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Determinants of domestic value added in exports of the EU countries

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ABSTRACT

Economies, including the European Union, face the risk on global scale of losing ability to maintain their competitive positions and of related inability to generate value added in satisfactory degree. We therefore examine factors assumedly having positive impact on the domestic value added in exports, as a recently introduced key indicator of country´s export competitiveness, reported in the TiVA database. The main aim of our paper is to test, for the selected countries, a relationship of the domestic value added in exports with the following factors: (1) number of patent applications per million inhabitants, (2) foreign direct investment per capita and (3) business expenditure on research and development as a percentage of GDP and (4) resource productivity as control variable. We proved by quantitative analysis of panel data that the domestic value added in exports increases with an increase in all deployed independent variables as well as in control variable.

KEYWORDS

domestic value added in exports, determinants, global value chains (GVCs), international trade

JEL CLASSIFICATION INDICES

F1, F14, F17, F19

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1 INTRODUCTION

Fragmentation of production has become a major driver of the world trade growth since the 1980s and 1990s (Duan et al. 2012). In result of trade barriers reduction, the interconnection of economies has intensified, enabling to extend value chains beyond the boundaries of economies. Product specialization of economies has been replaced by vertical specialization into tasks or stages of production process within global value chains (GVCs) (Baldwin 2013), whereby China and Southeast Asian countries have been playing an important role in completing production imported from Germany, United States, Republic of Korea, or Japan (Baláž et al. 2020).

Due to growing importance of GVCs in international trade, gross exports and imports data no longer provide an accurate representation of the value added being exchanged among countries. In the past, gross exports accounted for almost 100% of the export value, but this is not the case today (Johnson 2014). Due to the existence of GVCs, intermediate goods are crossing borders several times, thus being included repeatedly in external trade statistics. The longer are the international production chains, the more double or multiple inclusion of intermediate goods into global export statistics occurs (Wang et al. 2018). Therefore, the use of statistics capturing the added value of trade is beneficial to estimate the position of countries in global trade.

Economies, including the EU, face the risk on a global scale of losing ability to maintain their competitive positions on global markets and of related inability to generate value added in satisfactory degree. According to Olczyk and Kordalska (2017), EU countries face competition in GVCs from emerging economies such as China, Brazil, and India increasingly in high-value products. In support of this assumption, we present Figure 1 comparing the development of value added export indicators for these economies. It was the EU that recorded the lowest increase in domestic value added in exports per capita in the period under review. Maintaining or improving competitiveness at national level is crucial for achieving the principal goal of a nation that is to produce a high and rising standard of living (Porter 1990). Identification of factors that improve competitiveness is therefore an important topic of economic research.

Put here Figure 1

We built on a professional discussion at the Aspen Institute conference (Aspen Institute Central Europe 2019), taking ideas therefrom on the key impact of research and development (R&D)

on competitiveness and especially on creation of value added as a basis for our quantitative testing. Moreover, as particular stages of the production process are often allocated to other countries through foreign direct investment (FDI), we also include FDI effects into the quantitative testing. Here, we built on the literature dealing with the impact of inward FDI on the host country's export.

We examine factors, including R&D and FDI, assumedly having positive impact on domestic value added in exports as a competitiveness indicator for a country. The main aim of our paper is to prove, for the in-scope EU economies, a relationship of the domestic value added in exports with the following: (1) number of patent applications per million inhabitants, (2) foreign direct investment (FDI), quantified per capita, (3) business expenditure on R&D as a percentage of GDP, (4) resource productivity in Euro per kilogram as control variable. In-depth justification for selecting these variables based on the relevant literature is provided in Section 2. Section 3 presents both the methodology of the research conducted and data used. Next, results of the empirical analysis are provided and discussed. The paper ends with conclusions including their possible relevance in shaping policies aimed at improving competitiveness, and suggestions for further research.

2 THEORETICAL BACKGROUND

The concept of competitiveness at national level has been developed by Porter (1990). In his study, Porter investigated why nations gain competitive advantages in particular industries thus being able to improve their living standard. According to Porter, international trade can boost productivity growth by enabling nation's specialization. To measure the success of nation's companies on international markets, he chose data on exports as the best indicator.

The idea of Porter that "*a country's economic fortunes are largely determined by its success on world markets*" was criticized by Krugman (1994: 30). He argued that national living standards are determined by domestic productivity growth rather than by the productivity growth relative to other countries particularly in economies with very little international trade. However, with increasing horizontal specialization, we believe that involvement in international trade has become important for all major economies including the EU. Accordingly, national standards of living are increasingly determined by success in both international competition and cooperation.

At times of increasingly integrated GVCs, gross exports may provide just an inaccurate representation of country's export capacity (Xing 2020; Koch 2021). The reason is that the value of gross exports no longer corresponds to the exported value added. The value added in exports in relationship to gross exports was examined by several authors. According to Johnson and Noguera (2012) as well as Johnson (2014), the value added in global exports amounts only to about 70–75% of the value of gross exports compared to about 85% in the 1970s and 1980s. Following these authors, the ratio of value added in exports to the value of gross exports has been declining in result of double counting in gross trade data, thus reflecting the growing importance of GVCs in international trade. This has become true especially since 1990 due to the changes in the world economy such as trade liberalization in emerging economies, the EU enlargement, adoption of major regional trade agreements and the information technology revolution (Johnson 2014). In a more recent study, authors confirmed a worldwide decline in the ratio of value added to gross exports between 1970 and 2009 only in manufacturing, however, not in other sectors (Johnson – Noguera 2017). The decline in manufacturing amounted to 20 percentage points (p.p.). According to Wang et al. (2018), international trade in intermediate goods (which is responsible for double counting of exports and imports) accounts for more than half of world gross trade, most of it being two-way (i.e., intra-industry) trade in intermediate goods.

