



Friends with or without benefits? An empirical evaluation of bilateral trade and economic integration between some of the post-Soviet economies

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Received: 29 March 2022 / Revised: 8 May 2022 / Accepted: 12 May 2022 /

Published online: 23 June 2022

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Abstract

The third decade of post-Soviet transition has seen a significant resurrection of economic integration centered around Russia. This paper analyzes bilateral trade of the Eurasian Economic Union (EUEA) members using gravity models with incomplete specialization in production and reviews the impact of newly signed preferential/free trade agreements across 2008–2019. The presented study relies on the explicit use of per worker physical capital endowments in determining cross-country trade and theory-consistent discrimination method between a variety of neoclassical and monopolistic models of trade. Our analysis highlights the importance of intra-industry trade in low processing sectors such as agri-food, mineral products, and metals between the block members. We find that the impact of new treaties has been primarily beneficial for imports, where the EUEA-Vietnam treaty had the most significant and persistent economic effect, while the EUEA membership has generated short-lived gains across different modes of trade for all members, except Kyrgyzstan.

Keywords Eurasian integration · International trade · Free trade agreements · Gravity model

We thank Sarhad Hamza, an anonymous referee, and participants of the 38th EBES conference in Warsaw for their useful comments on the preliminary version of this paper. This research was funded in whole by National Science Centre, Poland under PRELUDIUM 20 grant no. 2021/41/N/HS4/00759. For the purpose of Open Access, the author has applied a CC-BY public copyright licence to any Author Accepted Manuscript (AAM) version arising from this submission. Dataset and estimation codes are publicly available at: <https://sites.google.com/view/olegurshev/data>.

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JEL Classification F14 · F15 · P33

1 Introduction

Ever since the dissolution of the Soviet Union in 1991, there were several significant attempts at re-establishing economic ties between the former republics, including the formation of the Commonwealth of Independent States (CIS), the Eurasian Economic Community (EurAsEC), and the current Eurasian Economic Union¹ (EUEA). In particular, the third decade of post-Soviet transition has seen a considerable expansion of trade cooperation both within and beyond the region. First, it was a consolidating CIS free trade treaty in 2012, then the ascension of Armenia and Kyrgyzstan to the EUEA in 2015, and finally the signing of the EUEA-Vietnam and Iran preferential trade agreements in 2016 and 2019, respectively. Given the geostrategic location² of the EUEA between the European Union (EU) and China as well as the importance of Russia to the post-Soviet economic space, it is very puzzling why the existing trade literature on the topic has remained rather thin (Adarov & Ghodsi, 2021).

The goal of this paper is twofold. First, we empirically study bilateral trade flows of the EUEA member states: Armenia, Belarus, Kazakhstan, Kyrgyzstan, and Russia across 2008–2019. To this end, we employ a nested gravity equation based on three competing theoretical frameworks of international trade: (i) Heckscher-Ohlin-Samuelson (HOS), (ii) Chamberlin-Heckscher-Ohlin (CHO), and (iii) pure monopolistic competition (PMC) to study the effects of various country characteristics on trade flows. Our approach features the explicit use of per worker physical capital endowments in determining cross-country trade as well as the theory-consistent discrimination method between the aforementioned models. Second, we broadly consider joint and country-specific impacts from participation in the related free/ preferential trade agreements³ (FTAs) across various treaties, members, and modes of trade.

This study is related to the following three literature strands. The first is the literature on the gravity equation. In particular, studies that derive the bilateral trade equation instead of bilateral import or export equations: Helpman (1987), Hummels and Levinsohn (1995) and studies that assume product homogeneity and incorporate incomplete specialization in production: Evenett and Keller (2002), Haveman and Hummels (2004). The featured theoretical approach largely borrows from Cieslik (2009), where model identification procedure is based on the signs and statistical significance of the estimated parameters on factor proportion variables. Because

¹ Previously also known as the Eurasian Customs Union. List of abbreviations is available in Table 10 (Appendix).

² We refer to a considerable number of important trade routes between the EU and China that run through territories of the EUEA members, in particular Russia, and Belarus. The most notable of which is the Trans-Siberian corridor.

³ Refers to trade cooperation agreements such as CIS Free Trade Area, EUEA-Vietnam, EUEA-Iran.

factor proportions are important only in models with incomplete specialization and only when at least one of the traded goods is homogeneous, the proposed identification mechanism allows for clear identification across the aforementioned theoretical models of international trade.

Second, the paper is linked to the vast literature studying the effects of FTAs as well as other bilateral and multilateral forms of economic cooperation: Sandberg et al. (2006), Carrere (2006), Baier and Bergstrand (2007), Caporale et al. (2009), Baier et al. (2019). In particular, we employ two-lag specification from Baier and Bergstrand (2007) to study the impact of economic cooperation on various modes of bilateral trade across the EUEA members. As we discuss below, our approach is necessarily very general as the analysis of post-Soviet economic integration has been mostly absent from the literature. Hence, the paper's contribution to this strand is mostly empirical as the featured methodology has not been previously applied to the EUEA trade data.

Third, this paper is also related to empirical studies that offer quantitative analyses of trade and economic cooperation/integration (both ex-ante and ex-post) across the post-Soviet space. The examples include: De Souza (2011), EBRD (2012), Tarr (2016), Falkowski (2018), Adarov (2018), Adarov and Ghodsi (2021), Golovko and Sahin (2021), Mazhikeyev and Edwards (2021). This set of studies has considered a fairly broad range of topics, ranging from the estimation of ex-ante effects of the Eurasian Customs Union (EACU), analysis of tariff barriers to comparative advantages of the EUEA members, gravity estimation, and so forth. Our contribution to this strand is the introduction of empirical analysis, based on the theoretical framework that assumes incomplete specialization in production, using data that features all of the EUEA members across 2008–2019. This approach consolidates previously found evidence with respect to the sectoral competitiveness of the EUEA member states, which is largely concentrated in the low value-added/tech sectors that produce relatively homogeneous goods: agri-food, petroleum products, and metals (Adarov, 2018; Falkowski, 2018). Moreover, the existing gravity analysis⁴ have only relied on trade theory with complete specialization, hence our study offers an alternative view from a significantly different theoretical angle that, in our opinion, better describes the specificity of the studied economies. Further, the presented analysis offers novel insights into the newly created network of preferential and free trade agreements across the post-Soviet space by considering country- and agreement-specific effects on various modes of trade among Armenia, Belarus, Kazakhstan, Kyrgyzstan, and Russia. A topic, which has only been considered very recently in Adarov and Ghodsi (2021) with respect to the EUEA-Iran preferential trade treaty.

The rest of the paper is organized as follows. Section 2 introduces and describes theoretical framework. Section 3 details econometric methodology and data. Section 4 presents and discusses results. Section 5 summarizes and concludes.

⁴ For example, Adarov (2018) applies gravity analysis a la Anderson and Van Wincoop (Anderson and Van Wincoop, 2003) that assumes perfect specialization in trade among the EUEA members and indicates implicitly that the factors endowments have no impact on the volume of trade.

2 Theoretical frameworks

This section follows Cieřlik (2009) and summarizes three competing theoretical models of international trade: Heckscher–Ohlin–Samuelson, Chamberlin–Heckscher–Ohlin, and pure monopolistic competition. Each of the frameworks introduces various assumptions with respect to the effects of physical capital endowments on bilateral trade.⁵

As a benchmark, we use the well-known Heckscher–Ohlin–Samuelson model of inter-industry trade that features identical and homothetic consumer preferences, perfect competition, and constant returns to scale (CRS) technology. There are two homogeneous goods: X and Y , two factors of production: capital (K) and labor (L), and two countries: Home (H) and Foreign (F). Home is assumed to be more capital abundant than foreign or $K_H/L_H > K_F/L_F$. Using the stated assumptions, it is possible to show that the volume of bilateral trade in homogeneous goods between H and F can be determined by the product of three terms: the differences in production structure of trading economies that result from their factor endowments, GDP similarity index of Helpman (1987), and the absolute economic size of trading partners. In the HOS model, the impact of factor proportions on bilateral trade is positive for capital–labor differences and negative for capital–labor sums.

