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Measuring innovation output in Europe: towards a new indicator

(Text with EEA relevance)

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COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

Measuring innovation output in Europe: towards a new indicator

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1. INTRODUCTION

This Communication presents an indicator to measure performance in innovation output. The rigorous measurement of the impact of innovation policies is key for evidence-based policy-making. Moreover, it bolsters the legitimacy of public action and the use of public funds.

Europe is today a knowledge centre of global importance. However, despite its world-class science base and technology leadership in strategic sectors, efforts are needed to improve innovation performance at the EU and national level with better framework conditions, notably for fast-growing firms in innovative sectors.

The proposed indicator will support policy-makers in establishing new or reinforced actions to remove bottlenecks that prevent innovators from translating ideas into products and services that can be successful on the market. Improved performance will contribute to smart growth, in line with Europe 2020 and its Innovation Union flagship initiative.[1]

The proposed indicator complements the Innovation Union Scoreboard (IUS),[2] and its Summary Innovation Index (SII), which assess how the various strengths and weaknesses of Member States and the EU determine their overall performance, against a broad set of 24 innovation indicators, including inputs, throughputs and outputs. In addition, the Innovation Union Competitiveness Report, also analyses innovation performance every two years.

The indicator in this Communication zooms in exclusively on innovation output and monitors a reduced set of dimensions, including the contribution to job creation of fast-growing firms. Given its complementarity with the IUS, it is planned that the results of the proposed indicator are published simultaneously with those of the IUS.

The European Council gave the Commission the mandate to develop an indicator in the context of Europe 2020 to complement the R&D intensity target,[3] taking into account the Innovation Union request that the Commission "*launch the necessary work for the development of a new indicator measuring the share of fast-growing innovative companies in the economy*". In March 2013, the Heads of State and Government requested a discussion on innovation in October 2013, calling on the Commission to deliver the indicator.[4]

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1 "Europe 2020 Flagship Initiative Innovation Union", COM(2010) 546 final, of 6 October 2010.

2 http://ec.europa.eu/enterprise/policies/innovation/files/ius-2013_en-pdf.

3 Conclusions of 4/2/2011 (Council doc. EUCO 2/1/11 REV1) and 1-2/3/2012 (EUCO 4/2/12 REV2).

4 The European Council noted "a debate next year on the Europe 2020 Strategy" and called for "preparatory work to be conducted giving priority to: (…) (b) innovation (October 2013)", looking

To advise the Commission on its formulation, a High-Level Panel of leading innovators and economists was set up in 2010.[5] It prompted the Commission to engage in data collections on fast-growing firms in innovative sectors, carried out by Eurostat. In parallel, cooperation was undertaken with the OECD to develop sectoral innovation coefficients. Discussions with Member States on the scope and definition of the indicator took place in workshops, in October and December 2012, and in July 2013.

This Communication introduces the indicator (section 2), the criteria and data for its development (section 3), and the robustness analysis carried out (section 4). It is accompanied by a Staff Working Document.

2. MEASURING INNOVATION OUTPUT

Innovation output is wide-ranging and differs from sector to sector. Measuring it entails quantifying the extent to which ideas for new products and services, stemming from innovative sectors, carry an economic added value and are capable of reaching the market.

Therefore, it can be captured by more than one measure. After exploring a broad set of options, the Commission opted for four IUS indicators, grouped into three components (patents, employment in knowledge-intensive activities (KIA), and competitiveness of knowledge-intensive goods and services), and a new measure of employment in fast-growing firms of innovative sectors.[6]

The patents component takes into account inventions that exploit the knowledge generated by investing in R&D and innovation, and which can be transformed into successful technologies. Similarly, the indicators of the intensity of employment of skilled labour, in KIA and in fast-growing firms, provide an indication of the orientation of the economy towards the production of goods and services with innovation added value. Finally, the trade flows associated with those commodities measure their capacity to reach global markets.[7]

