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THE IMPACT OF THE ACCESSION TO THE EU ON TRADE FLOWS OF THE VISEGRAD COUNTRIES. ANALYSIS BASED ON THE SYNTHETIC CONTROL METHOD

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The impact of the accession to the EU on trade flows of the Visegrad countries. Analysis based on the synthetic control method

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Abstract: In this paper, we analyse the trade implications of accession to the European Union (EU) for four Visegrad (V4) countries (Czechia, Hungary, Poland, and Slovakia). The estimation of the effects of integration with the EU was carried out as a comparative case study using the synthetic control method (SCM). The selection of control variables of "donor countries", necessary to construct counterfactual trade flows of "synthetic" countries, is based on the gravity model. We analyse the impact of the accession to the EU for 307 country pairs, which covers about 85% of the trade flows of V4 countries. Using this SCM approach we find a positive impact of accession to the EU on the country's performance 15 years after accession. The trade growth resulting from the accession - in comparison to counterfactual aggregates - is large but differentiated. The exports of V4 countries doubled, except for Hungary, while imports increased by 51% on average. Consequently, the trade balances of V4 countries greatly improved compared to counterfactuals. The trade flows strongly increased among V-4 countries, in contrast with the "Hub and spoke" hypothesis. We checked the robustness of our empirical results by running a placebo test.

Keywords: EU enlargement, Visegrad countries, trade flows, economic integration, synthetic control method

JEL codes: F10, F13,F14, F15

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1. Introduction

The liberalisation of trade was seen as a necessary condition to restore market equilibrium and economic transition to market economy in all post-communist countries. The Visegrad countries, i.e., Czechia, Hungary, Poland, and Slovakia were the front runners of economic reforms. Already, in December 1991, Poland signed (simultaneously with Czechoslovakia[1] and Hungary) the Europe Agreement (EA) with the European Communities (EC) and their Member States.[2] The EC and Poland created a free trade area (FTA) for non-agricultural products in March 1994 within a period of ten years. The FTA was not applied to agricultural products, where liberalisation was only very limited. The liberalisation of the European Union's (EU) imports has taken five years and was completed by the end of 1997.

Poland also concluded a free trade agreement and European Free Trade Area (EFTA) member states (Austria, Finland, Island, Liechtenstein, Norway, Switzerland, Sweden), in December 1992. The agreement covered mainly trade in non-agricultural products. EFTA members eliminated most import duties by the 1st of November 1993. Under Poland's transitional period, tariff duties and quantitative restrictions on EFTA imports were phased out by the 1st of January 1999.

Finally, Poland, Czechia, Hungary, and the Slovak Republic, established Central European Free Trade Area (CEFTA) in 1992. Slovenia joined on the 1st of January 1996; Romania on the 1st of July 1997; and Bulgaria on the 1st of January 1999. CEFTA covered all goods, except for a few agricultural products. Since 1992, V-4 countries have also signed bilateral free-trade agreements with the Baltic States (Estonia, Latvia, and Lithuania), Israel, and Turkey[3]. These agreements provided for phased reductions of tariff duties on industrial goods, coupled with tariff rate quotas on several agricultural products.

The Europe Agreement had the largest impact on the V-4 trade policy in the 1990's. In fact, all Visegrad countries were aiming for full integration with the EU. Already in March 1994, Hungary made a request for membership into the EU. The same application was made by Poland (April 1994), Slovakia (June 1995) and Czechia (January 1996)[4]. In 1998 the EU started accession negotiations with five CEE countries (Poland, Czechia, Hungary, Slovenia,

[1] This agreement was replaced – after split of Czech Rep. and Slovakia – by individual Europe Agreements signed in October 1993.
[2] *Europe Agreement* (1994).
[3] Moreover, in 1994 Estonia, Latvia and Lithuania signed Baltic Free Trade Agreement (BFTA) liberalizing their trade flows.
[4] Aggarwal and Fogarty (2004) p. 156.

and Estonia) as well as Cyprus. Soon after, Lithuania and Latvia joined the negotiations. The negotiations with the EU ended in December 2002 and the above-mentioned CEE countries became members of the EU in May 2004.

The transformation reforms and liberalisation of CEE economies constituted an important element of the accession strategy. The Copenhagen criteria required the ability to cope with the competitive pressures exerted by the EU single market and required that the acceding countries create the appropriate institutional environment, based on 'rule of law'.

On the other hand, the accession of V-4 countries to the EU gave them the access to Single European Market (SEM). The accession to the SEM significantly lowered the trade barriers in comparison to the Europe Agreements. In particular, it liberalised full trade in agricultural products, which was especially important for Hungary and Poland. Another important element was related to the elimination of technical barriers to trade (TBT) and Sanitary and Phytosanitary (SPS) measures, which have restricted access to the EU market. Moreover, entry to the SEM eliminated border control and other barriers, allowing for increasing managerial efficiency, increasing returns to scale, and the reduction of monopolistic profits (Cecchini, 1988). The CEE countries also received additional financial benefits resulting from large EU budgetary transfers and increased inflow of FDIs. Thus, the accession to the EU provided an additional important stimulus for the expansion of trade flows among old EU-15 and new member states of the EU.

The main goal of this paper is to study the trade implications of accession to the EU for four Visegrad countries. We analyse the period between 2004 and 2019, i.e., 15 years following the accession. We compare the actual trade flows to the counterfactual "synthetic" trade flows. In estimating counterfactual trade, we use characteristics of "donor" countries and other variables, which are based on the gravity model of international trade. We estimate changes in trade flows with the old EU members (EU-15), new member states (NMS) from the Central and Eastern Europe (CEE) countries and with the third countries.

We expect that the accession to the EU could significantly increase the intensity of trade flows of Visegrad countries with "old" members of the EU (EU-15) and among new member states from CEE. We also expect that the increase of the exports of CEE countries is more important than imports, since the NMS benefited from a large inflow of FDIs and EU budgetary transfers, which contributed to the modernisation of their economies.

The estimation of the effects of integration with the EU was carried out as a comparative case study using the synthetic control method (SCM), proposed by Abadie and Gardeazabal (2003). The selection of control variables of "donor countries", necessary to construct counterfactual trade flows of "synthetic" countries, is based on the gravity model. We analyse the impact of the accession to the EU for 307 country pairs, which covers approximately 85% of trade flows of V-4 countries. The key advantage of using SCM is that it allows to address selection bias and it provides a tool to analyse the changes in bilateral trade flows. Using the SCM we expect to find a positive impact of accession to the EU on CEE countries' trade performance. This approach will allow us to analyse the changes in the geographical structure and trade balances of the V-4 countries after accession.

The paper is organised as follows. In the first part, we present the review of empirical studies analysing changes in trade flows of CEE countries before and after the accession to the EU and a description of important SCM studies. In the second part, we describe the methodology of SCM, and the data used, to estimate changes in trade flows. The third part is devoted to the presentation of the results of our empirical analysis. The last section concludes.

