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Import of Goods and Services as a Stimulus for a Better National Innovation Performance in EU Member States

Introduction

Scholars have been analysing the concept of innovative capacity of countries and regions since the 1950s (Schumpeter 1942, Solow 1956, Villa 1990, Furman et al. 2002, Hu and Mathews 2005, 2008, Franco and Leoncini 2013, Wu et al. 2017). The innovation productivity differs across economies and the European Union is not an exception. The Union's innovation gap with the United States, Japan, and Canada is foreseen to diminish, yet South Korea is still in the front and China is catching up quickly.

According to Gong and Keller (2003), Huang et al. (2010) and Wu et al. (2017), NIC models should include not only the internal country-level factors, such as expenditures for research and development (R&D), gross domestic product (GDP) or average years of tertiary schooling, but also the attributes of international diffusion of knowledge. The latest works justify these arguments by showing that international economic activities (e.g. international trade and FDI) contribute to countries' ability to produce cutting-edge technologies and increase patent applications (Wu et al. 2017, Litsareva 2017, Filippetti et al. 2017).

Another strong debate is related to the outputs of the national innovative capacity. Among the most commonly used output measures there are patents, either in the form of an absolute number or per million people and patent citation rate (Trajtenberg 1990, Furman et al. 2002, Boly et al. 2014). Nevertheless, employment of these indicators gets quite a lot of critique. Firstly, because of the fact that patents can be effective to capture innovation in manufacturing but they might not be the most suitable indicators for innovation in services (Hipp and Grupp 2005). Consequently, innovation in this sector partly escapes traditional measurement: the use of traditional tools creates an innovation gap, so that actu-

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al innovation is higher than measured and the more economies are service-based, the wider is the innovation gap (De Liso and Vergori 2017). Secondly, not every innovation is patentable and not every patent is used to create an innovation. In practice, large corporations often file many patents but are able to use only a certain percentage of them to create products (Proksch et al. 2017).

To sum up, a remarkable increase in the interdisciplinary attention devoted to innovation capacity has been noticed over the recent decades, yet at least several areas can be improved with additional empirical research. Having in mind the global challenges and research gaps described above, this paper aims to evaluate the impact of imports of goods and services on EU member states' innovative capacity by engaging not only technological but also non-technological innovative output in NIC models. In order to reach this aim, first, the latest scientific literature is reviewed, second, a detailed description of data and methods is presented, and third, the findings of the conducted analyses are demonstrated and explained in six different regression models. Lastly, the most relevant results and implications for further research are highlighted.

1. Literature review

1.1. National innovative capacity and the importance of imports of goods and services

The concept of national innovative capacity (NIC) was originally introduced by Villa (1990). The author described national innovative capacity as changes in technology, invention (ideas that are patented) and the competitiveness of economic activities.

Furman et al. (2002) indicated the determinants of national innovative capacity, claiming it is based on three distinct areas: quality of the common innovation infrastructure, quality of the cluster-specific innovation environment, and quality of linkages. Common innovation infrastructure includes GDP per capita, the amount of scientific and technical skills devoted to the production of new technologies, R&D personnel, R&D expenditure, national investments and policy choices, expenditures on higher education, intellectual property protection, and openness to international competition. Cluster-specific innovation environment is explained by private R&D funding. Quality of linkages between common innovation infrastructure and industrial clusters is revealed by university R&D performance. According to the authors, the intensity of linkages influences the extent to which the potential for innovation evoked by the common innovation infrastructure is translated into specific innovative outputs in a nation's industrial clusters.

Hu and Mathews (2005) found that the process of building national innovation capacity in latecomer countries is comparable to that followed in more advanced countries, yet different in ways. They focused on four variables: patent stocks, levels of R&D manpower, private R&D expenditure and specialization in high-tech industry, along with public R&D funding. Scholars took into attention the contributions of six sectors: public research institutes, universities, state-owned enterprises, private enterprises, foreign ventures, and individuals.

In 2008, Hu and Mathews supplemented the set of determinants proposed by Furman et al. They added a variable of population and the strength of antitrust law of regime for the protection of intellectual property rights in common innovation infrastructure, specialization in technological sectors in cluster-specific innovation environment and the venture capital availability in linkages between innovative infrastructure and industrial clusters.

