. 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.

On the basis of its 25 indicators, the IUS 2014 calculates a composite index (Summary Innovation Index - SII), using the same weight for all indicators. In the calculation, the IUS makes no distinction between indicators reflecting (a) innovations as such, (b) determinants or inputs of innovation processes, and (c) consequences of innovations. After calculating this, as they call it, "EU Member States' innovation performance" the IUS has ranked the EU28 Member States on this basis.[27] Sweden has, for several years emerged as number one in this ranking. It has often been interpreted as if Sweden is the best performing country in Europe with regard to innovation. That this interpretation is common was documented in section 1.

Behind our choice of method of proceeding below is, of course, the fact that the only way to measure the efficiency or productivity of a firm, country or system is to compare outputs with inputs, as argued in section 2. There must be a nominator and a denominator in a productivity ratio. A measure of the efficiency or productivity of an innovation system is here designed as the ratio between the innovation output and the innovation input. Such a ratio shows how efficiently the countries use their innovation inputs. The data for Sweden are as follows.

Table 6: The efficiency and productivity of Sweden's innovation system[28]

	Score	Ranking (out of 28)	Leading countries (top 3)
Productivity of the innovation system	0.82 (0.575/0.698)	24	Greece (2.52) Bulgaria (2.19) Italy (1.98)

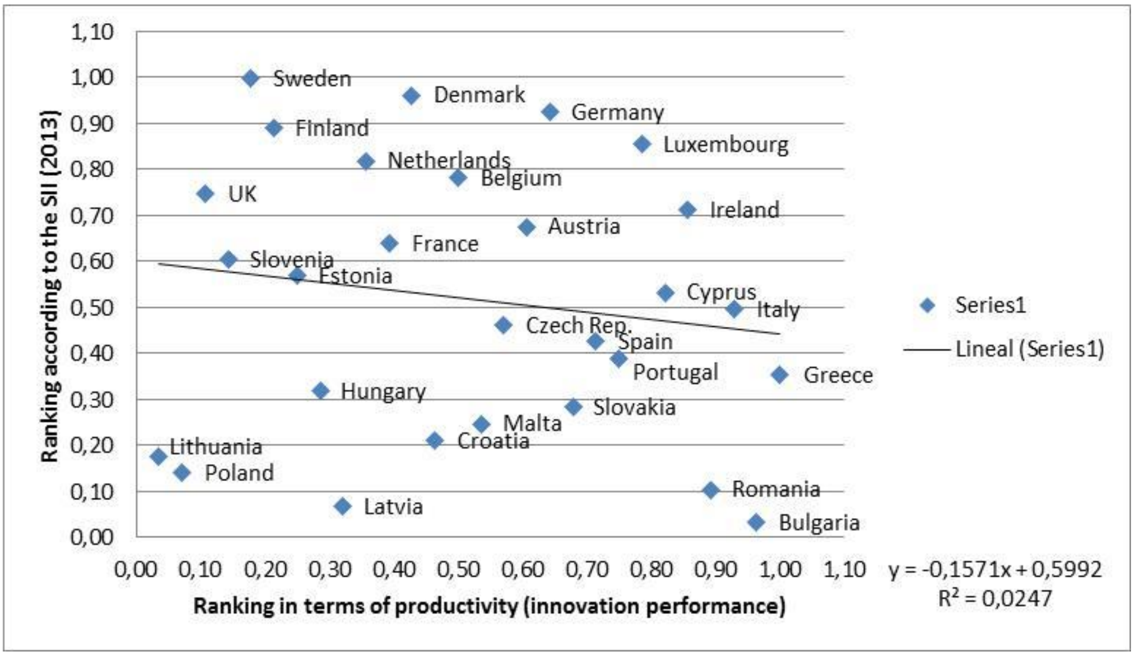
Source: own elaboration based on data from European Union (2014).

Sweden is ranked extremely high with regard to input (ranking number one) and fairly high (ranking number 10) with regard to output. But this obviously leads to a very low ranking with regard to productivity or efficiency of the innovation system. In Table 6,

[27] As we are indicating in this paper this measure has nothing to do with "innovation performance" in any meaningful sense of this term.
[28] The data and rankings for all EU28 Member Countries are presented in Annex 5.

we can see that Sweden is ranked as number 24 among the EU28 Member States with regard to the productivity of the innovation system as defined here (see Annex 5).[29] Obviously, the national innovation system in Sweden cannot be said to perform well at all from an efficiency point of view.