1. Literature review

The possible changes in trade flows resulting from the accession to the EU were analysed in the form of ex-ante and ex-post studies. Many economists (Baldwin, 1994; Brenton & Gros, 1995; Hamilton & Winters, 1992; Wang & Winters, 1992) argued that the CEE countries trade potential in the early 1990's was largely unexploited. Probably the earliest forecast was presented, based on the Computable General Equilibrium (CGE)) model, by Baldwin et al. (1997). The authors analysed subsequent steps in trade CEE-EU trade liberalisation such as: (1) the elimination of tariffs and quantitative restrictions, (2) the adoption of the common external tariff (3) the mutual recognition of health, safety, and industrial product standards, (4) the adoption of a common competition policy and, (5) removal of border controls. Moreover, they also analysed the implications of reduced risk premium, the inflow of FDIs and implications of UE budgetary transfers. Thus, the authors aimed at capturing all economic implications of the accession. In the middle scenario, they showed that the GDP of CEE countries could increase

by 18.8%[5], which could reflect more than 40% growth of trade flows resulting from the accession[6].

The trade implications of Europe Agreements (EAs) were evaluated *ex-post* by some economists, applying structural gravity models. Egger and Larch (2011) demonstrated significant positive effects of EAs on merchandise trade between the EU-15 and the CEE countries and induced trade redirection from other countries. They argue that the EU-15 GDP increased by less than 1%, while that in the 10 CEE countries increased by 6-8% percent in response to the EAs. Consequently, the effects on welfare were moderate in the EU-15 but led to double-digit percentage changes in the CEE countries. Spies and Marques (2009), applied the augmented gravity model, and found that the FTAs with the CEE countries have substantially increased intra-group trade during the 1990's. In the case of the Czech and Slovak Republic and Slovenia at the expense of the Rest of the World (ROW). They argued that earlier East–West studies, which ignored the relative price term's time-varying character, tended to be downward biased[7]. Their results indicated that after correcting for the omitted variable bias, the FTAs with the CEE countries created 7 - 20% more new trade, compared with the scenario where only time-invariant country pair effects were included. Cieślik and Hagemejer (2014) using generalised gravity model showed that the liberalisation in the framework of EAs were effective in raising trade flows of the CEE countries to the EU.

In the early stage of analysis of the implications of CEE accession, the concept of "Hub and Spoke" was discussed, with the "old" EU-15 being the hub of the system and CEE countries being the spokes. The empirical study by De Benedictis et al. (2005), based on GMM dynamic panel estimations, showed that the CEFTA (1992) and BFTA agreement (1994) significantly contributed to the expansion of trade flows among CEE countries before the accession. Thus, the accession to the EU presumably did expand trade of the V-4 countries with "old" EU-15 but with other CEE EU members as well. The importance of intra CCE trade expansion was also shown by Spornberger's (2021) estimating gravity model with time-invariant and time-variant effects. According to her analysis, since 1995, trade integration did not deepen for the EU-15 countries, while trade shares among the newly joined central and eastern EU members doubled.

[5] See Baldwin et all (1997). p. 147. The authors do not discuss changes in trade flows.
[6] This is assumes that increase in trade openness by one percent would raise GDP by 0.5 percent; see Frankel and Romer (1999). In Breuss (2009) and Lewer and Van den Berg (2003) one percentage point change in openness increases real GDP per capita growth by 0.2%.
[7] In the early studies based on gravity models the multilateral trade resistance was ignored.

Grančay et al. (2015) analysed whether, after the accession, there is trade convergence within the EU-15 and among the CEE countries. The authors found evidence of convergence of exports and imports per capita as well as of productivity levels but they observed divergence of geographical and commodity structures of trade; suggesting that multinational companies have adjusted their production structures across the EU to achieve higher economies of scale.

Breuss (2018), using the endogenous growth model approach, estimated that the trade openness of CEE countries increased by 22% as a result of accession to the SEM[8]. According to his study, the accession to the EU increased CEE countries per-capita GDP growth rate by 0.6 percentage point.[9] In a recent study, in t'Veld (2019) used the structural macro-model, which argues that the creation of the SEM and opening-up of economies has increased competition, reduced mark-ups, and lowered prices. The combined impact of these channels is found to have raised EU GDP by 8-9% on average in the long run.

There are also studies devoted to the sectoral implications of the accession of CEE countries to the EU. For example, Martinez-Zardoso (2020), using the generalised gravity model with difference-in-differences (DID) analysis, showed that the effect of the EU enlargement estimated an increase in bilateral trade of 28% for final goods and 24% for intermediates. The effects were heterogeneous by sub-sector. The authors argue that the trade creation effect has been more pronounced in trade in final goods because the CEE countries' trade, before 1989, has consisted mainly of final products. Another study (Stojčić et al., 2018), using the synthetic control method[10], analysed the effects of trade liberalisation on manufacturing export transformation in CEE countries. They show that trade liberalisation during 1990's significantly improved the quality and technological intensity export performance of the analysed countries. The magnitude of the effects was dependent on the speed of trade liberalisation.

Thus, there are studies analysing trade implications of the Eastern enlargement, focusing on the implications of the accession to the SEM. Only some of them were aiming at capturing all implications of economic and political factors associated with the EU membership. This issue became important in the context of Brexit. For example, Mayer et all. (2019), using the modern gravity model to estimate the trade creation resulting from the EU operation, applied

[8] In this estimation the liberalisation in the frameworks of GATT/WTO was also considered.
[9] According to his study. A one percentage point change in openness increases real GDP per capita growth by 0.2%. A very similar result as shown by Lewer and Van den Berg (2003).
[10] The concept of relatively new synthetic control method (SCM) is discussed in the next section.

those to counterfactual situations of a lower level of integration to quantify the "cost of non-Europe". According to their estimates, the trade implications of the EU integration are very important. Trade among the EU members, resulting from integration, more than doubled (increased by 109%)[11] on average, and the total trade increased by 36%. The trade creation of V-4 countries was even larger according to these estimates[12].

In another study, Felbmayer (2019) was evaluating the "cost of undoing Europe", i.e., dismantling customs union, SEM, Schengen, eurozone, and other RTA and financial transfers. According to his estimations, based on the sectoral gravity model, he shows that the percentage losses are more pronounced for more central EU members, while larger and richer countries tend to lose less[13].

In our study we aim to analyse trade implications of accession by constructing "counterfactual" pattern of alternative bilateral trade flows of V-4 countries in the case of non-accession to the EU. We base our analysis on synthetic control method.

The SCM was created by Abadie and Gardeazabal (2003) and first used to examine the GDP effects of terrorism in the Basque country and later developed by Abadie, Diamond and Hainmueller (2010). Since then, it has become a popular tool for studying the impact of various phenomena or policies in many fields of science. Examples of the use of SCM in recent years concerned, among others, checking the influence of Cuban immigrants on the labour market in Miami (Peri & Yasenov,2019), the impact of masks on the spread of Covid-19 (Mitze et al., 2020), the effect of Brexit on foreign investments of British companies (Breinlich et al., 2020), and effectiveness of the Kyoto protocol in reducing CO2 emissions (Maamoun, 2019).