Next, we summarize the Chamberlin–Heckscher–Ohlin model, where good X is differentiated and produced under increasing returns to scale at the firm level (capital-intensive), while good Y remains homogeneous (labor-intensive). The market structure in industry X is characterized by Chamberlinian perfect monopolistic competition that features a symmetric Bertrand–Nash equilibrium of perfectly informed producers facing perfectly informed consumers under conditions of perfect flexibility in the choice of product specification, absence of collusion, and free entry and exit. Further, consumer preferences for the differentiated good are defined by the symmetric CES function. Combination of consumer’s preferences for variety and complete specialization at the firm level with increasing returns to scale production gives rise to both exports and imports within industry producing good X . Taking into account the aforementioned assumptions, we establish that the volume of bilateral trade in the CHO model is determined by factor proportions of physical capital and country size variables, where the impact of both capital–labor sums and capital–labor differences on bilateral trade is positive.

Finally, in the pure monopolistic competition model, both goods X and Y become differentiated, which makes factor proportions irrelevant in determining the total volume of bilateral trade between H and F . Since in the pure monopolistic competition model varieties of X and Y flow in both directions each country consumes a share of output of each variety equal to the share of its GDP in the joint GDP of a country–pair. With homothetic and identical preferences in both countries, the same prices for all consumers and balanced trade, exports of varieties of both goods for countries H and F it is possible to demonstrate that the volume of bilateral trade

⁵ Detailed algebraic derivations are provided in the theoretical [Appendix](#) of the paper (Part C).

depends only on the relative and the absolute country size variables. Hence, the impact of capital-labor sums and capital-labor differences on bilateral trade is nil.

3 Methodology and data

This section consists of two parts. First, we introduce the research methodology and model identification procedure based on the previously discussed theoretical frameworks and describe our approach to evaluating the impact of CUEUEA and FTA membership on the various modes of trade. Second, we report and characterize the employed dataset.

3.1 Econometric methodology

In Sect. 2 of the paper we have introduced three main theoretical frameworks, where the impact of factor proportion variables is model-specific.⁶ Therefore, to study the determinants of bilateral trade under these competing models we specify the following nested baseline regression⁷:

$$\begin{aligned}
 VT_{ij,t} = & B_0 + B_1 \ln \left[\left| \frac{K_{i,t}}{L_{i,t}} - \frac{K_{j,t}}{L_{j,t}} \right| \right] + B_2 \ln \left[\frac{K_{i,t}}{L_{i,t}} + \frac{K_{j,t}}{L_{j,t}} \right] \\
 & + B_3 \ln \left[\left(1 - s_{i,t}^2 - s_{j,t}^2 \right) \right] + B_4 \ln \left[(GDP_{i,t} + GDP_{j,t}) \right] + \theta_{i,t} + \gamma_{ij} + \varepsilon_{ij,t}
 \end{aligned}
 \tag{1}$$

where: $VT_{ij,t}$ is the bilateral volume of trade⁸ between country i and country j in year t , $K_{i,t}$ and $K_{j,t}$ are capital stocks in countries i and j in year t , $L_{i,t}$ and $L_{j,t}$ are labor stocks in countries i and j in year t , $s_{i,t}$ and $s_{j,t}$ are shares of countries i and j in ij 's country-pair GDP in year t , $GDP_{i,t}$ and $GDP_{j,t}$ are GDPs of countries i and j in year t , $\theta_{i,t}$ encompasses time fixed effects, γ_{ij} captures country-pair fixed effects, and $\varepsilon_{ij,t}$ is the error term, for $i = \text{Armenia, Belarus, Kazakhstan, Kyrgyzstan, Russia, } j = 1, \dots, 72$ trading partners, $t = 2008, \dots, 2019$, and B 's are the parameters to be estimated.

Table 1 describes the expected coefficients signs on the explanatory variables from Eq. (1) based on the three competing gravity frameworks presented in Sect. 2.

⁶ See Eqs. (7), (22), (34) in Part C of Appendix.

⁷ As an alternative specification we also use a variant of the nested regression with explicit inclusion of distance and other common gravity controls (extended): $VT_{ij,t} = B_0 + B_1 \ln \left[\left| \frac{K_{i,t}}{L_{i,t}} - \frac{K_{j,t}}{L_{j,t}} \right| \right] + B_2 \ln \left[\frac{K_{i,t}}{L_{i,t}} + \frac{K_{j,t}}{L_{j,t}} \right] + B_3 \ln \left[\left(1 - s_{i,t}^2 - s_{j,t}^2 \right) \right] + B_4 \ln \left[(GDP_{i,t} + GDP_{j,t}) \right] + B_5 \ln \left[DIST_{ij} \right] + ControlSet + \theta_{i,t} + \varepsilon_{ij,t}$ where $ControlSet$ includes common border, colony, customs union, and FTA dummies (see Table 14 of Appendix).

⁸ In addition to the total volume of trade, we also employ export and import volumes.

Table 1 Expected coefficient signs on explanatory variables in competing trade models

Explanatory variable	Estimated parameter	Expected parameter signs		
		HOS incom- plete speciali- zation	HOS complete specialization, CHO complete specialization, PMC	CHO incom- plete speciali- zation
$ K_{it}/L_{it} - K_{jt}/L_{jt} $	B_1	+	0	+
$(K_{it}/L_{it} + K_{jt}/L_{jt})$	B_2	-	0	+
$(1 - s_{it}^2 - s_{jt}^2)$	B_3	+	+	+
$(GDP_{it} + GDP_{jt})$	B_4	+	+	+

Source: Cieslik (2009)

To study the impact of CU/EUEA and FTA membership on bilateral trade we specify two additional regressions based on the empirical work of Baier and Bertrand (2007):

$$VT_{ij,t} = B_0 + B_1 CU_{ij,t} + B_2 CU_{ij,t-1} + B_3 CU_{ij,t-2} + \theta_{i,t} + \gamma_{ij} + \varepsilon_{ij,t} \tag{2}$$

$$VT_{ij,t} = B_0 + B_1 FTA_{ij,t} + B_2 FTA_{ij,t-1} + B_3 FTA_{ij,t-2} + \theta_{i,t} + \gamma_{ij} + \varepsilon_{ij,t} \tag{3}$$

where: $VT_{ij,t}$ is the bilateral volume of trade between country i and country j in year t , $CU_{ij,t}$ is an indicator variable that takes a value of unity if at time t countries i and j are members of the CU/EUEA, we allow for gradual phasing-in by including lagged dummies: $CU_{ij,t-1}$ and $CU_{ij,t-2}$. Equation (3) follows similar logic, where $FTA_{ij,t}$ is an indicator variable that takes a value of unity if at time t countries i and j are members of the joint FTA together with two additional lagged dummies: $FTA_{ij,t-1}$, $FTA_{ij,t-2}$, $\theta_{i,t}$ encompasses time fixed effects; γ_{ij} captures country-pair fixed effects, $\varepsilon_{ij,t}$ is the error term, and B 's are the parameters to be estimated. Table 12 (Appendix) details the list of integration treaties.

To estimate Eqs. (1)–(3) we employ Poisson pseudo maximum likelihood (PPML) estimator with multiple fixed effects introduced in Correia et al. (2020). We follow well-established econometric literature on estimating gravity equations such as Silva and Tenreyro (2006, 2011), who demonstrate that PPML is able to deal with common data issues such as zero values in the dependent variable and heteroskedasticity of standard errors. Further, the employed estimator handles data in levels, hence the originally reported data do not need to undergo any additional transformations or manipulations. Finally, Weidner and Zylkin (2021) document that PPML is the only consistent estimator among a range of other PML gravity estimators. Considering the abovementioned advantages of PPML, this paper uses PPML for all of its estimations.