The results of research performed by Crescenzi, Rodriguez-Pose, Storper (2007), Huang et al. (2010), Franco and Leoncini (2013), and Proksch et al. (2017) show that national innovative capacity is not exclusively determined by local effects, e.g. R&D resource for technology development, but is also influenced by global network position and international cooperation. According to Crescenzi et al. (2007), particular economic geography in which innovation takes place is dependent on movements of labour and capital and the extent to which these produce or follow innovation.

Links between the import and innovation are investigated in a number of studies. Coe and Helpman (1995) emphasize the significance of international trade for international technology diffusion. These authors analyse whether a country's productivity is increasing in the extent to which it imports from high- as opposed to low-knowledge countries, and come to a conclusion that international R&D spillovers are related to the compositions of import. Bertschek (1995) finds that imports and inward foreign direct investment have significant positive effects on product and process innovation and this is mainly influenced by competition with foreign firms which encourages innovation in domestic enterprises. Eaton and Kortum (1996) shift the determinants of competition to the willingness to learn and claim that a country's engagement in international trade facilitates domestic firms' learning about foreign technological knowledge which, afterwards, leads to a considerably increased amount of the innovative products. As Franco and Leoncini (2013) note, the more a country is open and actively performing in research, the more patenting activity can benefit from their virtuous interactions.

In the beginning of the 21st century, more and more scholars started to accentuate the importance of the absorptive capability of a country and its' mediating role in transferring benefits or harm of imports on national innovative capacity. The results of Huang et al. (2010) empirical research show that not only the technology import has a significant positive effect on the innovative capacity of enterprises, but also a very important role is played by venture's absorptive capabilities (i.e. the research outlay input and research staff input).

On the other hand, Chang (2002), Schneider (2005), and Filippetti et. al. (2017) point out that despite the fact that imports facilitate knowledge diffusion across countries in a variety of ways and, in particular, via reverse engineering and the acquisition of knowledge about the seller's design, production and organizational methods, it may have a negative impact, especially in countries with a poor knowledge and innovation context.

All in all, globalization has highlighted a change in national innovative capacity and the latest studies prove that the traditional approach of a closed-system analysis is insufficient. Nevertheless, though scholars demonstrate the relationship between import and innovation capacity of the host country, the results are quite diverse because of the different inputs and methods used. Therefore, further investigation of economic integration variables as inputs of NIC models is necessary.

1.2. The conceptual framework of national innovative capacity

There is a substantial agreement that national innovative capacity greatly depends on the expenditures which are directly related to innovative processes. The most widely used input indicators for NIC (see Table 1) are: R&D expenditures,

Table 1

Indicators used for measuring inputs and outputs of national innovative capacity

NIC input indicators	NIC output indicators
Expenditures: R&D expenditures, private investment on education and training, public expenditures on higher education	Patents: absolute number of patents, patent rate per million people, patent citation rate
Level of property right protection: intellectual property protection	High-tech share of GDP
Specialization: specialization in high-tech or other country-specific innovative industry	Copyrights, trademarks, design applications
Human resources: new doctorate graduates, population with tertiary education, total R&D personnel	Sales: share of innovative sales, medium and high technology product exports, knowledge-intensive services exports
Economic openness: export and import, inward and outward foreign direct investment	The share of small and medium enterprises introducing marketing or organizational innovations
The efficiency of clusters and networks: innovative SMEs collaborating with others, public and private co-publications, private co-funding of public R&D expenditures	
Control variables: GDP per capita, urbanization rate, population density, employment share, gender equality, regime durability, and political stability, political imprisonment and cultural diversity, average years of tertiary schooling	
Publications: number of scientific and technical journal articles (used as both input and output)	
Employment: employment in knowledge-intensive activities, employment in fast-growing enterprises in innovative sectors (used as both input and output)	

Source: own compilation based on Trajtenberg 1990, Villa 1990, Furman et al. 2002, Gong and Keller 2003, Hu and Mathews 2005, 2008, Huang et al. 2010, Sandu and Ciocanel 2014, Boly et al. 2014, Kasa 2015, Proksch et al. 2017, Lee and Rodriguez-Pose 2013, Franco and Leoncini 2013, Zeng 2017, Wu et al. 2017, Zang et al. 2018, European Commission 2018a, Halkos and Skoloudis 2018.

private investment on education and training, and public expenditures on higher education (see e.g. Hu and Mathews 2008, Huang et al. 2010, Kasa 2015). Intellectual property protection, specialization in high-tech or other country-specific innovative industry, the efficiency of clusters and networks are also commonly used indicators (e.g. Sandu and Ciocanel 2014, Zeng 2017, European Commission 2018 a). The latest studies (Gong and Keller 2003, Huang et al. 2010, Franco and Leoncini 2013, Wu et al. 2017, Halkos and Skoloudis 2018) tend to additionally involve the indicators which depict the economic openness of a region, i.e. imports and exports of goods and services, high-tech related export, and inward and outward FDI. Control variables usually consist of GDP per capita, population growth rate, urbanization and employment share in innovative activities (e.g. Hu and Mathews 2008, Lee and Rodriguez-Pose 2013, Proksch et al. 2017).

