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The Structural Convergence of New Members of the European Union: An Input-Output Perspective

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Abstract: This paper aims to approach the topic of structural convergence for new member states from the perspective of input-output analysis. Using a set of input-output measures, based on the OECD RStan database, and a number of unit-root tests, both for individual time series and panel data, this paper tests whether there is convergence relative to the production structure of the German economy. Although the individual tests are somewhat mixed, the panel unit-root tests indicate the presence of convergence. The results highlight the importance of assessing structural convergence based on panel tests. They also highlight that as nominal and real convergence are gradually achieved, structural convergence should also become more prioritized.

Keywords: structural convergence; input-output; unit-root test; production networks

JEL Classification: F15; O11

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1. Introduction

The topic of economic convergence remains important for both the European Union and the Euro Area. First, the successful functioning of the Euro Area depends on the degree of both nominal and real convergence of the economies that are its members[1]. For example, The Delors Report, an essential document for the setting up of the Euro Area, Blavy et al. (2018), underscored the need for greater convergence as a solid foundation of a monetary union. Second, the new member states of the European Union would eventually join the Euro Area. Besides satisfying the nominal convergence criteria, they are also expected to progress in terms of real convergence. Some earlier research (see Imbs (2000)) showed that structural convergence, understood here as similar manufacturing sectoral shares, can impact the synchronization of business cycles.

This paper approaches the topic of convergence for the new member states from a structural perspective. The research question that this paper addresses is whether new member states are converging with the Euro Area from a structural point of view. This paper further discusses the importance of this topic and the key results in the literature in Section 2, which is dedicated to the literature review.

This study analyzes the topic of structural convergence from a new perspective. While previous studies focused on structural convergence by analyzing sectoral shares in the overall economy, this study focuses on structural convergence from the perspective of the production structure. Specifically, it focuses on several key measures derived from the input-output analysis.

There are several reasons that this topic is relevant. First, structural convergence implies that the economies tend to become similar from the structural point of view. In the case of new member states, most have passed through a transition period to market economies, and it is not yet clear how close or far they are from the Euro Area in terms of economic structure. Second, the topic is also significant for the performance of the Euro

Area during periods of big shocks since the member economies should have a similar structure. Imbs (2000) demonstrated the importance of structural convergence for business cycle synchronization.

This paper is structured as follows. Section 2 presents the literature review. Section 3 introduces the methodology used, as well as the econometric approach applied. Section 4 introduces the data, whereas Section 5 discusses the results. The section concludes this paper and looks at the limitations and implications of this research.

2. Literature Review

There are several types of convergence that are already acknowledged in the literature, see Bobeva (2021). First, there are nominal and real types of convergence, on which a large amount of literature has already been published. A critical literature review on real convergence can be found in Johnson and Papageorgiou (2020). The authors indicate that this question remains important in economics and that, at a global level, we cannot talk of reaching a real convergence.

The study by Johnson and Papageorgiou (2020) cites several approaches to this topic. At a theoretical level, real convergence is understood as a process in which the economies in a sample tend to approach the level of developed economies. An alternative definition says that convergence entails, in the long run, a per capita income that does not depend on the initial conditions.

Yet another type of convergence is structural convergence, which was first introduced by Wacziarg (2000) and refers to the convergence of sectoral shares. This paper finds that countries tend to achieve real convergence as their structure converges. There is also institutional convergence, but this is outside the scope of this paper. It has been studied, for example, by Schönfelder and Wagner (2019).

Since this paper focuses on the new member states, this concise literature review looks at the issue of structural convergence for the new member states, with an emphasis on the future Euro Area accession.

It is well known that the set of Maastricht criteria for the Euro Area accession only takes into account the nominal convergence criteria. However, the convergence (including real convergence) is significant. As del Hoyo et al. (2017) underline, the main difference between the Euro Area and the United States is that the latter has labor mobility and risk-sharing mechanisms to help cope with adverse shocks. Due to these reasons, real convergence in the case of the Euro Area is desirable.

