The impact of innovation on economic growth

JULIANA BÉREŠOVÁ

Abstract

Innovations are considered as an essential driver of economic progress that benefits customers, businesses, and the economy as a whole. They are crucial for value creation, employment, and have critical importance in sustaining long-run economic growth. The goal of this paper is to provide an overview of the different approaches and studies dealing with the impact of innovation on economic growth. We will also investigate the impact of innovation, measured by R&D expenditure, on economic growth in the EU27 during the period of 2008-2018.

JEL code: H50, O30, O31

Keywords: innovation, R&D expenditure, economic growth

1 Innovation and measurement of innovation performance

The concept of innovation was introduced by the Austrian economist Joseph Schumpeter at the beginning of the 20th century. According to his book, The Theory of Economic Development, innovation can be defined as a new or essentially improved product, process, market, raw material, or organizational arrangement (Schumpeter, 2012a). He used the word „innovation" surprisingly few times in the book and instead used „new combinations" more frequently since he considered *„to produce means to combine the things and forces within our reach"* and innovations mean *„to combine them in new ways*" (Schumpeter, 2012a: 14; Matsunaga, 2019: 2). According to his work, the concept of new combinations covers the following 5 cases:

1. The introduction of a new good,
2. The introduction of a new method of production,
3. The opening of a new market,
4. The conquest of a new source of supply or raw materials or half-manufactured goods,

5. The carrying out of the new organization of any industry (Schumpeter, 2012a: 66).

From the late 20th century onward, many new innovation-related concepts have emerged to better articulate the character and process of innovation in the global knowledge-based era. Such concepts include e.g. process innovation, design innovation, platform innovation, service innovation, inclusive innovation, open innovation, or responsible innovation (Jussi and Hooli, 2020: 35).

In general, we can summarize, that in the first years of functioning, the term „innovation" was seen predominantly in macroeconomic context, analyzing and describing how technological development affects the development of the economy. Over time, researchers have shifted away from perceiving innovation in macroeconomic context and microeconomic analysis has begun, where technological development has been perceived as a process (Brożek, 2017: 16).

Empirical measures of innovation relate to different aspects of innovation, different stages of the innovation process, and different conditions for innovation (Nooteboom and Stam, 2008: 22). According to Hekkert et al. (2007: 420-421), the measurement of innovation system performance is a complex task, which, depending on the purpose, may focus on the system functions, its ability to achieve certain outcomes, or directly capture the performance of its elements, such as actors, networks, and institutions.

When we look into the history, the first generation of innovation measures, dated from the late 1950s to the mid-1960s, originated from research and development investigation. The innovation performance of countries was compared based on input measures (e.g. R&D expenditure, number of scientists, etc.), despite the limitations of these measures and their definitions. At that time, several studies and contributions intended to develop international standards for R&D measurement, and to focus on measuring those activities in R&D that do matter to innovation and technology change (Donoso, 2017: 2). As a result, in June 1963, the first version of Proposed Standard Practice for Surveys of Research and Development, also known as the Frascati Manual, was released (Grzelak et al., 2017: 61). The Frascati Manual represents a standard for R&D surveys in OECD member countries and as a result of initiatives by the OECD, UNESCO, the European Union, and various regional organizations, it has become a standard for R&D surveys worldwide. Over the years of experience, the authors have elaborated on the concept of science and technology indicators and developed a series of methodological manuals known as the Frascati Family (OECD,

2002: 3). The most important manual from the Frascati Family in the field of statistical research into the innovation activity is the Oslo Manual, representing the international reference guide for collecting and using data on innovation (OECD/Eurostat, 2019: 258).

During the past decade, increasing literature has dealt with the development and use of indicators to improve the measurement and characterization of innovation systems (e.g. Archibugi et al., 2009). Currently, the innovation performance and innovativeness of countries are mostly measured by composite or multidimensional indices, combining different pillars of input and output measures of innovations. While a comprehensive overview of existing composite indicators is beyond the scope of this paper, Table 1 provides a brief overview of selected composite indicators of innovation.