2.1. The components of the innovation indicator

The first component is **technological innovation**, measured by patents, as a crucial output of the R&D and innovation process, showing the ability of an economy to transform knowledge into technology. Therefore, policies improving the intellectual property rights (IPR) system and making it less costly benefit businesses deriving growth from own innovations. Measures such as the professionalization of access to IPR portfolios and tax reductions on patent profits can be instrumental for innovative business dynamics.[8]

The chosen component, IUS indicator 2.3.1, uses the number of patent applications per billion GDP. The numerator is the number of applications filed in international phase, which name the European Patent Office (EPO) as designated office under the Patent Cooperation Treaty (PCT). The denominator is GDP in Euro-based purchasing power parities. An intrinsic bias in

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forward to "the presentation by the Commission of (…) its communication on the 'State of the Innovation Union 2012', including the single innovation indicator, in time for its discussions.", Council doc. EUCO 23/13.

5 Report of the High Level Panel on the Measurement of Innovation, A. Mas-Colell (Chair), September 2010.

6 The formula representing the indicator is included in equation 1 of the Staff Working Document.

7 The possibility of using any of the four additional indicators of the output type in the IUS was examined.

8 "State of the Innovation Union 2012: Accelerating Change", COM(2013) 149 final, 21 March 2013.

favour of countries relying more on international patents than on national ones might occur. Alternative statistics such as triadic patents from the OECD Patent Database were thus tested.

The second component focuses on how a highly skilled labour force feeds into the **economic structure** of a country. Investing in people is a challenge for Europe, as education and training provide workers with the skills for generating innovations. This component captures the structural orientation of a country towards knowledge-intensive activities (KIA), by measuring the people it employs in KIA in business industries, where at least one third of the employees have a higher education degree, as a proportion of the total number of employees in that country. It is the IUS indicator 3.2.1.

The third component is the **competitiveness of knowledge-intensive goods and services**. In a well-functioning economy, it reflects its ability, resulting from innovation, to export innovative products and to participate in global value chains. Competitiveness-enhancing measures and innovation strategies are mutually reinforcing for the growth of employment, export shares and turnover at the firm level. The component aggregates in equal weights the contribution of the trade balance of high-tech and medium-tech products to the total trade balance, and knowledge-intensive services as a share of the total services exports, IUS indicators 3.2.2 and 3.2.3.

Finally, the last component measures the **employment in fast-growing firms of innovative sectors**. Fostering the development of those firms is an integral part of modern research and innovation policy. Studies show that growth depends to a crucial extent upon fast-growing firms, which generate a disproportionally large share of jobs and can contribute to increased innovation investments during economic downturns.[9] Therefore, some Member States strongly support easier access to finance for fast-growing firms, including for innovative projects and for risk capital at seed, start-up and early-growth stages.

Sector-specific innovation coefficients, reflecting the degree of sectoral innovativeness, built on scores accounting for the share of tertiary-educated persons (the KIA score) and for how firms therein identify themselves as being innovative (the CIS score), serve as a proxy for distinguishing innovative enterprises. The employment data is from *ad hoc* business register collections carried out by Eurostat in 2011 and 2012. Fast-growing firms are those with 10 or more employees and an average employee growth of more than 10% per year, over 3 years. This component is proposed to fill in the placeholder (3.1.3 'High-growth innovative firms') in the IUS, reserved for an indicator reflecting the contribution to market dynamics of fast-growing firms, as foreseen by the Innovation Union. It could thus be the 25th Scoreboard indicator.

2.2. Country performance

Figure 1 shows the innovation indicator scores in 2010 and 2011, for Member States and international partners. The average refers to EU27, as the IUS 2013 was published prior to Croatia's accession. Improved time series, based on longer observation periods and further aligned reference years, are essential and will become available in the medium term.

