




DUAL-MODEL APPROACH TO MEASURING CONVERGENCE SUSTAINABILITY IN THE VISEGRAD GROUP*

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Abstract

Economic convergence has become a European research topic of interest during recent decades, particularly since new member countries joined the EU in 2004. Measuring cross-country convergence focuses on real convergence, taking per capita income as a measure of living standards based on the convergence criteria defined by Sala-i-Martin (1996). The objective of this paper is to bring together supply-side (real convergence) and demand-side (BoP-constrained approach) concepts of economic growth aimed at identification of convergence sources in the emerging economies of the Visegrad Group. The sustainability of convergence in this study utilizes the BoP-constrained growth theory developed by A. Thirlwall (1979). Our results show that all the countries in the Visegrad Group exhibit relatively instant convergence, which could continue considering the intensity and direction of structural changes that affect the export demand elasticities and labour productivity.

Key words: Real convergence, Thirlwall's law, convergence sustainability, Visegrad Group

JEL Classification: E12; E13; F43; O47

Introduction

In recent years, the focus on regional growth and convergence has increased enormously, with particular interest in whether poor regions are catching up with the rich ones, which plays an important role in regional policy. For instance, there exist significant regional disparities among EU member states. In 2018, regional GDP per capita in terms of purchasing power standards ranged from 30% of the European Union (EU) average

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in Mayotte, an overseas region of France, to 263% in Luxembourg (Eurostat, 2020).¹ Therefore, enhancing social, economic and territorial cohesion by reducing these disparities has become one of the main objectives, especially since the new member countries joined the EU in 2004.

In modern growth theory, the focus is on the convergence of developed and less developed countries. Nevertheless, many empirical studies differ in the applied convergence concepts as well as the methodology of convergence measurement. The hypothesis of income-level convergence has become the main standpoint of neoclassical growth theory. Particularly, the role of production factors in long-term economic development has been analysed. In this context, it must be stressed that the neoclassical approach to regional convergence is supply-side oriented and domestic demand plays no role here. On the other hand, the Balance-of-Payments (BoP) constrained access has been used to understand the determinants of sustainable convergence. Such a demand-side-oriented approach links differences in economic growth with differences in the ratio between the income elasticity of the demand for exports and imports. The evolution of income elasticities has been significantly affected by structural changes in the economies in question.

Chaudhury (2010) presents the first attempt to combine supply-side and demand-side concepts of economic growth aimed at explaining regional convergence for two regions (countries of Southeast Asia and countries of Central and Eastern Europe), applying the classical convergence methods in the period 1992–2007. Furthermore, the methods used are complemented by a model that seeks to capture changes in trade elasticities and describe the convergence sustainability in the region (Chaudhury, 2010).

Along this perspective, the paper empirically surveys whether these two approaches to regional convergence – real convergence or BoP-constrained approach – can explain the economic development in the countries of the Visegrad Group over the period 1996–2019. The paper is divided into three sections with an introduction and conclusion. The second section introduces the above-mentioned approaches to measuring regional convergence, the third one presents the data and methodology, and the last part reveals the empirical findings in real convergence and its sustainability. Finally, the conclusions are presented.

1. Regional Convergence and its Measurement

The concept of convergence involves many dimensions. Most recent empirical studies dealing with long-run economic development focus primarily on real convergence which

1 This information is based on data released by Eurostat, the Statistical Office of the EU (Eurostat, 2020). In the case of Luxembourg, this is largely a statistical effect (exclusion of non-residents from the denominator).

measures living standards and labour productivity and some challenges for convergence, such as the effects of the COVID-19 pandemic, globalisation, digitalisation, regional disparities, etc.

According to the latest OECD working paper, Pina and Sicari (2021) argue that the progress in EU regional convergence has been uneven over the last two decades. While Central and Eastern Europe has been catching up, Southern Europe has often lost ground, primarily in the period after the global financial crisis. Moreover, in most countries, gaps between large cities and rural areas have widened. Some challenges for convergence have stemmed from global as well as specific European factors, such as globalisation, digitalisation, global warming, the COVID-19 pandemic, incomplete financial integration and insufficiently effective fiscal governance and innovation performance. This study also proposes policy action to reduce regional divergence by helping regions improve their productive specialisation. Building on new approaches to regional and industrial policies, Europe needs to utilize the full potential of cross-country cooperation in innovation and of urban agglomeration economies. In addition, the two largest EU budget instruments, the Cohesion Policy and the Common Agricultural Policy, need to become more effective at promoting productive upgrading (Pina and Sicari, 2021).

Recently, the ECB's research study (2017) has made a significant contribution to real convergence. In the euro area, there is mixed evidence that GDP per capita of lower-income economies has been catching up with that of higher-income economies since the introduction of the monetary union. The significant real convergence performance of some most recent members contrasts with that of the economies of southern Europe, which have not met expectations. However, putting all the blame for this outcome on the introduction of the single currency simply misses the point (Diaz del Hoyo *et al.*, 2017). In addition, an increasing gap in institutional quality between the core and the periphery countries has been revealed. The divergence in institutional quality across the euro area countries constitutes a risk for the smooth functioning of the Economic and Monetary Union increasing the vulnerability of the euro to negative economic shocks (Pérez-Moreno *et al.*, 2020). The above-mentioned authors consider it critical that the euro area countries facing convergence challenges enhance the resilience of their economic structures by improving the relevant institutions and governance (Diaz del Hoyo *et al.*, 2017).