Based on the above, we believe that it is more beneficial to use data on the value added in exports than data on gross exports to assess country's competitiveness. Such data is contained in the Trade in Value Added (TiVA) database. It is a statistical approach to measure the international trade using value added in the production of goods and services consumed worldwide (OECD 2016). When examining the value added in exports, its origin is traced back. Gross exports of finished goods can be divided into exported domestic value added and exported foreign value added. Such decomposition of gross exports is more complicated if intermediate goods are exported as well (Wang et al. 2018).

In the literature, we have not encountered a comprehensive definition of factors affecting the value added in exports or its individual components. Available studies examine effects of selected factors. When studying factors affecting value added exports, it is important to note that it is the total domestic value added in exports, not the ratio of domestic value added to gross exports, that is crucial for country's competitiveness and economic development (Dollar et al. 2019). A high share of domestic value added in gross exports may reflect that primary products are exported (Johnson 2014; Fujii-Gambero et al. 2020). Moving from exports of such products to exports of manufactures and services via integration into GVCs leads to a decrease of the domestic value added share of gross exports which, however, does not mean that competitiveness decreases (Dollar et al. 2019).

The role of innovation in achieving sustainable global competitiveness is well established in the literature (e.g., Şener – Sarıdoğan 2011). As Courvisanos (2012) states, R&D expenditure is crucial in the endogenous innovation process. R&D of new technologies and products as well as effective protection of intellectual property help to increase export sophistication and value added (Wang et al. 2020). According to the OECD (2013) study, the value creation in GVCs is positively affected by the stock of knowledge-based capital comprising intangible assets, such as computerized information, innovative property and economic competencies. The ability to create high value added in GVC is influenced by the type of activity carried out within a GVC, with R&D being one of the activities with the highest added value. Wang and Ma (2020) assert that a strong national driving force towards innovation can significantly promote the domestic value added in export of services. In case of the EU countries, Vrh (2018) considers investments in intangible capital, specifically investments in R&D, to be an important factor supporting the growth of domestic value added in exports. Caraballo and Jiang (2016) recognized the number of patent applications by residents as a variable having positive effect on value added, albeit with less significance. At this point, it is useful to point out the difference between R&D expenditure and number of patents as indicators of the level of innovation in the economy. First, not all R&D spending result in patent applications. Either the results of R&D are not patentable, or the inventor is not interested in patenting them. Patents can be considered as confirmation of the commercial potential of R&D results as they incur significant costs. These costs are only worth bearing if patented products or technologies are expected to generate sufficient revenue. Moreover, the number of patents indicator does not capture all commercially successful R&D results, such as confidential know-how. Last but not least, the number of patent applications indicates not only the level of innovation but also the degree to which a country's laws protect intellectual property rights and the extent to which those laws are respected (The Heritage Foundation 2021).

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Operation of the GVCs is closely linked to FDI, as GVCs represent a combination of international trade and investment flows (Apostolov et al. 2020). There is a widely shared view that inward FDI influence both imports and exports of host countries. Within GVCs, foreign subsidiaries and branches of MNCs contribute to imports of intermediate goods and, at the same time, to exports of processed intermediate or final goods (Markusen 2002). MNCs may also stimulate export of local companies in the host country either directly or indirectly (Blomström − Kokko 1998). The direct effects concern companies that are suppliers to export oriented MNCs. They can benefit from access to foreign markets although they do not export in their own name. In addition, they can take advantage of knowledge about product and process technologies, or foreign market conditions provided by MNCs and establish own exports. Indirectly, all local firms may benefit from the market access spillovers. These spillovers arise, for example, when local employees of MNCs acquire knowledge of foreign markets and use them when they change jobs and work for a local company.

With respect to FDI, it is important to mention that while they initially moved from developed to developing countries, what led to the deindustrialisation of developed countries, the opposite trend of reindustrialisation has prevailed recently. Empirical studies have dealt with this trend since 1980s (Barta et al. 2008; Lengyel et al. 2017). The need for reindustrialisation has arisen in the EU especially in connection with the negative consequences of global economic crisis in 2008-2009 (Lengyel et al. 2017 or Nagy et al. 2020) associated with sharp fall of employment in manufacturing sectors and fall of manufacturing share in the GDP (Dhéret 2016). In response, the EU has been promoting "reindustrialisation" connected with the 4th industrial revolution as one of the relevant processes for sustaining or raising the EU competitiveness, thus underlining the key importance of strong industrial base (European Commission 2014), when expecting the return (reshoring) of production companies (Iozia − Leiriao 2014; Młody 2016). More recently, the need for reindustrialisation has been highlighted in connection to COVID-19 pandemic and negative consequences of the EU´s dependence on GVCs (LUSA 2021). We assume that the impact of reindustrialisation for the EU countries on their domestic value added exports should be similar to the impact of inward FDI on value added exports of host countries.

There are many empirical studies dealing with the impact of FDI on export performance, e. g. Kutan and Vukšić (2007) showed that inward FDI led to higher export performance in 12 European transition countries both due to the growth of production capacity as well as due to FDI-specific effects resulting from the MNCs´ superior knowledge about foreign markets or technology and better contacts to the supply chain of the parent company. Strong correlation between FDI and high-tech exports of the transition economies in Europe was confirmed by Mitic and Ivić (2016). Similar results have been achieved by Bayramoglu and Abasiz (2018) in case of 10 developing Asian countries or by Mukhtarov et al. (2019) in case of Jordan. Adarov and Stehrer (2019) examined relationship between FDI stock and trade in value added of 19 EU countries using shares of both the domestic and foreign valued added in exports as independent variables and confirmed the positive impact of inward FDI stock on the foreign value added share of exports. We did not encounter any study that would empirically verify the relationship between the inward FDI stock and domestic value added exports in absolute terms.