In terms of evidence, the study by del Hoyo et al. (2017) highlights the fact that although some later entrants into the Euro Area like the Czech Republic (and, in general, the new member states) have reached real convergence, for the initial members of the Euro Area, we could say that in terms of real convergence, too little has been achieved.

In another review on convergence in the Euro Area, Blavy et al. (2018) found that there has been a convergence of inflation and interest rates among Euro Area member states but not real convergence, except for the new member states. The authors also argued that although structural convergence is not necessary, mechanisms for dealing with adverse shocks are necessary (such that the relative prices are adjusted).

However, given the importance of the fact that a monetary union can cope with adverse shocks, structural convergence should be seen as more important. An adverse shock would have more similar effects if the economies of the Euro Area had more similar structural properties. Although this represents a gap in the literature, some work has been carried out with respect to institutional convergence (see del Hoyo et al. (2017)).

Some work has also been carried out with respect to structural changes in a given economy (see Chóliz et al. (2022)), or by using input-output data to study disguised unemployment across countries (see Liboreiro (2022)). This research shows that input-output analysis can be applied at the cross-country level by studying convergence issues. It also shows that we can analyze structural differences in the production networks in European Union countries.

For example, Masuch et al. (2017) showed that institutional quality is a key determinant of economic growth and, thus an indirect determinant of economic convergence. In the long run, it is the most important determinant of economic growth.

A few other studies looked at structural convergence from the perspective of sectoral activity (and, in this sense, they are closer to the scope of this paper). For example, Raleva and Marikina (2021) assessed structural convergence for the particular case of Bulgaria by looking at the trend regarding the relative sectoral shares for the gross value added or employment.

Bobeva (2021) studied structural convergence in the new member states and found that there was little connection between structural convergence and real convergence.

A more comprehensive study was carried out by Palan and Schmiedeberg (2010), who focused on a sample of Western European member states' economies. By looking at data for the last few decades (the study was published in 2010), the study concluded that there was structural convergence at the aggregate level for manufacturing and services. However, the results with respect to the inter-industry convergence rate were somewhat mixed.

At the same time, some research has been conducted with respect to the convergence of the labor market, given its vital role in smoothing the impact of adverse economic shocks. For example, Saridakis et al. (2019) found a pattern of convergence for self-employment in several regions of Europe (Western, Southern, and Northern Europe) for data between 1990 and 2011. At the same time, the overall convergence was relatively weak.

Some work has been carried out on structural convergence within the United States. In Boussemart et al. (2020), the authors looked at 63 industries in the United States during the period 1987–2016. They analyzed technological catching-up and structural convergence by decomposing the efficiency gaps into two components: one related to technical efficiency and another that was a structural component. Their main results were that convergence was achieved in both senses.

Finally, this paper is somewhat related to the work on structural decomposition developed in the input-output analysis. This methodology looks to perform a decomposition using the input-output analysis. Dietzenbacher and Los (1998) discussed the most important approaches and how can they help choose the right decomposition from the multiple potential decompositions. As suggested by Rose and Casler (1996), structural economic decomposition can be understood best in the context of comparative statistics, where key parameters from the input-output tables are modified.

3. Modeling Framework

3.1. Testing for Convergence

To evaluate convergence, this study uses unit-root tests. The literature (see, for example, Johnson and Papageorgiou (2020)) indicates that we can use unit-root tests. These tests are based on the idea that the difference between the income per capita of a developed economy and an emerging economy tends to diminish in time such that the difference becomes stationary.

Following Johnson and Papageorgiou (2020), convergence can be formally hypothesized as follows:

$$\lim_{T\to\infty} E(y_{i,t+T} - y_{j,t+T} | F_t = 0) \tag{1}$$

Here, $y_{i,t}$ is the log of income per capita for an economy i at the time t, whereas F indicates the history of $y_{i,t}$ și $y_{j,t}$ up to moment t. Intuitively, the equation demonstrates that there is a diminishing gap between the income per capita in the two countries.

