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Harrod – Balassa – Samuelson effect and the role of distribution sector: an empirical case study of Serbia and EMU*[1]

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Abstract

This research aims to test the functionality of the standard and the modified HBS model, with the intention to discover whether sectoral differences in labor productivity affect the dinar/euro real exchange rate. The first part of the analysis is based on the standard HBS model, which mathematically formalizes the dependence of the real exchange rate on the difference in the relative labor productivity in the open sector between Serbia and the EMU. The second part of the research relies on a modified version of the HBS model which differs from the standard HBS model since the effect of the distribution sector is separately analyzed. The empirical testing of both models was performed by applying the Johansen and the Engle-Granger tests. The results obtained by analyzing the standard HBS model indicates that there is no reliable evidence based on which it can be concluded that either the difference in the relative labor productivity in the open sector between Serbia and the EMU translates onto the difference in the relative prices of non-tradable goods or that the difference in prices affects the real exchange rate of the dinar against the euro. Furthermore, the analysis of the modified HBS model does not affect the previous results. Based on these findings, it can be concluded that the real euro/dinar exchange rate is not determined solely by sectoral differences in labor productivity, and that in future perspective Serbia will not have to choose between the dynamic economic growth and the membership in the EMU.

***Key words**: Harrod-Balassa-Samuelson model, open sector, distribution sector, relative prices of non-tradable goods*

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1. Introduction

The EU enlargement process has generated some concerns about the consequences of the Harrod-Balassa-Samuelson (HBS) effect in the accession countries. Namely, the essence of the problem stems from the impact that the more rapid productivity growth in the accession countries than in the European Monetary Union (EMU) member countries might have on the fulfillment of the nominal convergence criteria prescribed by the Maastricht Treaty. In the late nineties, this potential problem caught the attention of the researches, almost at the exact moment when the transition countries from the Central and Eastern Europe entered the accession process to the full EU membership. The fact is that if this problem really exists, we must take into consideration the inevitability and the need for the trade-off between the real convergence and the EMU membership

The key assumption of the Harrod-Balassa-Samuelson effect is that labor productivity growth in the traded goods sector (the open sector) is usually higher than the productivity growth in non-traded goods sector (the closed sector). In addition, the perfect labor mobility between sectors is assumed, which results in sectoral wage equalization. Increased labor productivity in the open sector reduces the unit labor input and makes it possible and enables proportional increase of wages without affecting the unit labor costs. If we assume that both the consumption and prices of other production inputs remain the same, there is no doubt that the total unit costs will remain the same, therefore there will not be any cost pressures on the increase of tradable goods prices. The growth of wages in the open sector, given the perfect mobility of labor, will affect the increase in wages in the closed sector. However, if labor productivity growth in the closed sector is lower than the labor productivity growth in the open sector, the higher wages will exert pressure on both absolute and relative prices of non-tradable goods. Thus, if labor productivity growth in the home country exceeds the growth in labor productivity in a foreign one, the total domestic inflation will be higher. At the same time, let us assume that changes in nominal exchange rate provide for the difference in price growth between the domestic and foreign tradables, then a higher domestic inflation, caused by the higher prices of non-tradable goods, would lead to the consumer price index (CPI) based on real exchange rate appreciation.

Theoretical considerations and mathematical formulation of the HBS effect bring to the attention the already mentioned conflict between the nominal and real convergence (Halpern and Wyplosz, 2001; Buiter and Grafe, 2002). Nominal convergence criteria are included in the Maastricht Treaty and are related to the need for the reduction of the five economic indicators (inflation, budget deficit, long-term nominal interest rate, public debt and exchange rate) to an acceptable level that would make optimal the country's membership in the EMU. On the other hand, real convergence is practically the same as the so-called "catch-up" effect. The possible risk of conflict

between the two forms of convergence makes us look for the mechanism that may cause their contradiction. The answer can be found in the fact that if the potential EMU members achieve significantly higher productivity growth compared to the current EMU members, the HBS effect and the growth of absolute (relative) prices of non-tradable goods would lead to higher inflation in these economies, that is, to such situation where the nominal convergence inflation criterion cannot be satisfied due to the stable nominal exchange rate. Alternatively, it is possible to avoid the increase in inflation concerning the adjustment of relative prices of non-tradable goods, but only if the domestic currency appreciation cause the lower prices of tradable goods (expressed in domestic currency), which would in turn automatically lead to deviation from the second nominal convergence criterion related to the stability of exchange rates. In other words, real convergence, which is tied to faster productivity growth in the accession countries, challenges the simultaneous fulfillment of the two above-mentioned nominal convergence criteria.

Although Serbia still has a long way to go until it achieves the full membership in the EU, it seems that against the background of the current European integrations, it would be very useful to examine the functionality of the HBS effect in Serbia in relation to the EMU. The subject of this research is the potential effect that the differences in the sectoral labor productivity might have on the dinar/euro real exchange rate. If this effect exists, i.e. if there is some empirical evidence of the HBS effect concerning the relation between Serbia and the EMU, then it can be expected that in some point in time, Serbia would be faced with the choice between the rapid economic growth and the membership in the Eurozone. If, however, both versions of the HBS model have no valid empirical support, Serbia will certainly not be faced with this dilemma. The initial hypothesis tested in this study is that the dynamics of the real exchange rate of the dinar against the euro cannot be explained by the differences in sectoral labor productivities. In other words, we assume that there is no sufficient empirical evidence for the HBS effect concerning the relations between Serbia and the EMU.

This paper is organized in six sections. In the introductory section we explained the theoretical essence of the HBS effect with special emphasis on the subject of the authors' research and their initial hypothesis that was tested in the paper. The second section is dedicated to the review of the most important literature concerning the HBS effect. We have presented theoretical postulates of the standard and modified HBS model in the third part of the Paper, after which we have briefly explained the econometric methodology underlying the empirical testing. The forth part encompasses the most important information on the data used during the course of the research. The fifth part refers to the results of the empirical testing. Finally, the concluding remarks are shown in the sixth part of the Paper.

2. Literature review

Harrod-Balassa-Samuelson model has become popular over the last twenty years for several reasons (Tica and Družić, 2006: 4). Among these are most certainly the reasons such as establishment of the comprehensive database and rapid development of econometric techniques necessary to carry out the empirical study. However, it is considered that the enlargement of the European Union (EU) is by far the most important event that underlines the growing interest in the HBS model.

The expansion of the HBS effect research led to the emergence of different opinions on its functionality. Namely, there is a wide consensus concerning the long-term influence of the relative labor productivity in the open sector on the relative prices of non-tradable goods. On the other hand, there are very different opinions on the long-term impact of the difference in the relative labor productivity in the open sector between the countries on the difference in their overall inflation and the real exchange rate (De Broeck and Slok, 2001; Halpern and Wyplosz, 2001; Égert, 2002).