An illustration of the results and their policy implications is provided in Box 1 of the Staff Working Document, focusing on four countries: Sweden (top performer), France (good

[9] OECD (2010), "High-growth Enterprises: What Governments Can Do to Make a Difference". Archibugi, D *et al*. (2013) "Economic crisis and innovation: is destruction prevailing over accumulation?" Research Policy 42, 2.

performer), Italy (medium-level performer), and Bulgaria (low performer).[10] Radar charts displaying the results for all components and countries are included therein. Comprehensive country assessment profiles will accompany those results.

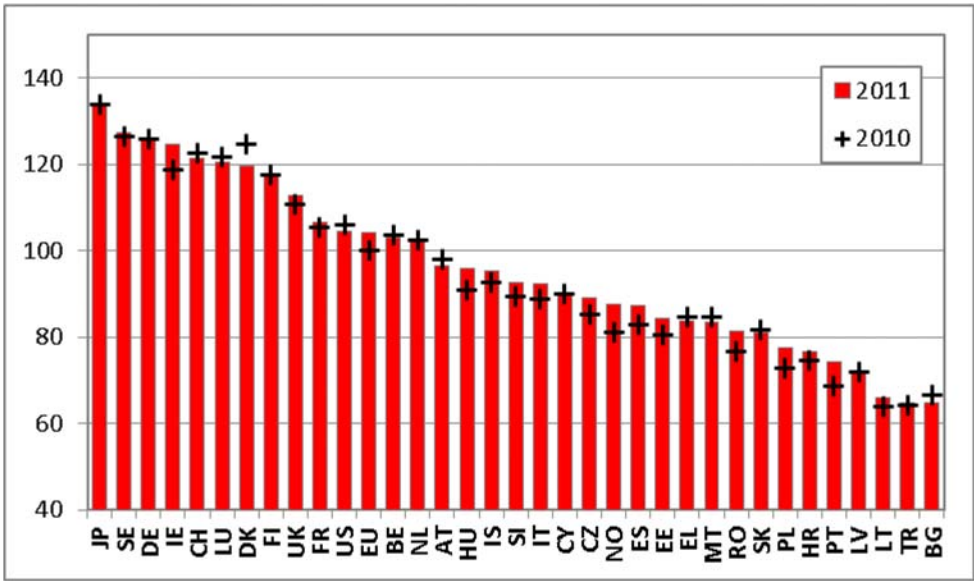

Figure 1. *The composite indicator measuring innovation output*
Countries' scores for 2011 (red bars) and 2010 (crosses), EU average set to 100 in 2010
In 2011, the components reflect the situation in 2009 (PCT), 2010 (DYN) or 2011 (KIA, COMP)
In 2010, they are based on 2008 (PCT), 2009 (DYN) or 2010 (KIA, COMP) data
Source: European Commission.

Overall, in 2011 six categories of performers are identified according to the country scores. Sweden, Germany, Ireland and Luxembourg are "top performers", with scores of over 120 and high values in all four components. These are followed by Denmark, Finland, and the UK, which appear as "very good performers", with scores of between 110 and 120. France, Belgium and the Netherlands are "good performers" with indicator values of between 100 and 110, followed closely by a group of "medium-level performers", including Austria, Hungary, Slovenia, Italy, and Cyprus, in the score range of 90 to 100. "Medium-low performers", with values of between 80 and 90, include the Czech Republic, Spain, Estonia, Greece, Malta, Romania, and Slovakia. Finally, the countries with scores of less than 80 are considered "low performers". These include Poland, Croatia, Portugal and Latvia, and Lithuania and Bulgaria, both of which have particularly low scores close to 65, equal to around half of the top score.

3. THE SELECTION CRITERIA

International quality standards by Eurostat, the OECD and the IMF were taken as a reference when constructing the indicator.

3.1. The four principles applied

Based on Eurostat's conceptual framework, four principles were applied.

(1) Policy relevance. Focus was set on a simple and intuitive interpretation, with sizeable and direct links to measured facts. The indicator permits monitoring dimensions such

[10] Indications of the performance of international partners, e.g. US, with respect to the EU, are also provided.

as IPR conditions, the upgrading of the skills demanded by the market in knowledge-intensive and innovative sectors, the creation of a breeding ground for trade in knowledge-intensive commodities, and framework conditions for fast-growing firms.

