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INCOME CONVERGENCE IN THE NEOCLASSICAL GROWTH MODEL: THE EXAMPLE OF THE WESTERN BALKAN STATES AND THE EUROPEAN UNION

ABSTRACT: Income convergence represents catching up of countries with different development levels, i.e., faster income growth in the less developed countries than in the developed ones in a certain period of time. The income convergence hypothesis was first introduced by Robert Solow in his neoclassical growth model, based on the assumption of diminishing returns on capital. The subject of this paper is a theoretical presentation of income convergence in the neoclassical growth model, as well as an empirical analysis of the income convergence hypothesis. The paper will present absolute and relative income convergence through graphical and theoretical analysis. In addition, the paper will present previous research on income convergence, with empirical verification of the income convergence hypothesis on the example of the Western Balkan states and the European Union. The results of the regression analysis showed the existence of income convergence in the observed countries in the period from 1995-2020.

Key words: income convergence, absolute convergence, relative convergence, neoclassical growth model, Western Balkans states, European Union

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INTRODUCTION

Robert Solow (1956) explained for the first time why income convergence occurs in his neoclassical model growth. The basic assumption of this model is the law of diminishing returns on capital, which means that lower returns on capital will first occur in the case of those countries that are rich in capital, i.e. in developed countries. At the heart of the neoclassical growth model is the claim that developed countries have a high level of productive funds per capita. If two countries with different development levels have a similar preferences system and approximately the same savings rates and investment in physical capital, the result will be slower economic growth of the developed country than the less developed one. Economic growth implies a real increase in national income per capita, which further means increase in wages, in standard of living, in accumulation, etc. (Pavlović & Čelić, 2022). In the long run, this fact, under unchanged circumstances, leads to the income convergence of countries with different levels of economic development (Cvetanović & Novaković, 2013, 2). In order to maximize the effects, and in accordance with the law of diminishing returns, capital is moved from countries where this factor is abundant to countries where there is a less abundant production factor. At the same time, the labor force is moving from countries with lower to countries with higher wages. Depending on whether countries converge towards the same or different steady states, absolute and relative income convergence can be distinguished.

The neoclassical convergence model was later critically re-examined within endogenous growth theories. The biggest difference between neoclassical and new growth theories is that the latter do not rely on diminishing returns on capital, which is the most significant argument of neoclassical growth theory on income convergence. Romer (1986) presented a “learning-by-doing” model in which economic growth rates increase with income levels, alluding to the process of divergence. In his model, Romer rejected all assumptions of the neoclassical growth model. He first rejected Solow’s basic assumption of diminishing returns on capital, arguing that the rate of return on investment and capital would rise over time, not fall, even when the country is rich in capital or its capital reserves increase (Pantić & Milojević, 2019, 100). When it comes to income convergence, Romer states that the income of countries with different development levels does not necessarily converge. On the contrary, in less developed countries, income growth may be slower or even missing. In addition, technological progress is an endogenous variable that, in the long run, grows under the influence of knowledge accumulation.

Regardless of the criticisms that followed, it can be said that income convergence represents one of the most important discoveries in the Solow's neoclassical growth model (Akinici & Yilmaz, 2012, 41). The debate about catching up with countries of different development levels, i.e. income convergence, occupies an important place in growth theories, since finding answers to this question can contribute to increasing the welfare of many countries. The subject of this paper is a theoretical presentation of income convergence (absolute and relative) in Solow's neoclassical growth model. In addition to the theoretical aspect, the paper analyzes income convergence from the empirical aspect, with a review of previous research, but also the empirical research of the author. The aim of this paper is to theoretically analyze income convergence and empirically test its existence on the example of the Western Balkan states and the European Union (EU). The rest of the paper is structured as follows. The introduction is followed by a theoretical and graphical presentation of absolute and relative income convergence. The fourth part of the paper represents an overview of previous research on income convergence, followed by empirical research by the author. At the end of the paper, the basic conclusions are drawn.