Figure 2. – Comparing the IUS Summary Innovation Index (SII) and our innovation performance measurement for the EU28 (year 2013)



Source: own elaboration

Figure 2 illustrates the distribution of the ranking scores obtained from the previous efficiency estimation (4 inputs and 8 outputs). This ranking is then compared with that provided by the SII, which according to the IUS, measures "EU Member States' Innovation Performance" (European Union, 2014:5).[30] In Figure 2 the two rankings are related: the y-axis refers to the SII index and the x-axis to the efficiency based one.

If the two rankings would coincide, one would expect the majority of countries to be along a 45° line. However, this is not the case. Indeed, the trend line indicates a negative relationship. The negative relation of these indices must result from their different conceptual settings, since the indicators are the same in both cases. As it can

[29] 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). Sweden then (productivity of 0.89) 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.

[30] The meaning of the notion of "innovation performance" is not explicitly specified in the Innovation Union Scoreboard, only contextually by the way it is used and measured.

be observed, Sweden is not the only country where the two rankings are reversed.[31] In fact, this is the case for most countries included among the innovation leaders, innovation followers, moderate innovators and modest innovators (European Union, 2014).

Our results indicate that the efficiency of the Swedish national innovation system is far from being adequate. When analyzing the relative (i.e. efficiency) performance of the Swedish innovation system, it becomes very clear that as compared to more efficient countries, Sweden invests more resources and still does not manage to produce as much outputs as others do. On the input side, the values of the four indicators are higher for Sweden than for all other EU28 countries. in particular the indicators related to venture capital (i.e. indicator 1.3.2) and business R&D expenditure (i.e. indicator 2.1.1). On the output side, the opposite trend is observed, namely, Sweden obtains much less outputs that its input investment levels would motivate.

To put this seemingly surprising result into perspective, we will make a comparison with the results of another innovation index which has now been produced for eight years. The latest version has been published as "The Global Innovation Index 2014", produced by Cornell University, INSEAD, and WIPO (Cornell University et al., 2014). We will not, however, summarize this Global Innovation Index in any detail; just give a few glimpses of the results.

"The Global Innovation Index" 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. Sweden is ranked high both with regard to the Innovation Input Sub-Index (6th) and the Innovation Output Sub Index (3th) (Cornell University et al., 2014: 16-18). It also provides a Global Innovation Index (GII) as a simple average of the two sub-indexes, in a similar way as IUS (2014) calculates its Summary Innovation Index (SII).

According to this GII index, Sweden was ranked number 3 in year 2014 after Switzerland (ranked number 1) and the United Kingdom (ranked number 2). In the GII indexes for years 2011 and 2013 Switzerland was ranked number 1 and Sweden number 2 (Cornell University et al., 2014).

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[31] The data and rankings for all EU28 Member Countries for the elaboration of Figure 2 are presented in Annex 5.

Outputs and inputs are not compared to each other in the GII (just like in the case of the SII). The GII can therefore not serve as a measure of efficiency or productivity of the innovation system. However, a ratio between the Innovation Output Sub-Index and the Innovation Input Sub-Index is calculated, which is defined as an Innovation Efficiency Ratio. “It shows how much innovation output a given country is getting from its inputs.” (Cornell University et al., 2014: 7).[32] It is therefore, in its basic characteristics, similar to the innovation performance (i.e. efficiency) measure discussed earlier.

In spite of Sweden’s very high ranking for inputs (6) and outputs (3), Sweden is ranked number 22 with regard to the Innovation Efficiency Ratio. Hence our use of Innovation Union Scoreboard data and the calculation of the Global Innovation Index “Innovation Efficiency Ratio” lead to results that point in the same direction: they both indicate that the Swedish innovation system is quite inefficient.

This result should be related to the old discussion of the so-called “Swedish paradox” (Edquist and McKelvey, 1998).[33] The notion of a ‘Swedish paradox’ has been central to innovation policy discussions in Sweden for decades by now. 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.[34] It was seen as a paradox between a high input and a low output measured by these specific indicators.

In other words, it pointed to a low productivity of 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, e.g., of 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

[32] It needs to be stressed that Cornell University et al. (2014) seem to give more weight to the Global Innovation Index than to the Innovation Efficiency Ratio in the presentation of their results.
[33] This publication of 1998 was written in 1994, was internally published in 1996 and was based on a publication from 1992 – which, in its turn, was a translation of a chapter in an appendix to the final study of the Swedish Productivity Delegation from 1991 (Edquist and McKelvey, 1991).
[34] The share of high-tech products was seen as a proxy for innovation output intensity.

partial data, it has been discussed to what extent there exists a paradox (Edquist and Hommen, 2009).[35]

The analysis presented in this paper indicates that the Swedish paradox, in the original sense of the term, is still in operation. It is clearly indicated by the comprehensive data presented by the Innovation Union Scoreboard as well as data provided and analyzed by the “The Global Innovation Index”. The reasonable interpretation is that Sweden invests substantial inputs for the development of innovations, but when it comes to the actual production of those outputs, Sweden shows relatively low results. The reasons for this low efficiency may be manifold and partly related to the path dependence of the Swedish national innovation system, the strong role played by multinational corporations in traditional industries, and its focus on basic science.

