

# Innovation and Competitiveness in the European Union with and without Britain

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## Abstract

This paper aims to assess the correlation between economic competitiveness and innovation potential within the European Union in the context of Brexit. For the quantitative evaluation of the mentioned relationship, we use the World Economic Forum Index as a proxy variable for economic competitiveness, respectively the following five indicators for different dimensions of the innovative potential at the level of EU member states: gross expenditures on R&D, R&D personnel, innovative enterprises, patent applications, and high-tech exports. In our research, we want to find out the impact of Brexit on the correlation between innovation and competitiveness in the EU, in which sense we demonstrate the hypothesis that the UK's exit from the EU has led to a differentiated reduction in the contribution of different innovative components on competitiveness. The main objective of our analysis aims to quantify / rank the intensity of the correlation between the different indicators of innovation and competitiveness, on the whole EU-27 compared to EU-28 in 2019 (the year before Brexit). In order to determine the intensity of the correlations, we calculated the correlation coefficients and the coefficients of determination between the variables of innovation and economic competitiveness, and then, to identify management priorities, we analyzed comparatively the values for EU-28 and EU-27 for each category of indicators. Our findings show that the strongest correlations are between competitiveness and R&D expenditures, respectively high-tech exports to both the EU-28 and the EU-27, but the most visible impact of Brexit was on the R&D personnel, an indicator whose contribution to competitiveness recorded the most significant decrease post-Brexit. In this context, the original contribution and practical implications of this research are given by the identification of priorities for intervention in the field of innovation to improve competitiveness in the EU-27 post-Brexit.

## Keywords

Innovation, competitiveness, correlation, impact of Brexit, European Union post-Brexit

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## Introduction

Increasing the interest of European governments and institutions to ensure sustainable growth in the European Union (EU) under the conditions generated by Brexit, has generated a constant focus of attention of EU forums on increasing economic competitiveness based on innovative input. Assuming that competitiveness depends on the ability to innovate and modernize (Porter, 1990), European decision-makers have in recent years focused on increasing competitiveness by pursuing policies to encourage advanced research and the application of industry results (Clark and Guy, 1998). Against this background, there has been a continuous evolution of the approach to innovation versus competitiveness, in the sense of sophistication and diversification of the subjects investigated. The reflection of these trends in current economic assessments has materialized through the configuration of several lines of analysis regarding the place and role of innovative components in the chain of support for competitiveness. Starting from standard approaches that postulate the comprehensible and positive relationship between innovation and competitiveness (Huang, 2011), current analyzes focus on multiple aspects, such as normative and legislative favorability of innovation (Berkhout, 2006), the potential of regional factors generating

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innovation and competitiveness (Camagni and Capello, 2013; Aarts, Van Woerkum and Vermunt, 2007; Martin, 2005), the valences of cultural factors in the innovation process (Branču et al., 2015; Petrakis, Kostis and Valsamis, 2015), the role of intermediaries in promoting innovation (Howells, 2006), the impact of ITC technologies (Ollo-López and Aramendía-Muneta, 2012) and the multi-level integration of technology systems on innovation and competitiveness (Markard and Truffer, 2008).

Quantitative knowledge of the relationship between the various components of innovation (investments in research and development - R&D, R&D personnel, innovative enterprises, patents, high-tech exports) and economic competitiveness is relevant for prioritizing decisions to improve the European and national regulatory framework with an impact on stimulating innovation in the post-Brexit European economy. In an organization with a level of integration such as the EU, the existence of an innovative environment based on incentive regulations is essential, as a prerequisite for sustainable economic performance (Haidar, 2012).

Against the background of the changes caused by the departure of the United Kingdom (UK) from the EU, our interest is focused on the specific research issue on the impact of Brexit on the correlation between innovation and competitiveness in the EU. In investigating the relationship between these terms, we are testing the hypothesis that Britain's exit from the EU has led to a differentiated reduction, on different innovative components, of the contribution of innovation to competitiveness. In this context, the objective of our research is to quantify / rank the intensity of the correlation and explanatory contribution between the different indicators of innovation and economic competitiveness in the EU-27 compared to the EU-28 at Brexit, in order to substantiate normative intervention priorities to improve EU competitiveness post-Brexit. The epistemological framework of our research was revealed through the systematic analysis of the literature, and the relationship between innovative components and competitiveness was investigated using quantitative methods (calculation of correlation and determination coefficients) and comparative analysis.

