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Production Networks in Europe: A natural experiment of the EU enlargement to the East

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Abstract

This paper focuses on the 2004 enlargement of the European Union to the East and treats it as a natural experiment to investigate two issues:first, whether there has been a trade creation effect in final and intermediate goods and second, to what extent this effect has been more pronounced for final or for intermediate goods. Using difference-in-difference analysis, we find that the effect of 2004 EU enlargement has been positive for both intermediate and final goods. Indeed, after controlling for the multilateral resistance and bilateral time-invariant factors, we estimate an increase in bilateral trade of 90% for final goods and 40% for intermediates.

Key Words: difference-in-difference, CEECs, EU accession, production networks.

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1. Introduction

Proximity plays an important role for trade relations, in particular when the products traded are intermediates that are used in several stages of the production process. International trade in parts and components has intensified in the last decades as a result of increasing globalization and reducing trade costs.This development has been of special relevance inEast Asia, starting in the 1990s. Several authors investigated the importance of trade and production networks as a means of fostering economic growth and development in this area (Ng and Yeats, 2001; Kimura, Takahashi and Hayakawa, 2007).

Only recently, a few attempts have been made to investigate whether a similar pattern emergedin the 2000s on the European continent, and, in particular,following the accession of the Central Eastern European Countries (CEECs) into the European Union (EU)[1]. Western and Eastern European countries are considered natural trading partners due to their proximity and historical ties[2]. Indeed the Europe Agreements in the early 1990s already established bilateral free trade between the EU and each individual CEEC in most industrial products. However, a number of artificial trade barriers, different from tariffs and non-tariff barriers still remained. Namely, behind-the-border trade barriers such as administrative burdens or differences in products standardsdeter international trade to a non-negligible extent (Wilson, Mann and Otsuki, 2003 and 2005).Since tariffs and non-tariff barriers were already eliminated in the 1990s, the accession[3] of eight[4] CEECs into the EU in 2004 and of Romania and Bulgaria in 2007 provides a quasi-natural experimental setting that can be used to investigate the importance of behind-the-border barriers

[1]Kaminski and Ng, 2005;Zeddies, 2010 are some examples.
[2] Not only trade flows, but also Foreign Direct Investment flows have gained importance between Western and Eastern European countries after accession.
[3] The accession also implied that all the new members have to adopt the EU common external tariff for trade flows with third countries.
[4] The eight CEECs that were granted accession into the EU in 2004 are the following: Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovak Republic, and Slovenia.

across integrated markets (Hornok, 2009).In particular, this exercise can be used to infer whether these barriers affect intermediates and final productsdifferently. According to the theory of fragmentation (Jones, Kierzkowski and Lurong, 2005) income and trade cost variables prove to be important in affecting the magnitude of trade in intermediates and final goods. Specifically, these variables are expected to have a stronger impact on trade in parts and components than on trade in final goods. In this study we use a difference-in-difference strategy to investigate the effects that the accession of the CEECs into the EU hadon bilateral trade of final and intermediate products[5]. We also investigate whether our results support the abovementioned theory. To our knowledge this is the first paper that shows evidence of the effect of the 2004 EU enlargement for bilateral trade in intermediate and final products separately. Section 2 outlines the empirical strategy, Section 3 discusses the main results and Section 4 concludes.

2. Empirical strategy

The main framework of analysis is based on the gravity model of trade, nowadays a well-established workhorse trade model. There is a huge number of empirical applications in the literature of international trade which have contributed to the improvement of performance of the gravity equation. Some of them discuss specification issues. In particular, Mátyás (1997) and (1998), Chen and Wall (1999), Breuss and Egger (1999) and Egger (2000) improved the econometric specification of the gravity equation an suggested to control for unobservable heterogeneity using panel data and introducing several sets of fixed effects. These suggestions are taken into account in the estimation strategy followed in this paper.

