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CONVERGENCE OF EXPORT-IMPORT FLOWS AND ECONOMIC DEVELOPMENT IN THE CENTRAL AND SOUTHEAST EUROPEAN UNION

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Abstract: *The study presents the long- and short-term relationship between international trade flows (exports/imports) and economic development (GDP) as the main driver of international economic trade. Panel data econometric models emphasize the fixed effects of the eight Central and Southeast European Union countries. The cointegration condition is met to identify the existence of long-run equilibrium. The error correction model is the iterative short-run adjustment solution to the long-run relationship for both exports and imports. Regional trade convergence is achieved by observing the cointegration of the analysed variables; it is described by their average levels for all countries.*

Key words: *unit root, stationarity, cointegration, panel data, error correction term.*

1. Introduction

The economic development of the member states of the European Union is different. The accession to the EU of the states of Central and Southeast Europe provides the framework for a similarity in the dynamics of their macro-indicators.

The economic openness of the countries in the Central and Southeast of the EU is the basis of economic development to ensure economic and social security, and also the well-being of the population.

The two international commercial flows: exports and imports, are highly interdependent. Imports involve payments and exports involve receipts. The coverage ratio is the rapport of exports to imports; if it is greater than 100%, it shows a positive state of the foreign trade balance, otherwise a negative one because the country has to pay more for its imports, and its exports become cheaper as a result of the changes in the exchange rate. Developed countries have higher export volume than import volume, meaning a coverage rate of exports higher than 100%.

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Fig. 1 shows the evolution of the proportions of exports (p_X) and imports (p_M), calculated as ratios in GDP at current prices, at the EU-27 level and for each EU CSE country.

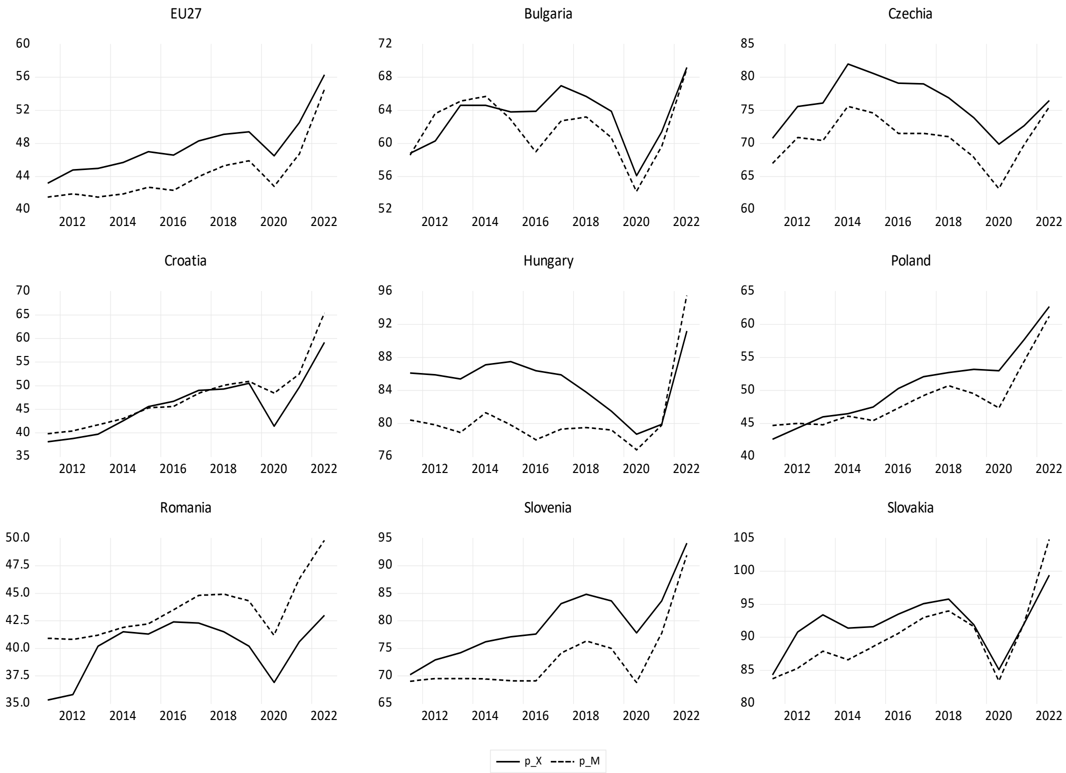

Fig. 1. *Proportions of exports/imports in GDP at the EU27 level and in the EU CSE countries in the period 2011-2022*

We see that in Romania, throughout the analysed period, the proportions of imports were higher than those of exports, standing between 40-50%. Only Croatia recorded higher import proportions than export proportions, but very close until 2019. The impact of the 2020 pandemic can be seen for all countries, including the EU-27.