(2) Data quality. The availability of timely, representative and validated time series, and the exploitation of all available sources, was deemed essential.

(3) International availability and cross-country comparability. The aim was to set the basis for an indicator suitable for meaningful cross-country comparisons and benchmarking.

(4) Robustness. Composite indicators are used worldwide by a large number of actors, including international organisations. Their construction requires such state-of-the-art validation and robustness analyses[11] that the picture produced enables benchmarking and meets policy needs.

Because of data limitations, criteria 2 and 3 could only be met partially at this stage, and remain areas for future analysis. The indicator relies on imputations for missing values and international comparability, carried out in the fourth indicator component for four Member States and international partners and tested for robustness.

3.2. Areas for future analyses

In order to refine the indicator and bring it to its full potential, four areas were identified.

First, ensuring the improvement of data on fast-growing firms in innovative sectors, in coverage and regular production, with a mandatory request for collection as part of the amended Commission Regulation implementing the European Parliament and Council Regulation on Structural Business Statistics, which will cover the financial sector. Financial services are excluded at this stage but they are relevant, given their pervasive function and impact on the economy. The production of these data will also improve the alignment of the reference years of the indicator.

Second, analysing how the data defining the innovation coefficients can be improved to ensure larger sets of observations across sectors and over time, and how variations in intensities across countries can be best captured. This includes sensitivity analysis on the coefficients using new data from the biennial CIS and the annual Labour Force Survey (LFS).

Third, examining whether and how: the data on the competitiveness of knowledge-intensive goods and services could be improved; the skills component could be refined to capture best the contribution of education, exploring its links with the indicator performance; other statistics of the market success of innovations could be considered.

Finally, enlarging its international dimension, through a wider collection of data on fast-growing firms and joint work with the OECD on the international coverage of the innovation coefficients, using comparable surveys in third countries.

[11] See: http://composite-indicators.jrc.ec.europa.eu/

4. ROBUSTNESS ANALYSIS

Monitoring innovation raises challenges related to the quality of data and their combination into a single measure. The conceptual and statistical coherence of the indicator and the impact of its modelling assumptions were thus assessed in an iterative process:

(1) Candidate indicators were selected for their relevance to innovation policy, on the basis of literature review, expert opinion, country coverage, and timeliness.

(2) The most recently released data were used, with at least a 93% availability in the two years across the components.

(3) The indicator was built with a balanced structure, insofar as its four components were given equal relevance, choosing their nominal weights as scaling coefficients in a similar approach to that of leading international indices such as the Global Innovation Index and the Environmental Performance Index.

(4) Finally, country scores and ranks were evaluated to verify their consistency with current evidence, research or prevailing theory.

The modelling assumptions were tested for imputation of missing data, aggregation formulae, alternative variants for all components, and weighting. Confidence intervals for the rankings were calculated, as was the distance to the efficient frontier.

5. CONCLUSIONS

In response to the European Council, this Communication presents an indicator of innovation output, building on the Commission's efforts to improve the quality of its evidence in support of policy-making and to assess the impact of innovation.

By zooming in on innovation output, the indicator complements the Innovation Union Scoreboard and its Summary Innovation Index.

In line with Europe 2020 and its Innovation Union flagship initiative, the indicator will support policy-makers in creating an innovation-friendly environment.

It was developed using international quality standards and state-of-the-art statistical analyses. Nonetheless, the Commission identified four areas to bring it to its full potential, including widening its international comparability, improving its data on fast-growing firms, and analysing how the innovation coefficient datasets could be improved.

The indicator is a composite index, quantifying four dimensions of innovation output: patents, skills, trade in knowledge-intensive goods and services, and employment in fast-growing firms. The Staff Working Document illustrates its results and policy implications.