3 METHODOLOGY AND DATA

Based on the theoretical background, we set up the following 3 hypotheses:

• H1: As the number of patent applications per million inhabitants in the economy increases, domestic value added in exports per capita increases.

• H2: With the increase in FDI stock in the economy quantified per capita, domestic value added in exports per capita increases.

• H3: As the business expenditure on R&D as a percentage of GDP increases, domestic value added in exports per capita increases.

We added a control variable of productivity that represents a factor positively influencing export expansion according to the “new-new” trade theory developed by Melitz (2003).

The overview of used variables is provided in Table 1. For the dependent variable, we used the definition of value added in exports per the TiVA indicators (OECD 2019a). The domestic value added in exports per TiVA database comprises of:

- direct domestic value added in exports (generated in the industry),
- indirect domestic value added in exports (created in supply industries),
- re-imported domestic value added in exports reflecting the domestic value added (in any industry) having been exported in the form of intermediate goods and subsequently contained in imports used for the production of exported products.

Put here Table 1

Both indicators of direct and indirect domestic value added are net of the domestic value added previously exported in the form of intermediate goods and subsequently re-imported.

The TiVA database includes data from 2005 to 2016, i.e., with a certain time lag, with the most recent data of 2016. Despite this limitation, it is a valuable source of information.

We confirmed by the graphical analysis (see Figures 2 and 3) the direct relationships between the dependent and explanatory variables assumed on the basis of theoretical background.

We tested our hypotheses on two datasets. The dataset one included all EU countries (including the United Kingdom, i.e., 28 countries). In order to capture potential specifics of Central and Eastern Europe (CEE) economies, we analysed also the dataset 2, i.e., the group of 11 EU member states in CEE. Existence of specifics here was pointed out e.g., by the study of Kordalska and Olczyk (2021) on the example of Germany as a reference country. While Germany specialises predominantly on R&D activities, CEE countries specialise mostly in low-knowledge intensive manufacturing sectors and services.

In order to test the hypotheses, we used the panel data regression analysis. This choice was natural as we analysed cross-sectional data in time series on the dataset of the EU member states. As recognized in the regression analysis practice, panel data regression analysis offers a large diapason of advantages (Hsiao 2014: 4-6).

We used either fixed-effects or random effects model depending on the result of Hausman's test. The econometric equation of a model with fixed effects is represented by the following equation, where α_i means a specific constant for individual cross-sectional units (Lukáčiková 2013):

$$y_{it} = \alpha_i + \beta_1 x_{it1} + \beta_2 x_{it2} + \cdots + \beta_k x_{itk} + u_{it}$$

The random effects model has an equation that contains a random observation component in the cross-sectional unit u_{it} and a random component specific to the cross-sectional unit ε_i (Lukáčiková, 2013):

$$y_{it} = \alpha + \beta_1 x_{it1} + \beta_2 x_{it2} + \cdots + \beta_k x_{itk} + \varepsilon_i + u_{it}$$

We included a lag parameter into our model to take into account that the impact of explanatory variables on the domestic value added in exports assumedly manifests itself with a time lag. Vernon (1979) elaborated this idea in his product life cycle theory. We chose 2-year lag between independent and dependent variables in line with Kersan-Škabić (2019) who used 2-year lag for independent variables, including investment in R&D (as an indicator of innovation) and several FDI variables as determinants of the level of participation in the GVC by the EU member countries.

We used the variables in form of natural logarithms. Thus, we interpret the results of the analysis as elasticity in percentage changes.

We prepared 6 models for each above-mentioned dataset:

Model 1 and 7: multiregression analysis with all independent variables,

Model 2 and 8: multiregression analysis with all independent variables except for the variable (1) number of patent applications per million inhabitants. Model 2 was set up to eliminate suspected colinearity between the variable (1) number of patent applications per million inhabitants and the variable (3) business expenditure on R&D as a percentage of GDP, by omitting the variable (1) number of patent applications per million inhabitants from the specification,

Model 3-6 and 9-12: pairwise regression analysis between the dependent variable and each independent variable (variables 1-4). These models were set up to test potential multicolinearity.

We tested autocorrelation by Durbin-Watson test and heteroskedasticity by Wald test. We used Hausman's test to opt for either fixed-effects or random effects approach for each model. The decision on accepting the non-zero hypotheses was made on the basis of t-statistics produced by GRETL software.

As for the limitations of our approach, it is, in particular, a low number of observations. This was given by the scope of our study, i.e., the EU countries and the length of time series in the TiVA database. In result of this, we were unable to test stationarity. Furthermore, a period of economic crisis was included in the time series. Despite that, we did not want to reduce the number of observations by omitting certain years from the time series and at the same time we preferred not to introduce an excessive complexity into our modelling. For these reasons, we accepted this limitation and continued with model creation and testing. Other limitations include the fact that our specifications do not include time effects. These time effects would reduce the statistical significance of the estimating parameters, especially for the business expenditure on R&D as a percentage of GDP. We therefore recommend the influence of time effects for further research (BERD_sGDP).