2. Objectives, Data and Methodology

2.1. Objectives

The objective of our study is to analyse the long-run relationships separately between exports and GDP and between imports and GDP for EU CSE countries.

The membership aspect of the CSE region can confer a resemblance of long-term equilibrium, taking into account country specificities, levels of economic development, and in accordance with each country's export/import policies.

2.2. Data

The annual data of volume macro-indicators of GDP, imports and exports are expressed in millions euro 2010. In Fig. 2 we can see the evolution of GDP and international flows of exports and imports for each CSE EU country.

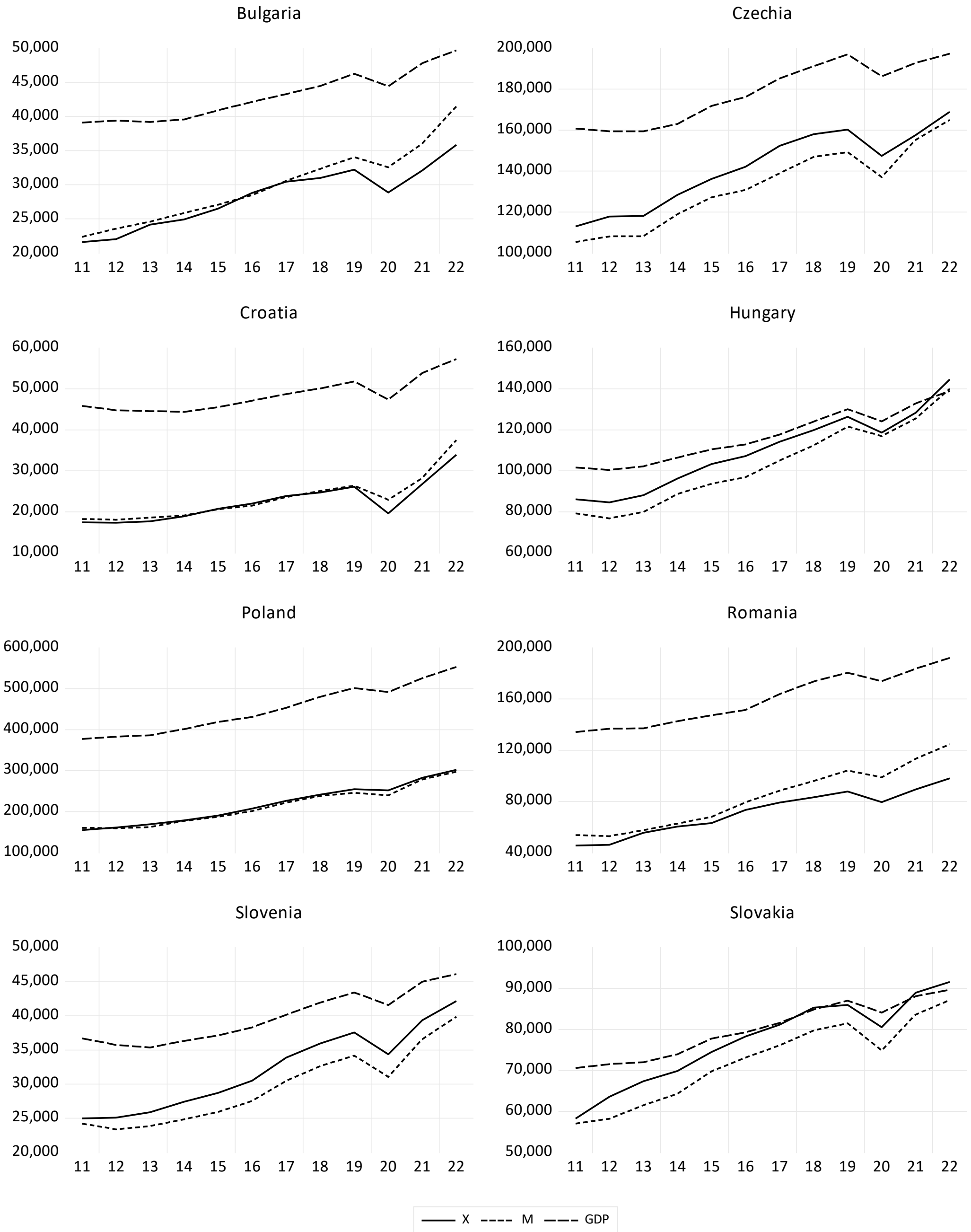

Fig. 2. *GDP volume and commercial flows of exports and imports in the CSE EU countries, 2011-2022*

We can see the very close evolution of imports and exports in Poland and Croatia until 2019. Slovenia, Slovakia, The Czech Republic, Poland and Hungary had positive trade balance for the entire period 2011-2022. Romania and Bulgaria had a foreign trade deficit for the entire period. The export volumes are very close to GDP in Hungary and especially in Slovakia, with proportions higher than 90%, in Figure 2.

2.3. Methodology

We consider GDP as explanatory variable firstly for exports (X) and then for imports (M). If the variables are non-stationary and they are integrated of the same order, they are cointegrated if they admit a stationary combination. The long-run equation offers the error correction term for the short-run equation.

The panel data models assumes to establish the significance of random effects and of fixed effects for each and then for both dimensions: cross-sections and periods.

After establishing the appropriate panel data model for the long-run model, the error correction term (ECT) is established. The residuals (ECT) become the cointegration term in the short-run equation (eqn. 1). The ECT variable must be stationary. The lag ECT is used in the short-run model which is the Error Correction Model (ECM).

$$\Delta y_t = \beta_0 + \beta_1 \Delta x_t + \beta_2 (y_{t-1} - \tau x_{t-1}) + u_t \quad (1)$$