There are few works using SCM to study the effects of European integration. Campos et al. (2019) analysed the impact of European accessions on GDP per capita and labour productivity. The effects varied depending on the year of accession but were positive except for Greece. Apart from Greece, the greatest effects on GDP per capita, 10 years after accession, were with the southern enlargement of 1986 (15,1%) and the eastern enlargement of 2004 (14,8%). Smaller effects were recorded for the enlargements related to northern Europe, 10.76% after 10 years for the 1973 enlargement and 4.24% for the 1995 enlargement. Labour productivity also increased; the greatest growth was recorded in CEE eastern countries

[11] Mayer et all. (2019), Table 6, scenario with intermediate inputs.
[12] The estimated increases of imports of goods of V-4 countries with other EU members were as follows: Czech Rep. (228%), Hungary (214%), Poland (230) and Slovakia (219%).
[13] Felbmayer (2018) estimates that losses of undoing Europe in per capita income of V-4 countries are as follows: Czech Rep.: -14.7%, Hungary: -20.8%, Poland: -11.8% and Slovakia: -14.3%.

(13,22%). Furthermore, Hagemejer et al. (2021) researched the impact of the accession to the EU of CEE countries on their GDP per capita. The effect after 12 years was positive in all countries surveyed except Slovenia. According to their analysis, half of the countries have had more than 30% increase in GDP per capita after the accession. Stojčić et al. (2018) examined export evolution of Central European NMS countries related to the accession to the EU. Trade liberalisation had a positive impact on quality of exports and the share of high technology intensive industries among all examined countries. Manufacturing share in exports also increased but the effect was smaller in Slovenia and did not exist in Croatia. The authors explain this by the fact that the subsequent liberalisation of trade with the EU had an impact on it. Rukavina (2019) checked the effects of Croatia's accession to the European Union on various macroeconomic indicators, including exports and imports. It turns out that Croatia's exports are growing faster than imports and that the level of exports has increased the most of all indicators.

In some texts, authors used the SCM to investigate the effects of the introduction of the Euro currency. Saia (2017) explores the alternative scenario of the UK joining the eurozone at the outset. Trade between the UK and the rest of the eurozone would be 16% higher, while the effect on the eurozone countries themselves is between 19% and 55%. Gyoerk (2017) checks various macroeconomic indicators for such a scenario in Sweden. On average, exports would be around 10 per cent lower over the period under analysis, while imports would be around 8 per cent higher year-on-year. This means that Sweden's trade balance would worsen after joining the euro area. In contrast, Gunella et. al. (2021) find that export flows increased by 30% between first and second groups that adopted the euro as opposed to those that did not, 10% for exports between countries in the first group and almost 3% between countries in the second group. The effects from the gravity models are smaller, but also significant and they found evidence for trade creation within the EU too. The development of regional production chains is the reason for such effects, according to the authors.

There are also few studies using SCM to estimate trade changes related to agreements liberalising trade. Hannan (2016 and 2017) used SCM in two papers studying Regional Trade Agreements (RTAs). These studies were based on covariates from the gravity model of trade. Hannan (2016), analysed trade agreements from 1983 to 1995 and showed that they contributed to an increase in trade between contracting parties by an average of 80% after 10 years. The EU 1986 enlargement generated 95% higher export growth and NAFTA exports increased by 79%. The second text (Hannan, 2017) examined trade agreements concerning Latin America from 1989 to 1994. After 10 years, the average increase was 76.4% but varied considerably between

groups. The export gains of Mercosur and Group of Three are smaller at 23.7% and 9.5% but NAFTA have increased to about 80.9%. Aytuğ et al. (2017) show a positive impact on the growth of exports to the EU and GDP per capita of Turkey in connection with the customs union with the EU.

Adarov (2018), Kassa & Coulibaly (2019) and Quimba & Barral (2019) examined the impact of trade liberalisation on individual sectors in addition to total exports. Adarov (2018) analysed Eurasian Economic Union. He showed that the growth of trade from the deal was blurred due to the sanctions imposed on Russia in 2014 and trade diversion effects existed for some countries and sectors. Kassa & Coulibaly (2019) examined the African Growth and Opportunity Act and demonstrated that most countries had gains in trade due to this agreement, but they were unsteady in most cases. Exports of fuels gains are temporary but in other sectors they increased over time. Quimba & Barral (2019) did research on JPEPA (The Japan-Philippines Economic Partnership Agreement). This Agreement had a positive impact on exports from the Philippines to Japan, but only certain sectors gained.

2. Methodology

In this study, we perform the SCM analysis to compare the level of bilateral trade flows of V-4 countries after accession to the EU and the counterfactual scenario of the V-4 countries not joining the EU. There is an assumption that for every estimation, there is one unit exposed to the event and the remaining units that constitute the "donor pool". From these donor units, a synthetic unit is created that reflects the situation that would occur if this event (accession) did not occur.

The estimate of the average effects resulting from a particular event, for a given entity, is as follows[14]:

$$\tau_{it} = Y_{it}^{I} - Y_{it}^{C}$$

Y_{it}^{I} –Actual value for a treated unit at a particular time

Y_{it}^{C} –Value for the synthetic unit at a particular time

The SCM proposed by Abadie et al. (2010) is based on estimating the potential results for a specific unit for the following model:

$$Y_{it}^{I} = \delta_t + \theta_t Z_i + \lambda_t \omega_i + \alpha_{it} D_{it} + \varepsilon_{it}$$

$$Y_{it}^{C} = \delta_t + \theta_t Z_i + \lambda_t \omega_i + \varepsilon_{it}$$

[14] We use notation from Campos et al. (2014) for the synthetic control method presentation.

where:

δ_t – unknown common factor

θ_t – vector of parameters

Z_i – vector of observed covariates at unit level

λ_t – unobserved common factor

ω_i – unit specific unobservable term

ε_{it} – zero-mean transitory shock

$\alpha_{it}D_{it} = \tau_{it}$, where D_{it} is a dummy variable which takes value 1 when the unit is exposed to the intervention, and zero otherwise.

Having data on the observed values and factor values for the entire group of units, we can approximate Y_{1t} which is the weighted average of variables Z_i of units from the donor pool $(i = 2, \dots, N+1)$ being as close as possible to the unit in time before the event happened.

The vector of weights $W = (w_2, \dots, w_{n+1})$, with the following conditions ($w_i \geq 0$ $i = 2, \dots, N+1$ and $\sum_{i=2}^{N+1} w_i = 1$), such that:

$$\sum_{i=2}^{N+1} w_i Y_{it} = Y_{1t}$$
$$\sum_{i=2}^{N+1} w_i Z_i = Z_1.$$

Ultimately, the event $\hat{\tau}_{it}$ effect can be calculated as follows:

$$\hat{\tau}_{it} = Y_{1t} - \sum_{i=2}^{N+1} w_i^* Y_{it} \ for\ t \geq 0$$

The synthetic unit is similar to the tested unit, being a weighted average itself of the characteristics for each unit in the group. The best-fit vector satisfies the following minimisation problem:

$$\min(X_1 - X_c W)' V (X_1 - X_c W)$$

X_1- vector of variables for the analysed unit in the pre-event period

X_c - is vector of same variables for units from donor pool

V – symmetric and positive semidefinite matrix

A synthetic unit created in this way may correspond to a situation in which a given event does not occur. The accuracy of such a study depends on the deviation of the synthetic unit from the real unit and the length of the period studied before the event. At the same time, the variables must be influencing the studied phenomenon and the units from which the synthetic

unit is created cannot be subject to the same processes examined with the use of SCM. Also, unlike DID models, unobservable confounding factors are independent of time.