In the application part, the study uses several input-output measures to which the test in Equation (1) will be applied.

3.2. Characterizing Production Networks

This paper focuses on studying real convergence from the perspective of the structural properties of production networks. To achieve this, it uses several measures regarding the production network. The presentation follows several reference papers and books (see, for example, Miller and Blair (2009)).

One can start by considering a typical input-output table (a discussion of the data can be found in Section 4), which typically consists of a matrix with dimensions of $N \times N$, with N corresponding to the number of sectors in the economy. x_i is used to indicate the final product of a sector i, whereas f_i is the final demand. The following equation can be used to characterize the links between these variables:

$$x_i = z_{i1} + ... + z_i n + f_i = \sum_{j=1}^{N} z_{ij} + f_i \tag{2}$$

$z_{i,j}$ measures the inter-industry sales, that is, the sales from sector i to the other sectors j. This equation describes the distribution of production from sector i and can be further simplified as follows:

$$x = Zi + f \tag{3}$$

Here, x is the vector of production at the level of each sector, Z is a matrix, f represents a vector, and i is a column vector with ones. x can be further rewritten as a matrix with the elements of the vector x on the main diagonal. We can denote this matrix with $\hat{x}$. Then, we obtain:

$$A = Z\hat{x}^{-1} \tag{4}$$

At the same time, we know that $x\hat{x}^{-1} = I$. Then, we can write:

$$(I - A)x = f \tag{5}$$

From here, the Leontief matrix can be written as $L = (I - A)^{-1}$. The Leontief matrix establishes a relationship between the output x and the final demand. A similar approach was proposed by Ghosh (1958). In his approach, the perspective is shifted to the supply side. In this case, we can write:

$$x' = i'Z + v' \tag{6}$$

Here, v' is the total expenditure for each industry, and $Z = \hat{x}B$. However, while A is interpreted as having as entries the technical coefficients, B can be understood as having as entries the allocation coefficients. Since we have that $i'\hat{x} = x'$, it results in:

$$x' = i'x^{-1}Z + v' = x'B + v' \tag{7}$$

Using this result, we obtain:

$$x' = v'(I - B)^{-1} \tag{8}$$

Here, the matrix G, given by $G = (I - B)^{-1}$, can be interpreted as standing for the inverse of the output (while L is the inverse of the input). The elements of G are $g_{i,j}$, and they can be seen as standing for the total value of production, which corresponds to sector j for a unit of input from sector i. Having these two matrices, L and G, we can measure several relevant coefficients that can be used to characterize the production networks. There is much literature that discusses these measures (see initial papers such as Hirschman (1958) or Rasmussen (1956)).

We should talk about the backward linkage and the forward linkage. Let us consider a scenario in which the production in a sector j grows. This will determine growth in the demand for inputs that are necessary for sector j, with the effects being of backward linkage type and coming through the demand side. In contrast, if we analyze the effects of the growth in the production of sector j, we would see that there is an increased supply of goods from sector j in the production of other sectors. A first such indicator that can be used is the backward linkage RHB index (Rasmussen–Hirschman):

$$h_{b_j} = Ni'L/i'Li \tag{9}$$

This is stated in its normalized version. Similarly, we can construct the forward linkage Hirschman–Rasmussen index (RHF), given by:

$$h_{f_j} = Ni'G/i'Gi \tag{10}$$

We can interpret the RHB as being backward since it reveals the impact of a shock from the demand side. At the same time, the RHF is a forward type as it measures the impact of supply-side shocks.