If the coefficient β_2 of ECT in ECM is negative and significant, then there exists a long-run equilibrium and the coefficient is just the speed of adjustment during one year.

Then we repeat the analysis for imports. The findings highlight the convergence of GDP influence on the two international trade flows in the EU CSE region.

3. Results

Pairwise Granger causality tests show that GDP is a Granger cause of exports (X). Pairwise Dumintrescu Hurlin causality tests support the null hypothesis that both X and GDP do not homogeneously cause the other variable.

In Table 1, the descriptive statistics of exports (X) and GDP volumes show the ascending order of the evolution of these indicators for the eight analysed countries.

Table 1

Descriptive statistics of export volumes

COUNTRIES	Mean	Min.	Max
Croatia	22435	17364	33922
Bulgaria	28200	21591	35822
Slovenia	32155	24978	42157
Romania	71708	45554	97941
Slovakia	77122	58244	91633
Hungary	109806	84640	144609
The Czech Republic	141681	112991	168948
Poland	218473	155025	301961
All	87698	17364	301961

Descriptive statistics of GDP volumes

COUNTRIES	Mean	Min.	Max
Slovenia	39806	35342	46105
Bulgaria	43004	39090	49684
Croatia	48444	44384	57301
Slovakia	80036	70602	89676
Hungary	116818	100364	138995
Romania	159688	134073	192084
The Czech Republic	178321	159366	197277
Poland	450177	377173	553105
All	139537	35342	553105

We opt to use the logarithmic values of exports (LX) and for GDP (LGDP), to explain the influence of the independent variable (LGDP) on the explained variable (LX) in relative terms.

3.1. The economic development and export policies in the Central and Southeast EU countries during 2011-2022

To test non-stationarity, we use the unit root tests for each of the two variables LX and LGDP; they are nonstationary in levels, but stationary in 1st differences. We conclude they both are integrated of order 1, I(1).

The Pedroni residual cointegration test with individual intercept for each cross-section presents 11 test statistics with the associated probabilities, in Table 2. There are 6 test statistics which reject the null hypothesis of no cointegration and accepting the majority, we decide that the variables are cointegrated.