The problem seems to be a lack of efficiency in the transformation of inputs into outputs. At the same time this inefficiency actually constitutes a potential for improvement. One policy conclusion is that large efforts should be made to identify the sources of the inefficiencies in the Swedish national system of innovation and design and implement instruments and mechanisms to overcome them. This means breaking with the linear model of innovation that still dominates innovation policy (although it is completely rejected in innovation research) (Edquist, 2014a). In its place a holistic innovation policy should be developed – and it must take into account all the determinants (driving forces as well as obstacles) of innovations, for example all the ten activities in innovation systems that are listed in Annex 2 (Edquist, 2011).[36]

As can be observed in Annex 5, many of the countries that perform high (e.g. top ten) in terms of the productivity of their national innovation system (e.g. Bulgaria, Romania, Greece, Italy, Portugal, Spain, Slovakia), devote very limited inputs, but still manage to get a reasonable amount of outputs in relation to the inputs put into the system. These results might partly be explained by the complexity of innovation processes and thus the need to coordinate the activities related to innovation processes and policies (Magro et al., 2014; Zabala-Iturriagagoitia et al., 2007a).

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[35] The “Swedish Paradox” has been intensively discussed in many publications (e.g. Jacobsson and Rickne, 2004; Granberg and Jacobsson, 2006; Audretsch, 2009; Ejermo and Kander, 2009; Ejermo et al., 2011). However, most of these publications define the phenomenon in different ways as compared with the Edquist/ McKelvey definition presented here. Hence the different views on whether there is a paradox or not is dependent on what is meant by the paradox. This could be analyzed, but it is not the purpose of this paper.

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

The countries with high inputs in the national system of innovation (See Annex 4) tend to develop new industries which imply uncertainties, higher risks, and failures in their innovation efforts. This might decrease the efficiencies of their innovation systems. At the same time, those investing less in innovation may copy the successful attempts made by the big investors and, in this way, increase the efficiency of their systems, as long as they are not close to the knowledge and innovation frontier.

As we have observed (see section 4.2) there are countries which invest similar amounts of resources, but which at the same time also manage to get a higher output. Worth mentioning are the cases of the Netherlands, Belgium, Luxembourg, Denmark, Germany or France (i.e. countries that have a better balance between the input and output sides). These are the countries that could be used as benchmarks for Sweden in developing its innovation system by means of innovation policy, since their structure (i.e. industrial, administrative and political) is rather similar to that in the Swedish case (see Table 7). As Navarro et al. (2009) illustrate, to foster learning in policy making processes and to derive sensible policy conclusions, countries need to be compared with others with similar characteristics. If we focus on the inputs, it can be observed that Denmark and Germany have a similar level of investment as compared to Sweden. On the output side, Belgium, France and the Netherlands have output levels similar to that of Sweden.

Table 7. - Possible benchmarks for the Swedish innovation system

	Output	Input	Productivity of innovation system	Ranking in terms of productivity	Summary Innovation Index (SII) 2013	Ranking according to the SII (2013)
Luxembourg	0.754	0.461	1.63	7	0.646	5
Germany	0.859	0.631	1.36	11	0.709	3
Belgium	0.603	0.507	1.19	15	0.627	7
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
Sweden	**0.575**	**0.698**	**0.82**	**24**	**0.750**	**1**

Source: own elaboration from European Union (2014).

5. Conclusions

The IUS reports have, for many years, highlighted Sweden as one of the innovation leaders in Europe, with a high "innovation performance" (e.g. European Union 2013, 2014). For several editions of the Innovation Union Scoreboard (IUS) annual report, Sweden has been ranked number one in the European Union with regard to EU member States' Innovation Performance. However, the IUS reports (e.g. European Union, 2014) do not provide any conceptual or theoretical discussion about the specific indicators used and the relations among them.

In this study we have set out to assess the Swedish innovation system in two senses. First, we have addressed a set of indicators that 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. We have used the data presented in the IUS 2014 report (which, in most cases, refers to year 2013), splitting the analysis into innovation inputs (i.e. four input indicators) and outputs (i.e. eight output indicators). It is not our purpose to evaluate the quality of the data in the IUS but rather to compare the methodology used in it with other approaches.