Table 2 Descriptive statistics of variables used in the empirical study

Variable	Obs	Mean	Std. Dev	Min	Max
VT	4320	2,187,000,000	7,639,000,000	0	111,500,000,000
IMP	4320	891,600,000	3,606,000,000	0	56,950,000,000
EXP	4320	1,318,000,000	4,674,000,000	0	76,040,000,000
K_DIFF	4320	11.769	1.276	0.052	13.579
K_SUM	4320	12.783	0.625	10.276	13.905
DISP	4320	− 1.436	1.114	− 5.77	− 0.223
DIST	4320	8.134	.818	5.133	9.743
GDP_SUM	4320	13.804	1.338	10.506	17.019
FTA	4320	0.048	0.213	0	1
FTA _{t-1}	3960	0.043	0.203	0	1
FTA _{t-2}	3600	0.039	0.194	0	1
CU	4320	0.03	0.171	0	1
CU _{t-1}	3960	0.028	0.164	0	1
CU _{t-2}	3600	0.025	0.156	0	1

Source: own summary

3.2 Statistical data

Bilateral cross-country trade data for Armenia, Belarus, Kazakhstan, Kyrgyzstan, and Russia are obtained from the COMTRADE database between 2008 and 2019 (United Nations, 2021). In particular, we construct a sample of 72 trading partners,⁹ which are identical across all five economies. The total number of observations for the pooled partner sample is 4320 with 0.2% of observations accounting for zero trade.¹⁰ Figures 1 through 4 plot various trade volumes (total, export, and import) using data from the collected sample (Appendix). It is not surprising that the EUEA trade volumes exactly mirror Russian trade¹¹ (see Fig. 1 or Fig. 4 in Appendix). Though, it's the trade patterns of other members that present a more interesting dynamic. For example, the total trade of Kazakhstan has generally been more volatile (Fig. 2 in Appendix) in comparison to other members. While the overall volume of trade across all member is extremely similar between two distinct groups: *i*) Armenia and Kyrgyzstan, *ii*) Belarus and Kazakhstan (see Figs. 3, 4 in Appendix). Next, data on the absolute and the relative economic size of trading partners as well as capital-labor ratios are sourced from the Penn World Table 10.0 database (Feenstra et al., 2015). Information on CU\EUEA and FTA participation is collected from

⁹ The constructed sample of partners represents ~99% of the reported total value of trade across Armenia, Belarus, Kazakhstan, Kyrgyzstan, and Russia. Table 11 (Appendix) describes the sample of trade partners.

¹⁰ This occurs in the following country pairs: Armenia-Azerbaijan, Kyrgyzstan-Ethiopia, Kyrgyzstan-Kuwait, and Kyrgyzstan-Malta.

¹¹ This is because Russian trade constituted approximately 79.1% of the total EUEA trade between 2010–2019 (annual average).

Table 3 Results from the nested regression, pooled sample, 2008–2019

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dep var:	VT	EXP	IMP	VT	EXP	IMP	VT	EXP	IMP
K_SUM	0.569+ (0.318)	0.771** (0.339)	0.236 (0.341)	0.819*** (0.253)	0.864*** (0.286)	0.771*** (0.256)	0.710+ (0.431)	0.798+ (0.484)	0.749+ (0.394)
K_DIFF	0.053 (0.103)	0.032 (0.115)	0.106 (0.101)	0.0643 (0.086)	0.0614 (0.103)	0.0820 (0.078)	− 0.041 (0.025)	− 0.012 (0.033)	− 0.094*** (0.024)
DISP	0.573*** (0.121)	0.657*** (0.131)	0.505*** (0.132)	0.455*** (0.078)	0.544*** (0.0873)	0.370*** (0.084)	0.627 (0.546)	0.183 (0.451)	0.649 (0.523)
GDP_SUM	1.376*** (0.170)	1.230*** (0.156)	1.572*** (0.202)	1.698*** (0.135)	1.486*** (0.137)	1.989*** (0.188)	1.749** (0.816)	1.251*** (0.473)	1.209** (0.544)
DIST				− 0.626*** (0.150)	− 0.608*** (0.156)	− 0.616*** (0.193)			
Control set	No	No	No	Yes	Yes	Yes	No	No	No
Time FE	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Country-pair FE	No	No	No	No	No	No	Yes	Yes	Yes
N	4320	4320	4320	4320	4320	4320	4320	4320	4320

Control set includes common border, colony, FTA, CUEUEA dummies (see Table 15 of Appendix for detailed output). Country-pair clustered standard errors in parentheses, significance levels: + $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: own summary

the WTO RTA database (World Trade Organization, 2021). Finally, common border, language, and bilateral distance data are obtained from CEPII (CEPII, 2021). Table 2 summarizes descriptive statistics of our dataset, while Table 13 (Appendix) provides a detailed account of data sources and computation methodology.

4 Estimation results

This section presents and discusses empirical results from Eqs. (1)–(3) across the pooled and country-specific samples of Armenia, Belarus, Kazakhstan, Kyrgyzstan, and Russia. The analysis comes in three parts: first, the augmented gravity results are discussed (baseline and extended). Next, we look into the effect of joint CUEUEA and FTA participation on various trade modes. The section ends with a discussion of the EUEA-Vietnam treaty and country-specific impacts of CUEUEA participation.

Columns (1)–(3) of Table 3 describe the baseline results obtained from Eq. (1). Each column reports a specific case, where the dependent variable is either: (i) the total volume of bilateral trade (VT), (ii) the total volume of exports (EXP), or (iii) the total volume of imports (IMP). The estimated parameters on factor proportions are positive and significant for the joint sum of physical capital (K_SUM) at the 5% (VT) and 10% levels (EXP). While the estimated parameters on the relative and the absolute country size variables (DISP, GDP_SUM) are

Table 4 The effect of joint CU/EUEA participation, pooled sample, 2008–2019

Dep. var:	VT (1)	IMP (2)	EXP (3)
CU	0.115 (0.252)	0.289 (0.246)	0.187 (0.655)
CU _{t-1}	0.174+ (0.092)	0.219+ (0.131)	0.142** (0.065)
CU _{t-2}	- 0.012 (0.050)	- 0.002 (0.044)	- 0.017 (0.076)
<i>N</i>	3600	3600	3600

All results include time and country-pair fixed effects, clustered standard errors in parentheses, significance levels: + $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: own summary

Table 5 Effect of joint FTA participation, pooled sample, 2008–2019

Dep. var:	VT (1)	IMP (2)	EXP (3)
FTA	0.183 + (0.106)	0.268*** (0.464)	0.038 (0.092)
FTA _{t-1}	- 0.148 (0.117)	- 0.189** (0.094)	- 0.042 (0.088)
FTA _{t-2}	0.0490 (0.077)	0.068 (0.072)	0.057 (0.100)
<i>N</i>	3600	3600	3600

All results include time and country-pair fixed effects, clustered standard errors in parentheses, significance levels: + $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: own summary

also positive and display significance at the 1% level (VT, EXP, IMP). As all of the estimated parameters are non-negative, and K_SUM displays significance, the results favor the CHO model, where trade gains are intra-industry, over other competing models. Further, columns (4)–(6) of Table 3 illustrate results, where we explicitly introduce distance as well as control set parameters and introduce time fixed effects. In this case, K_SUM displays significance at the 1% level across all modes of trade, while DISP, and GDP_SUM remain quantitatively similar and remain robust. Extended results with all of the estimated parameters are available in Table 15 (Appendix). Finally, we include country-pair fixed effects, in columns (7)–(9) K_SUM is positive and significant at the 10% level, while the absolute country size (GDP_SUM) is positive and significant at 5% and 1% levels. Next, for imports, the relative difference in physical capital (K_DIFF) is negative and significant at the 1% level, which is unexplained by any of the employed gravity models. Overall, depending on the type of specification, the impact of

Table 6 Effect of the EUEA-Vietnam treaty, pooled sample, 2008–2019

Dep. var:	VT (1)	IMP (2)	EXP (3)
EUEA-Vietnam	0.602*** (0.0790)	0.521*** (0.0603)	0.743*** (0.128)
EUEA-Vietnam _{t-1}	0.0826*** (0.0163)	0.0862*** (0.0107)	0.0685** (0.0323)
EUEA-Vietnam _{t-2}	- 0.0876*** (0.0278)	0.102*** (0.0225)	- 0.309*** (0.0744)
<i>N</i>	3600	3600	3600

All results include time and country-pair fixed effects, clustered standard errors in parentheses, significance levels: + $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: own summary

K_SUM is estimated between +76.6% and +137.2% [$(exp(x) - 1) * 100$]. Moreover, with the exception of column (9), the obtained results largely favor the CHO model, which is in line with the existing literature, as most gains across the current EUEA members are usually attributed to the relatively low processing sectors such as agri-food, mineral products, and metals (Adarov, 2018; Falkowski, 2018).