Bergin et al. (2004) investigated the empirical foundation of the HBS effect for a very long time period. The results of this study are surprising for two reasons. The first is that little or no evidence was found that would support the functionality of the HBS effect since the mid-20th century, which is quite opposite to the general viewpoint. Another reason is the fact that the HBS effect showed the tendency of steady growth in recent years that were relevant for the research. In other words, historical analysis reveals that the strength of the relationship between the price level and the level of GDP per capita has oscillated dramatically over time. Rogoff (1996: 660) showed that the relationship between GDP per capita and the price level is rather distinct. The strength of this relationship is significantly weaker if the developed and developing countries are being analyzed separately. Unfortunately, Bhagwati (1984) is one of few economists who tried to analyze the HBS effect within various income groups of countries . The positive results were also obtained in the studies carried out in individual countries, or pairs of countries (Edison and Klovland, 1987; Marston, 1987; Bahman-Oskooee and Rhee, 1996; Rother, 2000). On the other hand, Rogoff (1992) in his empirical study of the USA and Japan failed to find evidence for the HBS effect. Different results are also presented in the sectoral studies starting with Hsieh (1982) and Marston (1990). These results are largely influenced by the insufficiently long time series on which the conducted analysis was based (Frankel, 1985). In such circumstances it is completely unreasonable to expect solid evidence for the HBS effect. Some papers have suggested that there is a substantial amount of evidence of cointegration between productivity and price levels, but that there is not any evidence of interference between convergence induced inflation and EMU rules (Cipriani, 2001; Coricelli and Jazbec, 2001; Egert, 2002a; 2002b; Egert et al., 2002; Mihaljek and Klau, 2003). Two additional papers have not found any evidence of the HBS effect in transition countries (Fischer, 2002; Arratibel et al., 2002).

The analysis of the role of distribution sector should be given a special attention since it has been neglected in the standard HBS model. Furthermore, only a few authors have examined its impact on the real exchange rate. Distribution sector is usually considered as a part of the closed sector. Dornbusch (1989) stressed the importance of the distribution sector in determining the real exchange rate dynamics via the impact on consumer prices of goods. Some studies dealing with the HBS effect (De Gregorio and Wolf, 1994; De Gregorio et al., 1994) use the sectoral data to derive the measures of productivity in open and closed sector, also consider the distribution sector as a provider of non-tradable goods. Devereux (1999) and Burstein et al. (2000) have examined the influence of the distribution sector on real exchange rate, however, they investigated this phenomenon within a closed sector. Engel (1999) also referred to the distribution sector as one of the reasons for different influence of the relative prices of non-tradable goods on the real exchange rate in the United States.

3. Methodology[3]

3.1. The Harrod-Balassa-Samuelson model

A systematic study and testing of the HBS effect requires its decomposition into internal and external transmission mechanisms. Internal transmission mechanism includes the impact of relative labor productivity in the open sector (labor productivity in the open sector divided by the labor productivity in the closed sector) on the relative prices of non-tradable goods (the ratio between the prices of the non-tradable and tradable goods). Thus, technically speaking, if the HBS effect worked, the relative labor productivity in the open sector would affect the dynamics of the relative price of non-tradable goods. Furthermore, in this case, in the countries with the more rapid growth of the relative labor productivity in the open sector one can expect the faster increase in prices of non-tradable goods, and consequently the higher overall inflation. Since the nominal exchange rate is formed on the basis of purchasing power parity (PPP), taking into account the prices of tradable goods, the abovementioned phenomena should be accompanied by the CPI-based real exchange rate appreciation. The mechanism, which refers to the price levels convergence and the real exchange rate appreciation of the domestic currency, is known as the external transmission mechanism. A deeper and a more comprehensive understanding of both mechanisms requires their mathematical formulation.

[3] This paper shows shortened versions of theoretical models. Mathematical models derived in details are available at request.

3.1.1. Modeling of the internal transmission mechanism

The Harrod-Balassa-Samuelson model is actually a mathematical formulation of the HBS effect. The model is based on several assumptions that were introduced in order to determine the relative prices of tradable and non-tradable goods, and thus the overall price level by the supply conditions, i.e. by production function of the entire economy (Égert et al., 2002: 3). Each economy produces two types of goods (tradable and non-tradable goods), the production of which is described by the Cobb-Douglas production function (Égert et al., 2002: 3) with constant returns to scale and different elasticities of production in relation to individual inputs, which can be formulated as:

$$Y_t = A_t L_t^b K_t^{(1-b)}, \tag{1.1}$$

$$Y_n = A_n L_n^c K_n^{(1-c)}, \tag{1.2}$$

where Y denotes the total production of appropriate goods, K is the capital stock employed in production, L is the number of employees in the relevant sector, A is the total factor productivity, b and c denote the constant elasticity of production of appropriate goods in relation to the number of employees ($0<b<1$; $0<c<1$), t and n stand for tradables and non-tradables, respectively (Égert et al., 2002: 3). Also, the elasticity of production in the closed sector in relation to labor is greater than the corresponding elasticity in the open sector ($c>b$). Furthermore, interest rates and prices of tradable goods are exogenous variables, i.e. they are determined by the world market. In addition, the capital stock is fixed for one period ahead, while the mobility of labor between the sectors is perfect (very small between the countries). Finally, real wages in the open sector are determined by the marginal product of labor.

If all the above assumptions are fulfilled, the relative price of non-tradable goods is completely determined by the supply conditions. This conclusion is based on microeconomic conditions for profit maximization in both sectors, bearing in mind that prices of tradable goods and interest rates are exogenous variables. The condition for profit maximization in both sectors is the equality of the marginal products of both production factors and their real prices. This would specifically mean that the marginal product of labor equals the real wage, while the marginal product of capital equals the real interest rate. When the values of the marginal products of capital and labor are known, the conditions for profit maximization can be formulated as follows (Égert et al., 2002: 3-4):

$$(1-b)A_t\left(\frac{1}{K_t/L_t}\right)^b = \frac{I}{P_t}, \tag{1.3}$$

$$bA_t\left(K_t/L_t\right)^{(1-b)} = \frac{W}{P_t}, \tag{1.4}$$

$$(1-c)A_n\left(\frac{1}{K_n/L_n}\right)^{c} = \frac{I}{P_n}, \tag{1.5}$$

$$cA_n\left(K_n/L_n\right)^{(1-c)} = \frac{W}{P_n}, \tag{1.6}$$

where *I*, *P* and *W* denote, respectively, interest rate, prices of the relevant products and wage.

The only unknown variable in equation (1.3) is the labor input for the open sector (bearing in mind that the interest rate and prices of tradable goods are exogenously determined and that the capital stock is fixed for the one period ahead. By calculating this variable and by including it in the equation (1.4) we obtain the nominal wage that due to perfect mobility of labor and consequent intersectoral wage equalization may be included in the equation (1.6) as an exogenous variable. In this way we get a system of two equations (1.5 and 1.6) with two unknowns (the labor input for the closed sector and the price of non-tradable goods) whose solving gives the solution of above mentioned system of equations. So, there is no doubt that the conditions of supply determine the prices of non-tradable goods, which in interaction with other variables must satisfy the microeconomic conditions for profit maximization.

Given the logic of the HBS effect a more rapid increase in labor productivity in the open sector than in the closed sector should result in an increase in (relative) price of non-tradable goods. The system of equations (1.3) – (1.6) gives a technical explanation of this standpoint. Labor productivity growth in the open sector (1.4) will cause a proportional increase of nominal wages without affecting unit labor costs and price competitiveness, while the price of tradables, which is formed on the world market will remain unchanged. The payment of such increased wages in the closed sector (1.6) will implicate the growth of (relative) prices of non-tradable goods, since the growth of labor productivity in this sector is smaller than in the open sector. In other words, the relative growth of labor productivity in the open sector will result in an increase of (relative) price of non-tradable goods and overall inflation to the extent that the non-tradable goods participate in the CPI. This channel of influences is known as the internal transmission mechanism.