According to the underlying theory that has been reformulated and extended by Anderson and van Wincoop (2003), the model assumes constant elasticity of substitution and product

[5]Hornok (2009) uses a similar analysis but does not distinguish between final and intermediates.

differentiation by place of origin. In addition, prices differ among locations due to symmetric bilateral trade costs. The reduced form of the model is given by

$$X_{ijkt} = \frac{Y_{it}Y_{jt}}{Y_t^W}\left(\frac{t_{ijkt}}{P_{it}P_{jt}}\right)^{1-\sigma} \quad (1)$$

The empirical specification of the model in equation (1) in log-linear form is given by

$$\ln X_{ijkt} = ln\, Y_{it} + ln\, Y_{jt} - ln\, Y_t^W + (1-\sigma) ln\, t_{ijt} + (1-\sigma) ln\, P_{it} + (1-\sigma) ln\, P_{jt} \quad (2)$$

whereX_{ijkt} are bilateral exports of product *k*from country *i* to country *j* in year *t*, andY_{it}, Y_{jt} and Y_t^W are the GDPs in the exporting country, the importing country, and the world in year t, respectively. t_{ijt} denotes trade cost between the exporter and the importer in year *t* and P_{it}, and P_{jt} are the so-called multilateral resistance terms.σ is the elasticity of substitution between all goods.

The estimation of equation (2) is not straightforward, since some assumptions are required concerning trade costs and multilateral resistance terms. The trade cost function is assumed to be a linear function of a number of trade barriers, namely the time invariant determinants of trade flows, including distance, common border, landlocked and common language dummies.Based on the recent gravity literature the multilateral resistance terms are modeled as time-varying country specific dummies. That prevents us from obtaining estimates for the GDP variables, the effects of which are subsumed into the dummies.

Substituting the trade cost function into equation (2) suggestsestimating

$$\ln(X_{ijkt}) = \alpha_0 + \alpha_1 \ln Y_{it} + \alpha_2 \ln Y_{jt} + \alpha_3 ln\, D_{ij} + \alpha_4 Landl_i + \alpha_5 Landl_j + \alpha_6\, Border_{ij} +$$

$$+\alpha_7 EU_{ijt} + u_{ijt} \quad (3)$$

whereD_{ij} denotes geographical distance from country *i* to country *j*, $Landl_i$and $Land_j$take the value of one when countries i or/and j are respectively landlocked, zero otherwise, $Border_{ij}$takes the value of one when the trading countries share a border, zero otherwise, and EU_{ijt} takes the value of one when the trading countries are members of the EU, zero otherwise.

In equation (4) we introduce a set of dummies, $d_{it}$and d_{jt} to control for the abovementioned multilateral resistance terms. In this case, we are not able to estimate the coefficients of the income variables. In addition, instead of adding the usual gravity variables to control for differences in trade costs (distance, etc.), we use time-invariant bilateral fixed effects. The equation is given by

$$\ln(X_{ijkt}) = \gamma_{ij} + \beta_1 EU_{ijt} + \sum d_{it}\, I_{it} + \sum d_{jt}\, I_{jt} + u_{ijt} \qquad (4)$$

The difference-in-difference estimation strategyin this paper consistsofcalculating averages of bilateral trade before and after a given policy event occurs (e.g. EU enlargement) for a control group (countries not involved but similar) and a treatment group (countries joining the EU in 2004 and 2007). We do thisin order to examine whether the differences (in trade) are significant for the treatment group in comparison to the control group after the event. Therefore, we consider the 2004 EU enlargement as a natural experiment where the treatment group includes country pairs of EU-15 countries that trade with anyof the countries that gained accession in 2004, while the control group includes country pairs of EU-15 countries that trade with acountry that gained accession in 2007. Using Bulgaria and Romania as the control group is ideal because they have gone through the same transformation process as the 2004-accession countries but did not enter the EU in 2004.The only drawback is that the announcement of the accession of Bulgaria and Romania in 2004 could have also created some anticipatory trade effects, but this can only cause a downward bias in our estimates.

3. Main Results

We estimate equation (3) for a panel of 6 CEECs' (see Table 1 in Appendix) exports to 21 destinations (6 CEECs+ 15 EU countries) during the period 1999 to 2007. The information ondisaggregated exports at 5 digit-level SITC[6]is from the Eurostat database, the GDP data are from the World Development Indicators database, and the distance and the other gravity variables are drawn from CEPII[7].

