

November 2017

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Recommended Citation

Ambroziak, Łukasz (2017) "Determinants of trade in value added: the case of the Central and Eastern European Countries," *International Journal of Business and Technology*: Vol. 6 : Iss. 1 , Article 10.

DOI: 10.33107/ijbte.2017.6.1.10

Available at: <https://knowledgecenter.ubt-uni.net/ijbte/vol6/iss1/10>

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Determinants of trade in value added: the case of the Central and Eastern European Countries

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Abstract The aim of the paper is to investigate determinants of trade in value added of the CEECs (Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia) in the period 2000–2014. For this purpose, it uses a generalised gravity model based on panel data. The main independent variables (GDP of trading countries and the distance between them) have the same direction of impact on both value added exports/imports and gross exports/imports. Only the values of coefficients differ. The greatest difference concerns the geographical distance. It results from indirect value added trade.

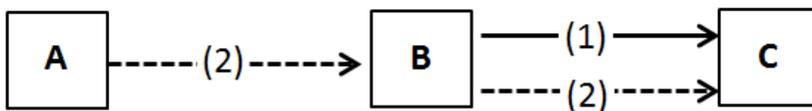
Keywords: trade in value added, gross trade, Central and Eastern European countries, WIOD

Introduction

The making available in the early 2010s of complex databases containing world input-output tables (e.g. the World Input-Output Database – WIOD) was a significant advancement in research on international trade. It allowed to compile statistics of value added (VA) flows between countries. Trade statistics in VA terms take account of the contributions of particular countries to the creation of VA and eliminate the multiple calculation in trade of components, first separately (as intermediate goods) and then as parts of final goods (OECD, 2013). Thus, trade statistics in VA terms enable us to better estimate trade changes resulting from internationalisation and globalisation as well as benefits derived by countries from international trade.

The concept of ‘trade in value added’ or ‘value added trade’ allows to determine how much of the VA created in a country is directly and indirectly embodied in the final consumption of another country (Stehrer, 2013). VA may flow to the destination country directly in the form of the final product or indirectly in the form of a semi-finished product through other countries. It means that the country concerned exports an intermediate product to a country in which it is used for the manufacture of the final product, subsequently exported to the country of destination where it is consumed or absorbed (Johnson and Noguera, 2012).

In order to demonstrate the difference between VA and gross trade balances, Figure 1 presents an example of trade between three countries. The differences between net trade in gross and VA terms result from the possibility that a country may trade with another country only indirectly via a third partner. In the example below, country A exports an intermediate worth 2 to country B, which then – after adding some value of its own – ships the final product worth 3 to C, where it is consumed. Thus, no physical shipment of the good between A and C is observed, although there is value added created in country A which is finally absorbed in country C.



	in gross terms	in VA terms
exports of country A to country B	2	0
exports of country A to country C	0	2
exports of country B to country C	3	1

Fig. 3. Illustration of trade in value added Source: Own study based on (Nagengast and Stehrer, 2014; Stehrer and Stöllinger, 2013).

The aim of the paper is to investigate determinants of the trade in value added of the CEECs (Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia) in the period 2000–2014. For this purpose, it uses a generalised gravity model based on panel data.

Material and methods

In order to calculate trade flows in value added terms, the *World Input-Output Database* (WIOD Release 2016) was used. It contains world input-output tables for the years 2000–2014 (Timmer et al., 2016). On the basis of the above-mentioned tables, using the input-output (IO) model, appropriate calculations were made.

The value added exports between country 1 and country 2 (VAX^{12}) are defined as the value added of country 1 which is ultimately absorbed in final demand by country 2. VAX^{12} are computed in the following way:

$$VAX^{12} = \begin{pmatrix} v^1 & 0 & 0 \end{pmatrix} \begin{pmatrix} l^{11} & l^{12} & l^{13} \\ l^{21} & l^{22} & l^{23} \\ l^{31} & l^{32} & l^{33} \end{pmatrix} \begin{pmatrix} f^{12} \\ f^{22} \\ f^{32} \end{pmatrix} = v^1 l^{11} f^{12} + v^1 l^{12} f^{22} + v^1 l^{13} f^{32} \quad (1)$$

where:

v_i is the value added coefficient of country i of the 1×2464 value added vector \mathbf{v} ,
 l^{ij} refers to the i th row, j th column element of the 2464×2464 Leontief inverse \mathbf{L} ,
 f^{ij} denotes flows of final goods from country i to country j .