Next, our analysis considers the impact of joint CU\EUEA and FTA participation on bilateral trade using Eqs. (2) and (3). Table 4 depicts the results obtained from Eq. (2) using the CU\EUEA membership dummy. The estimations show positive and significant gains for all modes of trade at the 10% and 5% levels in the first period following the accession with the estimated impact ranging between +15.2% and +24.4%. On the other hand, when we examine joint effects from FTA participation (Table 5), we find that in the joint impact of FTA membership appears for the import mode only, where the gains are quite substantial (+30%) and significant at the 1% level only in the first period. Alike estimates are also obtained for the

Table 7 Effect of country-specific CU\EUEA participation on total trade, 2008–2019

Dep var: VT	Armenia (1)	Belarus (2)	Kazakhstan (3)	Kyrgyzstan (4)	Russia (5)
CU	0.150** (0.0682)	0.0417 (0.157)	- 0.296*** (0.0800)	0.0732 (0.135)	0.440 (0.292)
CU _{t-1}	0.112** (0.0488)	- 0.0939 (0.0747)	0.645*** (0.0672)	- 0.461*** (0.133)	0.117*** (0.0277)
CU _{t-2}	- 0.000204 (0.0826)	0.131 (0.119)	0.0198 (0.0495)	0.231 (0.252)	- 0.0371 (0.0642)
<i>N</i>	720	720	720	720	720

All results include time and partner fixed effects, clustered standard errors in parentheses, significance levels: + $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: own summary

joint impact of the CIS FTA treaty (see Table 16 of Appendix). Further, we consider a special case of the EUEA-Vietnam treaty as it is the very first integration treaty signed between the whole union and a third country. Table 6 describes results obtained when using the EUEA-Vietnam dummy only. The results clearly demonstrate positive and persistent gains from participation beyond the initial coming-into-force period (especially noticeable in column (3)—IMP). Though, at $t - 2$ the estimated parameter for VT and EXP becomes negative, which may represent the fact that the treaty has been significantly more beneficial to importers in Vietnam rather than exporters in the EUEA members. The initial impact of the EUEA-Vietnam treaty on bilateral trade is +82.5% with subsequent periods averaging between +7% and +10% for imports, and between –26% and 7% for exports.

Lastly, we disaggregate the impact of the pooled CU\EUEA dummy by studying accession impact on a country-level. Table 7 describes results obtained from Eq. (2) for each EUEA member. The results are twofold: first, Armenia, Kazakhstan, and Russia have achieved notable trade gains (between +16% to +89%) in at least one

Table 8 Effect of country-specific CU\EUEA participation on imports, 2008–2019

Dep var: IMP	Armenia (1)	Belarus (2)	Kazakhstan (3)	Kyrgyzstan (4)	Russia (5)
CU	0.173*** (0.0359)	0.121*** (0.236)	0.226*** (0.0659)	– 0.0618 (0.0526)	0.123 (0.163)
CU _{t-1}	0.0134 (0.0416)	– 0.281*** (0.0324)	– 0.125*** (0.0489)	– 0.451** (0.183)	– 0.236 (0.199)
CU _{t-2}	0.127 (0.0832)	0.155*** (0.0708)	– 0.123 (0.0916)	0.137 (0.202)	0.187*** (0.066)
N	720	720	720	720	720

All results include time and partner fixed effects, clustered standard errors in parentheses, significance levels: + $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: own summary

Table 9 Effect of country-specific CU\EUEA participation on exports, 2008–2019

Dep var: EXP	Armenia (1)	Belarus (2)	Kazakhstan (3)	Kyrgyzstan (4)	Russia (5)
CU	0.221*** (0.102)	– 0.071 (0.0647)	0.114 (0.0816)	– 0.048 (0.261)	0.036 (0.296)
CU _{t-1}	0.240** (0.0972)	0.438*** (0.106)	– 0.066 (0.060)	– 0.021 (0.130)	– 0.112 (0.136)
CU _{t-2}	0.0848 (0.184)	– 0.127 (0.157)	0.212+ (0.120)	0.580 (0.569)	0.108 (0.140)
N	720	720	720	720	720

All results include time and partner fixed effects, clustered standard errors in parentheses, significance levels: + $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: own summary

time period following the accession, while Belarus and Kyrgyzstan have experienced negative or completely null gains. However, a different pattern is obtained when we examine volumes of imports and exports (Tables 8 and 9). In the former case Belarus also demonstrates positive and significant gains following its accession (up to +54% increase in exports, and up to +16.7% for imports). While in the latter case, the EUEA membership has facilitated exports in Armenia and Belarus only. Out of all cases considered, the applied cross-country approach falls short in quantifying any substantial trade gains for Kyrgyzstan. In fact, they are mostly negative (see column 4 in Tables 7 and 8), which may be due to two things: either the EUEA membership is overwhelmingly trade diverging for Kyrgyzstan or our analysis coincides with business cycle volatility (Adarov, 2018).

In sum, the obtained results from the nested regression (baseline and extended) underline the incomplete specialization in production and intra-industry trade across the pooled EUEA member sample. Second, the joint effects of CUEUEA participation indicate positive and diminishing gains for exports, while the joint effects of FTA membership show a strong and immediate impact on imports. Third, the results from the EUEA-Vietnam treaty indicate mostly positive and persistent gains across all modes of trade in the first two periods, and in all three periods for imports. Finally, when examining the country-specific impact on trade from the EUEA participation, with the exception of Kyrgyzstan, our analysis finds positive gains across different modes of trade for Armenia, Belarus, Kazakhstan, and Russia.

5 Conclusion

In the end, have there been significant benefits from the economic integration across the EUEA members in the past decade? In this paper, we applied a nested gravity equation with the explicit use of per worker physical capital endowments in determining cross-country trade. In particular, our approach has been based on three competing theoretical frameworks of international trade: HOS, CHO, and PMC derived in Cieslik (2009). Further, we studied country- and agreement-specific impacts of newly signed free/ preferential trade agreements using a two-lag specification from Baier and Bergstrand (2007) across the block members. All in all, the results are threefold: first, our analysis emphasizes the role of incomplete specialization in production and intra-industry trade across the EUEA. In particular, we find consolidating evidence that supports the existing works of Falkowski (2018) and Adarov (2018) that highlight the role of low processing/tech sectors. Second, our results feature novel empirical evidence with respect to newly signed treaties, which have promoted imports (up to +30%), whereas the CU/EUEA membership has generated short-lived gains for exports (up to +15.2%). With the exception of Kyrgyzstan, the effect of CU/EUEA participation has been positive, but short-lived across all modes of trade and block members. Lastly, our results report that the EUEA-Vietnam treaty has been highly beneficial for both parties with the initial impact on bilateral trade

being was quite large (+82.5%), while other integration/preferential treaties (such as the CIS treaty) generally do not feature persistent ($t > 1$) economic impact in the results.

The discussed findings have several policy and research implications. First, given the economic modus operandi of the post-Soviet space, the integration does present certain economic benefits, which happen to be persistent only when integration treaties are signed with the other non-Soviet parties (e.g. Vietnam). This notion can also be seen in the most recent analysis of the EUEA-Iran preferential treaty in Adarov and Ghodsi (2021), where the impact of the treaty has been fruitful for both parties. Considering this, a potential EUEA-China trade agreement may be feasible and have a strong economic impact on block's trade. Second, the research agenda for this topic remains quite large as future studies should look for a more granular analysis of country- and treaty-specific effects on bilateral trade across the block. Finally, we provide a word of warning, as the discussed results should be treated with caution because our study has relied on strong assumptions with respect to the functional form of the estimated regressions as well as particular sample and variable characteristics that need to be relaxed in future studies.

Appendix

Part A: Data

See Figs. 1, 2, 3 and 4; Tables 10, 11, 12, 13 and 14.