Computer programs, namely Microsoft EXCEL (data preparation) and GRETL (descriptive statistics, regression analysis), were used in the development and compilation of the econometric model. We used GRETL, Inkscape and Zoner Photo Studio 15 software to create graphs. We used methodological and statistical procedures using by Pacáková et al. 2009; Lukáčik et al. 2011; Lukáčiková 2013; Adkins et al. 2015; Cottrell -Lucchetti 2021. This literature was used as well when interpreting results of analyses.

4 RESULTS AND DISCUSSION

Descriptive statistics of our panel sample of observations from 2005 to 2016 for the full dataset of 28 EU countries is provided in Table 2, showing mean, median, minimum, maximum values, standard deviation, skewness and kurtosis for each variable, both in a non-logarithmic and logarithmic form, the latter having been used in our regression analysis. It can be seen that by using logarithms, heterogeneity of the dataset was reduced, e.g., for the dependent variable, its average value of decreased from 13,243.00 to 9.15 but its standard variance decreased from13,615.00 to 0.79. Similarly, skewness value fell from 2.88 to 0.30. The positive value indicates a right-sided asymmetric distribution, in other words, there are more observations with values below the average. Skewness was reduced by logarithmic transformation also for all other variables.

Put here Table 2

In respect of investigated indicators, the analysed EU countries show certain heterogeneity. As regards the business expenditure on R&D as a percentage of GDP, the highest values of the indicator in 2014 were achieved by Austria, Finland, Sweden, Germany, and Denmark (171% − 144% of the EU average), the lowest values were recorded in Cyprus, Romania, Lithuania, and Greece (8.6% − 22% of the EU average). During the period under review, the business expenditure on R&D as a percentage of GDP increased most significantly in case of Slovenia (by 1 percentage point), Hungary, Austria, and the Czech Republic (by about 0.6 − 0.4 percentage point). The average value for EU countries increased slightly from 1.1% to 1.29%.

If we consider the business expenditure on R&D as a percentage of GDP in relation to the value added in exports per capita, we can again observe certain differences in case of individual EU countries. Among the surveyed EU countries, Austria, Finland, Sweden, Germany, and Denmark were the five countries with the highest share of business expenditure in R&D and at the same time with the highest domestic added value of exports per capita. These were followed by Slovenia, the Czech Republic, and the United Kingdom. Slovenia and the Czech Republic are among the countries with the highest increase of business expenditure on R&D as a percentage of GDP which indicates a gradual change in nature of their production and exports in favour of increasing domestic value added in exports per capita. To the contrary, countries with a low ratio of business R&D expenditure in GDP and low domestic value added per capita include Romania, Greece, Croatia, Poland, and Bulgaria (although Bulgaria recorded a remarkable increase in the ratio of business R&D expenditure in GDP, it is still however, below the average). Italy, Spain, Portugal, Hungary, and France record slightly higher share of business R&D expenditure in GDP than the domestic value added in export per capita compared to the EU average. Finally, Latvia, Lithuania, Slovakia, and Estonia are the EU countries with a lower share of business R&D expenditure in GDP compared to the EU average, however, with a higher added value of exports per capita.

Put here Table 3

Put here Figure 2

Table 3 presents parameters and characteristics of models 1 – 6 for the dataset of all EU member states including the U.K. Due to low value of Durbin-Watson test (0.79) and of Wald test for heteroskedasticity (Chi-square(28) = 629.34) we used the robust standard error method for model 1 as well as for all other models. Decision for fixed effects method or random effects method was done on the basis of Hausman's test for each model separately. Based on this, we prepared all models related to dataset 1 (set of all EU member states) by the fixed effects method, except model 5 related to the variable (3) Business expenditure on R&D development as a percentage of GDP that was prepared by the random effects method.

It was not possible to test multicolinearity for the dataset 1 in GRETL as the model 1 was prepared by the fixed effects method. We therefore assessed the suspected risk of collinearity between the variable (1) number of patent applications per million inhabitants and the variable (3) business expenditure on R&D as a percentage of GDP by running the regression analysis for the separate specification (model 2) without the variable (1) number of patent applications per million inhabitants. We consider the results of model 1 and model 2 for acceptably close. We also tested potential multicolinearity of other explanatory variables, including the control variable, by running pairwise regression analyses for each explanatory variable (models 3 – 6). We consider the results of model 1 and models 3 – 6 for acceptably close as well.

Finally, the t-statistics provided by GRETL allowed us to reject hypotheses on insignificance of variable estimates for all 3 investigated variables, namely (1) number of patent applications per million inhabitants, (2) FDI stock per capita, (3) business expenditure on R&D as a percentage of GDP, with the probability of at least 95%. The parameter for the control variable (4) resource productivity and constant is estimated with 99% probability.

If we increase the (1) number of patent applications per million inhabitants by 1%, we expect an increase in domestic value added in exports per capita by 0.12%. In case of (2) FDI stock per capita, with increasing of this variable by 1%, dependent variable may increase by 0.05%. Finally, with a 1% increase of (3) business expenditure on R&D as a percentage of GDP, we expect an increase in the dependent variable by 0.11% in this specification. The value of the estimated parameter of the control variable reached 0.31%.