The main results are presented in Table 1. The first three columns of Table 1 present the results for exports of final products from the CEECs to the old EU countries and the last three columnscontain the results for imports of intermediated products from the CEECs to the EU countries.The first column of Table 1 presents the result of performing a difference-in-difference analysis with the EU dummy as the only explanatory variable in Equation (3). The estimated coefficient should be interpreted as the difference in means for the treatment group with respect to the control group. The coefficient on the EU variable indicates that the average bilateral exports from any 2004's accession country to any EU-15 country is around 40% ($e^{0.33}$-1)higher than the average bilateral exports of final goods between any 2007's accession country and any EU-15 country. Since our control and treatment groups could not be randomly selected, we add the usual gravity-covariates in columns 2 and 3. Column 2 presents the results obtained with added gravity variables, namely incomes, distance, landlocked and common border dummies. The EU coefficient is only slightly reduced (from 0.33 to 0.30) and the explanatory power of the model, as expected, increases considerably (from 23% to 83% as measured by the R^2). Finally in column 3 we control for the so-called multilateral resistance terms by adding country-and-time

[6]SITC=Standard InternationalTrade Clasiffication.

[7]Tables A.1 and A.2 in the appendix show the list of countries and the definition of the variables and Table A.3 shows the classification of products into final and intermediates.

fixed effects and country-pair fixed effects. Gravity variables are not included due to colinearity. The coefficient of the EU dummy for final goods shows a trade increase of around 90% ($e^{0.64}$-1) after controlling for multilateral resistance.

With respect to intermediate goods, columns 4, 5 and 6 present estimates comparable to those obtained in columns 1, 2 and 3 for final goods. We observe that the estimates of the accession effect are always lower for intermediates. Indeed, the coefficient on the EU dummy shows a 20% increase in trade for the treatment group when the average effect is calculated without controlling for other factors (column 4).The effect of the EU enlargement is not statistically significant after we control for gravity variables (column 5), and finally, the effect of the EU enlargement shows a 40% increase in trade for the treatment group when controlling for multilateral resistance terms (column 6).

Contrary to the theoretical predictions, the results indicate that the accession effect is considerably lower for intermediates than for final goods. Considering that the accession has reduced the behind-the-border barriers to trade, our results indicate that a reduction in these barriers made trade in final goods less difficult than the trade in intermediates.

4. Robustness

We also estimated the empirical model assuming that there was an anticipation effect and that the increase in trade started to take place in 2002. Table 2 shows that there was a small anticipation effect for exports of final goods but not for imports of intermediates.

Finally we estimated the model separately for sectors 7 and 8 to see if the effects vary across sectors and if there is an aggregation effect. The results of the difference-in-difference analysis

shown in Table 3 indicate that there is a positive effect of the 2004-enlargment for sector 8 but not for sector 7. However, after controlling for multilateral resistance the results indicate positive effects for both sectors and a higher effect for sector 7.

5. Conclusions

This paper usesa difference-in-difference strategy to investigate the effect of accession of the CEECs into the EU on bilateral exports of final goods and imports of intermediate products. We find evidence that there are positive trade effects of the 2004 EU enlargement towards the east. These are materialized in a trade creation effect in exports of both intermediate and final goods.Furthermore, after controlling for multilateral resistance and bilateral time-invariant factors, we find that the estimated extent of the trade creation effect has been more pronounced in final goods (90%) than in intermediate goods (40%). Several explanations support our findings as follows.

The CEECs accession to the EU's internal market resulted in a trade creation effect in general, for at least threemain reasons. First, there has been a number of administrative barriers to trade that have been eliminated following CEECs accession into the EU. These reflect the reduced costs of passing customs at the frontier resulting in less time delays, less formalities, leading to an overall simplification of customs procedures in intra-EU trade. The second is the reduction in technical barriers to trade. The Single Market is proven to reduce these technical barriers through mutual recognition of different technical regulations, minimum requirements and harmonization of rules and regulations.[8]Last, but not least, come the reduced risk and uncertainty (e.g. the possibility of agents defaulting in the link between producers and consumers) as well as the lower political risk associated with EU membership (e.g. CEECs democracies are thought to be more

[88] A detailed discussion of the above as well as their effect on trade is provided by Brenton et al. (2001).

stable hence benefiting from more credibility from their western counterpart following accession into the EU).

The reason why the trade creation effect has been more pronounced in trade in final goods as opposed to trade in intermediate products could be that the CEECs trade before 1989 has traditionally consisted of final products. While trade liberalization in the 1990s has significantly changed that pattern while creating an environment and the conditions for trade in intermediate products to develop, trade in final goods however, has remained predominant to this day. In addition, it should be noted that geographic proximity and sea access play an important role in determining trade in intermediate goods and their absence affects trade to a higher extent than in the case of final goods.We expect that the reduction in trade costs and the integration process itself will further foster the fragmentation of production processes while leading to a better exploitation of comparative advantages and location. The complete integration of the CEECs into the EU will continue to stimulate not only the exploitation of comparative advantages but also the production of new goods that was previously not supported by the command economy system.