The advantage of SCM in our case is that we can study the trade flows between individual countries separately from each other and not together as in DID models. Therefore, we can analyse not only changes in the bilateral trade flows but also shifts in the structure between different groups of countries (e.g., EU-15 and new members of the EU). Moreover, it is possible to study changes in the trade balances resulting from the accession to the EU.

However, the SCM has some drawbacks as well. The statistical significance of the SCM results cannot be calculated. In our study, we use the placebo tests, first established by Abadie et al. (2010) to verify the reliability of our results. If any significant event occurred for the unit during the examined period, the result may be unreliable[15]. Finally, the analysed unit cannot have extreme values of characteristics in relation to other units, because then it is difficult to create a synthetic unit (Craig, 2015).

We study the impact of EU accession on the trade of the V-4 countries. To achieve this goal, we are examining exports from country A to country B where A or B belongs to V-4. We study trade of V-4 group in all directions, i.e. to: EU member states before 2004[16]; the other V-4 countries, to the Baltic states and Slovenia; as well as to twenty largest trade partners (in terms of exports and imports) outside the EU for every V-4 country. This gives 307 pairs analysed by the SCM method. The study is done for the period between 1994-2019.

Like others (e.g., Hannan, 2016), to find the variables needed to estimate the SCM models of exports between countries, we will use covariates from the gravity model of trade which is able to explain this issue. In short, it is a simple equation that can explain trade between two countries as follows:

$$x_{ijt} = G_t M_{it}^{ex} M_{jt}^{im} \emptyset_{ijt}$$

Where x_{ijt} is trade flow between counties i and j in t time, G_t is variable independent of both countries (FE), M_{it}^{ex} represents the trade influencing variables related to the exporter and

[15] The SCM assumes that the event only affects the area that is being studied, which may lead to an underestimation of the effect. A good fit is essential for the results to be reliable as well.
[16] Belgium and Luxembourg are excluded from our analysis due to the lack of separate data for each country.

M_{jt}^{im} by analogy with the importer. $\emptyset_{ijt}$ stands for ease of trade between the two sides, which is the inverse of bilateral trade costs (UNCTAD & WTO, 2012).

The following variables, used in gravity models and in papers analysing trade flows by SCM (e.g., Hannan, 2016), were used in our estimations[17]:

- GDP (gdp)
- Distance (dist)
- GDP per capita (gdpcap)
- Remoteness[18] (rem)
- Trade openness[19] (trade_open)
- Percent of industry in GDP (industry)
- Binary variables representing:
  - Common legal origins before transition (comleg_pretrans)
  - Regional trade agreement (rta)
  - Contiguity (contig)

The continuous variables are measured in logs (l). Variables were checked by running PPML regression with fixed effects for years. On the basis of the regression, it can be assumed that all the above-mentioned variables have an impact on trade. Therefore, they can be used for SCM estimation. The data sources for the estimations are: CEPII Gravity database and the WDI World Bank database.

Table 1. PPML regression with variables used for the SCM estimations

	(1)
VARIABLES	export_d
l_gdp_o	0.949***
	(0.00722)
l_gdp_d	0.962***
	(0.00571)
l_gdpcap_o	-0.0474***
	(0.00881)

[17] Apart from distance and binary variables, we use values from exporter (origin: o) and importer (destination: d); names in brackets here and on the list are abbreviations used in Table 1. for these variables.

[18] $Rem_i = \sum_j \frac{dist_{ij}}{GDP_j / GDP_{world}}$; Remoteness measures a country's average weighted distance from its trading partners (Head, 2003), where weights are the partner countries' shares of world GDP (UNCTAD/WTO,2012).

[19] We measure it as sum of exports and imports divided by GDP.

l_gdpcap_d	-0.0964***
	(0.00800)
l_dist	-0.491***
	(0.0102)
l_rem_o	-0.833***
	(0.0794)
l_rem_d	-0.974***
	(0.0917)
contig	0.488***
	(0.0293)
rta	0.325***
	(0.0172)
l_trade_open_o	0.598***
	(0.0160)
l_trade_open_d	0.612***
	(0.0148)
l_industry_o	0.765***
	(0.0223)
l_industry_d	-0.258***
	(0.0206)
comleg_pretrans	0.256***
	(0.0142)
Constant	17.11***
	(3.355)
Observations	454,026
Pseudo R-squared	0.8191
Year FE	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Own calculations based on the CEPII Gravity database and WDI World Bank database

The lag of exports and the exports values from 1994, 1998, 2002 were also used as covariates to optimise the estimation fit, similarly to Abadie et al. (2010).

The donor pool included pairs of exports between 28 countries. We analysed the following countries: Albania, Argentina, Australia, Brazil, Canada, Chile, China, Hong Kong, Colombia, Egypt, Indonesia, Iceland, Israel, Japan, Korea, Morocco, Mexico, Macedonia,

Malaysia, New Zealand, Philippines, Russia, Thailand, Tunisia, Turkey, Ukraine, Uruguay and the United States[20]. The database created in this way contains 15,106 observations.