Žuk and Savelin (2018) take a closer look at real convergence in central, eastern and Southeastern Europe to the most advanced EU economies between 2000 and 2016. The empirical findings show that the most successful emerging economies in terms of the pace of convergence share common characteristics, such as strong improvement in institutional quality and human capital, more outward-oriented economic policies, positive demographic developments, and the quick re-allocation of labour from agriculture

into the other sectors. Looking ahead, accelerating and sustaining convergence in that region will require further efforts to enhance institutional quality and innovation, reinvigorate investment and address the adverse impact of population ageing (Žuk and Savelin, 2018).

Real convergence can be defined as “a long-term process that brings about a lasting increase in real GDP per capita in lower-income countries towards the levels shown by higher-income countries” (ECB, 2017). Real convergence covers the process of less developed countries catching up with economically more developed ones. Factors that are significant for the growth rate and the ways in which the real convergence can be accelerated have often been addressed. In principle, there are two approaches to expressing regional convergence: supply-side and demand-side.

1.1 Supply-side approach: Traditional convergence theories

Regional convergence is measured using the theoretical framework for real convergence presented by neoclassical growth theory. Neoclassical theory proposes that a country’s economic growth results from varying amounts of labour, capital and technology involved in production. In addition, the Solow model of economic growth (Solow, 1956) can be utilized in empirical analyses of β -convergence and σ -convergence first introduced by Barro and Sala-i-Martin (1991). Diminishing returns imply that poor countries’ growth rates should be higher and their incomes should catch up with rich countries. The growth leads economies to a long-term equilibrium. This convergence hypothesis has been explored in numerous empirical studies on economic growth. Many studies conclude that the speed of β -convergence is surprisingly similar and the rule “economies converge at a speed of two percent per year” (Sala-i-Martin, 1996) is applicable here.

In the economic literature two elementary forms of β -convergence are distinguished: unconditional and conditional β -convergence. **Unconditional β -convergence** (also called absolute convergence) stems from standard Solow growth theory based on diminishing returns on capital properties (Solow, 1956). As mentioned above, the steady level of GDP per capita towards which economies head is the same for all countries. In their study, Soukiazis and Castro (2005) argue that the initial level of GDP per capita is the only factor affecting real convergence process in long term development.

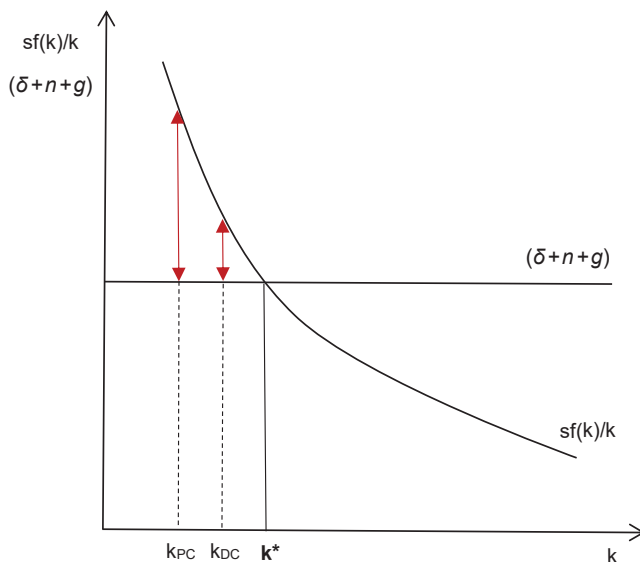
Absolute convergence can be estimated based on the equation below:

$$\ln(y_{i,t} / y_{i,t-1}) = \beta_0 + \beta_1 \ln(y_{i,t-1}) + u_{i,t} \quad (1)$$

where $y_{i,t}$ stands for real GDP per capita for the economy i at the time t ; β_0 is the steady-state constant; and β_1 means the convergence coefficient, which is expected to be negative in order to show convergence. According to the neo-classicists, unconditional convergence

occurs when the beta parameter identifies a negative relationship between the growth of per capita incomes over a given period and the previous level of income per capita.

Figure 1: Absolute convergence



Notes: k_{PC} – capital per worker in a poor country, k_{DC} – capital per worker in a developed country, k^* – steady-state level of capital per worker, $sf(k)$ – investment per worker as a function of the capital stock per worker, n – population growth, δ – depreciation rate, g – rate of labour-augmenting technological progress.

Source: Own elaboration based on Barro and Sala-i-Martin (1995)

Figure 1 depicts absolute convergence. We assume that a negative sign of the β coefficient could reveal faster economic growth in developing countries. This represents the concept of unconditional convergence, where all countries are expected to converge to the same steady-state level of capital and output per worker (k^*) (Sala-i-Martin, 1994). Convergence to the same steady-state level means that there are no differences between countries in their levels of technology, saving and investment rates and other factors.