The calculation of the VA imports of country 1 from country 2 is based on the equation allowing to estimate the VA exports of country 2 to country 1:

$$VAM^{12} = VAX^{21} = \begin{pmatrix} 0 & v^2 & 0 \end{pmatrix} \begin{pmatrix} l^{11} & l^{12} & l^{13} \\ l^{21} & l^{22} & l^{23} \\ l^{31} & l^{32} & l^{33} \end{pmatrix} \begin{pmatrix} f^{11} \\ f^{21} \\ f^{31} \end{pmatrix} = v^2 l^{21} f^{11} + v^2 l^{22} f^{21} + v^2 l^{23} f^{31} \quad (2)$$

In order to investigate the determinants of trade flows of the Central and Eastern European countries, a gravity model was used. Gravity models were developed as a result of employing Newton’s law of universal gravitation in the examination of socio-economic phenomena. The

first researcher to use a gravity model to analyse international trade flows was J. Tinbergen in the 1960s (1962). It followed from that model that the value of trade between two countries was in direct proportion to the product of the countries' gross domestic products and in inverse proportion to the distance between them. Since the 1960s, gravity models have been widely used to analyse trade flows.

The gravity model employed in this study was estimated with the use of the Poisson pseudo-maximum-likelihood (PPML) estimator, with a clustering variable – distance. Based on the gravity model proposed by Proença et al. (2015), the gravity equation takes the following form:

$$T_{ijt} = \exp[\beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \delta' \ln X_{ijt} + \phi' \ln Z_{ij} + \varphi' \ln V_{ijt} + \gamma' \ln D_{ij} + \alpha_t + \eta_{ij}] \varepsilon_{ijt} \quad (3)$$

where:

T_{ijt} – bilateral trade between country i and j at time t (here: bilateral exports/imports in gross terms and exports/imports in VA terms),

Y_{it} – GDP of reporter country i ,

Y_{jt} – GDP of partner country j ,

X_{ijt} – column vector of non-binary variables (here: $diffGDP_{ij}$, $diffGDPpc_{ij}$),

Z_{ij} – column vector of non-binary time-invariant variable (here: $dist_{ij}$),

V_{ijt} – column vector of binary variables (here: $FTAPre_{ij}$, $EUMem_{ij}$, $FTApst_{ij}$, $euro_{ij}$),

D_{ij} – column vector of binary time-invariant variables (here: $border_{ij}$)

δ , ϕ , φ , γ – column vectors of unknown coefficients,

β_1 , β_2 – unknown scalar coefficients,

α_t – time effects,

η_{ij} – unobserved heterogeneous effects,

ε_{ijt} – error term.

Apart from traditional variables included in gravity models (GDP of trading countries and the distance between them), the model also took account of a number of other variables which might influence the value of bilateral trade. Table 1 presents the list of those variables together with their effects on the explained variable as anticipated on the basis of theory and empirical investigations.

The analysis was carried out for bilateral trade between the ten CEECs and their 43 trading partners for the years 2000–2014. The model's estimations were made using the STATA 14 econometric package. The sources of data were as follows: the International Monetary Fund database (*World Economic Outlook database*), the CEPII (*French Research Centre in International Economics*) database and the database of the World Trade Organisation (*Regional Trade Agreements – International System*).

Table 1. Variables used in the model and their expected effects on dependent variables

Variable	Description	Expected impact
GDP_i	logarithm of reporter country's GDP, current prices, USD million	+
GDP_i	logarithm of partner country's GDP, current prices, USD million	+
$diffGDP_{ij}$	logarithm of the absolute value of the difference in GDP between the trading countries	-
$diffGDPpc_{ij}$	logarithm of the absolute value of the difference in GDP <i>per capita</i> between the trading countries	-
$dist_{ij}$	logarithm of the distance between the capital cities of the trading countries, in km	-
$border_{ij}$	dummy variable taking a value of 1 where the trading countries have a common border	+
	Dummy variable taking a value of 1 where the trading countries:	
$FTA_{EU_{ij}}$	- have concluded association agreements with the EU	+
$FTA_{pre_{ij}}$	- belong to the same preferential trade group prior to the EU enlargement in 2004	+
$EU_{mem_{ij}}$	- are EU Member States	+
$FTA_{post_{ij}}$	- belong to the same preferential trade group as a result of the adoption of the common commercial policy of the EU upon EU accession	+
$euro_{ij}$	- belong to the euro area	+

Source: Own study based on the literature review.

Research results

It followed from the estimations that the parameters for the three main explanatory variables (GDP of trading countries and the distance between them) in all the estimated equations were statistically significant, whereas the effects of those variables on trade flows appeared to be as expected. GDP growth in the reporter and partner countries had an upward impact on gross and VA exports as well as on gross and VA imports. At the same time, a growing distance between countries pushed down trade flows, whether in gross or VA terms. However, it must be pointed out that the absolute value of the coefficient in the model explaining gross exports (imports) is higher than the absolute value of the coefficient illustrating VA exports (imports). It results from the existence of indirect exports (imports) of value added. It means that the shares of geographically remote countries in trade measured by VA statistics tend to be greater than those in trade measured by traditional statistics. Similar conclusions for Poland's trade in 1995–2011 with the use of data from the Trade in Value Added database were drawn by Folfas (2016).