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Table 1.Estimation results

Dep. Var:	**Exports of final goods**			**Imports of intermediates**		
	Model 1	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
Variables	**Coeff (s.e.)**	**Coeff (s.e.)**	**Coeff (s.e.)**	**Coeff (s.e.)**	**Coeff (s.e.)**	**Coeff (s.e.)**
EU	0.331*** (0.020)	0.301*** (0.009)	0.640*** (0.033)	0.183*** (0.060)	0.039 (0.043)	0.408*** (0.259)
Ln Y_{it}		0.956*** (0.005)			0.667*** (0.023)	
Ln Y_{jt}		0.996*** (0.002)			1.105*** (0.011)	
Ln D_{ij}		-0.967*** (0.007)			-1.127*** (0.031)	
$Landl_i$		0.499*** (0.008)			-0.011 (0.040)	
$Landl_j$		0.327*** (0.009)			0.406*** (0.051)	
$Border_{ij}$		0.581*** (0.010)			0.276*** (0.046)	
R^2	0.23	0.83	0.98	0.037	0.223	0.270
Nobs	68398	68398	68398	68398	68398	68398
Gravity variables	no	yes	no	no	yes	no
Country-pair FE	no	no	yes	no	no	yes
Country-and-time Fe	no	no	yes	no	no	yes

Note: * p<0.05, ** p<0.01, *** p<0.001. The dependent variable is disaggregated bilateral exports at current prices; lnY_{it} and lnY_{jt} are exporters' and importers' GDPs, respectively; lnD_{ij} is geographical distance, $Landl_i$ *(*$Landl_j$*)* is a dummy that take the value of one if country *i (j)* is landlocked. Border is a dummy that takes the value of one when countries share a border. Robust standard errors are reported.

Table 2.Anticipation Effect

Dep. Var:	**Exports of final goods**			**Imports of intermediates**		
Variables	**Coeff (s.e.)**	**Coeff (s.e.)**	**Coeff (s.e.)**	**Coeff (s.e.)**	**Coeff (s.e.)**	**Coeff (s.e.)**
Anticipation Effect EU 2002-2003	0.051* (0.031)	0.056*** (0.015)	0.427*** (0.017)	-0.116*** (0.071)	-0.116** (0.050)	0.272 (0.186)
Ln Y_{it}		1.003*** (0.006)			0.746*** (0.021)	
Ln Y_{jt}		1.035*** (0.003)			1.107*** (0.010)	
Ln D_{ij}		-1.081*** (0.008)			-1.129*** (0.028)	
$Landl_i$		0.627*** (0.011)			0.079** (0.037)	
$Landl_j$		0.627*** (0.012)			0.436*** (0.046)	
$Border_{ij}$		-0.145*** (0.015)			0.286*** (0.043)	
R^2	0.17	0.85	0.98	0.028	0.222	0.282
Nobs	55020	50020	55020	39297	39297	39297
Gravity variables	no	yes	no	no	yes	no
Country-pair FE	no	no	yes	no	no	yes
Country-and-time Fe	no	no	yes	no	no	yes

Note: * p<0.05, ** p<0.01, *** p<0.001. The dependent variable is disaggregated bilateral exports at current prices; lnY_{it} and lnY_{jt} are exporters' and importers' GDPs, respectively; lnD_{ij} is geographical distance, $Landl_i$ $(Landl_j)$ is a dummy that take the value of one if country *i (j)* is landlocked. Border is a dummy that takes the value of one when countries share a border. Robust standard errors are reported.

Table 3. Results for Sectors 7 and 8

	Exports of final goods		
EU effect	No covariates	Covariates	With two sets of FE
Sector 7	-0.056** (0.028)	0.02* (0.011)	0.990*** (0.038)
Sector 8	0.360*** (0.026)	0.284*** (0.012)	0.360*** (0.019)

Note: * p<0.05, ** p<0.01, *** p<0.001. Robust standard errors are reported.