ABSOLUTE CONVERGENCE

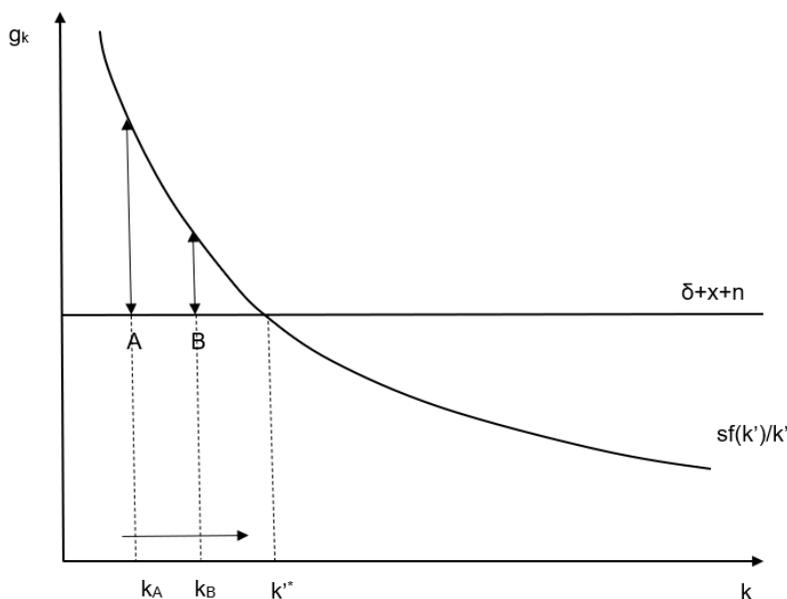
The absolute convergence hypothesis starts from the assumption that all countries have the same values of the parameters δ , x , n and s , i.e. they have access to the same technology at the rate of x , similar demographic characteristics and savings rates. Also, countries strive for the same steady state, which means that they have the same steady values of k^* and y^* , i.e. the same steady capital to labor ratio and output per capita level (Barro & Sala-i-Martin, 2004, 44). Taking these assumptions into account, the absolute convergence hypothesis states that countries with lower capital and output levels will grow faster and catch up with countries with higher capital and output levels. Graph 1 graphically shows the absolute convergence on the example of two countries A and B, where Country A is less developed (poorer) than Country B.

Graph 1 shows two countries with different levels of development. One is less developed, with a lower initial capital level k_A , while the other is developed, with a higher initial capital level k_B . The vertical difference between the savings curve $sf(k')/k'$ and the line $(\delta+x+n)$ represents the capital growth rate per employee, i.e. (Carlin & Soskice, 2006, 491):

$$g_k = sf(k')/k' - (\delta+x+n). \quad (1)$$

One of the implications presented in Graph 1 is that less developed countries, with lower initial capital levels, have a higher growth rate. It follows that absolute convergence represents a situation in which countries or regions with lower initial capital levels per employee have higher growth rates per capita, with tendency of catching up with countries with higher capital levels per employee (developed countries) (Barro & Sala-i-Martin, 2004, 45).

Graph 1. - Absolute convergence in Solow's growth model with technological progress