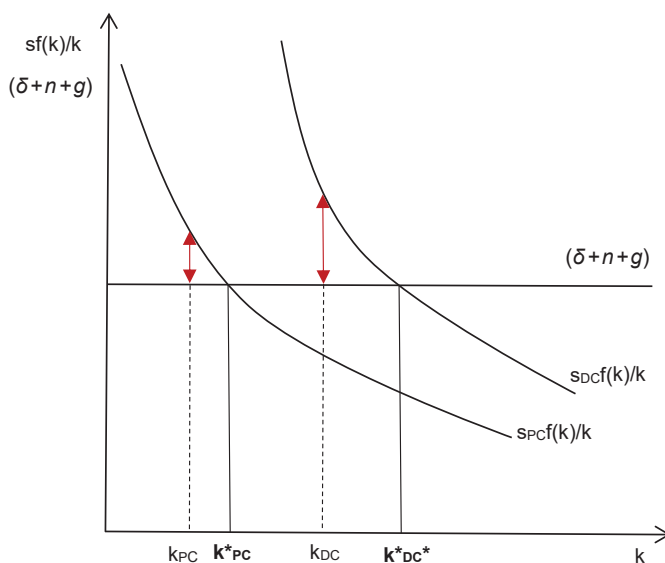
Many economists consider the assumption of absolute convergence unrealistic as there exist other relevant factors, such as economic policies, institutional factors, etc. **Conditional β -convergence**, based on the endogenous theory of economic growth, takes all these arguments into account. The conditional convergence concept implies that countries converge to several steady-state points because they exhibit differences in human capital, technology level, saving and investment rates and other structural variables (Barro and Sala-i-Martin, 1991).

Conditional β -convergence can be estimated using the following equation:

$$\ln(y_{i,t} / y_{i,t-1}) = \beta_0 + \beta_1 \ln(y_{i,t-1}) + \beta_2 \ln(gfcf_{i,t}) + \beta_3 \ln(pop_{i,t}) + \beta_4 \ln(open_{i,t}) + \beta_5 \ln(lp_{i,t}) + \beta_6 \ln(ulc_{i,t}) + u_{i,t} \quad (2)$$

where $y_{i,t}$ stands for real GDP per capita for the economy i at the time t , $gfcf$ is gross fixed capital formation, pop is total population, $open$ is trade openness, lp is labour productivity per person, ulc is unit labour cost, and β_1 is the convergence coefficient.

Figure 2: Conditional convergence



Notes: k_{PC} – capital per worker in a poor country, k_{DC} – capital per worker in a developed country, k_{PC}^* – steady-state level in a poor country, k_{DC}^* – steady-state level in a developed country, $sf(k)$ – investment per worker as a function of the capital stock per worker, n – population growth, δ – depreciation rate, g – rate of labour-augmenting technological progress.

Source: Own elaboration based on Barro and Sala-i-Martin (1995)

Figure 2 shows conditional convergence, where poor countries and developed countries converge to different steady-state points. Traditionally, conditional convergence is perceived to occur when a country's capital stock and total output are lower than their steady-state levels. It must be stressed that structural factors, such as population growth, human capital, saving and investment rates, innovative activities, public expenditure and

trade, significantly influence the speed of convergence. Conditional convergence allows us not only to better indicate whether countries are becoming more similar (convergence clubs), but also to explain why it is so.

1.2 Demand-side approach: Balance-of-payments constrained growth model

The neoclassical growth theory considers differences between countries to be the result of differences in technological levels, production factors and productivity; however, it does not provide any explanation why the disparities occur. For this reason, regional convergence needs to be seen from the perspective of an open economy; then, the BoP-constrained growth theory (also known as Thirlwall's law) should be used to identify the factors of long-term sustainable development. Thirlwall therefore assumes that the economic growth rate of an open economy can be determined by the ratio of the income elasticities of the demand for imports and exports and the growth of external demand (Thirlwall, 1979).

Thus, Thirlwall's model of measuring convergence with a demand-side approach should be explained briefly. Its dynamic version is expressed by the following equations. The current account function can be written as:

$$p_{f,t} + e_t + m_t = p_{d,t} + x_t \quad (3)$$

Then, export and import demand functions can be expressed as:

$$x_t = \eta \left(p_{d,t} - p_{(f,t)} e_t \right) + \varepsilon < z_t >, \quad \eta < 0; \varepsilon > \quad (4)$$

$$m_t = \psi \left(p_{(f,t)} e_t - p_{d,t} \right) + \pi (y_t), \quad \psi < 0; \pi > \quad (5)$$

where η , ψ represent trade elasticities of demand for exports and imports, p_d , p_f are relative prices of exports and imports, e is exchange rate, x , m is export and import growth, y , z is the growth of domestic income and foreign income, ε and π are income elasticities of demand for exports and imports.