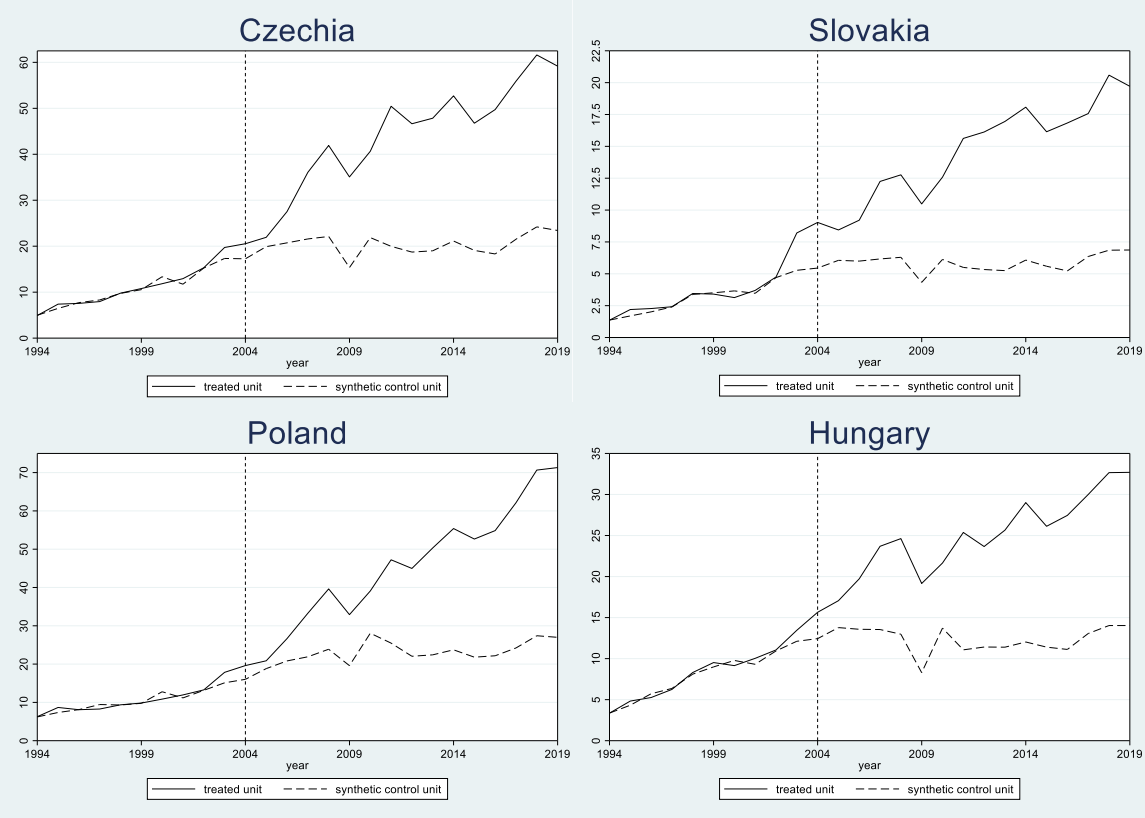
To be able to compare the fit of our estimates with other estimations, we use the fit index from Adhikari and Alm (2016). To be able to calculate it, first, we calculate the root mean square prediction error (RMSPE)[21] and the so-called benchmark RMSPE which is the theoretical RMSPE of the zero fit model. Then the fit index is obtained by dividing RMSPE by benchmark RMSPE. This gives us a tool to compare the fit of our estimates. For example, RMSPE would be very different between pairs with small and huge values of exports with the same percent difference between synthetic and treated units before intervention time. But the fit index would have the same value for them. In another sense, the value (1-fit value) can be compared to the value R^2 in the gravity model (Adhikari and Alm, 2016). With this in mind and knowing the R^2 value from the PPML estimation, let's assume that in our case the fit index will be good if the fit index value is approximately equal to or less than 0.2.

The SCM was applied to all country pairs. Below we show the results of the SCM method taking the example of the exports of the V-4 countries to Germany. The continuous line is the actual export of the V-4 country to Germany, and the dashed line of its synthetic counterpart to Germany, which reflects the situation of the examined country not joining the EU. The adjustment of the synthetic unit to the actual values before 2004 is noteworthy. It suggests that the results are reliable.

Graph 1. Counterfactual (synthetic: SCM) vs. real trade flows for V-4 exports to Germany in billion US dollars

[20] The list of countries is taken from Campos et. al. (2019). We dropped Switzerland from the list due to estimation issues. We also added the United States to better represent trade with large countries.

[21] $RMSPE = \sqrt{\frac{1}{T_0}\sum_{t=1}^{T_0}(Y_{1t} - \sum_{j=2}^{J+1} w_j^* Y_{jt})^2}$ and $Benchmark\ RMSPE = \sqrt{\frac{1}{T_0}\sum_{t=1}^{T_0}(Y_{1t})^2}$, where T_0 is the length of examined period before the year of the event, Y_{1t} is a value of treated unit and $\sum_{j=2}^{J+1} w_j^* Y_{jt}$ is a value of synthetic unit at time t.



Source: Own calculations

3. Empirical Results

According to the SCM estimation results, joining the EU contributed to a doubling of V-4 exports and an approximate 50% increase in V-4 imports after fifteen years. This result is higher than the majority of other studies but in line with the predictions of Mayer et al. (2019). Not all countries had the same trade growth at this time. Hungary is an exception that lowers the group's results as their exports only increased by about 68% and imports by 21%. The remaining countries perform above average for the entire V-4 group. As for the percentage of the examined trade, the result covers above 85%, which represents the behaviour of almost the entire trade.

Table 2 Comparison between real and counterfactual values of exports resulting from the accession to the EU (in bn $ and in %)

Exports	Value of exports in 2019 (bn $)	Counterfactual value (SCM) of exports in 2019 (bn $)	Percentage change resulting from the EU accession	Percentage of analysed exports

V-4	580.94	273.04	112.77%	91.33%
CZE	172.31	78.30	120.05%	91.96%
HUN	102.78	61.14	68.10%	91.34%
POL	227.94	102.40	122.60%	91.76%
SVK	77.92	31.20	149.77%	88.93%

Source: own calculations

Table 3 Comparison between real and counterfactual values of imports resulting from the accession to the EU (in bn $ and in %)

Imports	Value of imports in 2019 (bn $)	Counterfactual value (SCM) of imports in 2019 (bn $)	Percentage change resulting from the EU accession	Percentage of analysed imports
V-4	583.82	372.25	56.84%	93.27%
CZE	164.70	92.79	77.49%	94.00%
HUN	107.46	88.49	21.44%	93.60%
POL	228.46	150.22	52.09%	91.77%
SVK	83.21	40.75	104.20%	95.41%

Source: own calculations

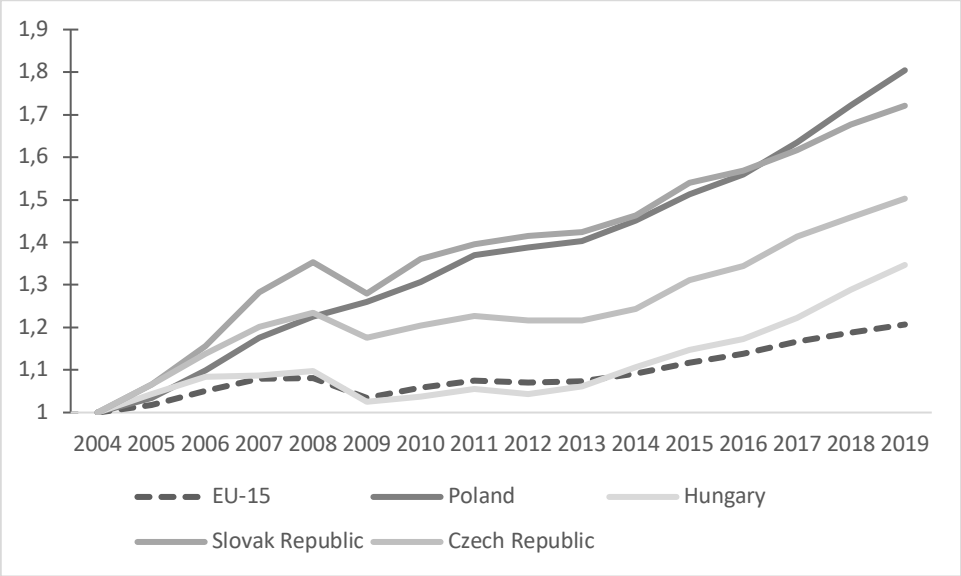
The high rate of trade expansion is derived from earlier transformations of V-4 countries and their accession to the EU. The economic transition and trade liberalisation of these economies increased their foreign direct investment (FDI) and domestic investment[22], supported by the infrastructure investment financed by the EU structural policies. In consequence, the growth rate of V-4 accelerated, especially in relation to the EU-15 countries (see Graph 2). The inflow of FDI came mostly from European countries and helped them to finance their large trade deficits (see Table 8) at the beginning of the accession process. The increased investments led to increased productivity in the manufacturing sector, higher GDP growth rates and - endogenously - to higher rates of growth of exports and imports (through spill-over effects within the gravity trade model). The expansion of trade of V-4 was reinforced by their active participation in Global Value Chains (GVCs). This phenomenon was well documented in several studies[23]. Thus, the unprecedented expansion of V-4 countries' trade – in our opinion - resulted from several phenomena related to the accession to the EU. We also