This paper also uses the influence field from Sonis et al. (1995). Let us first see its derivation. To achieve this, we can compute the change in L when there is a change in one or several elements of it. We can formalize the change as follows:

$$F(i,j) = (Li_i)i_j'L = l_i l_j' \tag{11}$$

Here, l_i, and l_j' are the rows and columns of the matrix L. Then, we can compute the influence field at the column level given by:

$$f_{c_j} = N\frac{i'(\sum_{i\neq j} F(i,j))i}{i'\sum_{j=1}^{n}\sum_{i\neq j} F(i,j)i} \tag{12}$$

Here, the normalized value is used. Similarly, we can compute the field influence at the row level. In this case, we use the input-output approach from the supply-side perspective:

$$f_{r_j} = N\frac{i'\sum_{j\neq i} F(i,j)i}{i'\sum_{i=1}^{n}\sum_{j\neq i} F(i,j)i} \tag{13}$$

Another measure that is used is the total linkage measure from Cella (1984).

$$t_j = N\frac{i'x - i'x^j}{i'x} \tag{14}$$

Here, x is the production vector for each sector of an economy. This is determined by the so-called hypothetical extraction method. The method implies eliminating a sector. To achieve this, we use $i'x^j$ to eliminate sector j from the economy.

Finally, this paper also uses a measure either from Dietzenbacher et al. (2005) or Dietzenbacher and Romero (2007), known as the average propagation length. We use this measure to quantify the distance between industries. From an informal point of view, this measure (APL, hereafter) quantifies how many steps are necessary for a shock to propagate from one industry to other industries. First, we define the matrix H given by:

$$H = L(L-I) \tag{15}$$

Then, the APL can be defined as:

$$APL = \begin{cases} (h_i j)/(l_i j), i \neq j, \\ (h_i j)/(l_i j - 1), i = j \end{cases} \tag{16}$$

4. Data

Since the analysis focuses on the input-output analysis, this study uses input-output data for the new member states of the European Union. To be more precise, it uses the input-output tables from the RStan database at OECD, IOT 2021 edition (https://stats.oecd.org/Index.aspx?DataSetCode=IOTS, accessed on 1 January 2023).

The data frequency is annual and spans from 1995 to 2018. Besides the new member states below, it also includes data for Germany, taken as the reference country for the specification in Equation (1) (see Table 1 below).

Using the German economy as a reference country is quite a conventional assumption, given the size and the economic links between the German economy and the new member economies.

Table 1. Input-Output Dataset.

Country	Sample	Observations
Bulgaria	1995–2018	24
Czech Rep.	1995–2018	24
Croatia	1995–2018	24
Cyprus	1995–2018	24
Estonia	1995–2018	24
Hungary	1995–2018	24
Latvia	1995–2018	24
Lithuania	1995–2018	24
Malta	1995–2018	24
Poland	1995–2018	24
Romania	1995–2018	24
Slovakia	1995–2018	24
Slovenia	1995–2018	24

Source: https://stats.oecd.org/Index.aspx?DataSetCode=IOTS, accessed on 1 January 2023.

5. Results

This section discusses the main results of this paper. Specifically, it examines the results regarding the convergence of the structural properties of the production networks. It also discusses the results at both the country level and panel data level.

5.1. Testing for Convergence at the Country Level

We can start by first discussing the results of the unit-root tests at the individual level. The results can be seen in Appendix A, Tables A1–A13. The unit-root test used the specification in Equation (1), with the reference series given by the corresponding data for the German economy.

The results were somewhat mixed. For some countries, there was a general tendency to not be able to reject the null hypothesis of the presence of a unit root, thus implying the rejection of convergence, whereas for others, there was at least partial evidence of convergence. However, the literature considers that the panel unit-root tests have a larger statistical power and are thus preferable.

For some countries, the null hypothesis of no convergence was not rejected at all or almost at all (Croatia, Estonia, Latvia, Romania, or Slovakia). There were also a few cases, where, for almost all measures and at least for one unit-root test, there was evidence of convergence, namely for Bulgaria, Cyprus, Lithuania, and Slovenia. To clarify the results, the countries below are grouped according to the results in Table 2.