As innovative capacity primarily depends upon investments and policy choices of both public institutions and the private sector, measuring of the NIC output includes not only patents or citation rate but also other elements of intellectual property, e.g. copyrights, trademarks and design applications (Huang et al. 2010). According to the European Commission (2018a), trademarks and designs reflect non-technological innovation in every sector of economic life, including services. In this context, indicators based on trademark and design data can provide a link between non-technological innovation and the market. In addition to the mentioned indicators, international innovation rankings (e.g. European Innovation Scoreboard (EIS)) evaluate the number of scientific publications and employment in knowledge-intensive activities and innovative sectors.

It can be concluded that a wide range of indicators is used when analysing the drivers and gains of national innovative capacity. Starting with the origins – R&D expenditures and patents, scholars have supplemented the models with more complex qualitative and quantitative indicators of knowledge stock, intangible resources, networks and even policy-making techniques for successful international economic activities.

2. Methodology

Seeking to enrich the research on national innovative capacity, the empirical part of this paper involves all the EU member states. It focuses on international inflows, namely imports of goods and services, as inputs for NIC, and it engages not only patents but also trademark and design applications as well as exports of high-tech products as outputs of NIC.

The most recent available data (from 2007 to 2017) was collected for 28 EU member states (note: United Kingdom is scheduled to leave the European Union on 31st October, 2019). Three sources that meet all statistical requirements (data consistency, availability, and reliability) were used to construct the evidence for 15 variables: Eurostat, EIS 2018 database (European Commission 2018b), and European Union Intellectual Property Office (EUIPO 2019a, b). All the variables are listed in Table 2.

Table 2
Definitions of variables

NIC INPUTS			
Quality of the common innovation infrastructure			
GDP_CAP	Gross domestic product (GDP), euro per capita	IMPORTS_GS	Imports of goods and services, % of GDP
TER_EDU	Population having tertiary education (levels 5–8), % of population	IMPORTS_G	Imports of goods, % of GDP
EDU_EXP	Total public expenditure on education, % of GDP	IMPORTS_S	Imports of services, % of GDP
EMPLOYMENT_HT	Employment in high-technology sectors (high-technology manufacturing and knowledge-intensive high-technology services), % of employment	IMPORTS_HT	Imports of high-tech products, % of GDP
Cluster-specific environment		Quality of linkages	
PRIVATE_RD	Intramural R&D expenditure in the business sector, % of GDP	PUBLIC_RD	Intramural R&D expenditure in the public sector, % of GDP
NIC OUTPUTS			
DESIGN	Community design (CD) applications per million inhabitants	HT_PATENT	High-tech patent applications to the EPO by priority year per million inhabitants
TRADEMARK	European Union trademark (EUTM) applications per million inhabitants	EXPORTS_HT	Exports of high-tech products, % of GDP
PATENT	Patent applications to the European Patent Office (EPO) by priority year, per million inhabitants		

Source: Eurostat Database (Eurostat 2018), EIS Database (European Commission 2018b).

Three different sets of variables were used in regression analysis in order to explore the role of import of goods and services in producing NIC outputs:

(1) all 9 variables + imports of goods and services (out of imports section);

(2) all 8 variables + imports of goods and imports of services (out of imports section);

(3) all 9 variables + imports of high-tech products (out of imports section).

In the beginning of an empirical research, the variable ‘imports of high-tech products’ was additionally decomposed into ‘imports of high-tech products intra-EU28' and 'imports of high-tech products extra-EU28', yet no relevant results were found and the authors of this paper left out this particular set of variables in the further calculations.

The results of correlation and regression analyses are presented in the next section of this article.