[22] See: International Monetary Fund (2014)
[23] See e.g.: Taglioni and Winkler (2016), WTO (2019).

believe that the construction of a counterfactual world allows to capture the effects of these complex economic relations.

Graph 2 shows that the GDP growth rate of Hungary was clearly lower in comparison to other V-4 members. The relatively poor economic performance of the country was observed between 2006 and 2009. As Graph 2 shows, when other countries in the region were approaching similar economic levels as the EU-15 in this period, Hungary's GDP growth was at the same level as the EU-15 countries. The reason for these results was the internal crisis that unfolded in 2006. Erroneous economic policies of successive governments led to the deterioration of public finances after 2000[24]. The world economic crisis in 2008 led to the currency crisis and the deterioration of the already falling economic situation in Hungary, at the cost of further budget cuts and the deterioration of the economic situation (Surányi, 2018). Hungary emerged from this crisis considerably weakened. In view of the estimation results, it can be said that the economic condition in the early years determined and limited the size of the benefits from European integration.

Graph 2 GDP growth in V-4 and EU-15 countries in relation to 2004



Source: WDI

The V-4 countries now have strong trade relations with the EU-15 countries, which can be seen in the tables below (Tables 3 & 4). Most of the trade is directed to the EU-15 countries

[24] Real wages were considerably higher than productivity which, combined with loose fiscal policy, led to an overheating of the economy. A very large imbalance in the budget and the balance of payments led to sudden budget cuts which had a negative impact on economic growth in the short term.

(60%), and to the NMS (about 20%). Thus, the liberalisation of trade with the EU has strengthen the scope of economic integration of these countries.

Table 4 Geographical structure of V-4 trade exports:

Exports of V-4	EU-15			NMS			Non-EU		
year	1994	2004	2019	1994	2004	2019	1994	2004	2019
CZE	59.45%	63.56%	60.88%	25.03%	21.70%	19.85%	15.52%	14.74%	19.27%
HUN	67.47%	67.12%	53.92%	10.28%	13.58%	23.43%	22.25%	19.30%	22.66%
POL	69.25%	66.75%	61.47%	6.53%	14.90%	18.01%	24.22%	18.35%	20.52%
SVK	42.06%	59.15%	47.51%	47.11%	27.57%	28.32%	10.82%	13.29%	24.17%
V-4	62.48%	64.91%	57.95%	18.01%	18.22%	20.98%	19.51%	16.87%	21.06%

Source: Own calculations based on data from the CEPII gravity database

Table 5 Geographical structure of V-4 trade imports:

Imports of V-4	EU-15			NMS			Non-EU		
year	1994	2004	2019	1994	2004	2019	1994	2004	2019
CZE	54.31%	66.75%	55.75%	20.19%	13.69%	20.20%	25.50%	19.56%	24.05%
HUN	61.82%	57.80%	52.50%	8.64%	10.91%	20.98%	29.54%	31.29%	26.53%
POL	64.58%	65.65%	57.63%	4.72%	9.79%	11.38%	30.70%	24.56%	30.99%
SVK	32.74%	50.94%	45.54%	35.38%	28.14%	35.30%	31.89%	20.92%	19.16%
V-4	57.18%	62.30%	54.48%	13.66%	13.34%	18.89%	29.16%	24.36%	26.62%

Source: Own calculations based on data from the CEPII gravity database

When it comes to import or export diversion effects for the V-4 countries, they do not occur. Even trade with third countries increased slightly, although to a much lesser extent than with EU countries[25]. As for the reasons, it is possible that the strong economic growth during this period led to spillover effects in terms of trade where the very large increase in trade with the EU led to a smaller increase in trade with third countries. It is worth noting that trade with the NMS countries increased more (in percentage terms) than with the EU-15 countries. This contradicts the hub-and-spoke hypothesis, according to which trade should develop more actively between the centre and the periphery of the EU. The changes in the destination of exports and imports of individual V-4 countries are reported in Tables A1 and A2 in Annex.

[25] The imports of Hungary and Slovakia form third countries decreased slightly during the analysed period (see Table A2).

Table 6 Comparison between real and counterfactual values of exports of V-4 countries resulting from the accession to the EU (in bn $ and in %)

Exports destination	Value of exports in 2019 (bn $)	Counterfactual value (SCM) of exports in 2019 (bn $)	Percentage change resulting from the EU accession	Percentage of analysed exports
NMS	105.51	40.42	161.06%	82.45%
EU-15	366.60	171.85	113.33%	95.97%
Non-EU	108.84	60.78	79.08%	83.08%

Source: own calculations

Table 7 Comparison between real and counterfactual values of imports of V-4 countries resulting from the accession to the EU (in bn $ and in %)

Imports origin	Value of imports in 2019 (bn $)	Counterfactual value (SCM) of imports in 2019 (bn $)	Percentage change resulting from the EU accession	Percentage of analysed imports
NMS	102.05	37.71	170.63%	88.55%
EU-15	334.07	206.42	61.84%	95.68%
Non-EU	147.70	128.12	15.29%	89.70%

Source: own calculations

The V-4 countries had a large negative trade balance before accession. According to the estimation results, joining the EU created improvements of the trade balances of these countries. Otherwise, the trade balance would deteriorate even more in Hungary and Slovakia relative to GDP in 2019. In practice, the Czechia and Poland would also have a worse trade balance in relation to GDP, because, in the event of failure to join the EU, the GDP of these countries would be lower, which would mean a weaker trade balance than in relation to their GDP in 2019.

Such trade balance values with high probability would mean large deficits in the current account. Thus, V-4 countries, without accession, would face serious economic imbalances in an alternative scenario. This may be one of the mechanisms causing lower GDP in the scenario of non-accession to the EU.