Our analysis confirmed all our three hypotheses: H1, H2 and H3 for dataset 1. We confirmed that for the dataset of all EU countries including the U.K., the domestic value added in exports per capita is affected by the number of patent applications per million inhabitants, by the amount of FDI stock per capita, by the amount of business expenditure on R&D as a percentage of GDP with statistical significance. The impact of these economic indicators can be wrapped up in terms that they express the economic and especially technological maturity of economies which, if high, is reflected in high domestic value added in exports per capita. We were able to confirm this conclusion for the whole analysed dataset of EU countries, without the need to divide them into separate, more homogeneous groups, as it was the case with the study by Kittová and Steinhauser (2020) trying to find a relationship between high-tech export share on the total export as a dependent variable and count of patent applications to the EPO per million inhabitants or R&D expenditure as percentage of GDP as independent variables. This relationship became only visible after splitting the EU countries into 2 groups using quite a complex procedure. Therefore, it appears that it is more suitable to analyse competitiveness of economies in terms of value added in exports than gross exports.

Table 4 presents parameters and characteristics of models 7 – 12 for the dataset of 11 CEE member states of the EU. We used the robust standard error method as in the dataset 1. Decision for fixed effects method or random effects method was done on the basis of Hausman's test for each model separately. Contrary to dataset 1, the full multiregression analysis specification (model 7) was processed by the random effects method. This allowed us to diagnose potential multicolinearity error in GRETL by "Belsley-Kuh-Welsch collinearity diagnostics" where the condition index reached the highest value 23.372 < 30 (cp. Adkins et al. 2015). Despite the favourable result, we also performed the same tests for multicolinearity as for the Dataset 1, i.e. we tested the specification with omitted variable (1) number of patent applications per million inhabitants (model 8) and specifications with pairwise regression analyses separately for each explanatory variable and the control variable (models 9 – 12). We considered the results of the diagnostic models for acceptably close, thus confirming the result of Belsley-Kuh-Welsch test.

Put here Table 4

Put here Figure 3

The full specification in model 7 produced similar parameter estimates as model 1 in dataset 1 for 28 EU countries, however, the estimate of the variable (2) FDI stock per capita. turned out statistically insignificant and the variable (3) business expenditures on research and development as share of GDP was estimated just with 90 % probability. However, when we ran an alternative analysis for the model 1 specification on an adjusted dataset 2 with just 1-year time lag, under the random effects method we estimated the parameter for the variable (2) FDI stock per capita at 0.14% with 95% probability and for the variable (3) business expenditure on R&D development as a percentage of GDP at 0.10% with 95% probability. The results of models 10 and 11 confirm for these variables as well, in the original 2-year lag, that the positive relationship exists also in case of CEE countries. In this way, we were eventually able to prove the positive relationship for all independent variables, i.e. (1) number of patent applications per million inhabitants, (2) FDI stock per capita, (3) business expenditure on R&D development as a percentage of GDP, (4) control variable of resource productivity as Euro per kilogram with the dependent variable domestic value added in exports per capita in USD.

Our results are in line with the findings of several studies. Niţescu et al. (2019) analysed the impact of FDI as well as innovation (measured by variables of R&D expenditures, patent applications and researchers involved in R&D) on export and import (expressed as a share of GDP) in 24 European countries including 12 CEE countries over a period of 22 years (1996 – 2017). They confirmed that FDI and R&D expenditures has had a positive effect on growth of exports' share in GDP in both the short and long term. In the long-term, however, the positive effect of R&D expenditure on export was more significant than the effect of other variables according to their findings.

Hagemejer and Mućk (2019) proved that FDI contributed to increasing growth rate of exports expressed as exported value added per capita in CEE countries during the period of 1995-2014. They argue that, during the 20 years examined, CEE countries had become highly vertically specialised in production of intermediates as well as dependent on intermediate imports and FDI, this increasing their integration into regional GVCs. This is consistent with the Kersan-Skabic (2017) analysis of the 13 new EU member states' participation in regional GVC covering the period 1995 – 2011. She found that a huge part of value added in gross export of the CEE countries comes from the EU member states, mainly from Germany and Italy. Similarly, Kašťáková and Ružeková (2019) highlighted the import of technologies into CEE countries and FDI to be important for building their export-orientated production capacities. A typical example is the automotive industry, as the most car manufacturers in the CEE countries are part of multinational corporations (more specifically in Pavelka et al. 2021).

For the CEE countries, it can be summarized that FDI contributed to increased participation in GVCs, export and, as we have confirmed, exported domestic value added per capita. However, prevailing specialisation in product assembly generates lower domestic value added in their exports compared to the EU countries such as Germany or Italy. To further increase the domestic value added embodied in exports, the countries concerned should change their GVCs participation and focus on the development of processes that add significant value added (Fujii-Gambero − García-Ramos 2015). From our point of view, there is no other real way than to support science, research, and innovation.

5 CONCLUSION

Our study helps to understand better functioning of GVCs and the impact of the examined factors on the domestic value added in exports in case of the EU countries. Its main aim was to explain domestic value added in exports per capita of EU economies by the number of patent applications per million inhabitants, FDI stock per capita, the business expenditure on R&D as a percentage of GDP and resource productivity as a control variable.

Domestic value added in exports is an important indicator of the competitiveness of the economy. In connection with growing importance of automation and digitalisation (development of Industry 4.0), the importance of innovation and growth of domestic value-added is increasing. Therefore, also in terms of recommendations for economic policy, our results indicate that in order to increase the EU countries´ competitiveness and domestic value added in exports (especially of those countries that reach the lowest values such as Bulgaria, Romania, Greece, Croatia and Poland) vis-à-vis emerging economies such as China, India or Brazil, it is necessary to support increased spending for R&D as well as the efficiency of R&D of new technologies and products, further optimize the structure of FDI, e.g. through an appropriate investment incentive strategy and to maximize the technological effects of FDI spillovers and imports. For those EU countries that have been most affected by deindustrialisation, it is fostering reindustrialisation, along with structural changes in the industry in terms of digitalisation and robotisation, that is gaining in importance. Like Krugman (2020), who proposes, in connection with economic consequences of the Covid-19 pandemic, a long-term policy of sustainable public investment in infrastructure, education and R&D, we consider sensible government interventions in economy respecting the principle of subsidiarity in these areas as desirable, either in form of legislative or financial measures.