By combining equations (4) and (5) with equation (3), a formula for the rate of economic growth in accordance with BoP equilibrium is obtained:

$$y_{BP,t} = \frac{(p_{d,t} - p_{f,t} - e_t)(1 + \eta + \psi) + \varepsilon(z_t)}{\pi} \quad (6)$$

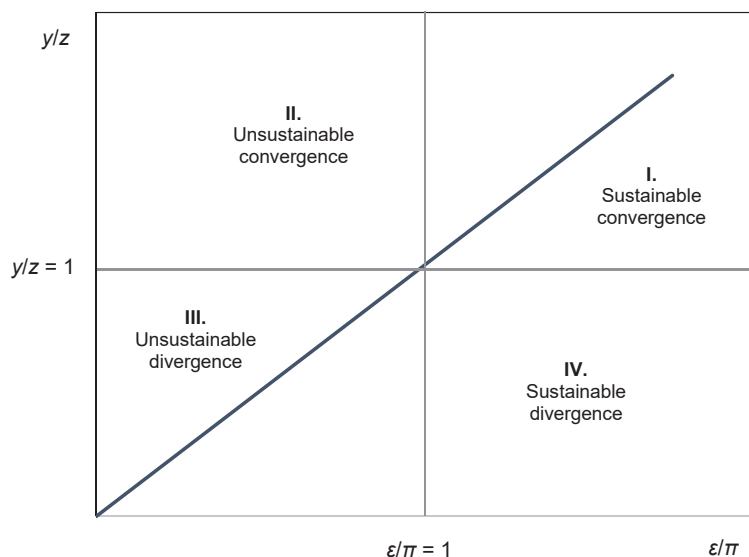
Based on model assumptions, relative prices are constant in the long-term perspective. The above equation is adjusted as follows:

$$y_{BP,t}^* = \frac{\varepsilon(z_t)}{\pi} \quad (7)$$

Equation (7) describes the calculation of *the BoP equilibrium growth rate* of the economy. It is evident that the level of external income (z) and the ratio of export to import income elasticity (ε/π) play a significant role in the economic development of an open economy. The ε/π ratio expresses the country's non-price competitiveness (Thirlwall, 2011).

Given the clarified Thirlwall model, it is possible to estimate the sustainability of convergence. External imbalances can be an obstacle to future economic development due to the pressure imposed on the country's aggregate demand when trade deficits become unsustainable (Soukiazis and Cerqueira, 2012). In international trade, it is crucial for a small open economy that the income elasticity of the demand for exports exceeds that of the demand for imports.

Figure 3: Four quadrants of the convergence diagram



Notes: y – growth of domestic income, z – growth of real foreign income, ε – income elasticity of the demand for exports, π – income elasticity of the demand for imports.

Source: Cimoli *et al.* (2010)

Figure 3 depicts the four quadrants of the convergence; the ratio of the country output rate (y) to the world output rate (z) is plotted on the vertical axis and the ratio of income elasticity of the demand for exports (ε) to income elasticity of the demand for imports (π)

is plotted on the horizontal axis. Cimoli *et al.* (2010) identify four potential types of regional convergence:

- *I. Sustainable convergence*
This case of convergence occurs when the rate of growth (y/z) is higher than one and lower than the elasticity ratio (ε/π). The current account shows a surplus.
- *II. Unsustainable convergence*
This type of convergence occurs when the ratio of growth (y/z) is higher than one and the elasticity ratio is lower. Regional convergence arises at the cost of increasing external debt.
- *III. Unsustainable divergence*
This is the case where the elasticity ratio (ε/π) is lower than the rate of growth (y/z) and the current account shows an external deficit. It is the worst scenario for a country that wants to achieve sustainable economic development.
- *IV. Sustainable divergence*
This type of divergence appears when a small open economy grows less than its trade partners. The current account shows a surplus or equilibrium (Cimoli *et al.*, 2010).

2. Data and Methodology

As suggested above, this paper contributes to the previous research using the two approaches to measure regional convergence by directly comparing them. Our empirical study examines four emerging economies of the Visegrad Group, namely the Czech Republic, Hungary, Poland and Slovakia. Annual data are available for each country and cover the period 1996–2019. The analysis is based on panel data transformed, in many cases, into six-year intervals. The applied data divided into subperiods allow us to examine the development of convergence processes more accurately. The authors consider the time span to be long enough to accommodate the theoretical conclusions on the model use. The annual macroeconomic database of the European Commission's Directorate General for Economic and Financial Affairs (AMECO) constitutes the main data source. Additional data were obtained from Eurostat, OECD and the World Bank.

In this study, we examine convergence in terms of real GDP per capita growth for the period in question by applying the classical approach to convergence. As explained above, β -convergence refers to a process in which developing countries grow faster than developed countries and therefore catch up with them. In this paper, particularly the concepts of conditional β -convergence and unconditional β -convergence are discussed. We expect that the ongoing growth process should lead countries to a long-term

steady-state. The basic specification of the convergence equation in per capita income is in line with the standard neo-classical model. Subsequently, the convergence equation is modified by economy-specific factors that clarify differences in steady-state points. For this reason, our analysis includes selected structural variables, such as gross fixed capital formation, total population, trade openness, labour productivity and unit labour cost.