However, although the presented model explains the method and logic behind the functioning of the internal transmission mechanism, the additional derivations must be performed in order to adequately conduct the empirical research. Namely, equations (1.4) and (1.6) can be written as:

$$bA_t\left(K_t/L_t\right)^{(1-b)}P_t = W, \tag{1.7}$$

$$cA_n\left(K_n/L_n\right)^{(1-c)}P_n = W. \tag{1.8}$$

By equating left sides of two expressions (1.7) and (1.8), and by performing subsequent rearranging we get (Égert et al., 2002: 5):

$$P_n/P_t = \frac{\partial Y_t/\partial L_t}{\partial Y_n/\partial L_n}. \tag{1.9}$$

The above given equation indicates the relationship between the relative marginal productivity of the open sector and the relative prices of non-tradable goods according to which, in compliance with the standard HBS model logic, a faster increase in the marginal productivity of labor in the open sector compared to closed sector results in an increase in the relative price of non-tradable goods. By transforming the equation of marginal product in both sectors and their replacement in equation (1.9), we get:

$$P_n/P_t = \frac{b}{c}\frac{Y_t/L_t}{Y_n/L_n}. \tag{1.10}$$

Previous equation (Égert et al., 2002: 6) suggests a positive long-term impact of relative average labor productivity in the open sector on the relative price of non-tradable goods with the coefficient smaller than one ($c>b$). Equation (1.10) served as our theoretical basis for the empirical testing of internal transmission mechanism.

3.1.2. Modeling of the external transmission mechanism

The external transmission mechanism, as we have already explained, implies convergence in price levels and domestic currency real exchange rate appreciation that occur as a result of rapid growth of relative labor productivity in the open sector of the home country in comparison with the productivity of labor in the open sector of a selected foreign country which serves as a benchmark. A prerequisite for testing external transmission mechanism is the functionality of internal transmission mechanism observed in both countries. In this case the difference between the relative prices of non-tradable goods observed in both countries is mainly determined by the difference in the relative labor productivity of their open sectors. In order to derive such dependence we must adjust the equation (1.10) in such manner to include the two countries (the domestic and the foreign one), as follows:

$$P_n / P_t = \frac{b}{c} \frac{Y_t / L_t}{Y_n / L_n}, \tag{1.11}$$

$$P_n^* / P_t^* = \frac{b^*}{c^*} \frac{Y_t^* / L_t^*}{Y_n^* / L_n^*}, \tag{1.12}$$

where the variables marked with * refer to a foreign country. By dividing the equation (1.11) with the equation (1.12) we get (Égert et al., 2002: 6):

$$\frac{P_n / P_t}{P_n^* / P_t^*} = \frac{\frac{b}{c} \frac{Y_t / L_t}{Y_n / L_n}}{\frac{b^*}{c^*} \frac{Y_t^* / L_t^*}{Y_n^* / L_n^*}}, \tag{1.13}$$

which gives the relationship necessary for the empirical testing of the first part of the external transmission mechanism. Equation (1.13) mathematically formalizes the dependency of the ratio of relative prices of non-tradable goods in both home and foreign country on the ratio of relative labor productivity in their open sectors. This points to a positive long-term relationship which results from the assumptions of the HBS model ($0<b<1$, $0<c<1$, $0<b^*<1$ and $0<c^*<1$).

Testing the second part of the external transmission mechanism requires that we first determine the impact of the ratio of relative prices of non-tradable goods on the real exchange rate. If the real exchange rate is formulated as:

$$Q = \frac{SP}{P^*}, \tag{1.14}$$

where S, P and P^* denote, respectively, the nominal exchange rate (the price of one currency unit of domestic currency denominated in foreign currency), the average level of prices in the domestic country and the average price level in a foreign country. Increase (decrease) in such constructed real exchange rate indicates its appreciation (depreciation). The logarithm of (1.14) is:

$$q = s + p - p^*, \tag{1.15}$$

where the small letters denote the logarithmic transformation of the original variables (MacDonald, 1997: 6-7). If we take into account only the average prices of

tradable goods, according to equation (1.15), we can express real exchange rate as (MacDonald, 1997: 6):

$$q_t = s + p_t - p_t^* . \tag{1.16}$$

Average price levels both in home and foreign country can be expressed via the price of tradable and non-tradable goods (MacDonald, 1997: 6), so that:

$$p = (1-\alpha)p_t + \alpha p_n , \tag{1.17}$$

$$p^* = (1-\alpha^*)p_t^* + \alpha^* p_n^* , \tag{1.18}$$

where α denotes the share of non-tradable goods in gross domestic product. By introducing (1.17) and (1.18) into equation (1.15), and subsequent processing, we get:

$$LnQ = Ln\left[Q_t \frac{\frac{(P_n)^{\alpha}}{(P_t)^{\alpha}}}{\frac{(P_n^*)^{\alpha^*}}{(P_t^*)^{\alpha^*}}} \right]. \tag{1.19}$$

The antilogarithm of the equation (1.19) together with the substitution of *Qt* (Égert et al., 2002: 6) produces:

$$Q = \left[\frac{SP_t}{P_t^*} \frac{\frac{(P_n)^{\alpha}}{(P_t)^{\alpha}}}{\frac{(P_n^*)^{\alpha^*}}{(P_t^*)^{\alpha^*}}} \right]. \tag{1.20}$$

By relying on the standard HBS model assumption that the nominal exchange rate PPP-based, taking into account the prices of tradable goods, in the long – term we can accept the following equality:

$$\frac{SP_t}{P_t^*} = 1 , \tag{1.21}$$

from which (Égert et al., 2002: 7) follows that:

$$Q = \left[\frac{\frac{(P_n)^{\alpha}}{(P_t)^{\alpha}}}{\frac{(P_n^*)^{\alpha^*}}{(P_t^*)^{\alpha^*}}} \right]. \tag{1.22}$$

Therefore, the effect of the internal transmission mechanism in both countries (1.11 and 1.12) determines the ratio of their relative prices for non-tradable goods (1.13) which is finally reflected in the real exchange rate (1.22). In other words, the faster growth of relative labor productivity in the open sector of the home country leads to faster growth of relative prices of non-tradable goods in this country, as well as the appreciation of the real exchange rate of the domestic currency.

3.2. Model which especially analyzes distribution sector

Testing the functionality of the HBS effect with emphasis on the analysis of the distribution sector requires development of completely different theoretical models that will enable us to isolate the influence of the distribution sector *per se* and distinguish it from the influence of other services (closed sector). The construction of the model begins with the allocation of all forms of economic activity to primary and secondary activities (MacDonald and Ricci, 2005: 7). The primary activities include the production of intermediate goods (*I*), production of non-tradables (*N*), the provision of distribution services (*D*) and the so-called aggregation services (*A*) necessary to manufacture tradables from intermediate goods. Production in primary sectors (in the country *i* and in the sector *k*) can be described by the following production function which implies constant returns to labor (MacDonald and Ricci, 2005: 7):

$$Y_{ki} = \frac{L_{ki}}{\beta_{ki}};\ k = I, N, D, A\ ,\ i = 1,2\ , \tag{1.23}$$

where L and β denote, respectively, the labor input and the unit labor consumption. The variety of unit labor consumption implies a different technology in the primary activity sectors and countries. Production technology in the open sector (production of tradable goods Y_T combination of Y_I, Y_D and Y_A) and in the distribution of produced tradable goods, (Y_{TC}) is modeled based on the Cobb-Douglas production function (MacDonald and Ricci, 2005: 7), i.e.:

$$Y_{Ti} = \frac{Y_{Ii}^{\gamma\eta} Y_{Di}^{1-\gamma} Y_{Ai}^{\gamma(1-\eta)}}{(\gamma\eta)^{\gamma\eta}(1-\gamma)^{1-\gamma}(\gamma(1-\eta))^{\gamma(1-\eta)}}, \quad (1.24)$$

$$Y_{TCi} = \frac{Y_{Ti}^{1-\phi} Y_{Di}^{\phi}}{\phi^{\phi}(1-\phi)^{1-\phi}}. \quad (1.25)$$

Also, the utility function (preference) has the linearly homogeneous Cobb-Douglas form (MacDonald and Ricci, 2005: 7) and is identical for both countries, which can be written as:

$$U_i = \frac{y_{Ni}^{\alpha} y_{TCi}^{1-\alpha}}{\alpha^{\alpha}(1-\alpha)^{1-\alpha}}, \quad (1.26)$$

where U_i, y_{Ni} and y_{TCi} respectively represent the total utility of an individual consumer in the country i and his demand for tradables and non-tradables. So according to this model, the role of the distribution sector comes down to the supply of the open sector with the intermediate goods (that are used for production of tradable goods in accordance with the equation 1.36) and the distribution of tradable goods to the final consumers (1.25). Of course, in reality, the distribution services are also used for closed-sector purposes, which is, for simplicity, abstracted in this model. The above given abstractions simplify the model but do not affect the quality of the results. In addition, neglecting of the role of the distribution sector with regard to the production and distribution of non-tradable goods can be justified by the fact that most services (non-tradable goods) have their own vertically integrated distribution channels.