Table 2

Pedroni Residual Cointegration Test
Series: LX LGDP
Sample: 2011 2022
Included observations: 96
Cross-sections included: 8
Null Hypothesis: No cointegration
Trend assumption: No deterministic trend
Automatic lag length selection based on SIC with a max lag of 1
Newey-West automatic bandwidth selection and Bartlett kernel

Alternative hypothesis: common AR coefs. (within-dimension)

	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	0.587736	0.2784	0.854772	0.1963
Panel rho-Statistic	-0.278797	0.3902	-0.547902	0.2919
Panel PP-Statistic	-1.913973	0.0278	-2.411811	0.0079
Panel ADF-Statistic	-2.236088	0.0127	-2.520095	0.0059

Alternative hypothesis: individual AR coefs. (between-dimension)

	Statistic	Prob.
Group rho-Statistic	0.866820	0.8070
Group PP-Statistic	-1.922101	0.0273
Group ADF-Statistic	-2.380151	0.0087

The Johansen Fisher panel cointegration test with linear trend (option 3) and maximum 1 lag for both variables is presented in Table 3. Except Poland, for all the other CSE countries, the Johansen Fisher cointegration test rejects the null hypothesis of no cointegration, so they are cointegrated and they all have at most one cointegration equation. In Table 1, we can see that Poland is the most developed country in the Central and Southeast region of the European Union.

Table 3

Johansen Fisher Panel Cointegration Test
Series: LX LGDP
Sample: 2011 2022
Included observations: 96
Trend assumption: Linear deterministic trend
Lags interval (in first differences): 1 1

Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)

Hypothesized No. of CE(s)	Fisher Stat.* (from trace test)	Prob.	Fisher Stat.* (from max-Eigen test)	Prob.
None	64.23	0.0000	69.32	0.0000
At most 1	9.818	0.8760	9.818	0.8760

* Probabilities are computed using asymptotic Chi-square distribution.

Individual cross section results

Cross Section	Trace Test Statistics	Prob.**	Max-Eigen Test Statistics	Prob.**
Hypothesis of no cointegration				
Bulgaria	26.6635	0.0007	26.6633	0.0004
The Czech Republic	20.6404	0.0077	19.5907	0.0065
Croatia	18.9253	0.0146	18.3958	0.0105
Hungary	14.3016	0.0750	14.2889	0.0496
Poland	11.0668	0.2074	11.0353	**0.1524**
Romania	18.0547	0.0201	16.6784	0.0204
Slovenia	19.9246	0.0100	19.8828	0.0058
Slovakia	15.7833	0.0452	14.8362	0.0406
Hypothesis of at most 1 cointegration relationship				
Bulgaria	0.0001	0.9927	0.0001	0.9927
The Czech Republic	1.0496	0.3056	1.0496	0.3056
Croatia	0.5295	0.4668	0.5295	0.4668
Hungary	0.0127	0.9099	0.0127	0.9099
Poland	0.0315	0.8590	0.0315	0.8590
Romania	1.3762	0.2407	1.3762	0.2407
Slovenia	0.0418	0.8381	0.0418	0.8381
Slovakia	0.9471	0.3305	0.9471	0.3305

**MacKinnon-Haug-Michelis (1999) p-values

To choose the best panel data model for long run equation, we build the long run model with the pool OLS regression, which is not recommended because it does not consider the heterogeneity of countries. The pooled OLS models is used only to test the existence of the random effects and the dimensions for which they may be significant.

The Lagrange Multiplier tests for random effects applied on the pooled OLS long run model find them as significant for cross-sections and for both cross-sections and periods, as seen in Table 4.