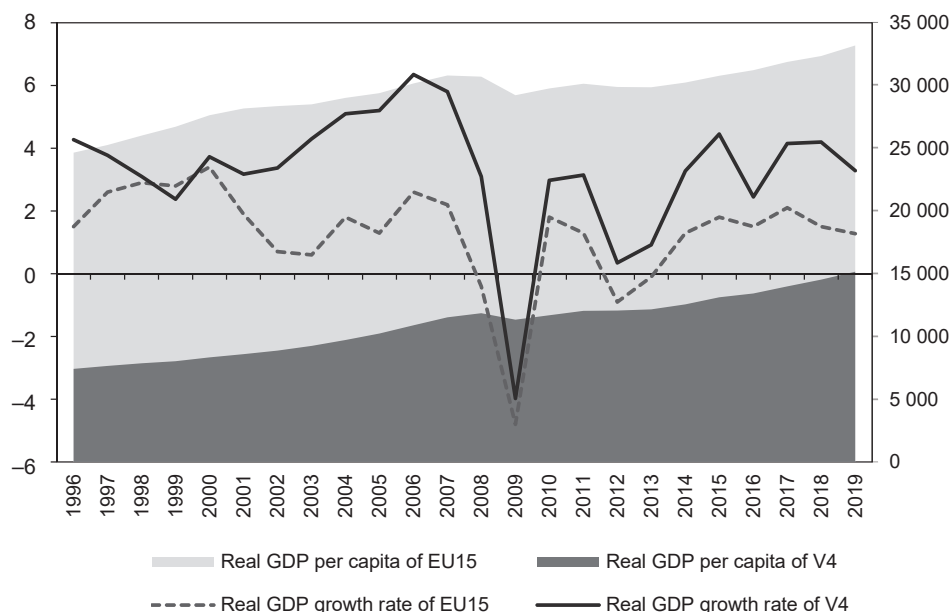
The sustainability of convergence is studied based on the concept of the BoP-constrained growth theory formulated by Thirlwall (1979). Thirlwall proposed that no economy can grow faster than at a rate consistent with the BoP equilibrium rate determined by the ratio of the growth in real exports and the income elasticity of the demand for imports (Thirlwall, 1979). For this purpose, it is necessary to apply demand equations using panel data. The export demand functions are usually estimated using ordinary least squares (OLS). On the other hand, the import demand functions are estimated using two-stage least squares (2SLS) because, in these equations, domestic income cannot be considered an exogenous variable. Finally, the Convergence Quadrants Diagram can be used to identify four potential scenarios for convergence of the Visegrad Group.

3. Convergence Perspective for Central Europe

Our analysis starts with considering the economic development to identify disparities between the emerging countries of the Visegrad Group and the EU15 countries as a whole. We focus mainly on the relation between the growth performances of these two regions and their comparison to the BoP equilibrium growth rate. The question is whether the Visegrad Group tends to converge with the founding EU countries during the reference period.

Figure 4 depicts the average real GDP per capita for two regions: EU15 and the Visegrad Group in the period 1996–2019. The EU15 region consists of 15 founding countries and is compared to the region of four new member countries that joined the EU in 2004. It is obvious and an expected result that the Central European economies grew at a higher level than EU15. Specifically, the average real GDP per capita of the Visegrad Group accounted for 3.29%, which is two and a half times higher than the growth rate of EU15 (1.28% on average). The catching-up effect was present since these countries began from a much lower GDP per capita compared to the developed economies of the EU. In 2019, the level of GDP per capita was €33,191 in EU15 and €15,160 in the Visegrad Group. This appears to be the evidence of income convergence with the founding countries of the EU.

Figure 4: Real GDP per capita of EU15 countries and the Visegrad Group, 1996–2019



Source: Own elaboration based on Eurostat

However, the interpretation of these results may not be accurate. In this study, we measure income convergence using the classical convergence methods of conditional and unconditional β -convergence for the period 1996–2019. After having identified the existence of income convergence, we will focus on the sustainability of convergence.

3.1 Empirical evidence of real income convergence

Measuring the cross-country convergence concentrates on income convergence related to living standards applying the convergence criteria specified by Sala-i-Martin (1996). The first regression focuses on estimating absolute convergence (per capita income level measured in logs) to test whether developing countries (represented by the four Visegrad countries) grow faster than the developed EU countries. It must be stressed that the first calculation does not include conditioning variables, whereas the next one includes them. Thus, it is crucial to distinguish between absolute and conditional β -convergence. Absolute convergence of the region is estimated using the common equation (1) covering the main convergence factor, as explained above, frequently presented in scientific publications.

Table 1: Absolute and conditional β -convergence, real GDP per capita (Visegrad Group)

	OLS pooling (absolute convergence)		OLS pooling (conditional convergence)
constant	1.491*** (15.71)	1.676*** (86.07)	1.659*** (39.79)
$\ln(y_{i,t-1})$	-0.053*** (-5.159)	–	–
$\ln(y_{i,t-1})^*$	–	-0.071*** (-35.02)	-0.095*** (-47.42)
$\ln(gfcf_{i,t})$	–	–	0.040*** (12.06)
$\ln(pop_{i,t})$	–	–	-0.046*** (-18.28)
$\ln(lp_{i,t})$	–	–	0.102*** (12.96)
$\ln(open_{i,t})$	–	–	-0.012 (-1.67)
$\ln(ulc_{i,t})$	–	–	0.030*** (6.86)
N. of observations	88	92	88
R^2	0.236	0.343	0.427
Adjusted R^2	0.228	0.336	0.416
D-W test	1.849	1.794	1.876
F (3, 83)	0.005 [0.999]	0.009 [0.998]	0.301 [0.824]