Microeconomic condition of profit maximization in primary sector requires the equality of price and marginal cost, that is:

$$P_{ki} = \beta_{ki}\omega_i \; ; \; k = I, N, D, A \; , \; i = 1,2 \; , \quad (1.27)$$

wher ω_i stands for the wages in country i.

Producer price of tradable goods, based on (1.24) and (1.27) can be formulated as (MacDonald and Ricci, 2005: 8):

$$P_{Ti} = P_{Ii}^{\gamma\eta} P_{Di}^{1-\gamma} P_{Ai}^{\gamma(1-\eta)} = \omega_i \beta_{Ii}^{\gamma\eta} \beta_{Di}^{1-\gamma} \beta_{Ai}^{\gamma(1-\eta)} . \quad (1.28)$$

Also, the consumer price of tradable goods and average consumer price level (MacDonald and Ricci, 2005: 8), according to equations (1.25) and (1.26), respectively, can be written as:

$$P_{TCi} = P_{Ti}^{1-\phi} P_{Di}^{\phi}, \tag{1.29}$$

$$P_i = P_{Ni}^{\alpha} P_{TCi}^{1-\alpha}. \tag{1.30}$$

The model assume that the law of one price holds for traded goods, which is the basic building block of the theory of purchasing power parity (Rogoff, 1996: 649-650), and which can be expressed as:

$$P_{T1} = EP_{T2}, \tag{1.31}$$

where *E* stands for the nominal exchange rate (price of one monetary unit of country 2 expressed in monetary units of country 1). The law of one price refers to the producer prices of tradable goods, which is explained by the existence of the goods arbitration at production level rather than at the consumer level. Finally, the real exchange rate equation based on the average consumer prices (1.30) can be rewritten as (MacDonald and Ricci, 2005: 8):

$$RER = \frac{P_1}{EP_2} = \frac{P_{N1}^{\alpha} P_{TC1}^{1-\alpha}}{EP_{N2}^{\alpha} P_{TC2}^{1-\alpha}}, \tag{1.32}$$

where an increase (decrease) of thus formulated real exchange rate indicates its appreciation (depreciation).

However, testing of the HBS model functionality primarily requires mathematical formulation of the relation (dependence) of the real exchange rate to the relative productivity of the open, closed and distribution sector. If we substitute the equation (1.27) in the expression for real exchange rate (1.32) we get:

$$RER = \frac{P_1}{EP_2} = \frac{P_{N1}^{\alpha} P_{TC1}^{1-\alpha}}{EP_{N2}^{\alpha} P_{TC2}^{1-\alpha}} = \frac{\omega_1}{E\omega_2} \left(\left(\frac{\beta_{T2}}{\beta_{T1}} \right)^{\gamma} \left(\frac{\beta_{D2}}{\beta_{D1}} \right)^{(1-\gamma)} \right)^{-(1-\phi)(1-\alpha)} \left(\frac{\beta_{N1}}{\beta_{N2}} \right)^{\alpha} \left(\frac{\beta_{D1}}{\beta_{D2}} \right)^{\phi(1-\alpha)}, \tag{1.33}$$

furtherly rearranged gives

$$RER = \left(\frac{\omega_1}{E\omega_2} \right)^{\alpha+\phi(1-\alpha)} \left(\frac{\beta_{N1}}{\beta_{N2}} \right)^{\alpha} \left(\frac{\beta_{D1}}{\beta_{D2}} \right)^{\phi(1-\alpha)}, \tag{1.34}$$

that is

$$RER = \left(\frac{\beta_{T2}}{\beta_{T1}}\right)^{\gamma\alpha+\gamma\phi(1-\alpha)} \left(\frac{\beta_{N2}}{\beta_{N1}}\right)^{-\alpha} \left(\frac{\beta_{D2}}{\beta_{D1}}\right)^{\alpha(1-\gamma)-\gamma\phi(1-\alpha)} \quad (1.35)$$

The equation (1.35) (MacDonald and Ricci, 2005: 9) represents a well-known relation, except that here it is extended by including the distribution sector. If we assume that $\Phi = 0$ and $\gamma = 1$, i.e. if distribution sector disappears from the production of tradable goods and their delivery to the final customers, the only remaining determinants of the real exchange rate include the relative labor productivity of open and closed sectors (the standard HBS model). According to the relation (1.35) the growth of relative labor productivity in the open (closed) sector of any country leads to an appreciation (depreciation) of the real exchange rate of its currency. Also, it should be noted that the hypothetical elimination of the distribution sector ($\Phi = 0$ and $\gamma = 1$) means that the respective elasticities of the real exchange rate with respect to the relative labor productivity in open and closed sectors are equal, but with the opposite sign (α and-α), which means that the simultaneous equal increase of the relative productivity in both sectors does not affect the real exchange rate, which is consistent with the standard HBS model.

According to equation (1.35) the influence of the distribution sector can be both positive and negative, depending on the sign of the exponent of the last term. Mathematical condition for the positive impact is $\alpha(1-\gamma)-\gamma\Phi(1-\alpha)>0$, *i.e.* $\Phi<\alpha(1-\gamma)/(\gamma(1-\alpha))$. The twofold effect of productivity in the open sector stems from the fact that this sector performs a dual function in the following way: (a) supplies the open sector with intermediate goods (so it can be considered as a part of the open sector) and (b) delivers the tradable goods to the final consumers thus, it can be considered as part of the service (closed) sector. The net impact will depend on whether the role of the distribution sector is larger in the first or the second case. Empirical testing of the model that we implemented is based on a logarithmic transformation of the equation (1.35).

3.3. Econometric methodology

Formal testing of non-stationarity of the time series using the Dickey-Fuller and Phillips-Perron test, showed that an I(1) processes is also present (test results are available on request). Non-stationarity of time series allows us to carry out a cointegration analysis by applying the Johansen and Engle-Granger cointegration (EG) test.

The Engle-Granger test is the simplest and simultaneously a rather wide-spread test introduced in the econometric theory in 1987 (Engle and Granger, 1987). Although

the authors suggested seven test statistics by means of which the null hypothesis of no cointegration can be tested, we have focused on the most used ADF test statistics of the augmented Dickey-Fuller unit root test. If we assume that the Y vector consists of N time series each of which is I(1), the application of the Engle-Granger test boils down to testing of non-stationarity of their linear combination. Namely, if the time series are cointegrated, then their linear combination of I(0) exists; otherwise, if they are not co-integrated, each linear combination of the observed time series will still be I(1). The application of the Engle-Granger test primarily implies the separation of the dependant variable from other independent (explanatory) variables within the vector Y. Afterwards, it is necessary to estimate the cointegration regression with the constant or with the constant and linear time trend by means of applying the OLS method. The next step is to compute the residual from thus estimated cointegration regressions and to test their non-stationarity. Testing of the null hypothesis of the non-stationarity of the residual time series is conducted by applying the ADF test statistics. It is necessary to expand the test regression equation by adding the first difference of the residual series with time lags until the serial correlation of the residuals in the test regression equation has been eliminated. The decision on the acceptance, i.e. rejection of the null hypothesis of the residual non-stationarity i.e. of no cointegration of the time series is made by comparison of the computed test statistics and critical values (James. G. MacKinnon, 2010) at a certain significance level.