Table 1 Overview and summary of selected composite indicators of innovation

Name	**Global Innovation Index (GII)**	**Summary Innovation Index (SII)**	**Innovations-indikator (II)**
Publisher	Cornell University, INSEAD, WIPO	European Commission	BDI, Fraunhofer ISI, ZEW, UNU-MERIT
First edition	2007	2001	2005
Latest edition	2019	2019	2020
Frequency	Annual	Annual	Annual
Target countries	World (129 countries)	EU countries and other European countries	35 selected countries from Europe, OECD, BRICS to benchmark Germany
Structure (of the most recent index)	80 indicators aggregated in 21 sub-pillars, 7 pillars, 2 sub-indices	27 indicators aggregated in 10 dimensions and 4 main types	38 variables aggregated into 5 sub-systems
Aggregation method	Linear average with weights as scaling coefficients	Linear average with nominally equal weights	Linear average with nominally equal weights

Source: Own summary based on Hollanders and Janz (2013: 280-281) and respective reports (Cornell University, INSEAD, and WIPO, 2019; European Union, 2019; BDI, 2020)

Composite innovation indexes, presented in scoreboards ranking the performance of countries or regions, are mostly produced by consultants, research institutes, and policy institutions by aggregating existing (normalized) indicators (OECD/Eurostat, 2019: 220). Although the indicators share a number of commonalities, they are distinguished by their structure, methodology, size of the sample, as well as their focus, what concept or aspect of innovation they aim to measure, and which policy goals they aim to support.

2 Innovation effects

Economic theories emphasize the critical importance of innovation in sustaining long-run economic growth (Kumar and Sundarraj, 2018: 49). Innovations are considered an important factor of economic growth, and more often than not, as the single most important factor (Noteboom and Stam, 2008: 53). According to Schumpeter (2012b), innovations are the prime movers of economic change, and sustained economic growth leads to substantial long-term enhancement in per capita income and is particularly vital to those who form the base of the economic pyramid (Ahuja et al., 2008).

There are several studies dealing with the effects of innovation on economic growth, employment, and total factor productivity. According to Kumar and Sundarraj (2018: 2), innovations permit to use of resources more frugally and efficiently and are key drivers of productivity and a crucial engine of growth. However, as mentioned in the article from Aghion and Howitt (1998), an instance of high technological discontinuity, such as the emergence of a major innovation, can initially have an effect of causing a decrease in economic activity before having a beneficial effect on long-term growth. This can be explained by the role of innovation in economic business cycles and it simplified rests on the idea that the emergence of a major technological innovation requires a period of adjustment before having beneficial effects (Bresnahan and Trajtenberg, 1992).

Considering the economic impact of innovation, several studies claim that innovation-intense industries create highly skilled jobs, have higher wages, are more productive, lead exports, and enhance competitiveness during the business cycle (e.g. Meriküll, 2010; Pianta and Tancioni, 2008; Dabla-Norris et al., 2012). However, the article by Cerisier and Postel-Vinay (1998) raises the important question of whether technical progress destroys more employment than in creates, or whether low-skill jobs destroyed in innovative industries are counterbalanced either by skilled jobs

created in those same industries or more generally by low-skill jobs in other industries due to the increase in overall demand.

Although innovation is mostly seen as primarily of economic value and purpose, it is widely recognized that regardless of economic growth, innovation is also of value in solving societal problems, has cultural value and intrinsic value for the flourishing of people, in activities of creation and self-realization (Nooteboom and Stam, 2008: 20).

3 Data and methodology

In order to investigate the impact of innovation, measured by R&D expenditure, on economic growth, we firstly collected all necessary data for the EU27. As the latest data for some of the measures were available for the year 2018, we limited our analysis to the period of 2008-2018. We used the official statistics of the European Union from the Eurostat Dataset to gain all relevant information for the analysis.

In our study, the dependent variable is the real GDP growth rate, which is intended to allow comparisons of the dynamics of economic development both over time and between economies of different sizes. For measuring the growth rate of GDP in terms of volumes, the GDP at current prices are valued at the prices of the previous year and the thus computed volume changes are imposed on the level of a reference year (Eurostat, 2020a).

Following the main goal of this paper, the dependent variable is the share of R&D expenditure on GDP. This measure is defined as the total expenditure (current and capital) on R&D carried out by all resident companies, research institutes, university and government laboratories, etc. in a country. It includes R&D funded from abroad but excludes domestic funds for R&D performed outside the domestic economy (Eurostat, 2020b).

Moreover, we enriched the study of further variables, which could impact the real economic growth rate, in order to use this study as a baseline for future research dealing with other aspects impacting economic growth. As a control variable, gross fixed capital formation as a percentage of GDP was chosen, as there are several empirical studies dealing with the linkage between the average rate of investment in fixed assets and the average growth rate of GDP (e.g. Sørensen and Whitta-Jacobsen,

2010). This measure consists of resident producers' investments, deducting disposals, in fixed assets during a given period. In other words, it measures the net increase in fixed capital.