Notes: OLS - Ordinary Least Squares method, $y_{i,t-1}$ – Real GDP per capita growth rate at time $t - 1$, $y_{i,t-1}^*$ – Real GDP per capita growth rate in Purchasing Power Standards at time $t - 1$, $gfcf_{i,t}$ – Gross fixed capital formation (Current prices) at time t , $pop_{i,t}$ – Total population at time t , $lp_{i,t}$ – Real labour productivity per person (Index, 2010 = 100) at time t , $open_{i,t}$ – Trade openness (Percentage of GDP) at time t , $ulc_{i,t}$ – Nominal unit labour cost on persons (Index, 2010 = 100) at time t , D-W test – Durbin-Watson test used to detect autocorrelation, R^2 – Coefficient of Determination. Significant at: *** 10% level, ** 5% level, * 1% level.

Source: AMECO, EUROSTAT, World Bank and authors' own calculations

Table 1 presents the results of the calculations using the convergence equations with panel data for the Visegrad Group during the period 1996–2019. Specifically, the table above offers the results of the pooled regression for all the countries in the region. The convergence estimation method unconditionally requires verification of panel diagnostic tests and identification of a functional shape of regression. A low p-value counts against the null hypothesis that the pooled OLS model is adequate, in favour of the fixed or random effects alternative.

As is seen from Table 1, on the one hand, the model confirms the existence of absolute income β -convergence for the Visegrad Group as a whole. The convergence coefficients are significant at the highest probability level with the expected negative sign. More specifically, our empirical findings support the neo-classical hypothesis of unconditional convergence. However, many economists consider the assumption of absolute convergence unrealistic due to the effectiveness of the structural factors. This argument should be considered by implementing conditional β -convergence (the last column in the table).

The concept of conditional convergence is estimated by the modified convergence equation (2), containing several key country-specific factors. We assume that disparities in economic development arise due to several structural factors. Thus, when testing conditional convergence, we decided for five conditioning variables, namely gross fixed capital formation (*gfcf*), total population (*pop*), labour productivity per person (*lp*), unit labour cost (*ulc*), trade openness (*open*). Depending on the combination of structural variables used, the hypothesis of unconditional convergence cannot be refuted. Panel-data regression is depicted in Table 1.

The last column shows the estimation of conditional convergence by applying the pooled OLS regression, which is the most appropriate in our case according to the panel diagnostic tests. According to Arellano and Bond (1991), the conditional convergence model could also be estimated using the Generalized Method of Moments (GMM), which is commonly applied to dynamic equations with a lagged dependent variable. This estimation first includes differences and instrumental variables to explain the problem of the endogeneity of the regressors. A two-step version of the GMM method can be implemented in the regression (Arellano and Bond, 1991).

In fact, in this empirical analysis, unconditional β -convergence occurs. The independent variable shows the expected negative sign, which is in line with the assumptions of the neo-classical model. Additionally, our results provide some interesting information on the other economic growth determinants. Primarily, the labour productivity growth as well as structural changes in the countries of the Visegrad Group contribute to the achievement of the living standards of the developed EU countries. Gross fixed capital formation and human capital also represent important factors for future development. Human capital and economic growth have a strong correlation. Human capital affects economic growth and can help to develop an economy by expanding the knowledge and skills of its people.

3.2 Convergence sustainability of Visegrad Group

To formulate the convergence sustainability of the Visegrad Group, we must apply the above-mentioned BoP-constrained growth theory adequately. The estimated import

and export demand functions, reflecting the income trade elasticities, enable us to determine the rate in line with the BoP equilibrium. The export-demand and import-demand functions can be estimated by the equations:

$$x_t = \beta_0 + \varepsilon(z_t) + \eta(rp_t) + u_t \quad (8)$$

$$m_t = \beta_0 + \pi(y_t) + \psi(rp_t) + u_t \quad (9)$$

where m_t is relative import growth; x_t is relative export growth; π, ε represent income elasticities of demand for exports and imports; y_t is domestic income growth; z_t is foreign income growth; ψ, η represent trade elasticities of demand for exports and imports; rp_t is change in relative prices. Our calculations are then compared with the real GDP for the period 1996–2019. Equation (7) has been used to verify Thirlwall's law in the context of the Visegrad Group. The results are shown in Table 2.

Table 2: Balance-of-payments equilibrium growth rate, 1996–2019

Country	y	ε	π	$y_{BP}^* = (\varepsilon \times z)/\pi$	$y_{BP}^* - y$	cc
Czech Republic	2.60	2.933	5.341	0.98	−1.62	−3.30
Hungary	2.60	4.149	5.216	1.42	−1.18	−2.22
Poland	4.10	2.415	6.122	0.70	−3.40	−7.77
Slovakia	3.87	3.165	5.471	1.03	−2.84	−1.33

Notes: z – foreign income growth, y – domestic income growth, π – income elasticity of demand for imports, ε – income elasticity of demand for exports, y_{BP}^* – BoP equilibrium growth rate, cc – current account (% of GDP).