Fig. 1 Total trade of the EUEA and Russia (current US\$, log), 2008–2019. Source: United Nations (2021)

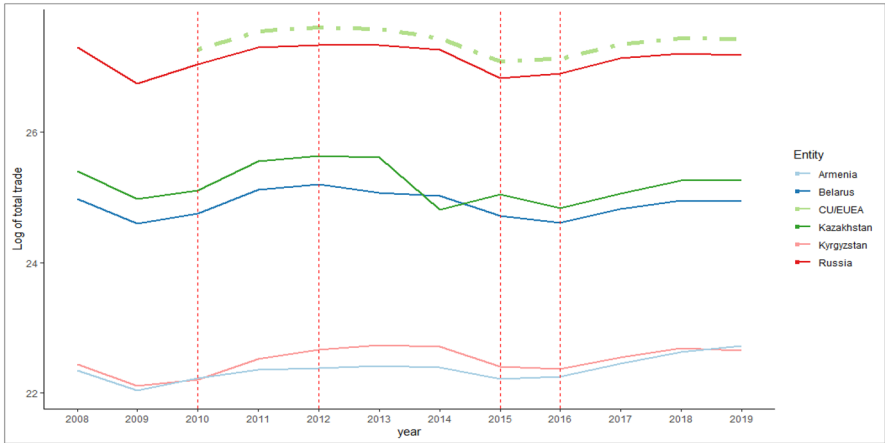


Fig. 2 Total trade of the EUEA members (current US\$, log), 2008–2019. Source: United Nations (2021)

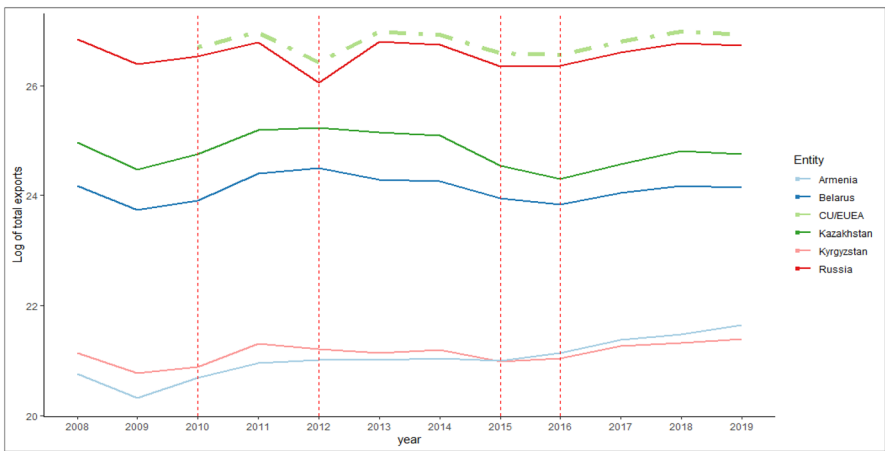


Fig. 3 Total exports of the EUEA members (current US\$, log), 2008–2019. Source: United Nations (2021)



Fig. 4 Total imports of the EUEA members (current US\$, log), 2008–2019. Source: United Nations (2021)

Table 10 List of abbreviations

CEPII	Centre d’Etudes Prospectives et d’Informations Internationales
CHO	Chamberlin-Heckscher-Ohlin model
CIS	Commonwealth of Independent States
EACU	Eurasian Customs Union
EU	European Union
EUEA/CU	Eurasian Economic Union
EurAsEC	Eurasian Economic Community
FTA	Free/ preferential trade agreement
GDP	Gross Domestic Product
HOS	Heckscher-Ohlin-Samuelson model
PMC	Pure monopolistic competition model
RTA	Regional Trade Agreement
WTO	World Trade Organization

Source: own summary

Table 11 Partner sample

Complete sample of partners	Argentina, <i>Armenia</i> , Australia, Austria, Azerbaijan, Bangladesh, <i>Belarus</i> , Brazil, Bulgaria, Canada, Chile, China, Colombia, Croatia, Czech Republic, Denmark, Egypt, Estonia, Ethiopia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, India, Indonesia, Iran, Ireland, Israel, Italy, Japan, Jordan, <i>Kazakhstan</i> , <i>Kyrgyzstan</i> , Kuwait, Latvia, Lithuania, Malta, Mexico, Mongolia, the Netherlands, Norway, Pakistan, Philippines, Poland, Portugal, Rep. of Korea, Romania, <i>Russia</i> , Serbia, Singapore, Slovakia, Slovenia, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Syria, Tajikistan, Thailand, Tunisia, Turkey, Turkmenistan, Ukraine, United Kingdom, United States, Uzbekistan, Vietnam
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Source: own summary

Table 12 List of FTA and integration agreements

Belarus-Russia-Kazakhstan Eurasian Customs Union treaty (2010)
 Treaty on a Free Trade Area between the CIS (2012, 2013, 2015) *
 Eurasian Economic Union treaty (2015)
 EUEA-Vietnam treaty (2016)
 EUEA-Iran treaty (2019) **

Agreements are listed in ascending order by the year of entry into force

*The CIS treaty was implemented under different timing for Armenia, Belarus, Kazakhstan, Russia, Ukraine (2012), Kyrgyzstan (2013), and Tajikistan (2015)

** Only included in the pooled FTA dummy

Source: WTO RTA database (2021)

Table 13 Description of variables

Variables	Description	Data source
VT, EXP, IMP	Total volume of bilateral trade, exports, and imports (current \$US million)	United Nations
K_DIFF	Physical capital difference, adjusted for the number of employed population (\$US million), log $\ln \left[\frac{K_{it} - K_{jt}}{L_{it} - L_{jt}} \right]$	Penn World Table
K_SUM	Physical capital sum, adjusted for the number of employed population (\$US million), log $\ln \left[\frac{K_{it} + K_{jt}}{L_{it} + L_{jt}} \right]$	
GDP_SUM	Sum of Real GDPs (constant 2010 \$US million), log $\ln [GDP_{it} + GDP_{jt}]$	
DISP	Helpman's (1987) GDP similarity index, log $\ln \left[\left(1 - s_{it}^2 - s_{jt}^2 \right) \right]$	
DIST	Geographical distance between partner economies (capital cities, in km), log	CEPII
CU	Dummy variable, unity if both trading partners are members of Customs Union/Eurasian Economic Union	World Trade Organization
FTA	Dummy variable, unity if both trading partners are members of FTA agreement	

Source: own summary

Table 14 Control set variables

Variables	Description	Data source
CONT	Dummy variable, unity if both trading partners share a common land border	CEPII
COLONY	Dummy variable, unity if both trading partners were part of the USSR	

Source: own summary

Part B: Extended results

See Tables 15 and 16.

Table 15 Results from the nested regression, pooled sample, extended results with control set parameters, 2008–2019

	VT	EXP	IMP	VT	EXP	IMP
	(1)	(2)	(3)	(4)	(5)	(6)
K_SUM	0.819*** (0.253)	0.864*** (0.286)	0.771*** (0.256)	0.818*** (0.253)	0.863*** (0.286)	0.771*** (0.256)
K_DIFF	0.0643 (0.0866)	0.0614 (0.103)	0.0820 (0.0786)	0.0643 (0.0867)	0.0615 (0.103)	0.0822 (0.0786)
DISP	0.455*** (0.0783)	0.544*** (0.0873)	0.370*** (0.0849)	0.455*** (0.0783)	0.543*** (0.0873)	0.369*** (0.0849)
GDP_SUM	1.698*** (0.135)	1.486*** (0.137)	1.989*** (0.188)	1.699*** (0.135)	1.487*** (0.0873)	1.990*** (0.188)
DIST	-0.626*** (0.150)	-0.608*** (0.156)	-0.616*** (0.193)	-0.627*** (0.150)	-0.609*** (0.156)	-0.617*** (0.193)
CU	1.559*** (0.349)	1.369*** (0.311)	1.900*** (0.443)	1.559*** (0.349)	1.369*** (0.311)	1.900*** (0.443)
FTA	0.183 (0.157)	0.047 (0.158)	0.381+ (0.220)	0.183 (0.157)	0.047 (0.158)	0.381+ (0.220)
CONT	0.621** (0.256)	0.606** (0.283)	0.650** (0.282)	0.621** (0.256)	0.606** (0.283)	650** (0.282)
COLONY	-0.738** (0.283)	-0.639+ (0.327)	-0.922*** (0.282)	-0.738** (0.283)	-0.639+ (0.327)	-0.922*** (0.282)
Time effects	No	No	No	Yes	Yes	Yes
N	4320	4320	4320	4320	4320	4320