The IUS appoints Sweden to having the top position (ranked number 1 of the 28 European Union Member States) in terms of what they call "EU Member States' Innovation Performance". Our analysis demonstrates that the results based on the separate analysis of inputs and outputs provides a different picture. We have shown that many countries which devote fewer resources than Sweden to innovation, achieve outstanding levels of efficiency and, contrary to what the IUS predicts, countries with comprehensive innovation systems such as Sweden, do not show efficiency levels commensurate with their innovation efforts (i.e. inputs). According to the results obtained with this approach, we strongly question whether Sweden could be regarded the innovation leader of Europe. In fact, Sweden is number 10 (within the EU28) and not number 1 in terms of innovation output, and number 24 out of 28 with regard to the efficiency or productivity of its innovation system.[37]

[37] We acknowledge that it is of large interest to know the position of Sweden with regard to *each* of the 25 indicators included in the IUS, for example, when designing innovation policies. Such a detailed discussion of each specific indicator remains though for further research endeavours. However, we have included an Annex 6 in which the rankings for all the EU28 countries are provided for all the 25 indicators considered by the IUS.

The average value of the four input indicators considered (including private and public R&D) is higher for Sweden than for all other EU28 countries. Out of the 28 countries considered, only Finland is investing similar amounts in public and private R&D. However, Sweden obtains much less outputs than its investment levels (i.e. not only in terms of R&D but also in terms of venture capital for example) would motivate. This (low) relative innovation outputs are particularly observed in the indicators related to community trademarks (i.e. indicator 2.3.3.), community designs (i.e. indicator 2.3.4) and knowledge-intensive services exports (i.e. indicator 3.2.3), illustrating the main gaps of the Swedish innovation system. In this regard, as discussed in section 3, the result observed in the indicator 3.2.4 'sales of new to market and new to firm innovations' is regarded as quite revealing of the overall 'health' of the innovation system. In this indicator, the result for Sweden is only 25% of that observed in the country with the best result for this indicator. It is obvious therefore that Sweden should not be considered as a leader in terms of innovation performance.

We very much agree with Foray and Hollanders (2015) that the statistical information provided by the IUS needs to be complemented with other more contextual and qualitative information of the innovation system under study. In this paper we have not done so, as the goal was to analyze and discuss the possible misinterpretations that the IUS is making of the data. However, we have also elsewhere studied the details about the structural characteristics of the Swedish innovation system (and nine more small innovation systems in Asia and Europe), which can be found in (Edquist and Hommen, 2009).

The approach followed by the IUS offers an incorrect view of the actual state of the EU national innovation systems. In addition, the lack of conceptual and theoretical work in it explains the potential flaws that have arisen from the interpretation of the results provided by the IUS and the SII included in it. These potential flaws are particularly relevant since they could lead to wrong (innovation) policy decisions. We have shown that the use of the same indicators and data provided by the IUS but with a different conceptual framework and a different methodology yields very different results. It can be said that the mere use of a set of indicators provides a partial picture of the phenomenon being examined (Grupp and Mogee, 2004). Different approaches should thus be seen and used complementarily (Zabala-Iturriagagoitia et al., 2007b). Therefore, policy makers need to consider the results of different and complementary analyses to obtain a comprehensive and correct picture of their respective innovation systems. From our point of view, the combination of several partial views will provide a clearer picture than that provided by each in isolation. We have shown that different conceptual frameworks and different methodologies lead to different results. To use different and complementary data can do the same.

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Annex 1: Definition of indicators from IUS report 2014

	Indicator	**Definition numerator**	**Definition denominator**	**Interpretation**	**Source**
1.- ENABLERS					
1.1.- HUMAN RESOURCES					
1.1.1	New doctorate graduates (ISCED 6) per 1000 population aged 25-34	Number doctorate graduates (ISCED 6)	Population between 25 and 34 years	The indicator is a measure of the supply of new second stage tertiary graduates in all fields of training. For most countries ISCED 6 captures PhD graduates only, with the exception of Finland, Portugal and Sweden where also non-PhD degrees leading to an award of an advanced research qualification are included.	Eurostat
1.1.2	Percentage population aged 30-34 having completed tertiary education	Number of persons in age class with some form of postsecondary education (ISCED 5 and 6)	Population between 30 and 34 years	This is a general indicator of the supply of advanced skills. It is not limited to science and technical fields because the adoption of innovations in many areas, in particular in the service sectors, depends on a wide range of skills. International comparisons of educational levels however are difficult due to large discrepancies in educational systems, access, and the level of attainment that is required to receive a tertiary degree. The indicator focuses on a narrow share of the population aged 30 to 34 and it will more easily and quickly reflect changes in educational policies leading to more tertiary graduates.	Eurostat