Source: Carlin & Soskice, 2006, 491

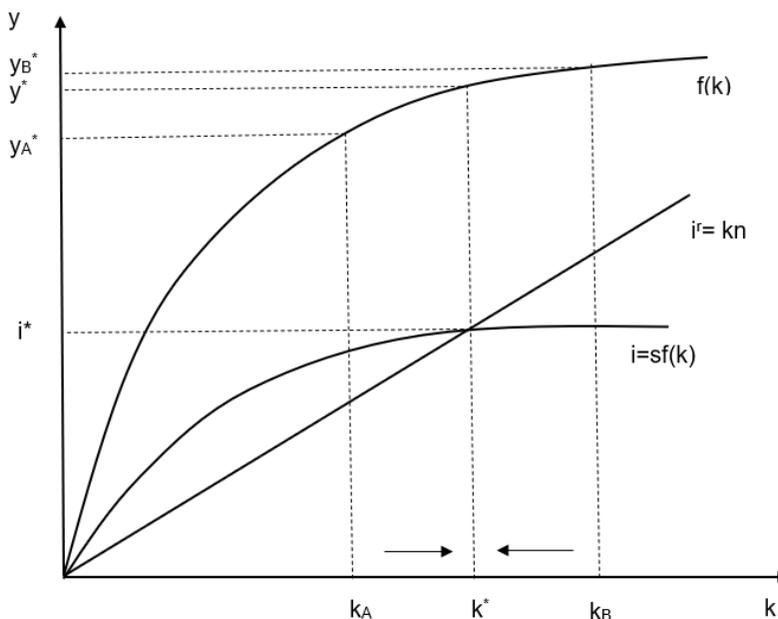
In Graph 1, it can be noticed that left of the steady state, the capital growth rate is positive and capital per employee level grows until it reaches the steady level k^* . Approaching the steady level k^* , gk decreases and approaches zero. The reason for this declining capital rate per employee is diminishing returns on capital (Barro & Sala-i-Martin, 2004, 45). When k is relatively low, the average capital product $f(k)/k$ is relatively high. It is assumed that households save and invest at the same rate s , and therefore when k is relatively low gross investment per unit of capital $sf(k)/k$ is relatively high. Given that capital per employee depreciates at a constant rate $\delta+x+n$, the growth rate gk is also relatively high.

It has already been pointed out that absolute convergence implies that all countries converge towards the same steady output per capita level, same capital to labor ratio and consumption per capita (y^* , k^* , c^*), and the same

growth rate. Absolute convergence is also shown in Graph 2, where k_A represents the capital to labor ratio of a less developed country, and k_B the capital to labor ratio of a developed country. The line $ir=kn$ represents the necessary investments per capita, in order to maintain a constant capital level. If there is no investment, the value of $k=K/L$ would automatically decrease with population growth (The Neoclassical Growth Model, 2022).

The steady state of Solow's model predicts that both less developed and developed countries will strive for the same k^* . This means that a less developed country will grow relatively fast (capital and production grow faster than the population), while a developed country will grow much more slowly (capital and production grow slower than the population). In other words as $k_A < k_B$ so is the $f(k_A) > f(k_B)$ so the marginal product of capital relative to labor is higher in less developed countries than in the developed ones. Consequently, less developed countries will accumulate more capital and grow faster than the developed ones (The Convergence Hypotheses, 2022).

Graph 2. - Absolute convergence



Source: The Convergence Hypotheses, 2022

Germany and Japan can be taken as examples of absolute convergence. At the end of World War II the capital, but not the labor, of Japan and Germany was destroyed by Allied bombing and other war destruction. Other characteristics of the defeated countries, such as their technological capability, savings rates, and population growth rates, were comparable to the

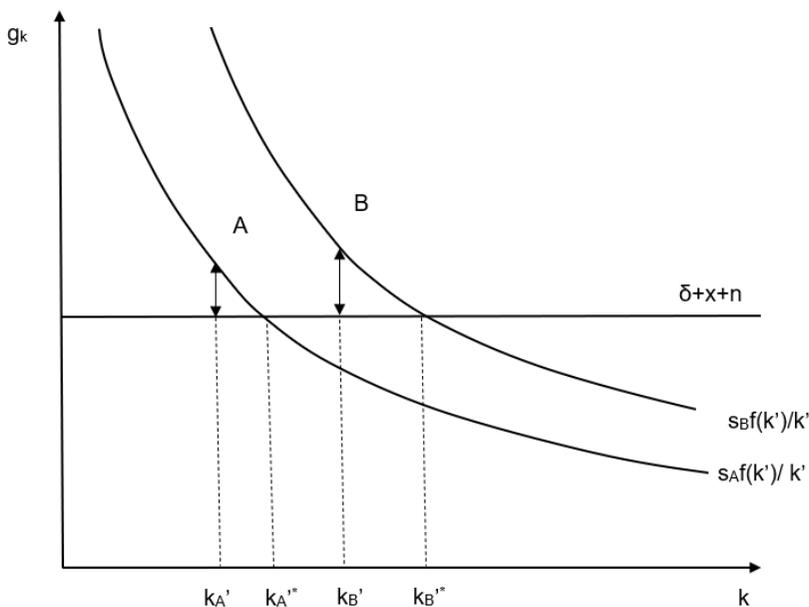
pre-war period. Moreover, they were practically the same as other countries in the industrialized world. Thus, in relation to other industrialized countries with similar parameters, post-war Germany and Japan had an extremely low capital to labor ratio, i.e. low k (similar to k_A in Graph 2). Consistent with the absolute convergence hypothesis, Solow's model would predict that these two countries would later grow faster than other developed countries in the immediate post-war period. That was exactly what happened (The Convergence Hypotheses, 2022).