Table 4

Lagrange Multiplier Tests for Random Effects
Null hypotheses: No effects
Alternative hypotheses: Two-sided (Breusch-Pagan) and one-sided (all others) alternatives

	Test Hypothesis		
	Cross-section	Time	Both
Breusch-Pagan	417.2775	0.622421	417.8999
	(0.0000)	(0.4301)	(0.0000)
Honda	20.42737	-0.788937	13.88647
	(0.0000)	(0.7849)	(0.0000)
King-Wu	20.42737	-0.788937	15.47682
	(0.0000)	(0.7849)	(0.0000)
Standardized Honda	23.64788	-0.637276	12.46316
	(0.0000)	(0.7380)	(0.0000)
Standardized King-Wu	23.64788	-0.637276	14.50472
	(0.0000)	(0.7380)	(0.0000)
Gourieroux, et al.*	--	--	417.2775
			(0.0000)

We build the FE panel data model, in Table 5. The long run model with fixed effects of countries and GLS weights as Cross-section SUR solves the dependence of residuals in cross-sections. We build the series of residuals, named ECT_long_fe.

The unit root tests show the series of residuals as being stationary and we conclude that the variables LX and LGDP are cointegrated, meaning that they have a significant long run relationship.

The ECT_long_fe term is normally distributed. The null hypothesis of no cross-section dependence (correlation) in weighted residuals is accepted.

The long run equation with fixed effects of cross sections rejects the null hypothesis of redundant fixed effects tests and it finds them as significant.

Table 5

Dependent Variable: LX
Method: Panel EGLS (Cross-section SUR)
Sample: 2011 2022
Periods included: 12
Cross-sections included: 8
Total panel (balanced) observations: 96
Linear estimation after one-step weighting matrix

Variable	Coefficient	Std. Error	t-Statistic	Prob.

LGDP	1.772054	0.025218	70.26805	0.0000
C	-9.303045	0.290217	-32.05543	0.0000

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.999473	Mean dependent var	100.9206
Adjusted R-squared	0.999425	S.D. dependent var	361.1639
S.E. of regression	1.048723	Sum squared resid	95.68433
F-statistic	20643.61	Durbin-Watson stat	1.777774
Prob(F-statistic)	0.000000		

Redundant Fixed Effects Tests
Equation: EQ_LONG_FE
Test cross-section fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	1058.216674	(7,87)	0.0000

As we can see in Table 5, the too high value of R-squared and the too low value of Durbin-Watson statistic is a sign of a spurious regression. It is important to build an Error Correction Model (ECM).

The long run equation with random effects of cross sections rejects the null hypothesis of Hausman test of correlated random effects and the fixed effects model is better, as seen in Table 6.

The series of residuals of random effects cross section model, named ECT_long_re, is not stationary. Verifying the autocorrelation coefficients in levels and in 1st differences with global tests Q-statistic of stationarity lead us to the same conclusion.

The random effects model is not good to be considered.

Table 6

Correlated Random Effects - Hausman Test
Equation: EQ_LONG_RE
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	30.155278	1	0.0000

Cross-section random effects test comparisons:

Variable	Fixed	Random	Var(Diff.)	Prob.
LGDP	1.786222	1.686111	0.000332	0.0000

We use the residuals of the fixed effects cross-section model, ECT_long_fe, as the lag term of ECT in the Error Correction Model (ECM), in Table 7.

Table 7

Dependent Variable: D(LX)
Method: Panel EGLS (Cross-section SUR)
Sample (adjusted): 2012 2022
Periods included: 11
Cross-sections included: 8
Total panel (balanced) observations: 88
Linear estimation after one-step weighting matrix

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.004683	0.002851	1.642807	0.1044
D(LGDP)	1.854559	0.063269	29.31235	0.0000
ECT_LONG_FE(-1)	-0.456942	0.049232	-9.281322	0.0000

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.914292	Mean dependent var	0.857571
Adjusted R-squared	0.904403	S.D. dependent var	4.145471
S.E. of regression	1.050153	Sum squared resid	86.02011
F-statistic	92.45211	Durbin-Watson stat	1.976462
Prob(F-statistic)	0.000000		

The ECT coefficient is negative and significant, as expected. The conclusion is that there exists a long run equilibrium of the export and economic development policies of the CSE EU countries. The coefficient ECT represents the speed of adjustment to the long run equilibrium. The system is running back with 45.69% annually towards the equilibrium running from GDP to exports.

The long-run equation is from Table 5, the FE cross-section model:

LX = 1.7720*LGDP - 9.3030 + [CX=F].

The coefficient of LGDP is significant at a probability value less than 1%. The interpretation of this coefficient is that at 1% increase in GDP, the exports (X) increase by 1.772%.