1.1.3	Percentage youth aged 20-24 having attained at least upper secondary education	Number of young people aged 20-24 years having attained at least upper secondary education attainment level, i.e. with an education level ISCED 3a, 3b or 3c long minimum	Population between 20 and 24 years	The indicator measures the qualification level of the population aged 20-24 years in terms of formal educational degrees. It provides a measure for the "supply" of human capital of that age group and for the output of education systems in terms of graduates. Completed upper secondary education is generally considered to be the minimum level required for successful participation in a knowledge-based society and is positively linked with economic growth.	Eurostat
1.2.- OPEN, EXCELLENT RESEARCH SYSTEMS					
1.2.1	International scientific co-publications per million population	Number of scientific publications with at least one co-author based abroad (where abroad is non-EU for the EU27)	Total population	International scientific co-publications are a proxy for the quality of scientific research as collaboration increases scientific productivity.	Science-Metrix Scopus (Elsevier) and Eurostat
1.2.2	Scientific publications among the top-10% most cited publications worldwide as % of total scientific publications of the country	Number of scientific publications among the top-10% most cited publications worldwide	Total number of scientific publications	The indicator is a proxy for the efficiency of the research system as highly cited publications are assumed to be of higher quality. There could be a bias towards small or English speaking countries given the coverage of Scopus' publication data. Countries like France and Germany, where researchers publish relatively more in their own language, are more likely to underperform on this indicator as compared to their real academic excellence.	Science-Metrix Scopus (Elsevier)
1.2.3	Non-EU doctorate students as a % of all doctorate holders	For EU Member States: number of doctorate students from non-EU countries (for non-EU countries: number of non-national doctorate students)	Total number of doctorate students	The share of non-EU doctorate students reflects the mobility of students as an effective way of diffusing knowledge. Attracting high-skilled foreign doctorate students will add to creating a net brain gain and will secure a continuous supply	Eurostat

				of researchers	
1.3.- FINANCE AND SUPPORT					
1.3.1	R&D expenditure in the public sector (% of GDP)	All R&D expenditures in the government sector (GOVERD) and the higher education sector (HERD)	Gross Domestic Product	R&D expenditure represents one of the major drivers of economic growth in a knowledge-based economy. As such, trends in the R&D expenditure indicator provide key indications of the future competitiveness and wealth of the EU. Research and development spending is essential for making the transition to a knowledge-based economy as well as for improving production technologies and stimulating growth.	Eurostat
1.3.2	Venture capital (% of GDP)	Venture capital investment is defined as private equity being raised for investment in companies. Management buyouts, management buyins, and venture purchase of quoted shares are excluded. Venture capital includes early stage (seed + start-up) and expansion and replacement capital	Gross Domestic Product	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. Comment: two-year averages have been used	Eurostat
2.- FIRM ACTIVITIES					
2.1.- FIRM INVESTMENTS					
2.1.1	R&D expenditure in the business sector (% of GDP)	All R&D expenditures in the business sector (BERD)	Gross Domestic Product	The indicator captures the formal creation of new knowledge within firms. It is particularly important in the science-based sector (pharmaceuticals, chemicals and some areas of electronics) where most new knowledge is created in or near R&D laboratories.	Eurostat
2.1.2	Non-R&D innovation expenditures (% of turnover)	Sum of total innovation expenditure for enterprises, in thousand Euros and current prices excluding intramural and extramural R&D	Total turnover for all enterprises	This indicator measures non-R&D innovation expenditure as percentage of total turnover. Several of the components of innovation expenditure, such as investment in equipment and	Eurostat (Communit y Innovation

		expenditures		machinery and the acquisition of patents and licenses, measure the diffusion of new production technology and ideas.	Survey)
2.2.- LINKAGES & ENTREPRENEURSHIP					
2.2.1	SMEs innovating in-house (% of SMEs)	Sum of SMEs with in-house innovation activities. Innovative firms are defined as those firms which have introduced new products or processes either 1) in-house or 2) in combination with other firms	Total number of SMEs	This indicator measures the degree to which SMEs, that have introduced any new or significantly improved products or production processes, have innovated in-house. The indicator is limited to SMEs because almost all large firms innovate and because countries with an industrial structure weighted towards larger firms tend to do better.	Eurostat (Communit y Innovation Survey)
2.2.2	Innovative SMEs collaborating with others (% of SMEs)	Sum of SMEs with innovation co-operation activities, i.e. those firms that had any co-operation agreements on innovation activities with other enterprises or institutions in the three years of the survey period	Total number of SMEs	This indicator measures the degree to which SMEs are involved in innovation co-operation. Complex innovations, in particular in ICT, often depend on the ability to draw on diverse sources of information and knowledge, or to collaborate on the development of an innovation. This indicator measures the flow of knowledge between public research institutions and firms and between firms and other firms. The indicator is limited to SMEs because almost all large firms are involved in innovation co-operation.	Eurostat (Communit y Innovation Survey)
2.2.3	Public-private co-publications per million population	Number of public-private co-authored research publications. The definition of the "private sector" excludes the private medical and health sector. Publications are assigned to the country/countries in which the business companies or other private sector organisations are located	Total population	This indicator captures public-private research linkages and active collaboration activities between business sector researchers and public sector researchers resulting in academic publications.	CWTS (Thomson Reuters) and Eurostat