RELATIVE CONVERGENCE

So far, a situation has been considered in which the observed countries have the same values of the parameters δ , x , n and s and strive to the same steady state. However, it is important to consider a situation in which two countries, with different development levels, converge towards different (own) steady states. This catching up process with countries of different development levels is called relative convergence. The steady state of each country is determined by parameters such as the savings rate, population growth rate and access to technology, with these parameters differing between countries. Less developed countries will have faster growth than the developed ones only in a situation when they are further from their steady state, compared to the distance of a developed country from its steady state (Stanišić, 2012, 165).

Graphical representation of relative convergence is showed in Graph 3. It shows two countries, a less developed and a developed one, where the less developed country has a lower savings rate than the developed one ($s_A < s_B$), as well as a lower initial capital rate per employee ($k_A < k_B$). In this case, absolute convergence does not apply. As can be seen in Graph 3, the growth rate is lower in the less developed country compared to the developed one. The neoclassical growth model predicts that each economy converges toward its steady state, and that the rate of convergence is inverse to the distance from the steady state (Barro & Sala-i-Martin, 2004, 48). In this case, the less developed country may have faster growth if it is further away from its steady state, than the developed country is from its steady state.

Graph 3. - Relative convergence in the Solow's model (different growth rates, as a consequence of different savings rates)



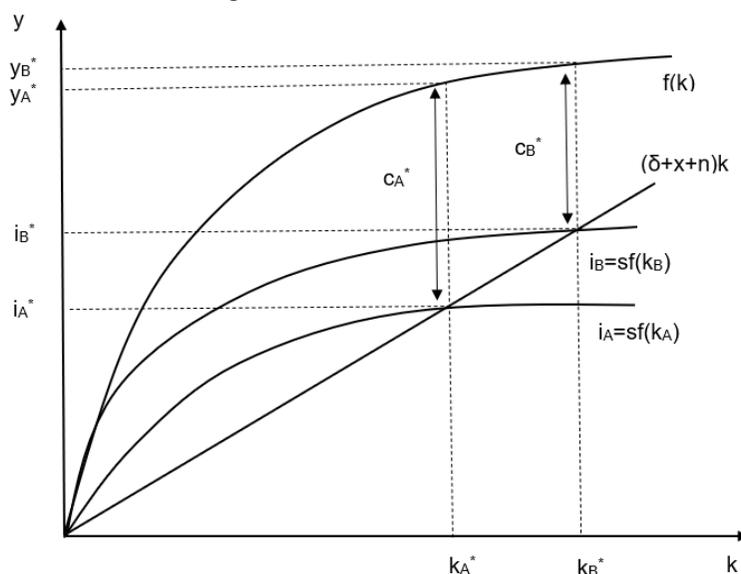
Source: Carlin & Soskice, 2006, 496

The relative convergence hypothesis also applies in the case where countries have the same technological possibilities and population growth rates, but differ in savings propensities and the initial capital to labor ratio. In this case, countries would converge towards the same growth rate, but with different capital to labor ratios. This is the result of Solow's paradox of savings (The Convergence Hypotheses, 2022). Namely, according to Solow's paradox of saving, a permanent change in the savings rate will not permanently change the growth rate of the economy. For example, an increase of the savings rate will move the investment curve upwards, and country moves from one steady state (k^*) to another (k^{**}). Prior to this change in savings, all variables grew at a population growth rate (n). Immediately after a change in the savings rate, capital (both production and consumption) grows faster than the population growth rate. But as k^* approaches k^{**} , the capital growth rate slows. When the economy reaches a new steady state (k^{**}), capital growth (both production and consumption) returns to n . A steady increase in the savings rate can only temporarily increase the growth rate. In the long run, this increase will not affect growth rates (The Solow Paradox, 2022).