Finally, we also included a share of general government final consumption expenditure on GDP, which consists of expenditure incurred by the government and its production of non-market final goods and services, as well as market goods and services provided as social transfers in kind. The last control variable ist the fertility rate, referring to the total number of children that would be born to each woman if she were to live to the end of her child-bearing years and give birth to children in alignment with the prevailing age-specific fertility rates (OECD, 2020).

For each of the above-mentioned variables, we performed correlation analysis separately according to different years as well as EU27 countries. The results are summed up in the following chapter.

4 Results

Table 2 provides information for the analyzed indicators mentioned above. The information includes mean values, standard deviation minimum, and maximum. The analysis was performed on 297 observations, corresponding to 27 EU countries and 11 years between 2008 and 2018 including.

The mean real GDP growth rate is 1,4% and the standard deviation is almost two times greater at 2,7%. The mean is based on observations from all countries and that could be the reason for a great standard deviation, as we suppose that every country has different characteristics that influence real GDP growth.

Table 2 Descriptive statistics

Variable	Obs.	Mean	Std. dev.	Min	Max
Real GDP growth rate	297	0,014	0,027	- 0,148	0,252
General government final consumption expenditure as a percentage of GDP	297	0,199	0,031	0,119	0,279
Gross fixed capital formation as a percentage of GDP	297	0,212	0,034	0,111	0,373
R&D expenditure as a percentage of GDP	297	0,016	0,009	0,004	0,037
Fertility rate	297	1,556	0,198	1,209	2,070

Source: Own calculations

Considering R&D expenditure as a percentage of GDP during the analyzed years there has been a standard deviation of only 0,9%. Countries with the highest degree of R&D carried out by all resident companies, research institutes, university and government laboratories are Sweden, Finland, Denmark and Austria that are also considered as innovation leaders and strong innovators within the European Innovation Scoreboard (European Commission, 2020).

Table 3 Correlation matrix between dependent variables and predictors

Variable	Real GDP growth rate	General government final consumption expenditure as a percentage of GDP	Gross fixed capital formation as a percentage of GDP	R&D expenditure as a percentage of GDP	Fertility rate
Real GDP growth rate	1				
General government final consumption expenditure as a percentage of GDP	- 0,309	1			
Gross fixed capital formation as a percentage of GDP	0,310	- 0,067	1		
R&D expenditure as a percentage of GDP	- 0,133	0,685	0,150	1	
Fertility rate	0,062	0,446	0,333	0,485	1

Source: Own calculations

Table 3 represents a correlation matrix between dependent variables and predictors. As we can see from the table, the real GDP growth rate is not even positively associated with R&D expenditure as a percentage of GDP. In our analysis there has been a positive correlation between these two variables only in the years 2009 and 2010, resulting from the world financial crises that took place in these years.

To sum it up, as a result of the conducted study, there is no relationship between real GDP growth rate and share of R&D expenditures on the GDP. Although the investment volumes allocated to R&D show increases in recent years, the real GDP growth rate slows down which can be explained

by the current situation of the global economy and the risk of its overheating. At the same time, we have to take into consideration that the investment in innovation is a long-term investment that can show its results in GDP in the next 10-20 years.

References

Aghion, P. and Howitt, P. (1998): On the Macroeconomic Effects of Major Technological Change. In: Annales D'Économie Et De Statistique, (49/50), pp. 53-75, doi: 10.2307/20076110.

Ahuja, G. et al. (2008): Moving Beyond Schumpeter: Management Research on the Determinants of Technological Innovation. In: The Academy of Management Annals, Vol. 2, No. 1, pp. 1-98, doi: 10.1080/19416520802211446.

Archibugi, D. et al. (2009): The technological capabilities of nations: The state of the art of synthetic indicators. In: Technological Forecasting and Social Change, 76(7), pp. 917-931. doi: 10.1016/j.techfore.2009.01.002.

BDI (2020): Innovationsindikator 2020. http://www.innovationsindikator.de/fileadmin/content/2020/pdf/Innovationsindikator_2020-kompakt.pdf. Accessed: 15.08.2020.

Bresnahan, T. and Trajtenberg, M. (1992): General Purpose Technologies: “Engines of Growth?”. doi: 10.3386/w4148.

Brożek, K. (2017): Comparative Analysis of Selected Determinants of Innovation in EU Countries. In: Grant Journal, Vol. 6, No. 2, pp. 16-19, http://www.grantjournal.com/issue/0602/PDF/0602brozek01.pdf. Accessed: 15.08.2020.

Cerisier, F. and Postel-Vinay, F. (1998): Endogenous Growth and the Labour Market. In: Annales D'Économie Et De Statistique, (49/50), pp. 105-126, doi: 10.1007/978-1-4757-3194-1_4.