The Johansen's procedure is more recent approach enabling a complete cointegration analysis of macro-economic time series (Hamilton, 1994: 635-650). The vector autoregression model (VAR) of the vector Y is the starting point of the aforementioned method. The vector autoregression model has to meet the following assumptions: (a) that the model is linear, (b) that the model's parameters are stable, and (c) that the disturbance term is normally distributed and that it is not serial correlated. The first step within the implementation of the Johansen`s procedure is the analysis of the VAR model residuals with the purpose of checking whether the aforementioned assumptions have been met. The starting specification of the VAR model is erroneous if at least one of the mentioned three assumptions has not been met. A formal statistical analysis of the normality of residuals is most commonly achieved by performing of the Shenton-Bowman test defined based on the skewness and kurtosis coefficients. This test serves the purpose of checking the normality of residuals` distribution for each individual equation and for all equations of the VAR model at the same time. The serial correlation of residuals of the VAR model is formally tested by the application of the one-dimensional and multi-dimensional Box-Ljung test. The one-dimensional test statistics serves the purpose of testing the serial correlation for each individual equation of the VAR model, while the multi-dimensional one serves the purpose of testing the serial correlation within the entire VAR model. The existence of the serial correlation requires an increase in the VAR model order in accordance with the values of the information criterion function until the serial

correlation has been eliminated. Finally, a careful selection of the statistical sample which does not contain any fundamental alterations should ensure the fulfillment of the parameters stability asumptions. Therefore, a careful selection of the sample should precede the estimation of the VAR model parameters. The starting VAR model may be transformed into the error correction model, most commonly used in practice, which does not lead to the alteration of the likelihood function. Influences of a short-term and long-term effect are thus separated. The Johansen`s approach boils down to determining the rank of the matrix defining influences of the long-term effect – matrix of the long-term adjustment in the movement of variables. The testing is performed by computing the Johansen's trace statistics and its comparison with critical values until the null hypothesis has been accepted, which implies a concrete number of cointegration vectors.

4. Data

Having in mind that there is no generally accepted method of classification of economy sectors into the open and closed ones (Égert et al., 2002: 8), we have opted for two manners of classification we consider appropriate for Serbia. Within the part of the Paper wherein we have analyzed the internal and external transmission mechanism of the standard HBS model, we have treated the industry and agriculture as open sectors, and services as non-tradable goods. The alternative manner implies the elimination of agriculture from the analysis procedure; hence tradable goods consist only of industry products, while services have the unchanged status. Testing of the model which especially analyses distribution sector required the sector to be re-grouped. The open sector still consists of the industry and agriculture (the first manner), i.e. only of the industry (the second manner); the distribution sector accounts for the wholesale and retail sector, while the closed sector consists of services, but excluding wholesale and retail trade on this occasion.

Quantifying the dynamics of relative prices of non-tradable goods in Serbia has been carried out by means of division of appropriate sectoral retail price indices. We have not used the consumer price index since it was introduced as late as in 2007. The time series refer to the period between January 2004 and December 2010 (January 2004=100). We have quantified the dynamics of relative prices of non-tradable goods in the EMU in two manners: (a) by ratio of sectoral harmonized indices of consumer prices and (b) ratio of sectoral deflators. The series refer to the period between January 2005 and December 2006 (January 2005=100).

The measure of average labor productivity for the open, closed and distribution sectors has been obtained by dividing seasonally adjusted sectoral gross values added with the total number of employed persons in the given sector. Dynamics of the relative labor productivity in the open sector has been quantified by the ratio

of appropriate sectoral labor productivity indices. Time series for Serbia refer to the period from January 2004 to December 2010 (January 2004=100), while for the EMU they refer to the period from January 2005 to December 2010 (January 2005=100).

The real exchange rate of the Dinar against the Euro has been calculated by using the nominal bilateral exchange rate, retail price index in Serbia and harmonized index of consumer prices in the EMU. The time series refer to the period between January 2005 and December 2010 (January 2005=100).

While testing the functionality of the external transmission mechanism of the standard HBS model and model which especially analyses distribution sector, all time series refer to the period between January 2005 and December 2010 (January 2005=100). The list of variables and sources of information are shown in the following Table, whilst any detailed information on the manner of their construction is available upon request.

Table 1: Variables we used in empirical research

Variable	Label	Source
Natural logarithm of the relative price index of non-tradable goods in Serbia	LNIRCN1	Author's calculation based on data dowloaded from http://webrzs.stat.gov.rs/WebSite/Public/PageView.aspx?pKey=110
	LNIRCN2	
Natural logarithm of the relative labor productivity index in the open sector in Serbia	LNSXAIRPRODOT1	Author's calculation based on data dowloaded from http://webrzs.stat.gov.rs/WebSite/public/PublicationView.aspx?pKey=41&pLevel=1&pubType=2&pubKey=467 and http://webrzs.stat.gov.rs/WebSite/Public/PageView.aspx?pKey=27
	LNSXMIRPRODOT1	
	LNSXAIRPRODOT2	
	LNSXMIRPRODOT2	
Natural logarithm of the relative price index of non-tradable goods in the EMU	LNEUIRCN1	Author's calculation based on data dowloaded from http://appsso.eurostat.ec.europa.eu/nui/setupModifyTableLayout.do
	LNEUIRCN2	
	LNEURDN1	
	LNEURDN2	
Natural logarithm of the relative labor productivity index of the open sector in the European Monetary Union	LNSXAEUIRPRODOT1	Author's calculation based on data dowloaded from http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/themes
	LNSXMEUIRPRODOT1	
	LNSXAEUIRPRODOT2	
	LNSXMEUIRPRODOT2	
Natural logarithm of the ratio of the relative price index of non-tradable goods in Serbia compared to the EMU	LNIDRCN1	Author's calculation based on data dowloaded from http://webrzs.stat.gov.rs/WebSite/Public/PageView.aspx?pKey=110 and http://appsso.eurostat.ec.europa.eu/nui/setupModifyTableLayout.do
	LNIDRDN1	
	LNIDRCN2	
	LNIDRDN2	
Natural logarithm of the ratio of relative productivity index of the open sector in Serbia compared to the EMU	LNSXAIDRPRODOT1	Author's calculation based on data dowloaded from http://webrzs.stat.gov.rs/WebSite/public/PublicationView.aspx?pKey=41&pLevel=1&pubType=2&pubKey=467 and http://webrzs.stat.gov.rs/WebSite/Public/PageView.aspx?pKey=27 and http:// epp.eurostat.ec.europa.eu/portal/page/portal/statistics/themes
	LNSXAIDRPRODOT2	
	LNSXMIDRPRODOT1	
	LNSXMIDRPRODOT2	
Natural logarithm of real exchange rate of dinar against euro	LNRER1	Author's calculation based on data dowloaded from http://webrzs.stat.gov.rs/WebSite/Public/PageView.aspx?pKey=110 and http://appsso.eurostat.ec.europa.eu/nui/setupModifyTableLayout.do
Natural logarithm of the ratio of labor productivity index of the open sector in Serbia compared to the EMU	LNSXAIRPRODOT1SE	Author's calculation based on data dowloaded from http://webrzs.stat.gov.rs/WebSite/public/PublicationView.aspx?pKey=41&pLevel=1&pubType=2&pubKey=467 and http://webrzs.stat.gov.rs/WebSite/Public/PageView.aspx?pKey=27 and http:// epp.eurostat.ec.europa.eu/portal/page/portal/statistics/themes
	LNSXAIRPRODOT2SE	
	LNSXMIRPRODOT1SE	
	LNSXMIRPRODOT2SE	
Natural logarithm of the ratio of labor productivity index of the distribution sector in Serbia compared to EMU	LNIRPRODDSXA	Author's calculation based on data dowloaded from http://webrzs.stat.gov.rs/WebSite/public/PublicationView.aspx?pKey=41&pLevel=1&pubType=2&pubKey=467 and http://webrzs.stat.gov.rs/WebSite/Public/PageView.aspx?pKey=27 and http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/themes
	LNIRPRODDSXM	
Natural logarithm of the ratio of labor productivity index of service sector (excluding distribution sector) in Serbia compared to the EMU	LNIRPRODZASXA	Author's calculation based on data dowloaded from http://webrzs.stat.gov.rs/WebSite/public/PublicationView.aspx?pKey=41&pLevel=1&pubType=2&pubKey=467 and http://webrzs.stat.gov.rs/WebSite/Public/PageView.aspx?pKey=27 and http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/themes
	LNIRPRODZASXM	