3. Empirical findings

There were five different independent variables used as NIC outputs: (1) community design applications per million inhabitants, (2) EU trademark applications per million inhabitants, (3) patent applications to the EPO per million inhabitants, (4) high-tech patent applications to the EPO per million inhabitants, and (5) exports of high-tech products, % of GDP. Their relationships with six distinct types of imports, together with other independent variables, were explored in a correlation analysis (see Table 3) and regression analyses (see Tables 4–15).

As Table 3 demonstrates, there are three NIC outputs which correlate with different types of imports positively (design applications, trademark applications, and exports of high-tech products) and two NIC outputs which correlate negatively (patent applications and high-tech patent applications).

There is a weak positive relationship between the number of design applications per capita and imports of goods and services (0.394, $p = 0.000$), population with tertiary education (0.385, $p = 0.000$) and government expenditures for education (0.307, $p = 0.000$). When the variable 'imports of goods and services' is decomposed into 'imports of goods' and 'imports of services', a moderate positive relationship between design applications and imports of services (0.595, $p = 0.000$) is found while imports of goods apparently affect the particular dependent variable negatively (–0.180, $p = 0.004$).

Another analysed output of NIC is trademark applications. A strong positive relationship between the number of trademark applications and imports of goods and services can be observed (0.681, $p = 0.000$). In addition to this, it can be noticed that import of services has even more positive effects on trademark applications (0.857, $p = 0.000$).

The last variable which has a positive relationship with imports is exports of high-tech products. It can be stressed that imports of high-tech products affect the amount of exported high-tech products substantially (0.922, $p = 0.000$). Indeed, there can be at least several explanations for these results. For example, a country can be acting as a transit one and reselling the goods. This might also explain why a positive relationship with import of goods is stronger than with import of services.

These results prove that an international transmission of knowledge through import spillover boosts a number of innovative outputs (design applications, trademark applications, and exports of high-tech products), and is even more important than direct expenditures on education or investment in R&D.

As it was mentioned above, the relationship between patent applications (both total and high-tech) and different types of imports (imports of goods in particu-

Table 3

Correlation analysis

Variables	DESIGN		TRADEMARK		PATENT		HT_PATENT		EXPORTS_HT	
	Pearson Corr.	Sig.	Pearson Corr.	Sig.	Pearson Corr.	Sig.	Pearson Corr.	Sig.	Pearson Corr.	Sig.
GDP_CAP	0.857**	0.000	0.733**	0.000	0.665**	0.000	0.534**	0.000	0.224**	0.000
EDU_EXP	0.307**	0.000	0.102	0.094	0.417**	0.000	0.523**	0.000	0.040	0.513
TER_EDU	0.385**	0.000	0.311**	0.000	0.364**	0.000	0.456**	0.000	0.045	0.432
EMPLOYMENT_HT	0.279**	0.000	0.132*	0.027	0.392**	0.000	0.513**	0.000	0.491**	0.000
IMPORTS_GS	0.394**	0.000	0.681**	0.000	–0.153**	0.007	–0.188**	0.009	0.581**	0.000
IMPORTS_G	–0.180**	0.004	–0.065	0.253	–0.357**	0.000	–0.313**	0.000	0.522**	0.000
IMPORTS_S	0.595**	0.000	0.857**	0.000	0.023	0.688	–0.024	0.736	0.396**	0.000
IMPORTS_HT	0.133*	0.035	0.201**	0.000	–0.068	0.235	–0.067	0.356	0.922**	0.000
PUBLIC_RD	0.216**	0.001	0.116*	0.043	0.199**	0.000	0.111	0.127	0.045	0.432
PRIVATE_RD	0.491**	0.000	0.062	0.280	0.885**	0.000	0.841**	0.000	0.139*	0.015

* Correlation significant at the 0.05 level (2-tailed).
** Correlation significant at the 0.01 level (2-tailed).

Source: own calculations.

lar) turned out to be negative (respectively, –0.357, p = 0.000; –0.313, p = 0.000). This is an unexpected outcome because, logically, import of goods and services should provide access to new technologies and knowledge, helping to develop innovative capabilities of a country (see more information in section 3.3). Therefore, future research should include this aspect and search for other factors which might influence the results.

It should be emphasized that the correlation method can only tell how the values of variables co-vary. Hence, in order to make a stronger claim, regression analysis was applied. A stepwise method that resolves multicollinearity was used (SPSS inspects which of the used predictors contribute to predicting the dependent variable and excludes those which do not). Final versions of the most accurate and non-repetitive regression models are introduced in the next section.