The ECM from Table 7 is:

D(LX) = 0.0047 + 1.8546*D(LGDP) - 0.4569*ECT_LONG_FE(-1) + [CX=F]

In Table 7, we can see the significant short run coefficient of GDP at less than 1% P-value. At 1% increasing in GDP, exports increase by 1.8546% on average in the short run. The discrepancy between 1.77% in the long run and 1.85% in the short run is corrected each year by 45.69%. Each country has a specific coefficient comprised in the fixed effects, which affects the intercept of each country model.

The theoretical values of ECM in Fig. 3 show the adjustment towards the equilibrium of the Central and Southeast region of the European Union, for each member country.

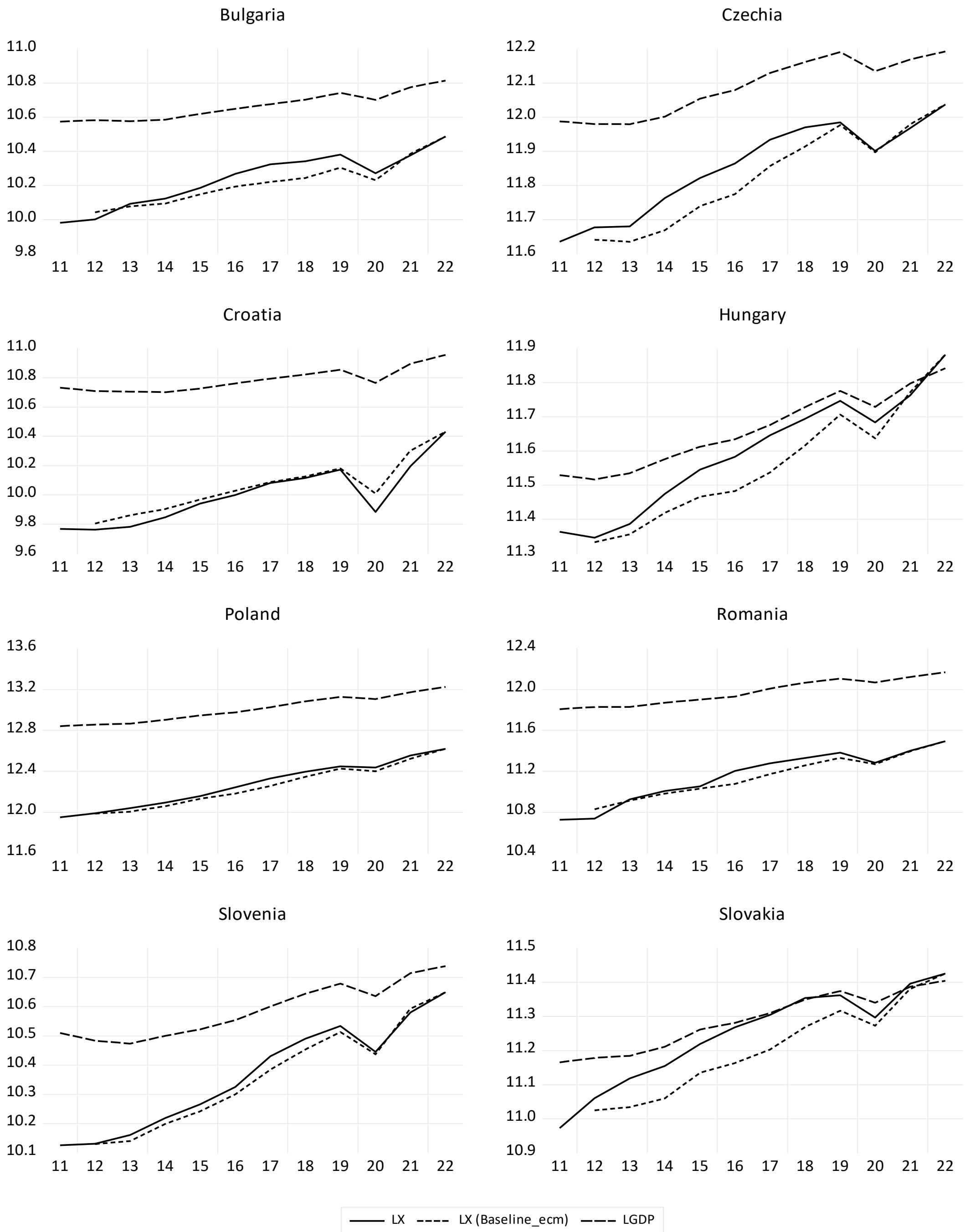

Fig. 3. *Evolution of GDP, exports and theoretical exports with ECM*

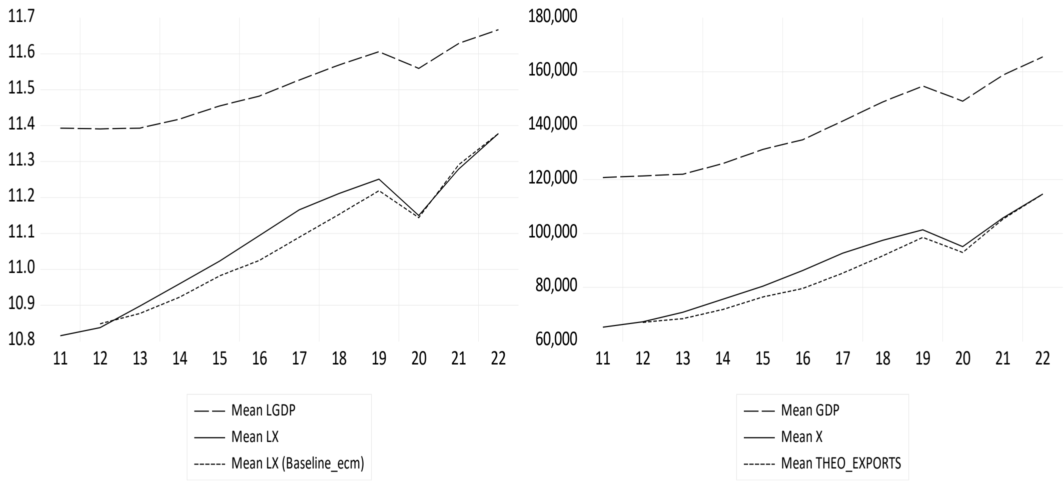

Fig. 4. *Average evolution of GDP, exports and theoretical exports in the CSE EU region*

The convergence of exports and economic development of the Central and Southeast countries of the European Union is shown in Fig. 4 with logarithmic values and the corresponding values in millions of euro 2010.

3.2. The economic development and import policies in the Central and Southeast EU countries during 2011-2022

We repeat the same analysis for the relationship between imports and GDP. Both GDP and imports are Granger cause of each other, and neither homogeneously causes the other.