Note: If the variable label contains the number 1 (2), it means that the open sector consists of the industry and agriculture (only of industry). Productivity measures containing SXA (SXM) in their label have been computed by using gross values added seasonally adjusted by the Census X11-Additive (Census X11-Multiplicative) method

Source: Author

5. Results of the empirical tests

5.1. Testing of the internal transmission mechanism for Serbia and EMU

Testing of the internal transmission mechanism for Serbia and the EMU is based on the equation (1.10).

Table 2: Results of the testing of the internal transmission mechanism for Serbia: Johansen test

Independent variables	LNIRCN1		LNIRCN2	
	(1)	(2)	(3)	(4)
C	0.004	0.010	0.005	0.0003
	(0.01925)	(0.02411)	-	-
LNSXAIRPRODOT1	-0.187	-	-	-
	(0.12762)	-	-	-
LNSXMIRPRODOT1	-	-0.124	-	-
	-	(0.16361)	-	-
LNSXAIRPRODOT2	-	-	-0.246	-
	-	-	(0.12823)	-
LNSXMIRPRODOT2	-	-	-	-0.271
	-	-	-	(0.12774)
Critical values at the level of significance of 5% (Ho: no cointegration equation)	19.96	19.96	15.41	15.41
Values of LR test statistics (Ho: no cointegration equation)	***10.23***	***6.04***	***11.87***	***12.36***
Critical values at the level of significance of 5% (Ho: at most one cointegration equation)	9.24	9.24	3.76	3.76
Values of LR test statistics (Ho: at most one cointegration equation)	4.11	2.01	4.48	4.66

Note: Detailed results of cointegration tests are available on request. Standard errors are given in parentheses below the coefficients

Source: Author

Research in Serbia covers the period from 2004-2010, where the last few years are intentionally omitted due to the fact that in the first years of transition the relative prices were under a strong influence of the liberalization and elimination of price disparity processes, while the productivity itself was largely under the influence of the privatization process, which inevitably led to enterprise restructuring and rationalization of the number of employees. Some of these effects are still present, but their intensity, however, is significantly smaller.

By applying Johansen cointegration test we obtained the values of the trace test statistics (Table 2) based on which, at a 5% significance level, we cannot reject the null hypothesis on the absence of cointegration between the observed time series.

Table 3: Results of the testing of the internal transmission mechanism for Serbia: Engle-Granger test

Independent variables	LNIRCN1		LNIRCN2	
	(1)	(2)	(3)	(4)
C	0.012	0.012	0.003	0.003
	(0.00536)	(0.00534)	(0.00664)	(0.00670)
LNSXAIRPRODOT1	-0.151	-	-	-
	(0.03567)	-	-	-
LNSXMIRPRODOT1	-	-0.151	-	-
	-	(0.03595)	-	-
LNSXAIRPRODOT2	-	-	-0.252	-
	-	-	(0.04023)	-
LNSXMIRPRODOT2	-	-	-	-0.253
	-	-	-	(0.04004)
Values of EG test statistics	***-2.7245***	***-2.6610***	***-3.0589***	***-3.1091***
Critical values of the EG test at the level of significance of 5%	-3.4137	-3.4137	-3.4137	-3.4137

Note: Detailed results of cointegration tests are available on request. Critical values of the EG test are obtained according to James. G. MacKinnon (2010). Standard errors are given in parentheses below the coefficients

Source: Author

Similar results are obtained by applying the EG test (Table 3). Estimated values of regression parameters are negative, as in previous case, which completely contradicts the expectations formed on the basis of the equation (1.10). In addition, the calculated values of EG test statistics suggest non-stationarity of the cointegration regression residuals at a 5% significance level, which suggests that the observed time series are not cointegrated.

Testing of the internal transmission mechanism with reference to the EMU was conducted for the period 2005-2010. Most of the values obtained for the trace test statistics require us to accept the null hypothesis on absence of cointegration at a 5% significance level (Table 4). The first two equations are considered the exception since the Johansen test shows that the observed time series are cointegrated, but with a negative cointegration coefficient which is not in accordance with the HBS model.

Table 4: Results of the testing of the internal transmission mechanism for the EMU: Johansen test

Independent variables	LNEUIRCN1		LNEURDN1		LNEUIRCN2		LNEURDN2	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
C	-0.010	-0.010	-0.001	-0.001	-0.017	-0.018	-0.004	-0.004
	-	-	-	-	-	-	-	-
@TREND	0.001	0.001	0.001	0.001	0.001	0.001	0.0003	0.0003
	(0.000049)	(0.000048)	(0.000086)	(0.000078)	(0.00013)	(0.00006)	(0.000058)	(0.000061)
LNSXAEUIRPRODOT1	-0.270	-	-0.199	-	-	-	-	-
	(0.02582)	-	(0.05101)	-	-	-	-	-
LNSXMEUIRPRODOT1	-	-0.267	-	-0.194	-	-	-	-
	-	(0.02546)	-	(0.04647)	-	-	-	-
LNSXAEUIRPRODOT2	-	-	-	-	-0.273	-	-0.029	-
	-	-	-	-	(0.07021)	-	(0.03589)	-
LNSXMEUIRPRODOT2	-	-	-	-	-	-0.369	-	-0.032
	-	-	-	-	-	(0.03715)	-	(0.03778)
Critical values at the level of significance of 5% (Ho: no cointegration equation)	25.32	25.32	25.32	25.32	25.32	25.32	25.32	25.32
Values of LR test statistics (Ho: no cointegration equation)	69.23	68.31	***18.29***	***15.28***	***24.24***	***25.18***	***18.49***	***16.79***
Critical values at the level of significance of 5% (Ho: at most one cointegration equation)	12.25	12.25	12.25	12.25	12.25	12.25	12.25	12.25
Values of LR test statistics (Ho: at most one cointegration equation)	***11.26***	***10.47***	5.76	2.84	1.83	6.63	4.73	4.50

Note: Detailed results of cointegration tests are available on request. Standard errors are given in parentheses below the coefficients

Source: Author

The Engle – Granger test (Table 5) almost completely confirms previous findings indicating non-stationarity of the cointegration regression residuals, with the exception of the first two equations whose regression coefficients are negative and therefore unexpected.