Table 2. Individual unit-root tests.

Country	Results
Bulgaria	Convergence for almost all measures for at least one test
Czech Rep.	Partial evidence
Croatia	No convergence
Cyprus	Convergence for almost all measures for at least one test
Estonia	No convergence
Hungary	Partial evidence
Latvia	No convergence
Lithuania	Convergence for almost all measures for at least one test
Malta	Partial evidence
Poland	Partial evidence
Romania	No convergence
Slovakia	No convergence
Slovenia	Convergence for almost all measures for at least one test

5.2. Testing for Convergence at Panel Data Level

This section examines the results based on the panel data. The empirical work has again considered the difference between the values of the input-output measures at the level of a new member state and the corresponding one for Germany. The results are shown in Table 3 below.

In contrast with the results for the individual tests, there is strong evidence for each type of input-output measure that the null of the unit root should be rejected. There are only a few cases where the unit root null hypothesis cannot be rejected for the Breitung unit-root test, but only for some of the measures that are considered.

Table 3. Panel data unit-root tests.

Variables	Levin–Lin–Chu	Harris–Tzavalis	Im–Pesaran–Shin	Breitung	Fisher
RHB	−7.3927 ***	−3.4435 ***	−3.2370 ***	0.1643	74.9486 ***
RHF	−3.2239 ***	−8.0102 ***	−1.7536 **	−0.5327	41.2521***
F_c	−7.6201 ***	−3.7167 **	−3.3754 ***	0.0642	80.7751 ***
F_r	−3.2070 ***	−12.3619 ***	−1.8906 **	−0.5216 **	44.0080 ***
T_av	−4.7655 ***	−7.2195 ***	−4.0645 ***	−1.6789 **	74.9944 ***
APL	−7.9745 ***	−1.5491 *	−1.3341 *	−0.197	31.0948 *

Note: * denotes statistical significance of the F-test at 0.10 level; ** statistical significance at 0.05 level and *** at 0.01 level.

6. Discussion of Results

The results indicate that there is convergence with respect to the structural properties of production networks. The unit-root tests especially confirm this for the panel-level data. This paper already mentioned that although the individual unit-root tests indicate rather mixed results (for only a few countries there is no evidence of structural convergence at the individual level), the literature instead supports the results at the panel level, as they have more statistical power (see Johnson and Papageorgiou (2020)).

In general, the studies on the convergence problem of the new member states of the EU relative to the Euro Area focused on nominal or real convergence analysis (inflation, interest rates, or, for real convergence, the real GDP per capita). However, there are several reasons why convergence in terms of structural properties of production networks is important.

First, for a monetary union to be resilient to strong adverse shocks, it is necessary to have an economic union that is more than a simple monetary union. The criticism by Milton Friedman is well known, as he suggested that the Euro Area is not as strong a monetary union as that of the Union States (comprised of its states) and that it will fail in the face of the first strong adverse shocks. The sovereign debt crisis has revealed the weaknesses of the Euro Area. The work by Imbs (2000) indicated that structural convergence helps with the synchronization of business cycles, whereas Wacziarg (2000) showed that structural convergence leads to real convergence.

The fact that there is convergence with respect to the structure of network production implies that the economic shocks would be similarly felt. Although this is not a sufficient condition for the functioning of the Euro Area, nevertheless, it indicates an increased capacity of resilience in the face of adverse shocks.

Second, the study of convergence in terms of the properties of the production network structure also helps understand the production chains in each economy. The severe recession induced by the COVID-19 epidemic underlined the importance of the resilience of (global) production chains.

There are several implications of these results, including some at the policy level. First, this study argues that structural convergence should be studied along with real and nominal convergence. This is not the first paper to address structural convergence and argue that this is important. As nominal (and real) convergence is gradually achieved, the focus moves toward greater integration, which can be studied from an institutional point of view or by looking at the structure of production. While Euro Area admission criteria use only nominal criteria, the structural assessment of convergence can be used when designing policy measures against future crises.