We believe that it is beneficial to continue in research of the factors affecting domestic value added in exports and thus the functioning of GVCs, e. g. by confirming the conclusions of this study using a different methodology, by targeting different set of economies, or by verifying the effects of other possible factors. Given that some industries such as machinery and equipment, electrical and optical equipment or transport equipment are highly integrated into the GVCs, we also recommend further research focused on sectoral differences and quantifying business expenditure on R&D as a percentage of GDP on domestic value added per capita, with time effects included.

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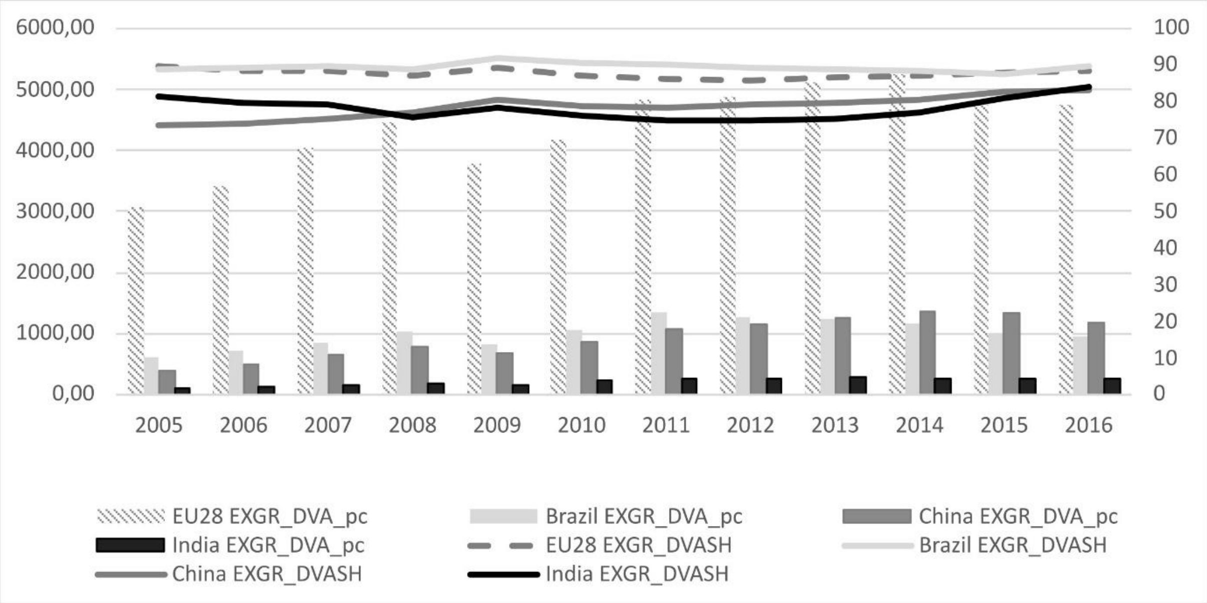
Figure 1. Comparison of the development of value added export indicators.



Source: own elaboration according to OECD 2019b; WBG 2019.

Legend: EXGR_DVA_pc represents the domestic value added of gross exports per capita; EXGR_DVASH is the domestic value added share of gross exports.

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Table 1. Characteristics of explanatory (X) and dependent (Y) variables

	Variable	Variable name	Source
1	Number of patent applications at the European Patent Office (EPO) per million inhabitants	PATENT (X)	Eurostat [pat_ep_ntot]
2	FDI stock in the economy in USD quantified per capita	FDI_In_Stock_USD_pc (X)	Combination of inward FDI stock data from UNCTADStat and population data [Population, total] from the World Bank Group
3	Business expenditure on R&D development as a percentage of GDP	BERD_sGDP (X)	Eurostat [rd_e_berdindr2]
4	Control variable of resource productivity as Euro per kilogram	Res_productivity (X)	Eurostat [env_ac_rp]
	Domestic value added in exports per capita in USD	VaExport_USD_pc (Y)	Combination of the share of domestic value added in gross exports from OECD TiVa [EXGR DVASH] and gross exports per capita: indicators of export value [Exports of goods and services (constant 2010 US$)] and population [Population, total] from the World Bank Group

Source: own elaboration according to OECD 2019b; Eurostat 2019; Eurostat 2021; WBG 2019; UNCTADStat 2019.

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Table 2. Descriptive statistics of the 28 EU countries (2005 – 2016)

N = 1:01 - 28:12	Mean	Median	Min.	Max.	Std. Dev.	Skew.	Kurt.
VaExport_USD_pc	13243.00	8879.60	1092.60	74209.00	13615.00	2.88	9.27
PATENT	86.28	31.67	0.80	350.41	97.29	1.01	-0.37
FDI_Inward_ Stock_millUSD_pc	43362.00	11534.00	1190.60	441330.00	87265.00	2.99	8.28
BERD_sGDP	0.92	0.71	0.07	2.67	0.68	0.74	-0.54
Res_productivity	1.60	1.27	0.19	4.79	1.02	0.93	0.20
l_VaExport_ USD_pc	9.15	9.09	7.00	11.22	0.79	0.30	0.22
l_PATENT	3.55	3.46	-0.22	5.86	1.52	-0.14	-1.17
l_FDI_Inward_ Stock_millUSD_pc	9.63	9.35	7.08	13.00	1.26	1.05	0.58
l_BERD_sGDP	-0.41	-0.34	-2.66	0.98	0.89	-0.43	-0.73
l_Res_productivity	0.26	0.24	-1.66	1.57	0.69	-0.33	-0.45

Source: own elaboration according to OECD 2019b; Eurostat 2019; Eurostat 2021; WBG 2019; UNCTADStat 2019.