Table 5: Results of the testing of the internal transmission mechanism for the EMU: Engle-Granger test

Independent variables	LNEUIRCN1		LNEURDN1		LNEUIRCN2		LNEURDN2	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
C	-0.009	-0.009	-0.002	-0.002	-0.015	-0.016	-0.005	-0.005
	(0.002310)	(0.002303)	(0.001809)	(0.001807)	(0.003184)	(0.003155)	(0.002039)	(0.002030)
@TREND	0.001	0.001	0.001	0.001	0.001	0.001	0.0004	0.000361
	(0.000063)	(0.000062)	(0.000049)	(0.000049)	(0.000080)	(0.000079)	(0.000051)	(0.000051)
LNSXAEUIRPRODOT1	-0.219	-	-0.121	-	-	-	-	-
	(0.032671)	-	(0.025582)	-	-	-	-	-
LNSXMEUIRPRODOT1	-	-0.218	-	-0.120	-	-	-	-
	-	(0.032400)	-	(0.025424)	-	-	-	-
LNSXAEUIRPRODOT2	-	-	-	-	-0.268	-	-0.030	-
	-	-	-	-	(0.043351)	-	(0.027760)	-
LNSXMEUIRPRODOT2	-	-	-	-	-	-0.270	-	-0.031
	-	-	-	-	-	(0.043014)	-	(0.027677)
Values of EG test statistics	***-4.4243***	***-4.3418***	***-1.8596***	***-1.6893***	***-3.6107***	***-3.5844***	***-1.7977***	***-1.7932***
Critical values of the EG test at the level of significance of 5%	-3.9449	-3.9449	-3.9478	-3.9478	-3.9449	-3.9449	-3.9421	-3.9421

Note: Detailed results of cointegration tests are available on request. Critical values of the EG test are obtained according to James. G. MacKinnon (2010). Standard errors are given in parentheses below the coefficients

Source: Author

To summarize, by applying the Johansen and Engle-Granger procedure we were unable to detect any effect of relative labor productivity in the open sector on the relative prices of non-tradable goods in Serbia. The reasons for such findings may be found in the administrative control of prices of some types of services. However, the results obtained for the EMU are slightly different. Only in two out of eight equations, the cointegration tests suggest the negative, i.e. the opposite effect of relative labor productivity in the open sector on the relative prices of non-tradable goods. In all other cases, we were not able to confirm cointegration of the time series. Thus, the results of empirical research conducted for Serbia and the EMU do not provide sufficient evidence that the internal transmission mechanism functions.

5.2. Testing of the external transmission mechanism

Since it is quite clear that the effect of internal transmission mechanism in both countries is a prerequisite for the functioning of the external transmission mechanism (1.11 and 1.12) the question arises whether it is justified to test the external mechanism. However, we believe that testing is necessary in order to check the validity of the

previous analysis, i.e. the robustness of the conclusions that we have derived from it. Examination of the external transmission mechanism consists of two parts. The first part is the analysis of the impact of the relative labor productivity ratio in the open sector on the ratio of the relative prices of non-tradable goods (1.13), while the second part involves testing of the impact of the relative price of non-tradable goods ratio on the real exchange rate (1.22). The analysis of the latter part is based on a simplified form of equation (1.22) which implies that α and α^* equals one (Égert et al., 2002: 19).

Table 6: Results of the testing of the external transmission mechanism: Johansen test

Independent variables	LNIDRCN1		LNIDRDN1		LNIDRCN2		LNIDRDN2		LNRER1			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
C	0.009	0.009	-0.001	-0.014	0.009	0.014	0.036	0.041	-4.157	-4.255	-4.189	-4.109
	(0.01794)	(0.01859)	(0.02388)	-	-	-	(0.04115)	-	(0.07344)	-	-	(0.08812)
LNSXAIDRPRODOT1	0.098	-	0.157	-	-	-	-	-	-	-	-	-
	(0.07956)	-	(0.10776)	-	-	-	-	-	-	-	-	-
LNSXMIDRPRODOT1	-	0.095	-	0.065	-	-	-	-	-	-	-	-
	-	(0.08136)	-	(0.09779)	-	-	-	-	-	-	-	-
LNSXAIDRPRODOT2	-	-	-	-	0.048	-	0.249	-	-	-	-	-
	-	-	-	-	(0.07553)	-	(0.21005)	-	-	-	-	-
LNSXMIDRPRODOT2	-	-	-	-	-	0.076	-	0.268	-	-	-	-
	-	-	-	-	-	(0.09008)	-	(0.22659)	-	-	-	-
LNIDRCN1	-	-	-	-	-	-	-	-	-3.453	-	-	-
	-	-	-	-	-	-	-	-	(2.84093)	-	-	-
LNIDRDN1	-	-	-	-	-	-	-	-	-	-2.155	-	-
	-	-	-	-	-	-	-	-	-	(2.12625)	-	-
LNIDRCN2	-	-	-	-	-	-	-	-	-	-	2.731	-
	-	-	-	-	-	-	-	-	-	-	(3.43108)	-
LNIDRDN2	-	-	-	-	-	-	-	-	-	-	-	-0.652
	-	-	-	-	-	-	-	-	-	-	-	(2.22488)
Critical values at the level of significance of 5% (Ho: no cointegration equation)	19.96	19.96	19.96	15.41	15.41	15.41	19.96	15.41	19.96	15.41	15.41	19.96
Values of LR test statistics (Ho: no cointegration equation)	***10.65***	***10.18***	***8.97***	***8.33***	***14.23***	***12.42***	***9.19***	***7.94***	***9.02***	***5.01***	***8.62***	***6.94***
Critical values at the level of significance of 5% (Ho: at most one cointegration equation)	9.24	9.24	9.24	3.76	3.76	3.76	9.24	3.76	9.24	3.76	3.76	9.24
Values of LR test statistics (Ho: at most one cointegration equation)	3.07	2.68	2.98	1.94	3.57	3.57	4.41	3.25	4.06	2.19	2.31	2.27

Note: Detailed results of cointegration tests are available on request. Standard errors are given in parentheses below the coefficients

Source: Author

Findings with regard to the time period 2005- 2010, that were obtained by applying the Johansen test (Table 6) lead us to reject the possibility of the existence of any external transmission mechanism regardless of whether it is in relation to the first (equation 1-8) or the second part (equation 9-12) of the mechanism.

The application of the Engle – Granger test does not challenge the previous results (Table 7). More specifically, the analysis shows that the time series are not cointegrated with relation to the first or the second part of the external transmission mechanism.