Our study covers an unprocessed area in the literature, namely the comparative investigation of the behavior of the different components of innovation in relation to economic competitiveness in the EU with and without the United Kingdom. The paper is structured modularly, starting with an introductory section followed by a brief review of the essential elements of the literature. Next section contains the general picture of empirical research, followed by a presentation and discussion of the results of empirical modelling, and finally a presentation of research findings.

## 1. Review of the scientific literature

The implications of Brexit for the European economy as a whole have led to a focus of scientific analysis on ways to increase the contribution of innovation to maintaining economic competitiveness in the EU. The different perspectives of the approach have considerably extended the epistemological and conceptual area of the field. Competitiveness is a concept specific to the integrated and globalized world influenced by a multitude of determinants (Van de Ven et al., 1999) of which innovation is unanimously recognized as one of the key engines. But the way in which the innovative dimension contributes to forging a competitive environment raises many views and controversies. Referring to EU innovation policies, Clark and Guy (1998) identify in the EU a number of paradoxes in the relationship between research and productivity, due to the inability of many Member States to make the most of their existing innovation base; the two authors consider the linear models of innovation to be outdated and propose "focusing European policies on promoting the diffusion and efficient use of technologies in order to close the development gaps and solve the paradoxes of research and productivity" (Clark and Guy, 1998, p. 389). Along the same lines, Shim and Shin (2022) show that the value of R&D investment does not necessarily have an impact on the performance of R&D programs, so that in order to generate the efficient effects of innovation it is necessary to add an efficient management of the innovative process (Tidd and Bessant, 2018), to use a highly qualified human resource (Koottatep, Sukavejworakit and Virasa, 2021) and to adopt adequate marketing strategies and implementation of R&D programs (Chabowski and Mena, 2017).

The concept of national competitiveness is even persecuted by Krugman (1994, p. 28), who states that "the idea that a country's economic fortunes are largely determined by its success on world markets is a hypothesis, not a necessary truth; and as a practical, empirical matter, that hypothesis is flatly wrong". Applying the above thesis to EU states, the author argues that "in each case, the growth rate of living standards essentially equals the growth rate of domestic productivity - not productivity relative to competitors, but simply domestic productivity" (Krugman, 1994, p. 41). The relationship between innovation and competitiveness has been approached even from a philosophical-economic perspective, with reference to the ways in which economists must convince European decision-makers on the strategies they propose for building innovation policies. The approach can be a difficult one, given that, according to Davies (2011), their advice must be precise, credible and loaded with the epistemological weight of

justification, but at the same time not be too burdened by quantitative, econometric and bureaucratic formulas. Empirical studies propose three ways for the effective transfer of knowledge from the scientific niche to the decision-making niche: by emphasizing its practical utilitarian character, by emphasizing its aesthetic attractiveness, or by suggesting its supreme character of ontological knowledge (Davies, 2011).

In an increasingly competitive and interdependent world, scientists point to different solutions to maximize the effects of innovation on EU competitiveness. In order to stimulate innovation, a flexible legislative framework is essential to create favorable conditions for investment in R&D infrastructure (Cebula and Mixon, 2014), and Haidar (2012) shows that every reform of business regulations induces an average increase of 0.15% in economic growth.

In line with the principle of subsidiarity and EU multilevel governance, a number of current studies include regional competitiveness in the concept of regional development. Thus, Camagni and Capello (2013) argue, through the grid of endogenous growth theory, that the use of local territorial capital is the basic link, at the regional level, in shaping competitiveness, and Martin (2005) assesses the competitive potential of regional factors from the perspective of different theories of economic growth. Based on case studies from the Netherlands, Aarts, Van Woerkum and Vermunt (2007) demonstrates the need to include innovative regional strategies in spatial planning policies. Socio-cultural factors are another explanatory element for the characteristics of the entrepreneurial and innovative spirit generating competitiveness (Brancu et al., 2015), context in which Petrakis, Kostis and Valsamis (2015, p. 1436) argue that "a society that has or is developing a pro-innovation culture can perform better in the future, despite adverse macroconditions. In contrast, an anti-innovation culture hinders innovation and competitiveness, even if policymakers improve macroconditions".