Second, structural convergence should be assessed at the group level using panel data since individual unit-root tests have weaker power against panel tests. The results here highlight the fact that individual-level assessment leads to mixed results, although in some cases, there is at least partial evidence of structural convergence.

Third, in contrast to the typical method used to assess structural convergence in the literature, this paper proposes a new approach based on input-output measures. A few papers addressed structural convergence (see Wacziarg (2000) or Bobeva (2021)); however, the focus was on sectoral shares. The results here are also novel since this is the first paper to look at the convergence of input-output measures.

Fourth, at the policy level, the work here suggests, as does recent related research, that as nominal and real convergence are gradually achieved, there should be more emphasis on following the degree of structural convergence. This can provide policymakers with a measure of how dispersed the Euro Area/European Union is and how potential adverse shocks could amplify effects because of this.

7. Conclusions

This paper aimed to study the real convergence of the new member states relative to the economy of Germany (taken as a reference economy for the European Union and the Euro Area being the largest economy and having strong economic ties with each of the economies of the new member states).

The analysis comprised two steps. First, using the input-output tables for each of the new member economies, as well as Germany, between 1995 and 2018, it computed several specific coefficients. Second, it tested whether there was convergence in terms of the values of these coefficients relative to the value of these coefficients for the case of Germany. This paper also tested for the unit root at both the individual and panel data levels. While the individual test results were somewhat mixed, in the case of the panel data, the results indicated robust evidence in favor of convergence.

There are some limitations to this study. First, the number of observations was reduced since the analysis was conducted with annual data. However, this limitation was addressed by considering panel unit-root tests.

Second, there is a need for more data from the beginning of the 1990s. This would help reveal the potential structural differences at the beginning of the transition period.

Lastly, the results here highlight the potential of using input-output measures to assess structural convergence. Future research could delve into how particular measures indicate important structural similarities between different economies and explore the implications for convergence.

There are also implications for policymaking: given the increased awareness regarding the perils of future crises, work should be carried out to provide an indicator of the degree of structural convergence. This indicator could be used as a variable to measure the overall resilience of the European Union or Euro Area to adverse shocks. Further work could also be undertaken to understand how adverse shocks might propagate in monetary unions with different degrees of structural convergence.

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Data Availability Statement: https://stats.oecd.org/Index.aspx?DataSetCode=IOTS (accessed on 1 January 2023).

Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations

The following abbreviations are used in this manuscript:

GDP	Gross Domestic Product
OECD	The Organization of Economic Cooperation and Development
STAN	Structural Analysis (Database)
IO	Input-Output
AR	Auto-regressive

Appendix A. Testing for Unit Root at Country Level

Table A1. Case of Bulgaria.

Variables	ADF	Phillips-Perron	GLS–ADF
RHB	−2.777	−2.737 *	−4.858 ***
RHF	−1.800	−1.645	−2.402
F_c	−2.884 *	−2.859 *	−4.945 ***
F_r	−1.779	−1.628	−2.375
T_av	−2.128	−1.926	−3.807 ***
APL	−1.149	−0.782	−4.048 ***

Source: Own computations. *** indicates statistical significance at 1%, and * statistical significance at 10%.

Table A2. Case of Croatia.

Variables	ADF	Phillips-Perron	GLS–ADF
RHB	−2.511	−2.496	−1.794
RHF	−2.549	−2.525	−1.833
F_c	−2.522	−2.515	−1.827
F_r	−2.563	−2.545	−1.856
T_av	−3.052 **	−3.082 **	−2.773
APL	−2.466	−2.426	−2.297

Source: Own computations. ** indicates statistical significance at 5%.

Table A3. Case of Cyprus.