Clustered standard errors in parentheses, significance levels: + $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: own summary

Table 16 Impact of CIS FTA treaty, pooled sample, 2008–2019

Dep. var:	VT	IMP	EXP
	(1)	(2)	(3)
CIS	0.0164 (0.109)	0.223*** (0.112)	0.0339 (0.0824)
CIS _{t-1}	- 0.168 ⁺ (0.0952)	- 0.203*** (0.0687)	- 0.0636 (0.0714)
CIS _{t-2}	0.0619 (0.0841)	0.0784 (0.0718)	0.0718 (0.0814)
<i>N</i>	3600	3600	3600

All results include time and country-pair fixed effects, clustered standard errors in parentheses, significance levels: ⁺ $p < 0.10$, ^{**} $p < 0.05$, ^{***} $p < 0.01$

Source: own summary

Part C: Competing theoretical frameworks

Heckscher–Ohlin–Samuelson model

As a useful benchmark, we first show how the augmented gravity equation can be derived from the well-known HOS model with incomplete specialization in production, which features identical and homothetic consumer preferences, perfect competition, constant returns to scale (CRS) technology, and product homogeneity. It assumes two sectors that produce two homogeneous goods: X and Y under CRS with two factors of production: capital (K) and labor (L). Trade is assumed to be inter-industry only and takes place between two countries: Home (H) and Foreign (F), where H is relatively more capital abundant than F : $K_H/L_H > K_F/L_F$.

Let A denote 2×2 technology matrix, whose element a_{ij} denotes the quantity of factor i , $i = K, L$, required to produce a unit of good j , $j = X, Y$. Good X is more capital-intensive than good Y : $a_{KX}/a_{LX} > a_{KY}/a_{LY}$. With CRS, total demands in each country are given by the products of a_{ij} 's and the levels of output, hence the requirement that both factors are fully employed in H and F as follows:

$$a_{KX}X_s + a_{KY}Y_s = K_s \tag{4}$$

$$a_{LX}X_s + a_{LY}Y_s = L_s \tag{5}$$

where X_s and Y_s denote output levels, K_s and L_s denote factor supplies, for $s = H, F$. The solution to the system of Eqs. (4) and (5) determines the volumes of each good produced given the existing factor endowments in either H or F .

Denoting r and w to be rewards to K and L , and good Y chosen to be the numeraire, the unit costs must equal market prices that are the same in H and F :

$$a_{KX}r + a_{KY}w = p_X = p \quad (6)$$

$$a_{LX}r + a_{LY}w = p_Y = 1 \quad (7)$$

In this setting, country s will consume s_s share of bilateral output of any good, where s_s is the share of country s in the sum of GDPs of trading partners. As a result, exports to partner country can be formulated as the difference between domestic production and consumption. Therefore, country H 's exports of good X to country F : EX_{HF} , and country F 's exports of good Y to country H : EX_{FH} , can be written as:

$$EX_{HF} = p[X_H - s_H(X_H + X_F)] = p[(1 - s_H)X_H - s_H X_F] = p[s_F X_H - s_H X_F] \quad (8)$$

$$EX_{FH} = Y_F - s_F(Y_H + Y_F) = (1 - s_F)Y_F - s_F Y_H = s_H Y_F - s_F Y_H \quad (9)$$

Let $GDP_s = pX_s + Y_s$, for $s = H, F$, and define $1 - \varphi_s = pX_s/GDP_s$ and $\varphi_s = Y_s/GDP_s$, we can rewrite Eqs. (5) and (6) as:

$$EX_{HF} = s_F(1 - \varphi_H)GDP_H - s_H(1 - \varphi_F)GDP_F = (\varphi_F - \varphi_H)s_H s_F(GDP_H + GDP_F) \quad (10)$$

$$EX_{FH} = s_H \varphi_F GDP_F - s_F \varphi_H GDP_H = (\varphi_F - \varphi_H)s_H s_F(GDP_H + GDP_F) \quad (11)$$

Because Eqs. (10) and (11) are equivalent, we focus on the total volume of trade in homogeneous goods between H and F , VT_{HF}^{H-H} , which is defined as the sum of exports of both countries or twice the exports of H or F due to their symmetry.

$$\begin{aligned} VT_{HF}^{H-H} &= EX_{HF} + EX_{FH} = 2EX_{HF} = 2EX_{FH} = 2(\varphi_F - \varphi_H)s_H s_F(GDP_H + GDP_F) \\ &= (\varphi_F - \varphi_H)(1 - s_H^2 - s_F^2)(GDP_H + GDP_F) \end{aligned} \quad (12)$$

From Eq. (12), it follows that the volume of bilateral trade in homogeneous goods between H and F is the product of three terms: the differences in production structure of trading economies that result from their factor endowments: $(\varphi_F - \varphi_H)$, Helpman's (1987) GDP similarity index that describes the relative size of trading partners: $(1 - s_H^2 - s_F^2)$, and the absolute economic size of trading partners: $(GDP_H + GDP_F)$.

If $\varphi_F > \varphi_H > 0$, then factor proportions play a significant role in determination of bilateral trade. This can be demonstrated using the solutions to the system of Eqs. (4), (5). The share of good X in GDP of country s can be expressed as the function of its factor proportions K_s/L_s :

$$1 - \varphi_s = z \left[\frac{a_{LY}K_s/L_s - a_{KY}}{rK_s/L_s + w} \right] \quad (13)$$

where $z = (a_{KX}r + a_{LX}w)/(a_{LY}a_{KX} - a_{KY}a_{LX})$, and $s = H, F$. Hence, we express the term $(\varphi_F - \varphi_H)$ that captures the impact of differences in the production structure (12) as the function of their factor proportions:

$$(\varphi_F - \varphi_H) = z \left[\frac{a_{LY}K_H/L_H - a_{KY}}{rK_H/L_H + w} - \frac{a_{LY}K_F/L_F - a_{KY}}{rK_F/L_F + w} \right] \tag{14}$$

But because it is more convenient to study the impact of differences and sum of capital-labor ratios across country-pairs rather than changes in particular capital-labor ratios on the volume of trade, we express $K_H/L_H > K_F/L_F$ as:

$$\frac{K_H}{K_F} = \frac{1}{2} \left[\left(\frac{K_H}{L_H} + \frac{K_F}{L_F} \right) + \left| \frac{K_H}{L_H} - \frac{K_F}{L_F} \right| \right] \tag{15}$$

$$\frac{K_F}{K_F} = \frac{1}{2} \left[\left(\frac{K_H}{L_H} + \frac{K_F}{L_F} \right) + \left| \frac{K_H}{L_H} - \frac{K_F}{L_F} \right| \right] \tag{16}$$

Let $|K_H/L_H - K_F/L_F| = DIFF$ and $(K_H/L_H + K_F/L_F) = SUM$, the difference in production structures of trading economies $(\varphi_F - \varphi_H)$ can be expressed as a function of differences and sum of capital-labor ratios, using Eqs. (15) and (16) together with Eq. (14), it is possible to write the trade volume Eq. (12) as:

$$VT_{HF}^{H-H} = z \left[\frac{DIFF}{0.25r^2(SUM^2 - DIFF^2) + wrSUM + w^2} \right] (1 - s_H^2 - s_F^2)(GDP_H + GDP_F) \tag{17}$$

Taking partial derivatives of $(\varphi_F - \varphi_H)$ with respect to capital-labor differences and sums:

$$\frac{\partial(\varphi_F - \varphi_H)}{\partial DIFF} = \frac{z[0.25r^2(SUM^2 + DIFF^2) + wrSUM + w^2]}{[0.25r^2(SUM^2 - DIFF^2) + wrSUM + w^2]^2} > 0 \tag{18}$$

$$\frac{\partial(\varphi_F - \varphi_H)}{\partial SUM} = - \frac{z[0.5r^2SUM + wr]DIFF}{[0.25r^2(SUM^2 - DIFF^2) + wrSUM + w^2]^2} < 0 \tag{19}$$

As a consequence of Eqs. (18) and (19) we obtain a similar result to Rybczyński (1955), which relates changes in the pattern of production to changes in relative factor endowments. An increase (a decrease) in the capital-labor ratio in the capital (or labor) abundant country increases (decreases) the output of the capital intensive good and decreases (increases) the output of the labor-intensive good in country H (F). In turn, this increases the volume of inter-industry trade.