Graph 4 shows the relative convergence. Two countries with different development levels may have different steady states k_A^* and k_B^* , and thus different consumption per capita, i.e. c_A^* and c_B^* . However, as long as they

have the same population growth, all their variables (capital, output, consumption) will grow at the same rate over time (The Convergence Hypotheses, 2022).

Graph 4. - Relative convergence



Source: The Convergence Hypotheses, 2022

The relative convergence hypothesis is not always valid when comparing the developed countries with the less developed ones, because the population growth rates between these countries are different. The relative convergence hypothesis is part of the explanation why countries with similar population growth rates may converge toward the same growth rate, albeit with different steady per capita income levels, capital to labor ratios, and per capita consumption (The Convergence Hypotheses, 2022).

REVIEW OF EMPIRICAL RESEARCH ON INCOME CONVERGENCE

Empirical research on income convergence emerged in the 1980s, with one of the first studies conducted by Baumol (1986). The research results showed that a homogeneous group of countries converges towards a certain growth rate, while in a heterogeneous group of countries divergence has been proven. Income convergence on the example of Western European countries has also been proven by Barro & Sala-i-Martin (1991).

After the first ones, numerous empirical studies of different authors followed, which showed the practical application of the income convergence hypothesis. A special place is occupied by research that examines the correctness of the income convergence hypothesis in the process of economic integration. Following the accession of the Central and Eastern Europe countries (CEE) to the European Union in 2004, a number of papers have emerged examining the existence of income convergence between “old” and “new” EU members (Matkowski & Próchniak, 2007; Rapacki & Próchniak, 2009; Vojinović & Oplotnik, 2008; Vojinović et al., 2009; Stanišić, 2012; Gligorić, 2014). Most of these empirical studies confirm the existence of income convergence.

Matkowski & Próchniak (2007) examined the existence of income convergence between CEE and the developed EU countries (EU15). The results showed that all CEE countries achieved faster growth than the EU15, which resulted in reduction of the income gap between these two groups of countries, i.e. the existence of income convergence. The authors proved that the acceleration of income convergence was caused by trade liberalization, increased inflows of foreign direct investment and coordination policy. Rapacki & Próchniak (2009) tested the income convergence hypothesis between the 27 former socialist countries. The results showed the existence of β -convergence, but not σ -convergence, proving that it is most pronounced in CEE countries.

The existence of income convergence within the CEE group was examined by Vojinović & Oplotnik (2008) and Vojinović et al. (2009). Research results by these two groups of authors showed that poorer CEE countries grew faster than richer CEEs. As a result, the income gap between these two groups of countries has narrowed, but remains quite large.

Stanišić (2012) examined the existence of income convergence between the 25 EU countries in the period 1993-2010 and proved the existence of income convergence. The results also showed the impact of the Global Economic Crisis on income convergence, leading to inverse results when it comes to income convergence in the group of CEE and EU15 countries. Since the beginning of the Global Economic Crisis in 2007, there has been divergence in the first group of countries, while the second group of countries showed income convergence.

The existence of income convergence between “old” and “new” EU members was also examined by Gligoric (2014). Research results showed convergence between these two groups of countries, which started significantly before the “new” members joined the EU. The author concluded that the process of pre-accession harmonization, with the implementation of major economic reforms, primarily leads to rapid integration and rapid growth towards a developed Europe.

In addition to a large number of papers examining the income convergence hypothesis between the “old“ and “new“ EU members, there have been papers examining the correctness of this hypothesis between the Western Balkan states and the EU (Murgasova et al., 2015; Stanišić, 2016). However, there is still not enough research to answer the question of whether the Western Balkan states are catching up with the EU.