We check the non-stationarity of imports, and LM (using the logarithms of M) is nonstationary and integrated of order 1. The LM and LGDP are cointegrated, as seen in Table 8; the null hypothesis of no cointegration is rejected for 8 of 11 test statistics:

Table 8

Pedroni Residual Cointegration Test
Series: LM LGDP
Sample: 2011 2022
Included observations: 96
Cross-sections included: 8
Null Hypothesis: No cointegration
Trend assumption: No deterministic trend
User-specified lag length: 1
Newey-West automatic bandwidth selection and Bartlett kernel

Alternative hypothesis: common AR coefs. (within-dimension)

	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	2.162603	0.0153	0.319080	0.3748
Panel rho-Statistic	-1.788289	0.0369	-0.943859	0.1726

Panel PP-Statistic	-4.409244	0.0000	-3.506910	0.0002
Panel ADF-Statistic	-3.880953	0.0001	-4.576551	0.0000

Alternative hypothesis: individual AR coefs. (between-dimension)

	Statistic	Prob.
Group rho-Statistic	0.011168	0.5045
Group PP-Statistic	-3.666738	0.0001
Group ADF-Statistic	-3.800379	0.0001

We find the best panel model with fixed effects for cross-sections with GLS SUR weights and we use it to build the Error Correction Term (ECT_M_FE) for the ECM of imports-GDP relationship:

LM = 1.9458*LGDP - 11.3120 + [CX=F]

D(LM) = 1.7339*D(LGDP) - 0.3023*ECT_M_FE(-1) + 0.0099 + [CX=F]

In Table 9, the ECM for imports and GDP shows the negative and significant coefficient of ECT shows that the system is coming back towards equilibrium with a speed of adjustment of 30.23% in one year.