3.1. NIC output: community design applications per million inhabitants

Tables 4 and 5 present the key statistics of the final version of multiple linear regression model 1a (with the omitted insignificant variables). The predictors: GDP per capita, imports of goods and services, employment in high-technology sectors, private and public investment in R&D can explain the fluctuations of the dependent variable 'community design (CD) applications per million inhabitants' by 79.3%.

Table 4

Model 1a summary

Model	R	R^2	Adj. R^2	Std. error
1a	0.8931a	0.798	0.793	1.25567

Predictors: Constant, GDP_CAP, IMPORTS_GS, EMPLOYMENT_HT, PRIVATE_RD, PUBLIC_RD.
Dependent variable: DESIGN.

Source: own calculations.

Table 5

Final results of model 1a statistical significance test

Model & variables		Unstandardized coefficients		Standardized coefficients	t	Sig.	Collinearity statistics	
		B	Std. error	Beta			Tolerance	VIF
1a	Constant	–13.254	0.374	–	–3.544	0.000	–	–
	GDP_CAP	0.001	0.000	0.766	8.531	0.000	0.565	1.771
	IMPORTS_GS	0.338	0.038	0.360	8.897	0.000	0.589	1.698
	EMPLOYMENT_HT	6.994	0.999	0.322	7.002	0.000	0.456	2.192
	PRIVATE_RD	10.525	0.164	0.258	4.863	0.000	0.344	2.905
	PUBLIC_RD	28.585	1.113	0.093	2.827	0.005	0.888	1.126

Source: own calculations.

There is no multicollinearity between the independent variables ($1 \leq VIF \leq 10$), thus the final proposed regression equation for model 1a is:

$$DESIGN = 0.001\ GDP\_CAP + 0.338\ IMPORTS\_GS + \\ + 6.994\ EMPLOYMENT\_HT + 10.525\ PRIVATE\_RD + \\ + 25.585\ PUBLIC\_RD - 13.254. \quad (1)$$

Accordingly, a conclusion can be made that the amount of CD applications increases when: (1) the market is open, (2) employment in knowledge-intensive sectors is high, (3) private firms and public institutions invest in R&D.

Tables 6 and 7 present the key statistics of the final version of multiple linear regression model 1b (with the decomposed variable 'imports of goods and services' and the omitted insignificant variables, e.g. imports of goods). The predictors: GDP per capita, imports of services, public and private investment in R&D, and employment in high-technology sectors can explain the fluctuations of the dependent variable 'community design (CD) applications per million inhabitants' by 80.6%.

There is no multicollinearity between the independent variables ($1 \leq VIF \leq 10$), thus the final proposed regression equation for model 1b is:

$$DESIGN = 3.528 + 0.001\ GDP\_CAP + 0.553\ IMPORT\_S + \\ + 37.231\ PUBLIC\_RD + 7.6576\ EMPLOYMENT\_HT + \\ + 14{,}235\ PRIVATE\_RD. \quad (2)$$

Table 6

Model 1b summary

Model	R	R^2	Adj. R^2	Std. error
1b	0.900	0.811	0.806	1.25665

Predictors: Constant, GDP_CAP, IMPORTS_S, PUBLIC_RD, EMPLOYMENT_HT, PRIVATE_RD.
Dependent variable: DESIGN.

Source: own calculations.

Table 7

Final results of model 1b statistical significance test

Model & variables		Unstandardized coefficients		Standardized coefficients	t	Sig.	Collinearity statistics	
		B	Std. error	Beta			Tolerance	VIF
1b	Constant	3.528	0.795	–	0.930	0.035	–	–
	GDP_CAP	0.001	0.000	0.572	10.616	0.000	0.374	2.674
	IMPORTS_S	0.553	0.056	0.468	9.908	0.000	0.406	2.466
	PUBLIC_RD	37.231	0.756	0.121	3.816	0.000	0.895	1.117
	EMPLOYMENT_HT	7.657	0.983	0.353	7.786	0.000	0.442	2.265
	PRIVATE_RD	14.235	2.273	0.348	6.264	0.000	0.293	3.414

Source: own calculations.

Accordingly, a conclusion can be made that the amount of CD applications increases when: (1) effective import of services policies are promoted, (2) employment in knowledge-intensive sectors is high, (3) private firms and public institutions invest in R&D. These results also show that imports of services are more important and provide a higher positive effect on the amount of design applications than imports of goods.