Table 2. Results of the estimation of the impact of specific determinants on CEEC trade in 2000–2014

Variable	Gross exports	VA exports	Gross imports	VA imports
GDP_i	0.887*** (0.032)	0.934*** (0.022)	0.801*** (0.039)	0.811*** (0.032)
GDP_i	0.854*** (0.052)	0.818*** (0.037)	0.941*** (0.052)	0.94*** (0.038)
$diffGDP_{ij}$	-0.009 (0.039)	0.003 (0.027)	-0.094*** (0.036)	-0.09*** (0.027)
$diffGDPpc_{ij}$	-0.109*** (0.037)	-0.058** (0.027)	-0.178*** (0.04)	-0.132*** (0.033)
$dist_{ij}$	-0.885*** (0.128)	-0.726*** (0.079)	-0.833*** (0.126)	-0.769*** (0.098)
$border_{ij}$	0.633*** (0.16)	0.526*** (0.099)	0.705*** (0.174)	0.55*** (0.16)
$FTAEU_{ij}$	0.897*** (0.21)	0.55*** (0.145)	0.449** (0.219)	0.372* (0.192)
$FTApr_{ij}$	0.711*** (0.203)	0.439*** (0.145)	0.169 (0.231)	0.154 (0.209)
$EUmem_{ij}$	0.961*** (0.213)	0.446*** (0.139)	0.371 (0.231)	0.075 (0.198)
$FTApost_{ij}$	0.400** (0.196)	0.074 (0.129)	-0.288 (0.231)	-0.375* (0.194)
$euro_{ij}$	-0.362 (0.226)	-0.311** (0.152)	-0.414* (0.215)	-0.449*** (0.174)
const.	3.924*** (0.841)	2.173*** (0.582)	5.172*** (0.958)	3.949*** (0.891)
R2	0.8949	0.9322	0.8513	0.8888

Note: (*), (**) and (***) mean statistical significance at the level of 10%, 5% and 1%, respectively.

Standard errors are in parentheses.

Source: Own calculations.

The effect of differences in GDP between trading countries was only negative and statistically significant for gross imports and VA imports. As regards gross exports and VA exports, it was insignificant statistically. Both export and import flows were pushed down by widening differences in GDP *per capita* between trading countries. Simultaneously, the existence of a common border between trading partners was conducive to increased trade flows between them. As in the case of the distance, the coefficient value for the *border* variable in the model explaining gross exports (imports) was higher than the absolute value of the coefficient illustrating VA exports (imports). It corroborates the prior finding of the existence of indirect trade in value added between countries.

Interesting conclusions can be drawn from the analysis of parameters for the variables concerning preferential trade agreements. The effects of association agreements with the then European Communities entered into by the CEECs in the mid-1990s, of the CEECs' EU membership and of other trade agreements concluded by the CEECs before EU accession (the variables *FTAEU*

and *memEU* respectively) on gross exports and VA exports were positive and statistically significant at the level of 1%. Free trade agreements resulting from the adoption of the EU common commercial policy had a positive and statistically significant (at the level of 5%) impact only on gross exports, whereas their effect on VA exports appeared to be statistically insignificant. Contrary to expectations, the influence of two countries' belonging to the euro area on VA exports proved to be negative and statistically significant.

With regard to imports, positive and statistically significant effects (although at a level not greater than 5%) were found in the case of association agreements with the then European Communities on gross imports and value added imports of the CEECs. Simultaneously, free trade agreements resulting from the adoption of the common commercial policy of the EU appeared to have a negative impact on VA imports, whereas the euro-area membership pushed down import flows measured using either method. Therefore, the findings were inconsistent with the theory and expectations as those suggested a favourable effect on trade of reduced barriers to trade.

Conclusions

According to the analysis carried out, for most variables the direction of impact on gross exports/imports and on value added exports/imports was identical. Simultaneously, the parameters for variables estimated in the models explaining gross trade and value added trade showed different values. The greatest differences were found in the case of the distance between countries. The absolute value of the coefficient in the model explaining gross exports (imports) was higher than the absolute value of the coefficient illustrating VA exports (imports). It results from the existence of indirect exports (imports) of value added.

In addition, the determination coefficient value in the model explaining VA exports/imports is greater than in the model explaining gross exports/imports. Since GDP is also the sum of value added (rather than gross value) the model containing the explained variable and explanatory variables measured in value added terms is a model of better quality.

Acknowledgements This article is a result of the research project financed by the National Science Centre, decision number: DEC-2014/13/D/HS4/01426.

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