2.3.- INTELLECTUAL ASSETS					
2.3.1	PCT patent applications per billion GDP (in PPP€)	Number of patent applications filed under the PCT, at international phase, designating the European Patent Office (EPO). Patent counts are based on the priority date, the inventor's country of residence and fractional counts.	Gross Domestic Product in Purchasing Power Parities	The capacity of firms to develop new products will determine their competitive advantage. One indicator of the rate of new product innovation is the number of patents. This indicator measures the number of PCT patent applications.	OECD and Eurostat
2.3.2	PCT patent applications in societal challenges per billion GDP (in PPP€)	Number of PCT patent applications in Environment-related technologies and Health. Patents in Environment-related technologies include those in General Environmental Management (air, water, waste), Energy generation from renewable and non-fossil sources, Combustion technologies with mitigation potential (e.g. using fossil fuels, biomass, waste, etc.), Technologies specific to climate change mitigation, Technologies with potential or indirect contribution to emissions mitigation, Emissions abatement and fuel efficiency in transportation and Energy efficiency in buildings and lighting. Patents in health-related technologies include those in Medical technology (IPC codes (8th edition) A61[B, C, D, F, G, H, J, L, M, N], H05G) and Pharmaceuticals (IPC codes A61K excluding A61K8)	Gross Domestic Product in Purchasing Power Parities	This indicator measures PCT applications in health technology and environment-related technologies and is relevant as increased numbers of patent applications in health technology and environment-related technologies will be necessary to meet the societal needs of an ageing European society and sustainable growth.	OECD and Eurostat

2.3.3	Community trademarks per billion GDP (in PPP€)	Number of new community trademarks applications	Gross Domestic Product in Purchasing Power Parities	Trademarks are an important innovation indicator, especially for the service sector. The Community trademark gives its proprietor a uniform right applicable in all Member States of the European Union through a single procedure which simplifies trademark policies at European level. 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 advertising. Comment: two-year averages have been used	Office for Harmonization in the Internal Market and Eurostat
2.3.4	Community designs per billion GDP (in PPP€)	Number of new community designs applications	Gross Domestic Product in Purchasing Power Parities	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. A product can be any industrial or handicraft item including packaging, graphic symbols and typographic typefaces but excluding computer programs. It also includes products that are composed of multiple components, which may be disassembled and reassembled. Community design protection is directly enforceable in each Member State and it provides both the option of an unregistered and a registered Community design right for one area encompassing all Member States. Comment: two-year averages have been used	Office for Harmonization in the Internal Market and Eurostat
3.- OUTPUTS					
3.1.- INNOVATORS					
3.1.1	SMEs introducing product or	Number of SMEs who introduced a new product or a new process to one	Total number of	Technological innovation, as measured by the introduction of new products (goods or services)	Eurostat (Communit

	process innovations (% of SMEs)	of their markets	SMEs	and processes, is a key ingredient to innovation in manufacturing activities. Higher shares of technological innovators should reflect a higher level of innovation activities.	y Innovation Survey)
3.1.2	SMEs introducing marketing or organisational innovations (% of SMEs)	Number of SMEs who introduced a new marketing innovation or organisational innovation to one of their markets	Total number of SMEs	The Community Innovation Survey mainly asks firms about their technological innovation. Many firms, in particular in the services sectors, innovate through other non-technological forms of innovation. Examples of these are marketing and organisational innovations. This indicator tries to capture the extent that SMEs innovate through non-technological innovation.	Eurostat (Communit y Innovation Survey)
3.1.3	Employment in fast-growing enterprises in innovative sectors (% of total employment)	The sum of sectoral results for the employment in fast-growing enterprises by economic sector multiplied by the innovation coefficients of these sectors. Fast-growing enterprises are defined as firms with average annualised growth in employees of more than 10 % a year, over a three-year period, and with 10 or more employees at the beginning of the observation period.	Total employment in fast-growing enterprises in the business economy (without financial sector)	The indicator shows the degree of innovativeness of successful entrepreneurial activities. It captures the capacity of a country to transform its economy rapidly to take advantage of emerging demand.	Eurostat
3.2.- ECONOMIC EFFECTS					
3.2.1	Employment in knowledge-intensive activities (% of total employment)	Number of employed persons in knowledge- intensive activities in business industries. Knowledge-intensive activities are defined, based on EU Labour Force Survey data, as all NACE Rev.2 industries at 2-digit level where at least 33% of	Total employment	Knowledge-intensive activities provide services directly to consumers, such as telecommunications, and provide inputs to the innovative activities of other firms in all sectors of the economy.	Eurostat