3.2. NIC output: EU trademark applications per million inhabitants

Tables 8 and 9 present the key statistics of the final version of multiple linear regression model 2a (with the omitted insignificant variables). The predictors: GDP per capita, imports of goods and services and employment in high-technology sectors can explain the fluctuations of the dependent variable 'European Union trademark (EUTM) applications per million inhabitants' by 80.1%.

Table 8

Model 2a summary

Model	*R*	R^2	Adj. R^2	Std. error
2a	0.897a	0.804	0.801	1.46173

Predictors: Constant, GDP_CAP, IMPORTS_GS, EMPLOYMENT_HT.
Dependent variable: TRADEMARK.

Source: own calculations.

Table 9

Final results of model 2a statistical significance test

Model & variables		Unstandardized coefficients		Standardized coefficients	*t*	Sig.	Collinearity statistics	
		B	Std. error	Beta			Tolerance	VIF
2a	Constant	–175.979	0.654	–	–5.560	0.000	–	–
	GDP_CAP	0.015	0.001	0.714	12.200	0.000	0.793	1.260
	IMPORTS_GS	6.375	0.323	0.603	9.766	0.000	0.882	1.134
	EMPLOYMENT_HT	91.186	0.834	0.365	10.929	0.000	0.735	1.360

Source: own calculations.

There is no multicollinearity between the independent variables ($1 \leq \text{VIF} \leq 10$), hence the final proposed regression equation for model 2a is:

$$\text{TRADEMARK} = 0.015\ \text{GDP\_CAP} + 6.375\ \text{IMPORTS\_GS} + 91.186\ \text{EMPLOYMENT\_HT} - 175.979. \quad (3)$$

The results show that the amount of trademark applications strongly depends on imports of goods and services and the employment in high-technology sectors. As the correlation analysis revealed (see Table 3), import of services might have a bigger effect on this particular innovative output than import of goods. Hence, Tables 10 and 11 provide information about a very accurate (adjusted $R^2 = 0.871$) regression model which excludes the import of goods as an insignificant variable.

Table 10

Model 2b summary

Model	R	R^2	Adj. R^2	Std. error
2b	0.935	0.873	0.871	1.17609

Predictors: Constant, IMPORTS_S, GDP_CAP, EMPLOYMENT_HT, TER_EDU.
Dependent variable: TRADEMARK.

Source: own calculations.

Table 11

Final results of model 2b statistical significance test

Model & variables		Unstandardized coefficients		Standardized coefficients	t	Sig.	Collinearity statistics	
		B	Std. error	Beta			Tolerance	VIF
2b	Constant	104.365	1.970	–	3.264	0.001	–	–
	IMPORTS_S	9.695	0.359	0.745	7.033	0.000	0.700	1.429
	GDP_CAP	0.009	0.001	0.438	3.632	0.000	0.516	1.939
	EMPLOYMENT_HT	89.289	0.712	0.358	3.304	0.000	0.736	1.359
	TER_EDU	2.553	0.263	0.057	2.021	0.044	0.667	1.500

Source: own calculations.

There is no multicollinearity between the independent variables ($1 \leq \text{VIF} \leq 10$), hence the final regression equation for model 2b is:

$$\text{TRADEMARK} = 104.365 + 9.695\ \text{IMPORTS\_S} + 0.009\ \text{GDP\_CAP} + \\ + 89{,}289\ \text{EMPLOYMENT\_HT} + 2.553\ \text{TER\_EDU}. \quad (4)$$

This model reveals that the amount of trademark applications is positively affected by imports of services and the capacities of a part of population which has a tertiary education and works in a high-technology sector.

3.3. NIC output: patent applications to the EPO by priority year, per million inhabitants

Tables 12 and 13 present the key statistics of the final version of multiple linear regression model 3a (with the omitted insignificant variables). The predictors: private R&D, GDP per capita, employment in high-technology sectors and imports of goods and services can explain the fluctuations of the dependent variable 'patent applications to the EPO by priority year, per million inhabitants' by 85.1%.

Table 12

Model 3a summary

Model	R	R^2	Adj. R^2	Std. error
3a	0.924[a]	0.853	0.851	3.79875

Predictors: Constant, PRIVATE_RD, GDP_CAP, EMPLOYMENT_HT, IMPORTS_GS.
Dependent variable: PATENT.

Source: own calculations.