Chamberlin–Heckscher–Ohlin model

It is now assumed that good X is differentiated and produced under increasing returns to scale at the firm level (capital-intensive), while good Y remains homogeneous (labor-intensive). The market structure in industry X is characterized by Chamberlinian perfect monopolistic competition that features a symmetric Bertrand–Nash equilibrium of perfectly informed producers facing perfectly informed consumers under conditions of perfect flexibility in the choice of product specification, absence of collusion, and free entry and exit. Each variety of good X is produced by firms with complete specialization with total costs consisting of identical fixed and variable components across different varieties and countries.

Considering abovementioned assumptions, full employment and pricing conditions become:

$$(F_{KX} + a_{KX}x)n_{sX} + a_{KY}Y_s = K_s \quad (20)$$

$$(F_{LX} + a_{LX}x)n_{sX} + a_{LY}Y_s = L_s \quad (21)$$

where F_{KX} , F_{LX} are fixed set-up costs in the production of good X that are independent of the volume of output, x is the output of a representative variety of good X , n_{sX} is the number of varieties of good X produces in country s , for $s = H, F$.

Consumer preferences for varieties of differentiated good X are defined by the symmetric CES utility function:

$$X = \left(\sum_{k=1}^{n_X} x_k^\beta \right)^{\frac{1}{\beta}} \quad (22)$$

where $\beta = 1 - (1/\sigma)$ with $\sigma > 1$, denotes the elasticity of substitution between varieties of good X . Considering the fact that many varieties of good X are available in the market, each firm in either H or F faces a demand curve with a constant elasticity. The solution to the profit maximization problem of a representable firm that produces good X yields the standard mark-up pricing formula:

$$p_X = (1/\beta)(a_{KX}r + a_{LX}w) = p \quad (23)$$

Under free entry and exit, a firm's optimal output of good X can be derived by setting its profits to zero:

$$x = (\sigma - 1)(F_{LX}w + F_{KX}r)/(a_{KX}r + a_{LX}w) \quad (24)$$

Combination of consumer's preference for variety and complete specialization at the firm level with increasing returns to scale production gives rise to both exports and imports within industry X . Though, in the CHO model with incomplete specialization in production, good Y is exported by country F to country H as in the standard HOS model, but different varieties of good X flow in both directions, with more capital-abundant country H being the net exporter.

Taking into account homothetic and identical preferences between countries, equal prices for all consumers and balanced trade as well as definitions of GDP_s , s_s , and φ_s , export volumes for countries H and F can be written as:

$$\begin{aligned}
 EX_{HF} &= s_F p X_H = s_F [p X_H + Y_H] - s_F Y_H = s_F GDP_H - s_F Y_H \\
 &= (1 - \varphi_H) s_F GDP_H = (1 - \varphi_H) s_H s_F (GDP_H + GDP_F)
 \end{aligned}
 \tag{25}$$

$$\begin{aligned}
 EX_{FH} &= s_H p X_F + [Y_F - s_F (Y_H + Y_F)] = s_H [p X_F + Y_F] - s_F Y_H = s_H GDP_F - s_F Y_H \\
 &= s_H GDP_F - \varphi_H s_F GDP_H = (1 - \varphi_H) s_H s_F (GDP_H + GDP_F)
 \end{aligned}
 \tag{26}$$

where $X_s = n_s X$, for $s = H, F$.

Therefore, the volume of bilateral trade in the CHO model can be expressed as the sum of exports in both countries (or twice the exports in either H or F):

$$\begin{aligned}
 VT_{HF}^{H-D} &= EX_{HF} + EX_{FH} = 2EX_{FH} = 2(1 - \varphi_H) s_H s_F (GDP_H + GDP_F) \\
 &= (1 - \varphi_H) (1 - s_H^2 - s_F^2) (GDP_H + GDP_F)
 \end{aligned}
 \tag{27}$$

Equation (27) postulates that the volume of bilateral trade (VT_{HF}^{H-D}) between countries H and F in the CHO model depends on the production structure of H 's economy, which is captured by $(1 - \varphi_H)$, and GDP-related measures that proxy the relative and the absolute size of a given country-pair. Hence, the production structure of labor-abundant economy of country F does not affect the volume of trade in the CHO model.

If $1 > \varphi_H > 0$, it is the case when capital-abundant country H is not completely specialized in production and both factor proportion and country size variables affect the volume of bilateral trade in the CHO model. However, their impact is different from the HOS model, using the solutions to the system of Eqs. (20), (21) and definitions of capital-labor sums and differences, it is possible to express the share of good X in country H 's GDP as:

$$1 - \varphi_H = z' \left[\frac{a_{LY} K_H / L_H - a_{KY}}{r K_s / L_s + w} \right] = z' \left[\frac{0.5 a_{LY} (SUM + DIFF) - a_{KY}}{0.5 r (SUM + DIFF) + w} \right] \tag{28}$$

where $z' = \sigma(F_{KX} r + F_{LX} w) / [(a_{LY} F_{KX} - a_{KY} F_{LX}) + (a_{KX} a_{LY} - a_{KY} a_{LX})]$, and x is defined by Eq. (24).

Plugging Eq. (28) into (27) allows us to express the trade volume equation as:

$$VT_{HF}^{H-D} = z' \left[\frac{0.5 a_{LY} (SUM + DIFF) - a_{KY}}{0.5 r (SUM + DIFF) + w} \right] (1 - s_H^2 - s_F^2) (GDP_H + GDP_F) \tag{29}$$

The effect of factor proportion variables on the total volume of bilateral trade in the CHO model can be determined by computing two partial derivatives of $(1 - \varphi_H)$ with respect to capital-labor differences and sums:

$$\frac{\partial(1 - \varphi_H)}{\partial DIF F} = \frac{0.5z'}{[0.5r(SUM + DIF F) + w]^2} > 0 \tag{30}$$

$$\frac{\partial(1 - \varphi_H)}{\partial SUM} = \frac{0.5z'}{[0.5r(SUM + DIF F) + w]^2} > 0 \tag{31}$$

Using Eq. (30) and (31), we can see that an increase (a decrease) in the capital-labor ratio in the capital (labor) abundant country increases (decreases) the output of the capital intensive good and decreases (increases) the output of the labor-intensive good in country H (F). Such mechanism increases inter-industry trade as in the HOS model, however now an increase in the volume of inter-industry trade is accompanied by a decrease in the volume of intra-industry trade due to a fall in the number of varieties of X produced in country F . But because the former effect is stronger than the latter, the total volume of trade increases.

Pure monopolistic competition model

In the pure monopolistic competition model both goods X and Y become differentiated, which makes factor proportions irrelevant to the volume of trade even if countries are not completely specialized in production. As a result, this allows us to demonstrate that if there is complete specialization in production at the firm level, the trade volume equation is exactly the same as in the case of complete specialization in production at the country level.

The full employment conditions can be formulated as:

$$(F_{KX} + a_{KX}x)n_{sX} + (F_{KY} + a_{KY}y)n_{sY} = K_s \tag{32}$$

$$(F_{LX} + a_{LX}x)n_{sX} + (F_{LY} + a_{LY}y)n_{sY} = L_s \tag{33}$$

where F_{KY} , F_{LY} are fixed set-up costs in the production of good Y that are independent of the volume of output, y is the output of a representative variety of Y , and n_{sY} is the number of varieties of Y produced in country s , for $s = H, F$.