Source: EUROSTAT and authors' calculations

Table 2 depicts the actual rate of real GDP (y), the trade elasticity of demand for exports and imports (ε and π respectively) and the BoP equilibrium growth rate (y_{BP}^*). The difference between actual growth and the BoP equilibrium growth rate is captured in column 5, and column 6 shows the development of the current account for selected countries.

As we can see, the actual rates of real GDP in countries of the Visegrad Group are much higher than the BoP equilibrium growth rates for the period 1996–2019. This indicates that all the Visegrad countries are undergoing the process of convergence with the developed EU countries. However, there is a problem if the foreign trade balance is considered, which is in deficit (see the last column). To maintain sustainable economic

development without disturbing the external balance, it is necessary to improve the trade elasticities of demand for export products by increasing the competitiveness of products on international markets (Soukiazis *et al.*, 2017).

In this paper, the sustainability of convergence is estimated according to the BoP-constrained growth theory. As mentioned above, to compute Thirlwall's model in line with the traditional convergence theory, we need to express the demand function for imports and exports. The results of the regression for the whole Visegrad Group are presented in Tables 3 and 4 and cover the period 1996–2019.

Table 3: Regression results from export demand functions (Visegrad Group, 1996–2019)

	1996–2001	2002–2007	2008–2013	2014–2019
z_t	5.368*** (3.157)	4.511*** (13.85)	3.716*** (8.276)	2.830*** (13.04)
rp_t	0.040 (0.326)	0.927*** (4.574)	0.545* (1.953)	−0.145 (−0.422)
R^2	0.218	0.548	0.871	0.893
N. of observations	24	24	24	24
Breusch-Pagan test	LM = 1.104 [0.293]	LM = 0.583 [0.445]	LM = 0.380 [0.538]	LM = 4.595 [0.032]
Hausman test	H = 0.110 [0.946]	H = 1.895 [0.388]	H = 0.892 [0.640]	H = 1.986 [0.159]

Notes: rp_t – change in relative prices, z_t – real GDP of EU28, R^2 – coefficient of determination.

Significant at: *** 10% level, ** 5% level, * 1% level.

Source: EUROSTAT and authors' own calculations

Using the panel data in the regression analysis, Table 3 shows estimates of trade elasticity of demand for exports. The Hausman specification test detects endogenous regressors (predictor variables) in a regression model. Endogenous variables reach values determined by other variables in the system. The absence of such endogenous variables allows us to use the linear OLS model for estimation of the export demand function. All estimated values of trade elasticities (in Table 3) are statistically significant with anticipated positive sign. On the contrary, relative prices are constant in the long run (one of the assumptions of the model), which was confirmed by weak statistical significance.

Table 4: Regression results from import demand functions (Visegrad Group, 1996–2019)

	1996–2001	2002–2007	2008–2013	2014–2019
y_t	3.367*** (6.076)	2.304*** (6.959)	2.633*** (6.491)	1.599** (2.546)
rp_t	−0.058 (−0.206)	0.920 (1.492)	2.044 (2.855)	−0.327 (−0.525)
R^2	0.287	0.534	0.744	0.293
N. of observations	24	24	24	24
Endogeneity test	$\chi^2 = 4.510$ [0.001]	$\chi^2 = 55.74$ [0.000]	$\chi^2 = 26.96$ [0.000]	$\chi^2 = 5.39$ [0.067]
Sargan test	LM = 2.451 [0.294]	LM = 2.414 [0.230]	LM = 4.283 [0.117]	LM = 14.095 [0.010]

Notes: rp_t – change in relative prices, y_t – Real GDP of the Visegrad Group, R^2 – coefficient of determination.

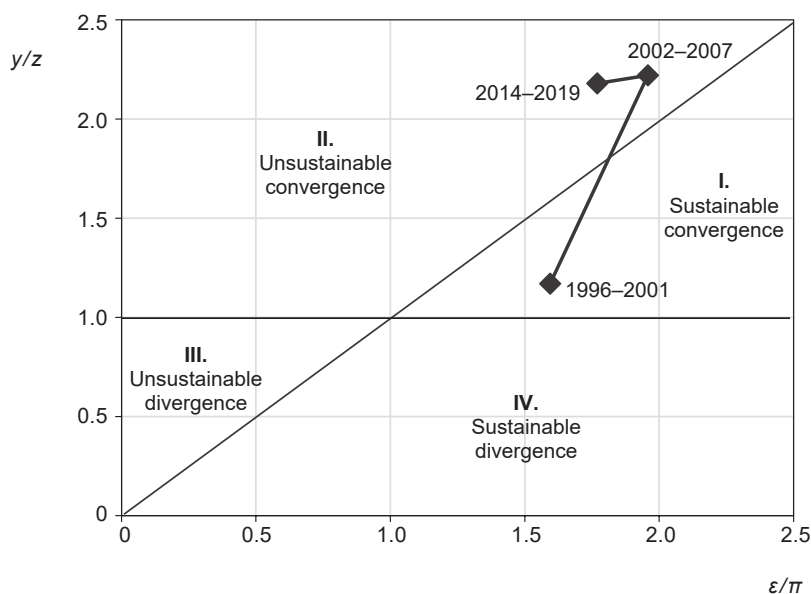
Significant at: *** 10% level, ** 5% level, * 1% level.