Murgasova et al. (2015) tested the difference in the rate of income convergence between the Western Balkan states and the “new” EU members, on the one hand, and the EU15, on the other. The results obtained by the authors confirm the existence of income convergence between the “new” EU members and the EU15, but weak income convergence between the countries of the Western Balkans and the EU15. These results refer to the period before the outbreak of the Global Economic Crisis. Observing the period after the Global Economic Crisis, the authors proved that income convergence exists for the Western Balkan states, but was slower than that achieved by the “new” EU members. As possible reasons for such results, the authors cited the dominance of the public sector in the Western Balkans, better quality governance and revised market-oriented institutions, as well as a stronger human base and a developed financial system in the “new” EU member states. Also, as one of the possible reasons, the authors state a closer geographical position in relation to the EU15 of most “new” EU member states, comparing to the Western Balkan states. Geographical proximity allows them easier access to the market, investments and knowledge transfer.

Stanišić (2016) also tested the existence and speed of income convergence of the Western Balkan states and the EU15, compared to the “new” EU member states. The author concluded that there is an income convergence between the Western Balkan states and the EU15. However, the results also show that this income convergence was interrupted by the outbreak of the Global Economic Crisis, which led to an increase in the income gap between the Western Balkan states and the “new” EU member states.

EMPIRICAL ANALYSIS OF THE INCOME CONVERGENCE HYPOTHESIS

Barro & Sala-i-Martin (1991) introduced the equation for testing the existence of β -convergence, which was later used by numerous authors such as Matkowski & Próchniak, 2007; Rapacki & Próchniak, 2009; Vojinović & Oplotnik, 2008; Vojinović et al., 2009. The equation has the following form:

$$1/T \log (y_{i,T} / y_{i,0}) = \alpha_0 + \alpha_1 \log y_{i,0} + e_i, \quad (2)$$

where: T - length of the observed period, $y_{i,T}$ - gross domestic product (GDP) per capita in current prices in the last year of the observed period, $y_{i,0}$ - GDP per capita in current prices in the first years of observed period, α_0 - constant, e_i - standard error. A negative value of the coefficient α_1 indicates the existence of income convergence.

In a later study by the International Monetary Fund, an equation was introduced that, in addition to its existence, also compared the speed of convergence among “new” EU member states and the Western Balkan states (Murgasova et al., 2015). Stanišić (2016) used the same equation in his analysis. The mentioned equation has the following form:

$$\text{GRGDP}_{i,t} = \beta_0 + \beta_1 \text{DIST}_{i,t-1} + \beta_2 \text{DIST}_{i,t-1} \times \text{WBS} + \beta_3 \text{WBS} + u_{i,t}, \quad (3)$$

where $\text{GRGDP}_{i,t}$ represents GDP per capita growth rate in current prices of the country i in year t , t stands for the observed time period, and $\text{DIST}_{i,t-1}$ represents a gap in GDP per capita between the country and the EU15 average in the previous period. WBS is an artificial variable that takes the value 1 if the country belongs to the Western Balkan states, and 0 if it belongs to the “new” EU member states. β_0 is constant, and $u_{i,t}$ is standard error.

A positive value of the β_1 coefficient shows that there is income convergence between the Western Balkan states and “new” EU member states, on the one hand, and the EU15, on the other. A higher value of this coefficient means faster convergence. The β_2 coefficient measures the interaction of belonging to the Western Balkan states and the income gap. A positive value of this coefficient means that the rate of income convergence of the Western Balkan states is higher than the rate of income convergence of “new” EU member states. A negative value of this coefficient means a lower rate of income convergence of the Western Balkan states than the rate of income convergence of “new” EU member states. The coefficient β_3 shows the extent to which the growth rates of the Western Balkan states differ from “new” EU member states. Positive value of this coefficient shows that, with the same initial income gap with the EU15, the countries in the Western Balkan states group achieved higher growth rates compared to the countries in the “new” EU member states group, which means faster income convergence. The reverse is for the negative value of this coefficient.