Cornell University, INSEAD and WIPO (2019): The Global Innovation Index 2019: Creating Healthy Lives—The Future of Medical Innovation. https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2019.pdf. Accessed: 15.08.2020.

Dabla-Norris, E. et al. (2012): Firm Productivity, Innovation, and Financial Development. In: Southern Economic Journal, Vol. 79, No. 2, pp. 422-449, doi: 10.4284/0038-4038-2011.201.

Donoso, J. F. (2017): A simple index of innovation with complexity. In: Journal of Informetrics, 11(1), pp. 1-17, doi: 10.1016/j.joi.2016.10.009.

European Commission (2020): European innovation scorerboard. https://ec.europa.eu/growth/industry/policy/innovation/scoreboards_en. Accessed: 15.08.2020.

European Union (2019): European Innovation Scoreboard 2019. Luxembourg: Publications Office of the European Union, 2019. ISBN 978-92-76-01394-5.

Eurostat (2020a): Real GDP growth rate – volume. https://ec.europa.eu/eurostat/web/products-datasets/-/tec00115&lang=en. Accessed: 15.08.2020.

Eurostat (2020b): Statistics on research and development (rd). https://ec.europa.eu/eurostat/cache/metadata/en/rd_esms.htm#stat_pres1580396515916. Accessed: 15.08.2020.

Grzelak, M. M. et al. (2017): Innovation activities of industrial enterprises in Poland in the light of public statistics. In: Acta Sci.Pol. Oeconomia, 16(4), pp. 61-70, doi: 10.22630/ASPE.2017.16.4.45.

Hekkert, M. P. et al. (2007): Functions of innovation systems: A new approach for analysing technological change. In: Technological Forecasting and Social Change, 74(4), pp. 413-432, doi: 10.1016/j.techfore.2006.03.002.

Hollanders, H. and Janz, N. (2013): Scoreboards and indicator reports. In: Handbook of Innovation Indicators and Measurement. Cheltenham: Edward Elgar Publishing, 2013. eISBN 9780857933652.

Jussi, S. J. and Hooli L. (2020): Innovation for Development in Africa. New York: Routledge, 2020. ISBN: 978-0-367-34957-8.

Kumar, V. and Sundarraj, R. P. (2018): Global Innovation and Economic Value. New Delhi: Springer India, 2018. ISBN 978-81-322-3760-0.

Matsunaga, N. (2019): Innovation in developing countries: Lessons from Vietnam and Laos. Singapore: Springer, 2019. ISBN 978-981-13-3524-2.

Meriküll, J. (2010): The Impact of Innovation on Employment: Firm- and Industry-Level Evidence from a Catching-Up Economy. In: Eastern European Economics, Vol. 48, No. 2, pp. 25-38, doi: 10.2753/EEE0012-8775480202.

Nooteboom, B. and Stam, E. (2008): Micro-Foundations for Innovation Policy. Amsterdam: University Press, 2008. eISBN 978-90-485-0130-4.

OECD (2002), Frascati Manual 2002: Proposed Standard Practice for Surveys on Research and Experimental Development, The Measurement of Scientific and Technological Activities, OECD Publishing, Paris, https://doi.org/10.1787/9789264199040-en.

OECD (2020): Fertility rates. https://data.oecd.org/pop/fertility-rates.htm. Accessed: 15.08.2020.

OECD/Eurostat (2019), Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation, 4th Edition, The Measurement of Scientific, Technological and Innovation Activities, OECD Publishing, Paris/Eurostat, Luxembourg, https://doi.org/10.1787/9789264304604-en.

Pianta, M. and Tancioni, M. (2008): Innovations, Wages, and Profits. In: Journal of Post Keynesian Economics, Vol. 31, No. 1, pp. 101–123, doi: 10.2753/PKE0160-3477310105.

Schumpeter, J. A. (2012a): The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle. New Brunswick and London: Transaction Publishers, 2012. ISBN 0-87855-698-2.

Schumpeter, J. A. (2012b): Capitalism, socialism and Democracy. Floyd, Va.: Wilder Publications, 2012. ISBN: 978-16-172-0865-2.

Sørensen, P. B. and Whitta-Jacobsen, H. J. (2010): Introducing advanced macroeconomics: Growth and business cycles. Edinburgh: McGraw-Hill Education, 2010. ISBN 978-0077117863.

Contact information

Ing. Juliana Bérešová
Department of Economics
Faculty of Business Economics
University of Economics in Bratislava
Tajovského 13
041 30 Košice
Slovakia
Juliana.Beresova@student.euke.sk