Table 13

Final results of model 3a statistical significance test

Model & variables		Unstandardized coefficients		Standardized coefficients	t	Sig.	Collinearity Statistics	
		B	Std. error	Beta			Tolerance	VIF
3a	Constant	–14.587	0.832	–	–1.772	0.048	–	–
	PRIVATE_RD	101.559	0.684	0.713	11.868	0.000	0.386	2.588
	GDP_CAP	0.002	0.000	0.360	10.867	0.000	0.560	1.786
	EMPLOYMENT_HT	8.419	0.560	0.112	3.231	0.001	0.509	1.964
	IMPORTS_GS	–0.298	0.103	–0.094	–2.888	0.004	0.583	1.714

Source: own calculations.

There is no multicollinearity between the independent variables ($1 \leq \text{VIF} \leq 10$), hence the final regression equation for model 3a is:

$$\text{PATENT} = 101.559\ \text{PRIVATE\_RD} + 0.002\ \text{GDP\_CAP} + \\ + 8{,}419\ \text{EMPLOYMENT\_HT} - 0.298\ \text{IMPORT\_GS} - 14.587. \qquad (5)$$

The results show that the amount of patent applications strongly depends on private investment on R&D and employment in high-tech sector, but it is slightly negatively influenced by the imports of goods and services. As already mentioned in the correlation analysis, this is an unexpected outcome because a net importer nation should benefit through embodied technology diffusion (at least from imports of goods). Nevertheless, as Huang et al. (2010) claim, acquiring knowledge involves not simply purchasing or trading goods, but rather systematic and purposeful knowledge-based learning and construction; therefore, the amount of benefits from import is affected by the import country's absorptive capabilities.

Very similar results to model 3a have been obtained in a regression model with a NIC output: high-tech patent applications to the EPO by priority year per million inhabitants, which is not demonstrated here to avoid a duplication of information.

3.4. NIC output: exports of high-tech products, % of GDP

Tables 14 and 15 present the key statistics of the final version of multiple linear regression model 4a (with the omitted insignificant variables). The predictors:

Table 14

Model 4a summary

Model	*R*	R^2	Adj. R^2	Std. error
4a	0.938a	0.880	0.879	0.01451

Predictors: Constant, IMPORTS_HT, PRIVATE_RD, EMPLOYMENT_HT.
Dependent variable: EXPORTS_HT.

Source: own calculations.

Table 15

Final results of model 4a statistical significance test

Model & variables		Unstandardized coefficients		Standardized coefficients	*t*	Sig.	Collinearity Statistics	
		B	Std. error	Beta			Tolerance	VIF
4a	Constant	–0.026	0.003	–	–9.116	0.000	–	–
	IMPORTS_HT	1.038	0.027	0.895	7.768	0.000	0.772	1.295
	PRIVATE_RD	0.008	0.002	0.127	4.946	0.000	0.661	1.513
	EMPLOYMENT_HT	0.003	0.001	0.080	2.884	0.004	0.564	1.773

Source: own calculations.

imports of high-technology products, private R&D and employment in high-technology sectors can explain the fluctuations of the dependent variable 'exports of high-tech products, % of GDP' by 87.9%.

There is no multicollinearity between the independent variables ($1 \leq \text{VIF} \leq 10$), hence the final regression equation for model 4a is:

$$\text{EXPORTS\_HT} = 1.038\ \text{IMPORTS\_HT} + 0.008\ \text{PRIVATE\_RD} + 0.003\ \text{EMPLOYMENT\_HT} - 0.026. \quad (6)$$

As the equation suggests, exports of high-tech products can be boosted by: (1) private investment in R&D, (2) hiring more employees into high-technology sectors, (3) importing high-technology products.

Conclusions

The national innovative capacity can be characterised as a country's potential (as both an economic and political entity) to produce a long-term stream of commercially relevant innovations. However, most empirical studies on the subject do not include international economic activities and limit themselves to exclusively domestic indicators for NIC (e.g. public and private R&D expenditures, the share of population with tertiary education and the level of intellectual property protection).

Seeking to enrich the research on national innovative capacity, regression models were supplemented with different types of imports as NIC inputs and trademark and design applications as NIC outputs which reflect non-technological innovation. The analysis covering 28 EU member states in the years 2007–2017 demonstrates that imports of goods and services play an important role in boosting the non-technological innovation. In fact, imports of services turned out to provide a much higher positive effect on the amount of trademark and design applications than imports of goods. To continue with, the regression equations revealed that imports of high-technology products, together with private investment in R&D and a greater number of employees in high technology sector, can increase exports of high-tech products.