Appendix

Table A.1. List of countries in the dataset

Abbreviation	Economic Area	Members
EU	European Union	*Admitted before 1999:* Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom *Admitted in 2004:* Czech Republic, Hungary, Poland, Slovak Republic *Admitted in 2007:* Bulgaria, Romania
CEECs	Central Eastern European Countries	Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovakia

Table A.2. Definitions of variables

Variable	Definition
Reporter	CEECs countries
Partner	EU-15 countries
Y_i	GDP of reporter country i.
Y_j	GDP of partner country j.
D_{ij}	The distance expressed in kilometers between reporter's i and partner's j capital cities.
$LAND_i$:	Binary variable that takes the value of "1" if the reporter country is landlocked, meaning they don't have access to sea or coastline, and "0" otherwise.
$LAND_j$	Binary variable that takes the value of "1" if the partner country is landlocked and "0" otherwise.
$CONTIG_{ij}$	Binary variable that takes the value "1" if the reporter country "i" and partner country "j" share a common border.
$CEEC_{sj}$	Binary variable that takes the value "1" if reporter and partner countries belong to CEECs and "0" otherwise.
EU_j	Binary variable that takes the value "1" if both countries are members of EU.

Table A.3. List of Parts and Components and Final goods according to the Standard International Trade Classification (SITC) System Revision 3

Division	Codes for Parts and Components	Codes for Final Goods
Power-generating machinery and equipment	7119, 7128, 71319, 7139, 7149, 7169, 71819, 71878, 71899	7111, 7112, 7121, 71311, 7132, 7133, 7138, 71441, 7148, 716, 71811, 71871, 71449, 71891, 71892, 71893
Machinery specialized for particular industries	72119, 72129, 72139, 72198, 72199, 7239, 72449, 72467, 72468, 72488, 7249, 7259, 72689, 7269, 72719, 72729, 72819, 72839, 7285	7211, 72121, 72122, 72123, 72126, 7213, 72191, 72195, 72196, 7231, 7232, 7233, 7234, 7443, 7244, 72451, 72452, 72453, 72454, 7248, 7247, 7751, 7251, 7252, 72681, 72631, 7265, 7266, 72711, 72127, 72722, 7281, 7283, 72721, 7284
Metalworking machinery	7359, 73719, 73739, 73749	731, 733, 7371, 73721, 7373, 7374
General industrial machinery and equipment, n.e.s., and machine parts, n.e.s	74128, 74135, 74139, 74149, 74159, 74172, 74190, 7429, 74380, 7439, 74419, 7449, 74519, 74529, 74539, 74593, 74597, 7469, 7479, 7499	7412, 74131, 74132, 74133, 74134, 74136, 74137, 74138, 7414, 7415, 74171, 7417, 7418, 742, 7435, 7436, 74414, 74415, 74411, 74412, 74413, 7442, 7444, 7447, 7448, 7451, 7452, 77530, 7453, 7456, 74591, 74595, 746, 747, 7483, 748, 749
Office machines and automatic data processing machines	7591, 7599	751, 752
Telecommunications and sound recording and reproducing apparatus and equipment	7649	7641, 7642, 7643, 7648, 761, 762
Electrical machinery, apparatus and appliances, n.e.s., and electrical parts thereof	77129, 77238, 7728, 77429, 77549, 77579, 77589, 77629, 77688, 77689, 77817, 77819, 77829, 77833, 77835, 77848, 77869, 77879, 77883, 77885	771, 7723, 7724, 7725, 7726, 7742, 7754, 7757, 7758, 7761, 7762, 7763, 7764, 77681, 7781, 7782, 77831, 77834, 7784, 7786, 7787, 77882, 77884
Road vehicles	7841, 7842, 7843, 78535, 78536, 78537, 78689	772, 781, 782, 783, 7851, 7852, 78531, 7861, 7862, 78683, 78685
Other transport equipment	79199, 7929	7911, 7912, 7916, 7917, 7918, 7921, 7922, 7923, 7924, 7925, 7928
Furniture and parts thereof	82119, 8218	8211, 8213, 8215, 8217
Measuring, checking, analyzing and controlling instruments and apparatus, n.e.s.	87424, 87426	87422, 87425
Photographic apparatus, equipment and supplies and optical goods, n.e.s; watches and clocks	88114, 88115, 88123, 88124, 88134, 88136, 8859	88111, 88113, 88121, 88122, 88131, 88132, 88133, 88135, 885
Optical goods, n.e.s	88422	88421

Source: Eurostat.