The paper starts from the assumption that the Western Balkan states are catching up with the income level of EU countries, i.e. that there is income convergence between these two groups of countries. In order to test this assumption, the equation introduced by Barro & Sala-i-Martin (1991) will be used (equation 2), where the observed period is from 1995 to 2020. This equation will be used in the paper because it only tests the existence of

income convergence, not the difference in the speed of income convergence among the observed countries.

Table 1. - Results of regression analysis of income convergence

	Coefficient	p
Constant	0,06	0,03
logy_i	-0,004	0,05
R²	0,12	

Source: author's calculation

logy_i - logarithm of GDP per capita in the initial year of observation

The results of the income convergence analysis are shown in Table 1, where it can be seen that the coefficient with the independent variable is negative and amounts to -0.004. This means that the assumption of the existence of income convergence is confirmed. The results of the regression analysis indicate that income convergence between the Western Balkan states and the EU exists. In other words, the countries of the Western Balkan region are catching up with the income of EU member states.

CONCLUSION

One of the more important questions that growth theories deal with is whether poor countries will catch up with rich ones, that is whether the income of poor countries will converge towards the income of the rich ones. Robert Solow started a debate on catching up with countries of different development levels, i.e. the issue of income convergence. The income convergence hypothesis is based on the law of diminishing marginal returns on capital. This means that lower returns on capital will first occur in the case of those countries that are rich in capital, i.e. in developed countries. At that time, this debate caused great controversy and was rejected. Namely, the proponents of endogenous growth theories rejected Solow's assumptions, i.e. diminishing returns on capital and exogenous technological progress, due to which convergence does not necessarily occur, on the contrary, divergence may occur. Regardless of the criticism made, it can be said that the income convergence hypothesis represents one of the most significant discoveries in Robert Solow's growth model. Today, there is a large number of empirical studies whose results support this hypothesis and confirm the existence of income convergence. In this paper, income convergence is analyzed both from the theoretical and the empirical aspects. A regression analysis was performed with the aim of testing the assumption of the existence of income

convergence between the Western Balkan states and the European Union in the period 1995-2020. This assumption has been confirmed, which means that the Western Balkan states are catching up with the income level of the European Union member states. In addition to the theoretical and graphical presentation of income convergence, the scientific contribution of the paper is an empirical analysis that contributes to the enrichment of the literature in this field. As a possible direction of future research, larger number of years to be analyzed can be mentioned, as well as the division of the entire period into subperiods, in order to analyze the impact of the transition process and the Global Economic Crisis on income convergence.

REZIME

DOHODOVNA KONVERGENCIJA U NEOKLASIČNOM MODELU RASTA: PRIMER ZEMALJA ZAPADNOG BALKANA I EVROPSKE UNIJE

Dohodovna konvergencija predstavlja sustizanje zemalja različitog nivoa razvijenosti, odnosno brži rast dohotka nerazvijene u odnosu na razvijnu zemlju u određenom vremenskom preiodu. Toremu o konvegenciji dohodaka prvi je predstavio Robert Solow u svom neoklasičnom modelu rasta, bazirajući je na pretpostavci o opadajućim prinosima na kapital. Predmet ovog rada je teorijski prikaz dohodovne konvergencije u neoklasičnom modelu rasta Robert Solow-a, kao i empirijska analiza hipiteze o dohodovnoj konvergenciji. U radu će, grafičkim putem i teorijskom analizom, biti prikazane apsolutna i relativna konvergencija dohodaka. Osim toga, u radu će biti prikazana dosadašnja istraživanja o dohodovnoj konvergenciji, uz empirisjku proveru ispravnosti hipoteze o dohodovnoj konvergenciji na primeru zemalja Zapadnog Balkana i Evropske unije. Rezultati regresione analize su pokazali postojanje dohodovne konvergencije na primeru posmatranih zemalja u periodu 1995-2020. godine.

Ključne reči: dohodovna konvergencija, apsolutna konvergencija, relativna konvergencija, neoklasični model rasta, zemlje Zapdanog Balkana, Evropska unija

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