Quite unexpectedly, regression analysis disclosed that the amount of patent applications strongly depends on private investment on R&D and employment in high-tech sector but is slightly negatively influenced by the imports of goods and services. This proves that international transmission of knowledge requires more than just trading goods and that import country's absorptive capabilities can act as a critical factor in this situation.

All in all, it is undeniable that exogenous factors drive a country towards economic growth and innovative progress. The findings of an empirical research help us to better understand the role of different international economic activities in enhancing national innovative capacity, and facilitate EU efforts to catch up with the strongest innovators in the world.

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IMPORT OF GOODS AND SERVICES AS A STIMULUS FOR A BETTER INNOVATION PERFORMANCE IN EU MEMBER COUNTRIES

Abstract

A remarkable increase in the attention devoted to national innovative capacity (NIC) has been noticed over the last decades. There is a strong debate whether a country's national innovative capacity is solely determined by local factors or it is also influenced by global network position and international economic activities. Furthermore, despite its importance, there is a lack of studies which take the variables of non-technological innovations into account. This paper aims to fill the empirical research gap by focusing on import of goods and services as an input of NIC and engaging non-technological innovations as an output in NIC models. An investigation of 28 European Union member states in the period of 2007–2017 shows that the international transmission of knowledge through import spillovers has a positive effect on trademark applications, design applications and exports of high-tech products. The findings help to better understand the role of international trade in enhancing national innovative capacity.

Keywords: import; innovation; national innovative capacity; EU

JEL: F19, O31, O52

IMPORT DÓBR I USŁUG JAKO CZYNNIK STYMULUJĄCY INNOWACYJNOŚĆ W KRAJACH UE

Streszczenie

W ostatnich czasach wyraźnie wzrosło zainteresowanie potencjałem innowacyjnym gospodarek. Toczy się intensywna dyskusja nad tym, czy potencjał innowacyjny określonego kraju jest określony jedynie przez czynniki lokalne, czy też kształtuje się pod wpływem pozycji zajmowanej w globalnej sieci biznesowej i międzynarodowej współpracy gospodarczej. Poza tym brakuje badań uwzględniających innowacje pozatechniczne – pomimo ich dużego znaczenia. Artykuł próbuje wypełnić tę lukę istniejącą w badaniach empirycznych, skupiając uwagę na roli importu dóbr i usług jako czynnika określającego potencjał innowacyjny poszczególnych krajów, z uwzględnieniem innowacji pozatechnicznych. Badanie obejmujące 28 państw członkowskich Unii Europejskiej w okresie 2007–2017 pokazuje, że międzynarodowa transmisja wiedzy poprzez import ma pozytywny wpływ na liczbę zgłaszanych do opatentowania lub zarejestrowania wynalazków, projektów i znaków towarowych oraz na eksport produktów o wysokim poziomie technologicznym. Te ustalenia pozwalają lepiej zrozumieć rolę handlu międzynarodowego w stymulowaniu zdolności innowacyjnej gospodarek.

Słowa kluczowe: import, innowacje, potencjał innowacyjny gospodarki, UE

JEL: F19, O31, O52

ИМПОРТ ТОВАРОВ И УСЛУГ КАК ФАКТОР, СТИМУЛИРУЮЩИЙ ИННОВАЦИИ В СТРАНАХ ЕС

Резюме

В последнее время заметно вырос интерес к инновационному потенциалу экономик. Идет интенсивная дискуссия относительно того, чем определяется инновационный потенциал данной страны – только ли местными факторами, или он формируется под влиянием позиции, занимаемой этой страной в глобальной сети бизнеса и в международном экономическом сотрудничестве. Кроме того, не хватает исследований, учитывающих нетехнические инновации, несмотря на их большое значение. Статья пытается заполнить этот пробел в эмпирических исследованиях, сосредоточивая внимание на роли импорта товаров и услуг как фактора, определяющего инновационный потенциал отдельных стран, с учетом нетехнических инноваций. Исследование, охватывающее 28 государств-членов Евросоюза в период 2007–2017 гг. показывает, что международная трансмиссия знаний посредством импорта имеет положительное влияние на количество заявок на патенты и зарегистрированных изобретений, проектов и товарных знаков, а также на экспорт продуктов высокого технологического уровня. Эти констатации позволяют лучше понять роль международной торговли в стимулировании инновационных способностей экономик.

Ключевые слова: импорт, инновации, инновационный потенциал экономики, ЕС

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