Firms can act as redistributors of innovative goods and services as agents of innovation, a process widely practiced in the United Kingdom (Howells, 2006) and which can be successfully replicated in the EU, especially in the field of high technologies (Ollo-López and Aramendía-Muneta, 2012). IT&C technologies are responsible for most of the innovative contribution to the EU (Fagerberg, 1996), which has led to the recent emergence of the concepts of technological sustainability and sustainable technologies as complementary terms to sustainable development (Vacchi et al., 2021). Non-polluting technologies are the main elements in the category of sustainable technologies (Saunila et al., 2019), whose integration in the form of multi-level networks is the key to the spill-over of innovation and competitiveness (Markard and Truffer, 2008).

Against the background of the trends of quantification and modelling of the innovative process, the concept of responsible research and innovation (RRI) was recently launched as a model in which social and innovative actors become mutually responsible to each other in the innovative process (Stahl et al., 2017). In this regard, Owen et al. (2013) proposed the creation of a legal and ethical framework for responsible innovation.

The effects of Brexit on regional competitiveness appear to be different in the UK from the EU. According to research by Thissen et al. (2020), the greater vulnerabilities of the British regions compared to the vulnerabilities of the EU regions (due to the dependency of the UK on the EU via global value chains), will shape the rise of interregional inequalities in the UK compared to the EU situation. However, current studies do not indicate the correlations between the components of innovation and economic competitiveness in the EU in the context of Brexit, a segment that our current analysis investigates.

## **2. Research methodology**

In investigating the relationship between competitiveness and innovation we use a series of indicators as evaluation proxy variables. To express competitiveness, we use the global competitiveness index (built by the World Economic Forum), and to express the innovative potential we use five specific indicators (provided by Eurostat): volume of R&D expenditure, R&D staff, number of innovative enterprises, number of patent applications and volume high-tech exports. At the same time, we use as analysis tools the reports of the European Commission (Annoni and Dijkstra, 2019; Martin, 2005) and of the World Economic Forum on economic competitiveness in the EU (World Economic Forum, 2019). The reference administrative-territorial units are the EU Member States, for which we use statistics at the level of the last year (2019) of the UK's presence in the EU (Table no. 1).

**Table no. 1. Parameters of competitiveness and innovation in the European Union**

Countries	Competitiveness Index (points)	R&D Expenditures (€ billion)	R&D Personnel (No.)	Innovative enterprises (No.)	Patent applications (No.)	High-tech exports (€ billion)
Belgium	76.4	15.109	93,524	9,835	876	33,078
Bulgaria	64.9	0.512	26,399	4,664	186	2,098
Czechia	70.9	4.348	79,245	11,358	765	37,656
Denmark	81.2	9.107	62,229	5,301	1,351	9,578
Germany	81.8	110.025	735,584	100,250	46,632	208,148
Estonia	70.9	0.453	6,394	2,801	31	1,735
Ireland	75.1	4.370	32,170	2,007	58	39,354
Greece	62.6	2.337	53,932	7,368	356	1,778
Spain	75.3	15.572	231,413	21,986	1,288	15,036
France	78.8	53.427	461,891	35,716	14,103	120,534
Croatia	61.9	0.600	14,492	3,915	195	0,952
Italy	71.5	26.259	355,854	74,856	9,229	32,548
Cyprus	66.4	0.164	2,121	1,394	4	0,093
Latvia	67.0	0.195	5,924	1,558	82	1,469
Lithuania	68.4	0.486	12,998	3,917	90	2,527
Luxembourg	77.0	0.737	5,790	982	117	0,791
Hungary	65.1	2.158	56,943	4,814	427	18,426
Malta	68.5	0.080	1,588	498	5	0,754
Netherlands	82.4	17.760	160,422	13,523	2,228	86,981
Austria	76.6	12.441	83,660	11,333	2,066	15,959
Poland	68.9	7.046	164,006	14,675	3,887	19,829
Portugal	70.4	2.991	61,455	7,843	703	3,594
Romania	64.4	1.067	31,665	4,198	881	6,994
Slovenia	70.2	0.990	16,983	2,365	255	2,333
Slovakia	66.8	0.776	21,196	2,599	206	8,048
Finland	80.2	6.715	51,494	5,399	1,321	4,563
Sweden	81.2	16.154	92,172	11,600	1,802	17,416
United Kingdom	81.2	44.364	486,088	42,515	12,061	76,894
<b>EU-28</b>	<b>72.4</b>	<b>356.243</b>	<b>3,407,632</b>	<b>409,270</b>	<b>101,205</b>	<b>769,166</b>
<b>EU-27</b>	<b>72.0</b>	<b>311.879</b>	<b>2,921,544</b>	<b>366,775</b>	<b>89,144</b>	<b>692,272</b>