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Table 3. **Econometric models — 28 EU countries**

Fixed-effects estimates (FEM) and Random-effects estimates (REM)

Robust standard error (HAC)

Dependent variable: l_VaExport_USD_pc

	(1)	(2)	(3)	(4)	(5)	(6)
	FEM	FEM	FEM	FEM	REM	FEM
const	8.24***	8.71***	8.61***	7.73***	9.32***	9.11***
	(0.27)	(0.26)	(0.22)	(0.60)	(0.12)	(0.01)
l_PATENT_2	0.12**		0.16**			
	(0.05)		(0.06)			
l_FDI_Inward_Stock_millUSD_pc_2	0.05**	0.05*		0.15**		
	(0.02)	(0.03)		(0.06)		
l_BERD_sGDP_2	0.11**	0.16***			0.29***	
	(0.05)	(0.05)			(0.05)	
l_Res_productivity_2	0.31***	0.32***				0.43***
	(0.05)	(0.06)				(0.06)
n	280	280	280	280	280	280
Adj. R^2 (Within)	0.56	0.45	0.19	0.17	n/a	0.38
Durbin-Watson	0.79	0.55	0.48	0.43	0.37	0.53
Wald test for heterosked. (p-val)	$1.09e^{-114}$	$1.22e^{-173}$	$4.27e^{-180}$	$1.83e^{-99}$	-	0

Probability of parameter´s estimation: *** 99% prob.; ** 95% prob.; * 90% prob. Standard errors in parenthesis.

L – variables are in the form of a natural logarithm; explanatory variables are lagged by two years.

Source: own elaboration according to OECD 2019b; Eurostat 2019; Eurostat 2021; WBG 2019; UNCTADStat 2019.

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Figure 2. Graphical representation of relationships between variables ─ panel data of 28 EU countries – graphical pool model.

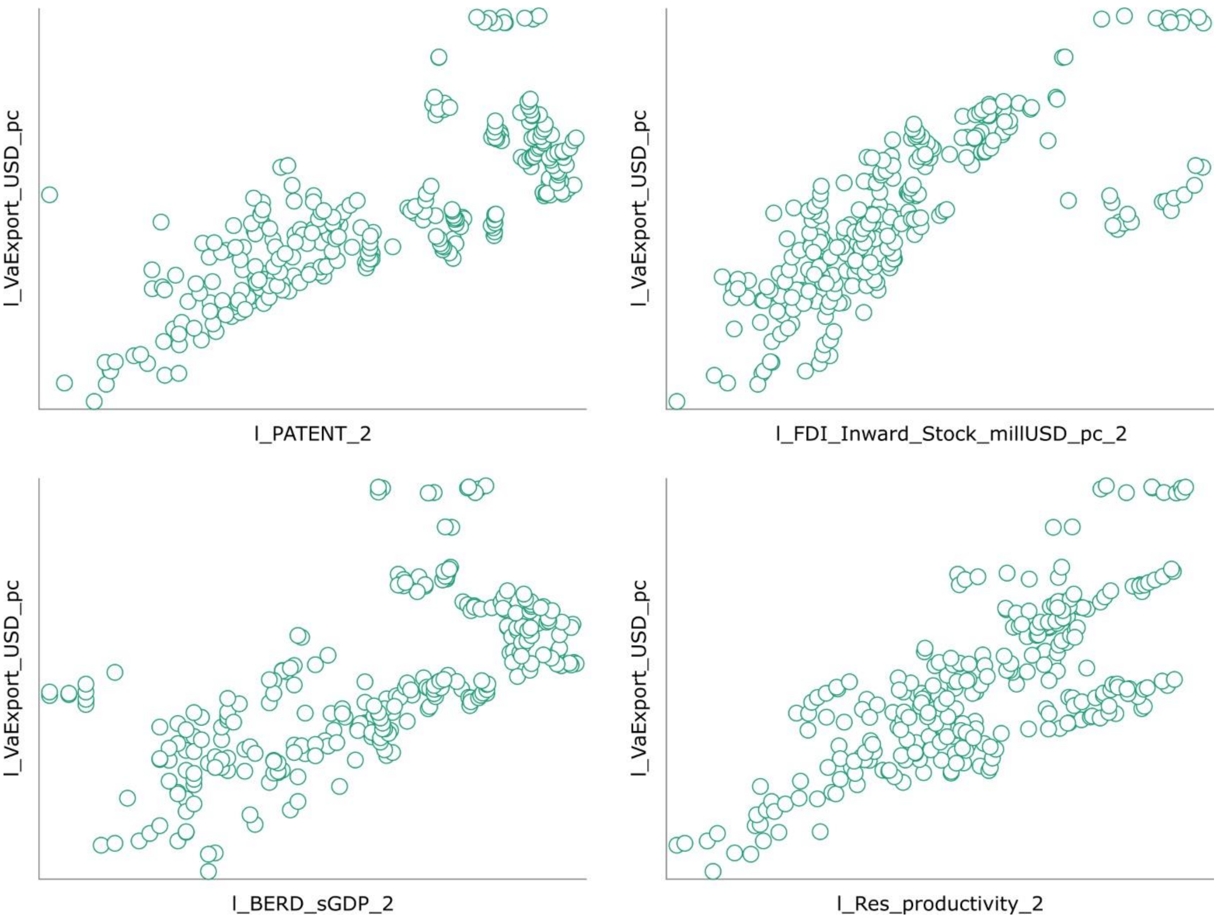

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Table 4. **Econometric models — 11 EU countries**