Variables	ADF	Phillips-Perron	GLS–ADF
RHB	−1.771	−1.522	−4.417 ***
RHF	−1.927	−1.893	−2.855
F_c	−1.744	−1.488	−4.541 ***
F_r	−1.948	−1.916	−2.876
T_av	−2.973 **	−2.935 **	−2.924
APL	−2.649 *	−2.628 *	−2.297

Source: Own computations. *** indicates statistical significance at 1%, ** statistical significance at 5%, and * statistical significance at 10%.

Table A4. Case of Czech Republic.

Variables	ADF	Phillips-Perron	GLS–ADF
RHB	−2.024	−1.929	−3.631 **
RHF	−3.265	−3.314 **	−3.193 *
F_c	−2.072	−1.971	−3.702
F_r	−3.191 **	−3.251 **	−3.140 **
T_av	−1.620	−1.521	−3.525 **
APL	−1.313	−1.298	−2.494

Source: Own computations. ** indicates statistical significance at 5%, and * statistical significance at 10%.

Table A5. Case of Estonia.

Variables	ADF	Phillips-Perron	GLS–ADF
RHB	−2.040	−2.124	−2.088
RHF	−1.027	−1.009	−2.069
F_c	−2.022	−2.120	−2.086
F_r	−1.036	−1.014	−2.097
T_av	−2.997 **	−3.018 **	−3.371 *
APL	−1.694	−1.781	−2.115

Source: Own computations. ** statistical significance at 5%, and * statistical significance at 10%.

Table A6. Case of Hungary.

Variables	ADF	Phillips-Perron	GLS–ADF
RHB	−3.684 ***	−4.609 ***	−1.770
RHF	−1.471	−1.470	−2.334
F_c	−3.960 ***	−4.797 ***	−1.701
F_r	−1.537	−1.532	−2.380
T_av	−2.684 *	−2.790 *	−3.893 ***
APL	−1.845	−1.890	−2.356

Source: Own computations. *** indicates statistical significance at 1%, and * statistical significance at 10%.

Table A7. Case of Latvia.

Variables	ADF	Phillips-Perron	GLS–ADF
RHB	−2.446	−2.354	−2.738
RHF	−2.709 *	−2.746 *	−2.983
F_c	−2.516	−2.422	−2.841
F_r	−2.717 *	−2.754 *	−2.989
T_av	−2.377	−2.326	−2.371
APL	−1.858	−1.869	−1.945

Source: Own computations. * indicates statistical significance at 10%.

Table A8. Case of Lithuania.

Variables	ADF	Phillips-Perron	GLS–ADF
RHB	−4.495 ***	−5.711 ***	−3.219 *
RHF	−3.143 **	−3.128 **	−2.943
F_c	−4.586 ***	−6.046 ***	−3.105
F_r	−3.125 **	−3.108 **	−2.911
T_av	−4.426 ***	−4.623 ***	−4.392 ***
APL	−2.917 **	−2.970 **	−2.603

Source: Own computations. *** indicates statistical significance at 1%, ** statistical significance at 5%, and * statistical significance at 10%.

Table A9. Case of Malta.

Variables	ADF	Phillips−Perron	GLS–ADF
RHB	−1.533	−1.705	−1.554
RHF	−2.406	−2.347	−3.626 **
F_c	−1.524	−1.706	−1.524
F_r	−2.953 **	−2.962 **	−4.109 ***
T_av	−4.064 ***	−4.088 ***	−5.938 ***
APL	−1.433	−1.440	−1.910

Source: Own computations. *** indicates statistical significance at 1%, ** statistical significance at 5%.

Table A10. Case of Poland.

Variables	ADF	Phillips-Perron	GLS–ADF
RHB	−2.634 *	−2.898 **	−2.484
RHF	−1.467	−1.254	−3.745 **
F_c	−2.724 *	−3.004 **	−2.421
F_r	−1.536	−1.349	−3.754 **
T_av	−2.349	−2.370	−2.438
APL	−1.619	−1.622	−2.256

Source: Own computations. ** indicates statistical significance at 5%, and * statistical significance at 10%.