Sources: World Economic Forum, Eurostat, 2019.

Against the background of the UK's exit from the EU, there is a decrease in the competitive and innovative potential of the EU-27 compared to the EU-28 for all benchmarks, a context in which we want to find out the impact of Brexit on the correlation between innovation and competitiveness in the EU. To quantify the intensity of the link between economic competitiveness and the five parameters of innovation in Brexit conditions, we used the Pearson correlation coefficient ( $r$ ) as an evaluation tool. Then, we calculated the coefficient of determination ( $r^2$ ) in order to quantify the extent to which the decline in innovation potential in the EU-27 explains the variation in economic competitiveness (Table no. 2).

**Table no. 2. Correlations between competitiveness and innovation components in the European Union**

Correlated variables and reference space		Coefficients used		
		Pearson correlation	Coefficient of determination	p-value
Competitiveness Index & R&D expenditures	EU-28	0.56	0.31	0.001818***
	EU-27	0.52	0.27	0.004535***
Competitiveness Index & R&D Personnel	EU-28	0.52	0.27	0.004473***
	EU-27	0.46	0.21	0.013709**
Competitiveness Index & Innovative enterprises	EU-28	0.40	0.16	0.033714**
	EU-27	0.36	0.13	0.063368*
Competitiveness Index & Patent applications	EU-28	0.41	0.16	0.026189**
	EU-27	0.39	0.15	0.043265**
Competitiveness Index & High-Tech exports	EU-28	0.55	0.30	0.002107***
	EU-27	0.53	0.28	0.004392***

Notes: \*\*\* Significance level of 0.01; \*\* Significance level of 0.05; \* Significance level of 0.1

Source: Author's proceedings based on World Economic Forum and Eurostat, 2019.

We evaluate the robustness of the link between competitiveness and innovation based on the values of the Pearson coefficient ( $r$ ) and, according to the interpretive grid of Hopkins (2000), we find the following:

- a high correlation ( $r: 0.5 - 0.7$ ) between competitiveness and R&D expenditures, as well as between competitiveness and high-tech exports, both in the EU-28 ( $r = 0.56$  and  $0.55$  respectively) and in the EU-27 ( $r = 0.52$  and  $0.53$  respectively).

- a moderate correlation ( $r: 0.3 - 0.49$ ) between competitiveness and innovative enterprises, as well as between competitiveness and patents, both in the EU-28 ( $r = 0.40$  and  $0.41$  respectively) and in the EU-27 ( $r = 0.36$ , respectively  $0.39$ ).

- on the size of the relationship between competitiveness and the share of R&D staff, the correlation is high only in the EU-28 ( $r = 0.52$ ), and after Brexit it is moderate ( $r = 0.46$ ).

Then, we analyzed the impact of the decrease in innovative parameters on the level of competitiveness in the EU-27 based on the values of the coefficient of determination ( $r^2$ ) and, according to the evaluation model of Cohen (1988), we found the following situations:

- the volume of R&D expenditures and high-tech exports induces a substantial effect on economic competitiveness ( $r^2 > 0.26$ ), both in the EU-28 ( $r^2 = 0.31$  and  $0.30$  respectively) and in the EU-27 ( $r^2 = 0.27$ , respectively  $0.28$ ).

- the number of innovative enterprises and patents has a moderate effect on competitiveness ( $r^2: 0.13 - 0.26$ ), both in the EU-28 ( $r^2 = 0.16$  both) and in the EU-27 ( $r^2 = 0.13$  and  $0.15$  respectively).