		employment has a higher education degree (ISCED5 or ISCED6)			
3.2.2	Contribution of medium and high-tech products exports to the trade balance	The contribution to the trade balance is calculated as follows: $(X_{MHT}-M_{MHT}) - (X-M)*[(X_{MHT}+M_{MHT}) / (X+M)]$, where $(X_{MHT}-M_{MHT})$ is the observed trade balance for medium and high-tech products and $(X-M)*[(X_{MHT}+M_{MHT}) / (X+M)]$ is the theoretical trade balance (where X denotes exports and M denotes imports of resp. MHT products and all products). MHT exports include exports of the following SITC Rev.3 products: 266, 267, 512, 513, 525, 533, 54, 553, 554, 562, 57, 58, 591, 593, 597, 598, 629, 653, 671, 672, 679, 71, 72, 731, 733, 737, 74, 751, 752, 759, 76, 77, 78, 79, 812, 87, 88 and 891	Value of total trade	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 countries' trade specialisation. A positive value indicates a structural surplus, while a negative value indicates a structural deficit. The indicator is expressed as a percentage of total trade in order to eliminate business cycle variations.	UN Comtrade
3.2.3	Knowledge-intensive services exports as % of total services exports	Exports of knowledge-intensive services are measured by the sum of credits in EBOPS (Extended Balance of Payments Services Classification) 207, 208, 211, 212, 218, 228, 229, 245, 253, 260, 263, 272, 274, 278, 279, 280 and 284	Total services exports as measured by credits in EBOPS 200	The indicator measures the competitiveness of the knowledge-intensive services sector. Knowledge-intensive services are defined as NACE classes 61-62 and 64-72. These can be related to the above-mentioned EBOPS classes using the correspondence table between NACE, ISIC and EBOPS as provided in the UN Manual on Statistics of International Trade in Services (UN, 2002).	Eurostat
3.2.4	Sales of new-to-market and new-to-firm	Sum of total turnover of new or significantly improved products, either new to the firm or new to the	Total turnover for all	This indicator measures the turnover of new or significantly improved products and includes both products which are only new to the firm and	Eurostat (Communit y

	innovations as % of turnover	market, for all enterprises	enterprises	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).	Innovation Survey)
3.2.5	License and patent revenues from abroad as % of GDP	Export part of the international transactions in royalties and license fees	Gross Domestic Product	Trade in technology comprises four main categories: Transfer of techniques (through patents and licences, disclosure of know-how); Transfer (sale, licensing, franchising) of designs, trademarks and patterns; Services with a technical content, including technical and engineering studies, as well as technical assistance; and Industrial R&D. TBP receipts capture disembodied technology exports.	Eurostat

Source: European Union (2014).

Annex 2: Key activities in innovation systems

Box 1: Key Activities in Systems of Innovation

I. Provision of knowledge inputs to the innovation process

1. Provision of R&D results and, thus, creation of new knowledge, primarily in engineering, medicine and natural sciences.

2. Competence building, e.g. through individual learning (educating and training the labour force for innovation and R&D activities) and organisational learning. This includes formal learning as well as informal learning.

II. Demand-side activities

3. Formation of new product markets, for example through public procurement of innovation.

4. Articulation of new product quality requirements emanating from the demand side.

III. Provision of constituents for SI

5. Creating and changing organisations needed for developing new fields of innovation. Examples include enhancing entrepreneurship to create new firms and intrapreneurship to diversify existing firms; and creating new research organisations, policy agencies, etc.

6. Networking through markets and other mechanisms, including interactive learning among different organisations (potentially) involved in the innovation processes. This implies integrating new knowledge elements developed in different spheres of the SI and coming from outside with elements already available in the innovating firms.

7. Creating and changing institutions – e.g., patent laws, tax laws, environment and safety

regulations, R&D investment routines, cultural norms, etc. – that influence innovating organisations and innovation processes by providing incentives for and removing obstacles to innovation.

IV. Support services for innovating firms

8. Incubation activities such as providing access to facilities and administrative support for innovating efforts.

9. Financing of innovation processes and other activities that may facilitate commercialisation of knowledge and its adoption.

10. Provision of consultancy services relevant for innovation processes, e.g., technology transfer, commercial information, and legal advice.

Source: Adapted from (Edquist 2005) and (Edquist 2011).