Table 9

Dependent Variable: D(LM)
Method: Panel EGLS (Cross-section SUR)
Sample (adjusted): 2012 2022
Periods included: 11
Cross-sections included: 8
Total panel (balanced) observations: 88
Linear estimation after one-step weighting matrix

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LGDP)	1.733875	0.033898	51.14972	0.0000
ECT_M_FE(-1)	-0.302318	0.056288	-5.370914	0.0000
C	0.009918	0.002022	4.903964	0.0000

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.968312	Mean dependent var	0.305369
Adjusted R-squared	0.964656	S.D. dependent var	6.144359
S.E. of regression	1.061045	Sum squared resid	87.81366
F-statistic	264.8354	Durbin-Watson stat	2.040418
Prob(F-statistic)	0.000000		

We find that there is also a long-run equilibrium between the imports and GDP, for the EU member states in the Central and Southeast Europe in the period 2011-2022.

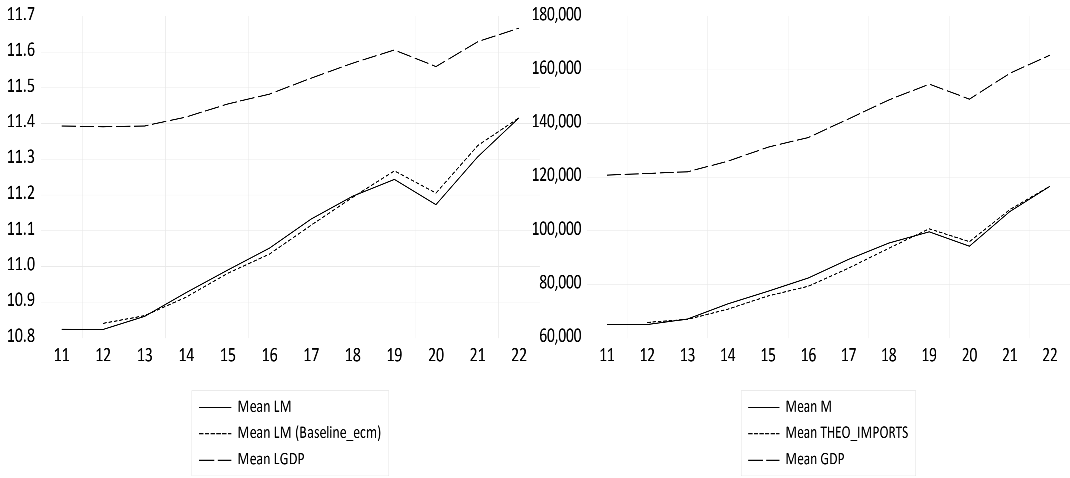

Fig. 5. *Average evolution of GDP, imports and theoretical imports in the CSE EU region*

The convergence of imports and economic development of the Central and Southeast countries of the European Union is shown in Figure 5 with logarithmic values and the corresponding values in millions of euro 2010.

Conclusions

We can see in Table 10 a summary of the coefficients of the long run and short run equations for both international commercial flows.

In the short run, GDP influences more the exports than the imports.

In the long run, the influence of GDP is higher on imports than on exports. The speed of adjustment is higher for exports during one year.

Table 10

Equations for:	Exports		Imports	
Terms	Long run	Short run	Long run	Short run
GDP	1.7720	1.8546	1.9458	1.7339
ECT	-	-0.4569	-	-0.3023

Analysing the long run coefficients, we conclude that the imports should be higher than the exports, because the influence of 1 % of increase in GDP is higher for imports of about 1.9458% compared with 1.772% for exports.

The convergence of export-import flows with economic development is sustainable in the long term for the Central and Southeast region of the European Union.

In the short term, we can see the greater influence of GDP on exports as a stimulating factor. For imports, it is less encouraging than for exports. Imports are a source for final consumption, and especially for household final consumption, and it is important by increasing the standard of living of the population.

The same conclusion of export stimulation goes for explaining and interpreting the higher speed of adjustment for export than for import.

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