Table 8 Comparison of trade balances between real and counterfactual values resulting from the accession to the EU (in bn $)

Countries	Trade balance of examined trade in 2019 (bn $)	Counterfactual (SCM) trade balance (bn $)	Trade balance in 2019 (bn $)	Trade balance in 2004 (bn $)	Trade balance in 1994 (bn $)
V-4	-2.88	-99.21	11.40	-46.02	-10.24
CZE	7.61	-14.49	13.51	-10.78	-1.77
HUN	-4.68	-27.35	2.27	-8.62	-3.48
POL	-0.52	-47.82	-6.28	-24.00	-3.96
SVK	-5.29	-9.55	1.89	-2.62	-1.03

Source: own calculations

Table 9 Comparison of trade balances between real and counterfactual values resulting from the accession to the EU (in % of GDP)

Countries	Trade balance of examined trade in 2019 (% of GDP)	Counterfactual (SCM) trade balance (% of 2019 GDP)	Trade balance in 2019 (% of GDP)	Trade balance in 2004 (% of GDP)	Trade balance in 1994 (% of GDP)
V-4	-0.26%	-8.90%	1.02%	-8.63%	-4.67%
CZE	3.04%	-5.78%	5.39%	-9.06%	-3.74%
HUN	-2.86%	-16.73%	1.39%	-8.36%	-8.11%
POL	-0.09%	-8.02%	-1.05%	-9.47%	-3.64%
SVK	-5.03%	-9.09%	1.80%	-4.57%	-5.13%

Source: Own calculations

In order to verify the reliability of the results, it is necessary to check whether the fit of the estimates is sufficient. To do this, we use the fit index previously defined in our text. As far as the results are concerned, they are almost the same for exports and imports, but there are slight differences between countries, although they are irrelevant as they fall within the acceptable range. We don't also have overfitting of estimates. We may consider that the mismatch is not a problem for our estimations.

Table 10 Mean fit indexes for examined export by country and group of importers

	CZE	HUN	POL	SVK	V-4
Whole Export	0,1201	0,1393	0,2128	0,1195	0,1481
NMS	0,1277	0,1219	0,1696	0,1213	0,1357
EU-15	0,1259	0,1350	0,2257	0,1143	0,1502
Non-EU	0,1136	0,1482	0,2195	0,1223	0,1509

Source: Own calculations

Table 11 Mean fit indexes for examined import by country and group of importers

	CZE	HUN	POL	SVK	V-4
Whole Import	0,1358	0,1379	0,1856	0,1285	0,1467
NMS	0,1499	0,1203	0,1203	0,1286	0,1301
EU-15	0,1623	0,1315	0,1779	0,1379	0,1524
Non-EU	0,1136	0,1482	0,2195	0,1223	0,1509

Source: Own calculations

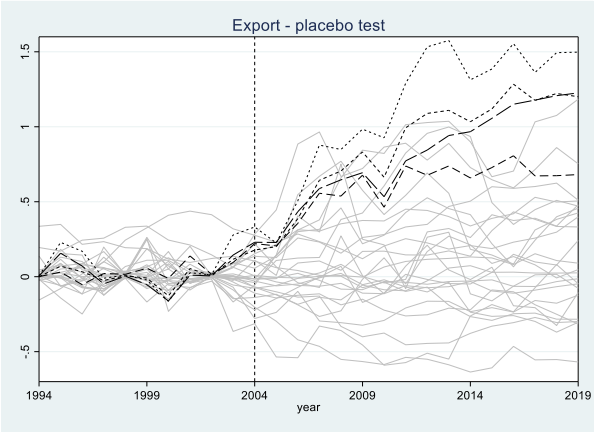
Also, placebo tests were carried out to validate the results. It is a method for checking the plausibility of SCM results, developed by Abadie, Diamond and Hainmueller (2010). The method checks whether the effect resulting from the SCM estimation is not similar to the effect of randomly tested units from the donor pool. However, it is not possible to conduct the tests in the way proposed by the authors, due to the large database size and the number of SCM estimates. Therefore, we run the following procedure to check the validation of our results: Firstly, we do SCM estimations for every pair from the donor pool. For each pair studied, we exclude pairs with the same exporter or importer from the donor pool and then do SCM estimation for the pair on a truncated base of pairs from the donor pool. Secondly, we group them by country and measure changes in trade as a percentage by country of export or import depending on the test. The idea is that by having a large database as in our case and many countries, instead of checking each estimate separately, we can group them by country and check them together. Finally, we make a comparison with the trade developments of the V-4 countries.[26] We have one test for exports and one for imports.

For the exports side, export growths of Poland, Czechia and Slovakia after 2004 is bigger than any placebo. Hungary has worse results than other V-4 countries, but far bigger than almost all of placebo countries. Therefore, the results for exports are reliable for the

[26] We exclude placebo countries with maximum, bigger than 50% effect before 2004. This is in accordance with Abadie et al. (2010) placebo test procedure to exclude estimations with poor fit.

Visegrad group as a whole. When it comes to imports, this is more difficult to interpret. We have some outlier observations that complicate the interpretation of the placebo test.[27] Without them, it is apparent that the Czechia and Slovakia are again above the vast majority of placebo countries. Hungary's import score, on the other hand, does not differ from that of other placebo countries. The case of Poland is a borderline case. This does not mean that the import results for these countries are unreliable. It cannot be interpreted without the export results. This shows that the difference between the percentage of exports and imports of all V-4 countries is greater than the vast majority of placebo countries. This difference is also almost the same for all V-4 countries. Therefore, for all V-4 countries, the results of the SCM estimation can be considered reliable.

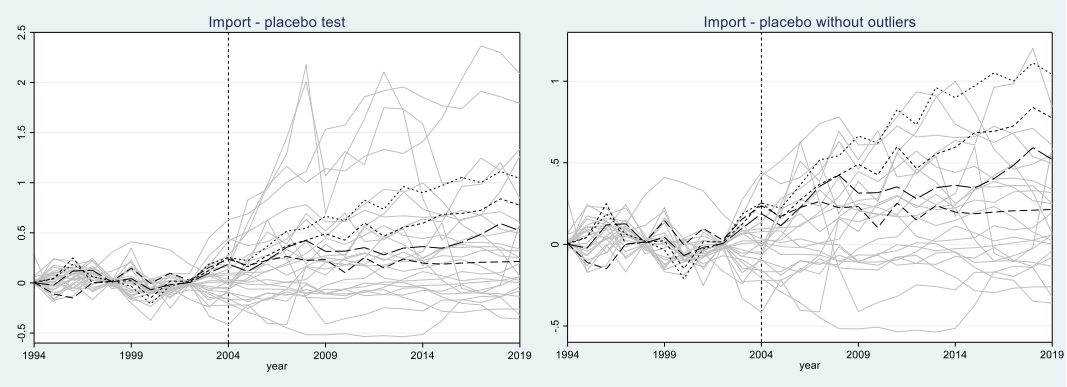
Graph 3 Export placebo test visualisation, the percentage difference between real data and SCM results (Patterns for V-4 countries: very short dash – Slovakia, short dash – Czechia, dash – Hungary, long dash – Poland)