- the share of R&D personnel generates a substantial effect ( $r^2 = 0.27$ ) on competitiveness in the EU-28, while in the EU-27 it induces a moderate effect ( $r^2 = 0.21$ ).

The comparative analysis of the coefficients of determination ( $r^2$ ) at EU-28 and EU-27 level for each innovation indicator allowed the ranking of innovative parameters according to the size of the decrease of their competitive contribution with Brexit. In fact, the method has made it possible to identify the most vulnerable innovative indicators, the improvement of which would raise the level of competitiveness at European level in the post-Brexit era.

The evaluation of the correlations between the innovation variables and the economic competitiveness with the help of the coefficients used is valid because it is based on data on the entire community space, and the veracity of the results is ensured by the margin of significance of 0.05 for each of the correlations (except for the correlation between innovative enterprises and competitiveness, credited in the margin of significance level of 0.1).

### 3. Results and discussion

Our results show that within the EU-28, among the innovative parameters used, the volume of R&D expenditure was the strongest correlation with economic competitiveness, followed by high-tech exports, and the weakest correlation was for innovative companies. Without the UK, however, the strongest link between competitiveness and innovation in the EU-27 lies in high-tech exports, followed by R&D investment, and the lowest correlation also lies with innovative companies. The explanation for the phenomenon lies in the fact that many of the companies included in the category of innovative ones do not constantly operate innovative solutions, partially apply them or have abandoned some of the processed innovative schemes.

The hierarchy is also maintained in terms of effects on competitiveness. In the EU-28, the variation in competitiveness is determined in proportion of 31% by fluctuations in R&D investments and 30% by fluctuations in high-tech exports. In the EU-27, the main share belongs to high-tech exports (28%), and investments in the R&D sector occupy the second place with 27%, while the innovative enterprises register the weakest impact of only 13%.

Regarding the impact of Brexit on reducing the competitive contribution of innovation indicators, the most significant decrease is in the case of the R&D personnel category: the contribution of this indicator on economic competitiveness decreases by 6% with the transition from EU-28 to EU-27. Similarly, the correlation and deterministic effect of R&D investment on economic competitiveness is reduced by 4%. The smallest decrease in deterministic effects concerns the category of patents whose correlation with competitiveness decreases by 2%, and its effect on competitiveness is reduced by only 1%.

Therefore, the hierarchy of declines in the contribution of innovation to competitiveness, as a result of the UK's withdrawal from the EU, shapes the priorities for action by EU decision-makers to overcome the innovative deficit generated by Brexit. Thus, the priority areas of normative intervention identified are: stimulating the training of highly qualified human resources for the R&D field, encouraging investments

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(public and private) in the R&D sector and stimulating high-tech exports. It should be noted that the decrease in the contribution of high-tech exports and innovative enterprises is approximately equal (2-3%) in the absence of the UK, but the situation of the contribution of high-tech exports at a much better level (28%) compared to innovative firms (13%), makes encouraging high-tech exports more important than stimulating innovative companies.

## Conclusions

In the conditions of Brexit, the innovative dimension acquires new valences in the configuration of the competitive potential in the EU, materialized by the differentiated reduction, on different innovative components, of the contribution of the innovation on the competitiveness. The strongest deterministic effects of innovation on economic competitiveness are provided by the R&D investment component, followed by the volume of high-tech exports, both at EU-28 and EU-27 level, but the most visible impact of Brexit was on the component human resources R&D, an indicator whose contribution to competitiveness registered the most significant decrease with the departure of Great Britain from the union club. In this context, the original contribution of this research is the construction of a hierarchy of innovative deficits responsible for the relative decline of the EU. The practical implications of our approach are to identify the most suitable innovative segments for legislative-normative intervention in order to maximize the improvement of the competitive potential in the EU-27 post-Brexit. Stimulating the training of research staff for the R&D sector, promoting the favorable regulatory framework for R&D investments and favoring high-tech exports are the main levers for remedying the competitive deficit generated by the withdrawal of the UK. The concrete construction of the mechanisms for implementing these instruments opens the perspective of interdisciplinary extensions of research between complementary epistemic areas, such as European economics and business, European law, territorial planning, regional development, economic geography.

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