Source: EUROSTAT and authors' own calculations

The panel data are also used in Table 4 to estimate the import demand functions. Table 4 depicts the results of the calculation of π (y_t variable estimation). As we can see, the endogeneity test revealed endogenous regressors (predictor variables) in the regression model. For this reason, we determine the domestic income of the Visegrad Group as an endogenous descriptive variable and some instruments were therefore needed for an accurate estimation. Our selected instruments, such as consumption, investment and exports, are not weak, which was confirmed by the Sargan test. The Sargan test of overidentifying restrictions should be performed routinely in any overidentified model estimated with instrumental variable techniques. This test is used to verify the validity of all external instruments in the model. As is further seen from the table, the trade elasticities of the demand for imports are significant and exhibit the expected positive sign.

Estimates of trade elasticity in Tables 3 and 4 were used to construct the Convergence Quadrants Diagram to illustrate the convergence sustainability in the Visegrad Group. In this context, it should be emphasized that the four quadrants represent four different scenarios that could occur during the period under review.

Figure 5: Evolution of the convergence sustainability – Visegrad Group, 1996–2019



Source: Authors' elaboration based on the data in Tables 4 and 5

Figure 5 shows the trade elasticity ratio (ε/π) over six-year periods between 1996 and 2019. The position of the region can be influenced by the relationship between the elasticity ratio (ε/π) and the ratio of the economic growth in the Visegrad Group to the EU 28 (y/z) with regard to the development of the balance of payments (cc). Despite of that, the convergence process has taken place, but with growing external debt, -3.65% of GDP on average, for the whole region. The evolution of the convergence sustainability is extremely irregular. In the first observed period 1996–2001, the Visegrad countries were situated in Quadrant I (Figure 5) representing *sustainable convergence* with a growth rate higher than 1. As mentioned above, the continuing convergence of the region is accompanied by increasing external debt ($cc < 0$). As the debt will have to be paid back at some point in time, the stability of the convergence process can be disturbed.

During the years 2002–2007 and 2008–2013, the Visegrad Group occurred in Quadrant II (Figure 5), which characterizes *unsustainable convergence* due to the low level of trade elasticity ratio. For instance, in the third period (not represented in Figure 5), the ratio of economic growth reached a high value of 58.5 while the trade elasticity ratio

was only 1.41. A Similar situation holds for the last reference period 2014–2019; however, external imbalances are not as high as in the first period.

In our opinion, there is one possible reason why the Visegrad Group still struggles with sustainable convergence. The relatively weak trade elasticity in Central Europe might reflect low diversification of the economic structure of these emerging countries. Moreover, the inability to balance the current account may lead to a slowdown of the countries' economic development in the future. However, since joining the EU in 2004, the situation has partially improved.

Concluding Remarks

This paper contributes to the existing literature on regional convergence by examining the convergence process of the four emerging economies of the Visegrad Group (the Czech Republic, Hungary, Poland and Slovakia) with the developed EU countries in the period 1996–2019. For this purpose, two main approaches measuring economic convergence are compared: supply-side and demand-side approaches. Real income convergence is traditionally evaluated using the theoretical concept developed by neoclassical growth theory, but the sustainability of convergence needs to be seen from the perspective of an open economy and the BoP-constrained growth theory. In other words, we have made an attempt to classify the factors of sustainable development from the long-term perspective.

The empirical analysis shows that the whole Visegrad Group tended to converge with the developed EU countries during the reference period. According to the neoclassical growth theory, regional convergence occurs when developing countries grow faster than developed countries and thus they catch up with them. We could observe that the average real GDP per capita growth rate of the Visegrad Group was at the level of 3.29%, which is two and a half times higher than the average growth rate of EU15 (1.28%). The convergence or divergence was also estimated in this study using convergence equations. The obtained results confirmed the absolute β -convergence of the Visegrad Group. In addition, our findings provide support for the neo-classical hypothesis of conditional convergence, which includes structural factors that explain differences between regions better.

The convergence sustainability is studied along the lines of the BoP-constrained growth theory. After calculating the export and import demand functions, we constructed a Convergence Quadrants Diagram. As explained above, the placement of a subject into a quadrant depends on the trade elasticity ratio and economic development of the region. During the period in question, the Visegrad Group was situated in Quadrant I, representing sustainable convergence, as well as in Quadrant II, representing unsustainable

convergence. It must be stressed that the countries of the region still struggle with sustainable convergence. The problem of achieving sustainable convergence might lie in the low degree of diversification of the economic structure of these emerging countries.

Finally, we have found new evidence suggesting that the regional convergence is closely associated with the convergence in economic structures. The main policy recommendation based on our empirical analysis suggests that improvements in labour productivity and structural changes (developing innovation activities) are required to make the economies more competitive on the European Single Market. In addition, from the perspective of the demand-side approach (Thirlwall's model), the emerging economies of the Visegrad Group should increase their income elasticity of demand for exports by making their exports more competitive on international markets and, most importantly, reduce the import elasticity of demand for imports by making domestic products more attractive on the domestic markets.

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