Source: Own calculations

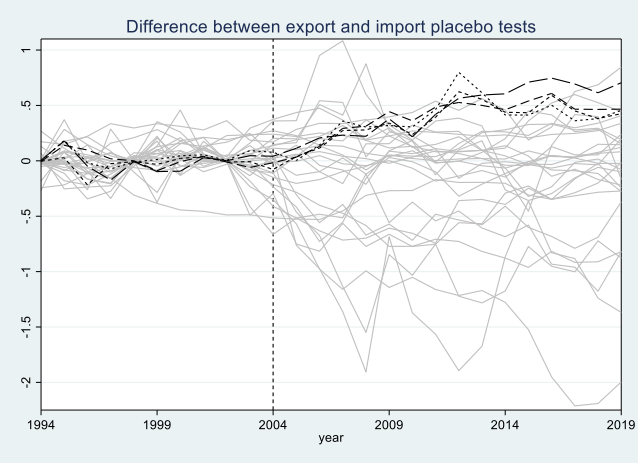
Graph 4 Import placebo tests visualisations, the percentage difference between real data and SCM results (Patterns for V-4 countries: very short dash – Slovakia, short dash – Czechia, dash – Hungary, long dash – Poland)

[27] There are from the highest to lowest effect at the end of the period: India, China, Russia, Ukraine. We present import placebo graphs with and without them to better examine the results.



Source: Own calculations

Graph 5 Difference between export and import placebos and results for V-4 (Patterns for V-4 countries: very short dash – Slovakia, short dash – Czechia, dash – Hungary, long dash – Poland)



Source: Own calculations

4. Conclusions

In this paper, we analysed the trade implications of accession to the EU for four Visegrad (V-4) countries (Czechia, Hungary, Poland, and Slovakia) between 2004 and 2019. We estimated changes in trade flows with the old EU-15 members, new member states from the Central and Eastern Europe (CEE) countries, and with the third countries.

The V-4 countries signed the "Europe Agreements" in 1992, liberalising non-agricultural trade with the EU 15 countries. In 1998 the V-4 started accession negotiations and became members of the EU in 2004. The accession to the EU guaranteed them the access to Single European Market (SEM). In consequence, the whole trade was fully liberalised, TBTs and SPSs barriers were eliminated as well as border controls and other barriers. The V-4

countries also received additional financial benefits resulting from large EU budgetary transfers and increased inflow of FDIs.

There have been several studies, based mostly on the gravity model, aiming to evaluate the trade implications of the accession to the EU. The majority of them estimated that the trade flows increased by 20-40%. On the other hand, in a recent study, Mayer et al. (2019) used the modern gravity model and the counterfactual analysis and estimated that trade creation resulting from EU integration more than doubled.

In our study, we estimated the trade effects of integration by applying the synthetic control method (SCM), proposed by Abadie and Gardeazabal (2003). The SCM was used to analyse the implications of various political and economic events, such as the implications of terrorism in the Basque country, the reunification of Germany, the influence of Cuban immigrants on the labour market in Miami, or the effects of Brexit on foreign investments of British companies. The SCM, based on gravity covariates, has also been used to estimate trade implications of some RTAs (NAFTA, African Growth and Opportunity Act) in non-European countries.

In our SCM analysis, the control variables of "donor countries" (necessary to construct counterfactual trade flows of "synthetic" countries) are based on the gravity model. We analyse the impact of the accession to the EU for 40 country pairs, which covers about 85% of the trade flows of V-4 countries. The key advantage of using SCM is that it allows to address selection bias and provides a tool to analyse the changes in bilateral trade flows.

Using this SCM approach we find a positive impact of accession to the EU on the trade performance 15 years after accession. The estimated growth of trade resulting from the accession - in comparison to counterfactual aggregates – is large but differentiated. The exports of V-4 countries doubled, except for Hungary, while imports increased by 52%. The exports of V-4 countries to the CEE EU countries increased by 150%, to the EU-15 by 104% and to the third countries by 76%. The imports of V-4 from CEE countries increased by 145%, from EU-15 by 53% and from the third countries by 17%.

Thus, the accession to the EU led to large trade creation effects with the EU members. The expansion of trade among CEE members of the EU did not support "hub and spoke" hypothesis and the trade with third countries did not decrease. According to our analysis, larger expansion of exports than imports significantly improved trade balances of V-4 countries in comparison to counterfactuals. We confirmed the robustness of our empirical results by running placebo tests.

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Appendix

Table A1 Comparison between real and counterfactual values of exports resulting from the accession to the EU (in bn $ and in %)

Origin of exports	Value of exports in 2019 (bn $)	Counterfactual value (SCM) of exports in 2019 (bn $)	Percentage change resulting from the EU accession	Percentage of analysed exports
V-4	580.94	273.04	112.77%	91.33%
CZE	172.31	78.30	120.05%	91.96%
CZE(NMS)	33.21	14.58	127.80%	89.32%
CZE(EU-15)	111.57	47.88	133.04%	95.88%
CZE(Non-UE)	27.52	15.85	73.65%	78.96%
HUN	102.78	61.14	68.10%	91.34%
HUN(NMS)	18.05	6.82	164.50%	75.24%
HUN(EU-15)	62.56	37.87	65.18%	96.89%
HUN(Non-UE)	22.17	16.44	34.84%	83.33%
POL	227.94	102.40	122.60%	91.76%
POL(NMS)	37.59	8.45	344.87%	86.28%
POL(EU-15)	150.03	70.04	114.21%	94.72%
POL(Non-UE)	40.32	23.91	68.62%	85.46%
SVK	77.92	31.20	149.77%	88.93%
SVK(NMS)	16.66	10.56	57.71%	72.47%
SVK(EU-15)	42.43	16.06	164.24%	97.62%
SVK(Non-UE)	18.83	4.58	311.43%	84.40%

Source: Own calculations

Table A2 Comparison between real and counterfactual values of imports resulting from the accession to the EU (in bn $ and in %)

Origin of imports	Value of imports in 2019 (bn $)	Counterfactual value (SCM) of imports in 2019 (bn $)	Percentage change resulting from the EU accession	Percentage of analysed imports
V-4	583.82	372.25	56.84%	93.27%
CZE	164.70	92.79	77.49%	94.00%
CZE(NMS)	32.34	13.06	147.56%	96.41%
CZE(EU-15)	94.56	52.62	79.69%	95.98%
CZE(Non-UE)	37.81	27.11	39.45%	85.56%
HUN	107.46	88.49	21.44%	93.60%
HUN(NMS)	20.33	8.19	148.11%	81.90%
HUN(EU-15)	59.76	45.86	30.31%	96.66%
HUN(Non-UE)	27.37	34.44	-20.52%	92.04%
POL	228.46	150.22	52.09%	91.77%
POL(NMS)	20.23	7.04	187.47%	76.04%
POL(EU-15)	140.08	88.49	58.31%	94.87%
POL(Non-UE)	68.15	54.69	24.61%	89.76%
SVK	83.21	40.75	104.20%	95.41%
SVK(NMS)	29.15	9.42	209.65%	97.90%
SVK(EU-15)	39.68	19.45	103.94%	95.64%
SVK(Non-UE)	14.38	11.88	21.03%	91.51%

Source: Own calculations

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