Fixed-effects estimates (FEM) and Random-effects estimates (REM)

Robust standard error (HAC)

Dependent variable: l_VaExport_USD_pc

	(7)	(8)	(9)	(10)	(11)	(12)
	REM	FEM	FEM	FEM	REM	REM
const	8.06***	7.34***	8.02***	5.16***	8.95***	8.89***
	(0.60)	(0.92)	(0.12)	(0.55)	(0.14)	(0.10)
l_PATENT_2	0.17***		0.27***			
	(0.05)		(0.05)			
l_FDI_Inward_Stock_millUSD_pc_2	0.05	0.18		0.40***		
	(0.06)	(0.10)		(0.06)		
l_BERD_sGDP_2	0.10*	0.1409*			0.32***	
	(0.06)	(0.07)			(0.05)	
l_Res_productivity_2	0.34***	0.30**				0.61***
	(0.10)	(0.12)				(0.09)
n	110	110	110	110	110	110
Adj. R^2 (Within)	-	0.58	0.46	0.42	-	-
Durbin-Watson	0.81	0.60	0.58	0.63	0.31	0.56
Wald test for heterosked. (p-val)	-	$2.26e^{-6}$	$3.58e^{-19}$	0.10	-	-

Probability of parameter´s estimation: *** 99% probability; ** 95% probability; * 90% probability.

l - variables are in the form of a natural logarithm; explanatory variables are lagged by two years.

Source: own elaboration according to OECD 2019b; Eurostat 2019; Eurostat 2021; WBG 2019; UNCTADStat 2019.

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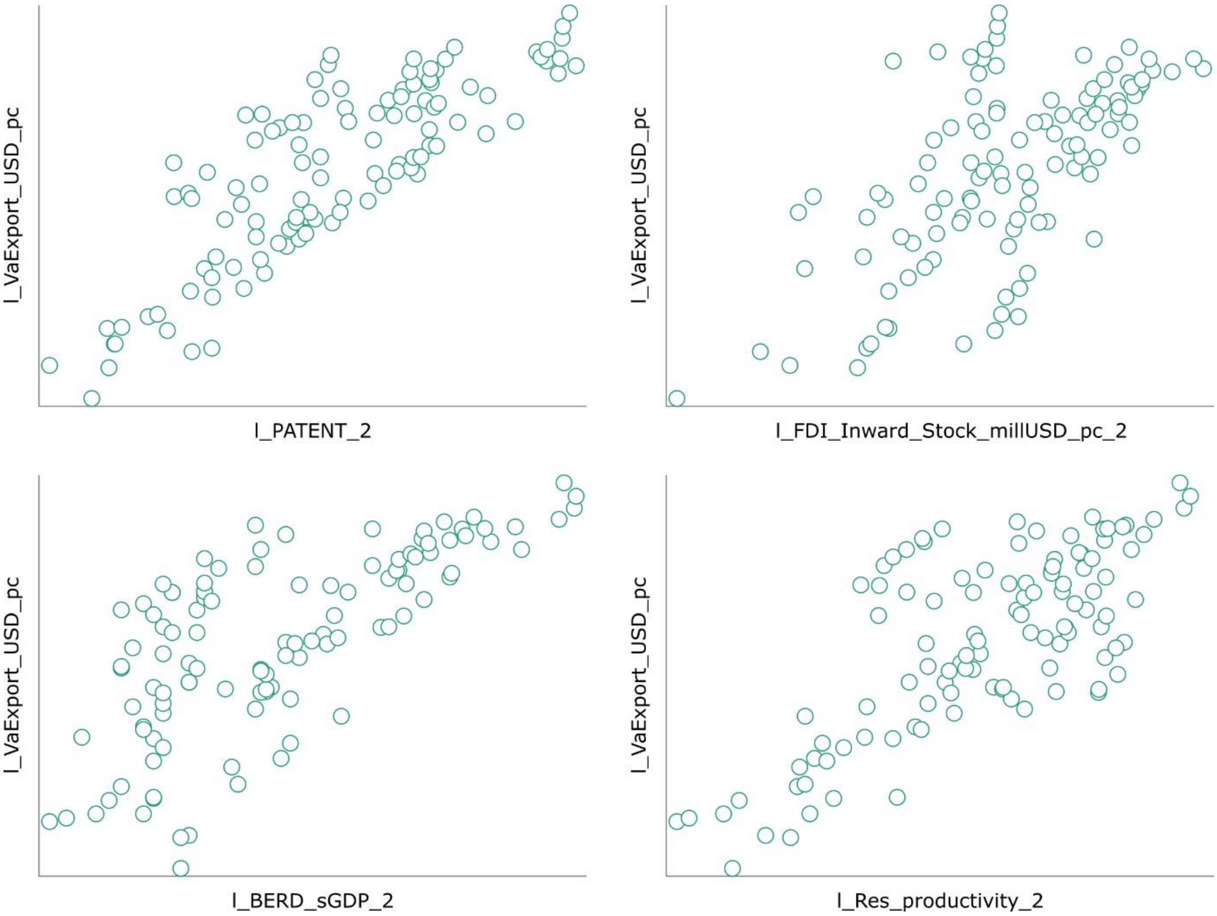

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