The market structure in both industries is Chamberlinian perfect monopolistic competition and preferences for varieties of both goods are represented by CES utility. In particular, good X remains to be described by Eq. (22), while consumption of good Y is:

$$Y = \left(\sum_{l=1}^{n_Y} y_l^\beta \right)^{\frac{1}{\beta}} \tag{34}$$

With the standard mark-up pricing formula:

$$p_Y = \beta(a_{KY}r + a_{LY}w) = 1/\beta \tag{35}$$

The optimal output of a variety of Y produced by a representative firm can be obtained from the free market entry condition:

$$y = (\sigma - 1)(F_{LY}w + F_{KY}r) \quad (36)$$

Because in the pure monopolistic competition model varieties of X and Y flow in both directions each country consumes a share of output of each variety equal to the share of its GDP in the joint GDP of a country-pair. With homothetic and identical preferences in both countries, the same prices for all consumers and balanced trade, exports of varieties of both goods for countries H and F can be formulated as:

$$EX_{HF} = s_F(pX_H + Y_H) = s_F GDP_H = s_H s_F (GDP_H + GDP_F) \quad (37)$$

$$EX_{FH} = s_H(pX_F + Y_F) = s_H GDP_F = s_H s_F (GDP_H + GDP_F) \quad (38)$$

where $X_s = xn_{sX}$, and $Y_s = yn_{sY}$, for $s = H, F$.

Combining Eqs. (32) and (33), the total volume of bilateral trade between H and F equals:

$$\begin{aligned} VT_{HF}^{D-D} &= EX_{HF} + EX_{FH} = 2EX_{HF} = 2EX_{FH} = 2s_H s_F (GDP_H + GDP_F) \\ &= (1 - s_H^2 - s_F^2)(GDP_H + GDP_F) \end{aligned} \quad (39)$$

From Eq. (34) it follows that the volume of bilateral trade in the pure monopolistic model between H and F depends only on the relative and the absolute country size variables. Despite the fact that varieties of goods X and Y are produced with different factor intensities, factor proportion variables do not play any role in the determination of the bilateral trade.

Funding Narodowe Centrum Nauki, 2021/41/N/HS4/00759, Oleg Gurshev.

Declarations

Conflict of interest Andrzej Cieslik and I declare that we have no conflict of interest in this paper.

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References

Adarov, A. (2018). Eurasian economic integration: Impact evaluation using the gravity model and the synthetic control methods (No. 150). *WIIW Working Paper*. <https://doi.org/10.4337/9781782544760>

- Adarov, A., & Ghodsi, M. (2021). The impact of the Eurasian Economic Union-Iran preferential trade agreement on mutual trade at aggregate and sectoral levels. *Eurasian Economic Review*, 11(1), 125–157. <https://doi.org/10.1007/s40822-020-00161-2>
- Anderson, J. E., & Van Wincoop, E. (2003). Gravity with gravitas: A solution to the border puzzle. *American Economic Review*, 93(1), 170–192. <https://doi.org/10.1257/000282803321455214>
- Baier, S. L., & Bergstrand, J. H. (2007). Do free trade agreements actually increase members' international trade? *Journal of International Economics*, 71(1), 72–95. <https://doi.org/10.1016/j.jinteco.2006.02.005>
- Baier, S. L., Yotov, Y. V., & Zylkin, T. (2019). On the widely differing effects of free trade agreements: Lessons from twenty years of trade integration. *Journal of International Economics*, 116, 206–226. <https://doi.org/10.1016/j.jinteco.2018.11.002>
- Caporale, G. M., Rault, C., Sova, R., & Sova, A. (2009). On the bilateral trade effects of free trade agreements between the EU-15 and the CEEC-4 countries. *Review of World Economics*, 145(2), 189–206. <https://doi.org/10.1007/s10290-009-0020-7>
- Carrere, C. (2006). Revisiting the effects of regional trade agreements on trade flows with proper specification of the gravity model. *European Economic Review*, 50(2), 223–247. <https://doi.org/10.1016/j.eurocorev.2004.06.001>
- CEPII (2021). GeoDist database, Retrieved July, 2021, from http://www.cepii.fr/CEPII/en/bdd_modele/presentation.asp?id=6
- Cieslik, A. (2009). Bilateral trade volumes, the gravity equation and factor proportions. *The Journal of International Trade & Economic Development*, 18(1), 37–59. <https://doi.org/10.1080/09638190902757400>
- Correia, S., Guimarães, P., & Zylkin, T. (2020). Fast Poisson estimation with high-dimensional fixed effects. *The Stata Journal*, 20(1), 95–115. <https://doi.org/10.1177/1536867X20909691>
- De Souza, V. L. (2011). An initial estimation of the economic effects of the creation of the EurAsEC customs union on its members. *World Bank Economic Premise*, 47, 1–7.
- EBRD. (2012). EBRD transition report 2012: Integration across borders. London: European Bank for Reconstruction and Development.
- Evenett, S. J., & Keller, W. (2002). On theories explaining the success of the gravity equation. *Journal of Political Economy*, 110(2), 281–316. <https://doi.org/10.1086/338746>
- Falkowski, K. (2018). Long-term comparative advantages of the Eurasian Economic Union member states in international trade. *International Journal of Management and Economics*, 53(4), 27–49. <https://doi.org/10.1515/ijme-2017-0024>
- Feenstra, R. C., Inklaar, R., & Timmer, M. P. (2015). The next generation of the Penn World Table. *American Economic Review*, 105(10), 3150–3182. <https://doi.org/10.1257/aer.20130954>
- Golovko, A., & Sahin, H. (2021). Analysis of international trade integration of Eurasian countries: Gravity model approach. *Eurasian Economic Review*, 11(3), 519–548. <https://doi.org/10.1007/s40822-021-00168-3>
- Haveman, J., & Hummels, D. (2004). Alternative hypotheses and the volume of trade: The gravity equation and the extent of specialization. *Canadian Journal of Economics/revue Canadienne D'économique*, 37(1), 199–218. https://doi.org/10.1111/j.0008-4085.2004.011_1.x
- Helpman, E. (1987). Imperfect competition and international trade: Evidence from fourteen industrial countries. *Journal of the Japanese and International Economies*, 1(1), 62–81. [https://doi.org/10.1016/0889-1583\(87\)90027-X](https://doi.org/10.1016/0889-1583(87)90027-X)
- Hummels, D., & Levinsohn, J. (1995). Monopolistic competition and international trade: Reconsidering the evidence. *The Quarterly Journal of Economics*, 110(3), 799–836. <https://doi.org/10.2307/2946700>
- Mazhikeyev, A., & Edwards, T. H. (2021). Post-colonial trade between Russia and former Soviet republics: Back to big brother? *Economic Change and Restructuring*, 54(3), 877–918. <https://doi.org/10.1007/s10644-020-09302-8>
- Rybczynski, T. M. (1955). Factor endowment and relative commodity prices. *Economica*, 22(88), 336–341.
- Sandberg, H. M., Seale, J. L., Jr., & Taylor, T. G. (2006). History, regionalism, and CARICOM trade: A gravity model analysis. *The Journal of Development Studies*, 42(5), 795–811. <https://doi.org/10.1080/00220380600741995>
- Silva, J. S., & Tenreyro, S. (2006). The log of gravity. *The Review of Economics and Statistics*, 88(4), 641–658. <https://doi.org/10.1162/rest.88.4.641>

- Silva, J. S., & Tenreyro, S. (2011). Further simulation evidence on the performance of the Poisson pseudo-maximum likelihood estimator. *Economics Letters*, 112(2), 220–222. <https://doi.org/10.1016/j.econlet.2011.05.008>
- Tarr, D. G. (2016). The Eurasian Economic Union of Russia, Belarus, Kazakhstan, Armenia, and the Kyrgyz Republic: Can it succeed where its predecessor failed? *Eastern European Economics*, 54(1), 1–22. <https://doi.org/10.1080/00128775.2015.1105672>
- United Nations (2021). COMTRADE database, Retrieved July, 2021, from <https://comtrade.un.org/data/>
- Weidner, M., & Zylkin, T. (2021). Bias and consistency in three-way gravity models. *Journal of International Economics*. <https://doi.org/10.1016/j.jinteco.2021.103513>
- World Trade Organization (2021). Regional trade agreements database, Retrieved July, 2021, <https://rtais.wto.org/UI/PublicMaintainRTAHome.aspx>

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