Annex 3: Innovation outputs of the national innovations systems of the EU28 member states

	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		Output 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).

Annex 4: Innovation inputs of the national innovations system of the EU28 member states

	Latest data year		2012		2012		2012		2010			
	SII 2013		1.3.1		1.3.2		2.1.1		2.1.2		Input 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).

Annex 5: The Efficiency of the EU28 Innovation Systems

	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).

Annex 6: Rankings for the EU28 countries for all 25 indicators

	1.1.1	1.1.2	1.1.3	1.2.1	1.2.2	1.2.3	1.3.1	1.3.2	2.1.1	2.1.2	2.2.1	2.2.2	2.2.3	2.3.1	2.3.2	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
Sweden	**1**	**5**	**10**	**2**	**5**	**3**	**2**	**8**	**2**	**10**	**8**	**6**	**2**	**1**	**1**	**7**	**8**	**4**	**10**	**1**	**4**	**15**	**10**	**21**	**3**
Finland	4	7	11	5	9	14	1	3	1	18	13	7	4	2	6	11	9	9	13	7	9	16	12	5	2
UK	8	6	18	11	4	2	15	2	12	-	-	1	8	9	9	12	19	23	20	11	3	6	4	26	10
Slovenia	12	13	4	10	18	15	13	-	3	14	-	12	7	10	7	18	16	17	14	20	14	2	25	17	15
Denmark	2	10	25	1	2	9	3	7	4	17	3	8	1	4	2	8	3	11	8	3	8	24	3	7	6
Germany	3	17	23	14	7	11	4	11	5	6	1	11	9	3	3	6	4	1	1	4	7	1	5	4	11
Estonia	13	14	19	12	16	16	6	-	9	3	12	5	19	12	12	5	11	7	17	22	20	23	11	15	19
Netherlands	6	11	21	4	1	5	5	6	10	11	6	9	3	5	4	9	13	5	16	10	11	18	17	19	7
Belgium	7	8	17	6	3	4	10	4	7	16	5	4	5	8	10	14	12	2	11	9	10	13	9	14	8
Lithuania	24	4	6	24	19	28	12	-	24	2	21	18	23	24	21	22	24	22	23	26	25	22	27	27	26
France	11	9	14	15	12	1	9	5	8	26	15	15	10	7	8	19	15	16	7	5	12	4	13	9	9
Austria	10	22	9	7	10	12	7	17	6	23	9	3	6	6	5	4	2	10	9	14	13	9	22	16	13
Ireland	9	1	8	8	8	6	17	13	11	24	7	14	12	11	11	13	23	8	5	2	2	14	1	20	1
Cyprus	14	2	7	9	17	23	25	-	28	1	2	2	18	27	22	2	6	14	15	25	6	12	8	10	27
Luxembourg	5	3	26	3	6	7	20	1	14	27	4	10	11	15	16	1	1	3	2	6	1	25	2	22	4
Czech Republic	16	23	3	18	20	17	8	18	13	8	16	16	13	18	19	20	14	15	12	12	17	8	16	6	17
Poland	25	15	5	25	24	22	16	9	23	4	25	26	26	22	25	23	10	27	27	23	24	19	18	23	21
Slovakia	21	24	2	23	23	24	21	-	21	9	20	19	22	23	28	24	22	21	22	17	23	7	23	2	28
Croatia	23	25	1	20	27	20	24	-	22	12	17	17	17	17	17	28	28	18	18	21	21	17	26	18	20

Latvia	27	16	15	27	28	27	19	-	26	22	22	25	28	21	20	21	20	26	25	27	22	26	14	28	24
Portugal	18	20	27	13	14	10	11	12	16	15	11	20	20	20	18	17	7	6	4	24	26	21	15	11	25
Hungary	20	19	16	21	21	19	23	10	15	20	24	21	15	16	15	26	25	24	26	8	16	3	20	13	5
Spain	17	12	28	16	11	8	14	14	18	21	19	22	16	14	14	10	17	20	21	13	19	11	24	3	18
Italy	15	28	22	19	13	13	18	15	17	13	10	24	14	13	13	16	5	12	6	19	15	5	19	8	14
Greece	19	18	13	17	15	26	22	19	25	7	14	13	21	25	24	27	27	13	3	16	18	28	6	1	23
Romania	26	27	20	28	25	21	27	16	27	19	26	28	25	28	27	25	26	28	24	15	28	20	7	12	16
Malta	22	26	24	22	22	25	26	-	19	5	18	23	24	19	23	3	21	19	19	18	5	10	28	25	12
Bulgaria	28	21	12	26	26	18	28	20	20	25	23	27	27	26	26	15	18	25	28	28	27	27	21	24	22

Source: own elaboration from European Union (2014).