Table A11. Case of Romania.

Variables	ADF	Phillips-Perron	GLS–ADF
RHB	−1.620	−1.569	−2.159
RHF	−0.625	−0.587	−1.729
F_c	−1.665	−1.593	−2.177
F_r	−0.524	−0.477	−1.680
T_av	−1.879	−1.889	−2.022
APL	−2.042	−2.202	−2.111

Table A12. Case of Slovakia.

Variables	ADF	Phillips-Perron	GLS–ADF
RHB	−1.188	−1.329	−0.802
RHF	−0.751	−0.966	−1.866
F_c	−1.204	−1.335	−0.864
F_r	−0.754	−0.965	−1.913
T_av	−1.464	−1.456	−1.595
APL	−0.986	−1.019	−1.307

Table A13. Case of Slovenia.

Variables	ADF	Phillips-Perron	GLS–ADF
RHB	−2.629 *	−2.957 **	−1.666
RHF	−2.594 *	−2.530	−2.691
F_c	−2.623 *	−2.902 **	−1.593
F_r	−2.640 **	−2.578 *	−2.752
T_av	−2.613 *	−2.490	−3.642 **
APL	−1.722	−1.728	−2.152

Source: Own computations. ** indicates statistical significance at 5%, and * statistical significance at 10%.

Appendix B. The Sectors in the Input-Output Data

The Selection of Industries		
Industry Code	**ISIC 4 Corresponding Division**	**Description**
D01T02	01, 02	Agriculture, hunting, and forestry
D03	3	Fishing and aquaculture
D05T06	05, 06	Mining and quarrying, energy-producing products
D07T08	07, 08	Mining and quarrying, non-energy-producing products
D09	9	Mining support service activities
D10T12	10, 11, 12	Food products, beverages, and tobacco
D13T15	13, 14, 15	Textiles, textile products, leather, and footwear
D16	16	Wood and products of wood and cork
D17T18	17, 18	Paper products and printing
D19	19	Coke and refined petroleum products
D20	20	Chemical and chemical products
D21	21	Pharmaceuticals, medicinal, chemical, and botanical products
D22	22	Rubber and plastic products
D23	23	Other non-metallic mineral products
D24	24	Basic metals
D25	25	Fabricated metal products
D26	26	Computer, electronic, and optical equipment
D27	27	Electrical equipment
D28	28	Machinery and equipment, nec
D29	29	Motor vehicles, trailers and semi-trailers
D30	30	Other transport equipment
D31T33	31, 32, 33	Manufacturing; repair and installation of machinery and equipment
D35	35	Electricity, gas, steam, and air-conditioning supply
D36T39	36, 37, 38, 39	Water supply; sewerage, waste management, and remediation activities
D41T43	41, 42, 43	Construction
D45T47	45, 46, 47	Wholesale and retail trade; repair of motor vehicles
D49	49	Land transport and transport via pipelines
D50	50	Water transport
D51	51	Air transport
D52	52	Warehousing and support activities for transportation
D53	53	Postal and courier activities
D55T56	55, 56	Accommodation and food service activities
D58T60	58, 59, 60	Publishing, audiovisual, and broadcasting activities
D61	61	Telecommunications
D62T63	62, 63	IT and other information services
D64T66	64, 65, 66	Financial and insurance activities
D68	68	Real estate activities
D69T75	69 to 75	Professional, scientific, and technical activities

The Selection of Industries		
Industry Code	**ISIC 4 Corresponding Division**	**Description**
D77T82	77 to 82	Administrative and support services
D84	84	Public administration and defense; compulsory social security
D85	85	Education
D86T88	86, 87, 88	Human health and social work activities
D90T93	90, 91, 92, 93	Arts, entertainment, and recreation
D94T96	94,95, 96	Other service activities

Note

[1] Nominal convergence refers to the convergence of variables like inflation or interest rates, whereas real convergence refers to real GDP (per capita) convergence.

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