Table 7: Results of the testing of the external transmission mechanism: Engle-Granger test

Independent variables	LNIDRCN1		LNIDRDN1		LNIDRCN2		LNIDRDN2		LNRER1			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
C	0.004	0.004	-0.007	-0.006	0.015	0.015	0.0001	-0.0003	-4.207	-4.232	-4.197	-4.202
	(0.00601)	(0.00615)	(0.00692)	(0.00707)	(0.00656)	(0.00663)	(0.00797)	(0.00806)	(0.01353)	(0.01631)	(0.01248)	(0.01349)
LNSXAIDRPRODOT1	0.067	-	0.104	-	-	-	-	-	-	-	-	-
	(0.02666)	-	(0.03070)	-	-	-	-	-	-	-	-	-
LNSXMIDRPRODOT1	-	0.066	-	0.106	-	-	-	-	-	-	-	-
	-	(0.02710)	-	(0.03115)	-	-	-	-	-	-	-	-
LNSXAIDRPRODOT2	-	-	-	-	0.081	-	0.049	-	-	-	-	-
	-	-	-	-	(0.03251)	-	(0.03951)	-	-	-	-	-
LNSXMIDRPRODOT2	-	-	-	-	-	0.081	-	0.046	-	-	-	-
	-	-	-	-	-	(0.03290)	-	(0.04000)	-	-	-	-
LNIDRCN1	-	-	-	-	-	-	-	-	-1.037	-	-	-
	-	-	-	-	-	-	-	-	(0.48988)	-	-	-
LNIDRDN1	-	-	-	-	-	-	-	-	-	-1.277	-	-
	-	-	-	-	-	-	-	-	-	(0.39579)	-	-
LNIDRCN2	-	-	-	-	-	-	-	-	-	-	-1.322	-
	-	-	-	-	-	-	-	-	-	-	(0.49294)	-
LNIDRDN2	-	-	-	-	-	-	-	-	-	-	-	-0.560
	-	-	-	-	-	-	-	-	-	-	-	(0.43446)
Values of EG test statistics	***-2.6685***	***-2.6593***	***-2.2800***	***-2.2488***	***-2.3790***	***-2.3799***	***-2.0351***	***-2.0238***	***-1.7669***	***-1.5008***	***-1.9303***	***-1.6019***
Critical values of the EG test at the level of significance of 5%	-3.4248	-3.4248	-3.4248	-3.4248	-3.4396	-3.4396	-3.4248	-3.4248	-3.4248	-3.4235	-3.4288	-3.4248

Note: Detailed results of cointegration tests are available on request. Critical values of the EG test are obtained according to James. G. MacKinnon (2010). Standard errors are given in parentheses below the coefficients

Source: Author

The absence of cointegration of time series means that the external transmission mechanism does not work, which is entirely expected result consistent with the previous conclusion that the internal transmission mechanism in Serbia and the EMU does not function.

5.3. Testing of the model which especially analyzes distribution sector

Given the fact that we failed to detect the effect of the standard HBS model, we had to examine whether the cause of the obtained results comes from the fact that the standard HBS model somewhat unfairly treats distribution sector only as a component of the closed sector. In this regard, we addressed this problem by the empirical testing of the model which especially analyzes the distribution sector, which is based on the logarithmic transformation of equation (1.35).

Table 8: Results of the testing of the model which especially analyzes distribution sector: Johansen test

Independent variables	LNRER1		
	(1)	(2)	(3)
C	-4.371	-4.316	-4.423
	-	-	-
LNIRPRODDSXA	0.621	0.136	-
	(0.26079)	(0.26122)	-
LNIRPRODDSXM	-	-	0.795
	-	-	(0.16869)
LNIRPRODZASXA	-0.236	0.722	-
	(0.35923)	(0.42267)	-
LNIRPRODZASXM	-	-	-0.178
	-	-	(0.22460)
LNSXAIRPRODOT1SE	-0.265	-	-
	(0.28808)	-	-
LNSXMIRPRODOT1SE	-	-	-0.792
	-	-	(0.17692)
LNSXAIRPRODOT2SE	-	-1.110	-
	-	(0.35548)	-
Critical values at the level of significance of 5% (Ho: no cointegration equation)	47.21	47.21	47.21
Values of LR test statistics (Ho: no cointegration equation)	***42.96***	***43.12***	***45.87***
Critical values at the level of significance of 5% (Ho: at most one cointegration equation)	29.68	29.68	29.68
Values of LR test statistics (Ho: at most one cointegration equation)	18.67	18.98	20.49

Note: Detailed results of cointegration tests are available on request. Standard errors are given in parentheses below the coefficients

Source: Author

The results of the Johansen test (Table 8) show that there is no cointegration between the analyzed time series, i.e. that the final equation of the theoretical model (1.35) has no empirical ground.

Table 9: Results of the testing of the model which especially analyzes distribution sector: Engle-Granger test

Independent variables	LNRER1		
	(1)	(2)	(3)
C	-4.414	-4.399	-4.422
	(0.017464)	(0.016133)	(0.017269)
LNIRPRODDSXA	0.547	0.160	-
	(0.133628)	(0.125018)	-
LNIRPRODDSXM	-	-	0.551
	-	-	(0.125409)
LNIRPRODZASXA	0.206	1.013	-
	(0.175713)	(0.198977)	-
LNIRPRODZASXM	-	-	0.218
	-	-	(0.164099)
LNSXAIRPRODOT1SE	-0.681	-	-
	(0.138059)	-	-
LNSXMIRPRODOT1SE	-	-	-0.764
	-	-	(0.140147)
LNSXAIRPRODOT2SE	-	-1.148	-
	-	(0.169108)	-
Values of EG test statistics	***-3.0374***	***-3.5043***	***-2.9802***
Critical values of the EG test at the level of significance of 5%	-4.2579	-4.2579	-4.2579

Note: Detailed results of cointegration tests are available on request. Critical values of the EG test are obtained according to James. G. MacKinnon (2010). Standard errors are given in parentheses below the coefficients

Source: Author

The application of the EG test did not produce any new facts (Table 9). The observed time series are not cointegrated, i.e. there is no evidence that would lead us to believe that the modified HBS model functions. In other words, the special analysis of the distribution sector did not affect our previous findings, thus we cannot claim that the inclusion of the distribution sector in the service sector is the reason why the standard HBS model is not functioning.

6. Conclusion

Based on the results of the authors' research we can accept the initial hypothesis that the dynamics of the dinar/euro real exchange rate cannot be explained by the differences in sectoral labor productivity. The testing of the standard HBS model did not confirm the effect of the relative labor productivity in the open sector on the relative prices of non-tradable goods both in Serbia and the EMU. As it had been expected, the further testing of the external transmission mechanism pointed out that the difference in the relative labor productivity in the open sector between Serbia and the EMU did not affect the difference in relative prices of non-tradable goods, as well as that the difference in relative prices of non-tradable goods did not translate to the real exchange rate of the dinar against the euro. This practically means that there is no empirical evidence that would confirm the functioning of the standard HBS model concerning the relations between Serbia and the EMU. The idea that a key reason for these results could be the unjustified inclusion of the distribution sector in the group of other services has been proven incorrect. Namely, the empirical testing of a modified version of HBS model, which especially analyzes distribution sector, has not challenged the previous results. In this research, like in the previous ones, we were not able to detect the influence of the relative labor productivity in the open sector, as well as in the closed and the distribution sector on the dinar/euro real exchange rate. These results support a relatively small number of previous studies that generally challenge the empirical validity of the HBS effect. The immaence of managed floating exchange rate regime in Serbia quite commonly causes heated discussions, even debates, about reasons for volatility of exchange rates Dinar against Euro, currency risks that exist, and alternative scenarios of its dynamics in the forthcoming period. Such debates, unfortunately, are rarely based on results of empirical researches, but more commonly rely on economists' intuition. Reasons for exchange rate real appreciation since 2001 until present day have been related to a number of impacts – starting from the Nominal Anchor Exchange Rate Policies, via effects of privatisation incomes and debts, to faster economic growth in Serbia compared to Eurozone, which implicitly imposes the HBS effect as an impact mechanism. With this paper we have tried to provide for exact empirical findings about the effectiveness of HBS effect between Serbia and EMU, thus contributing to better and more comprehensive understating of this phenomenon. The special importance of this research lies in the fact that this is the only analysis of the functionality of the HBS model concerning the relations between the Serbia and the EMU that we know of, and therefore the only analysis that addresses the issues of potential conflict between the *catch-up* process and fulfilling the nominal convergence criteria concerning the aforementioned relations. In addition, our methodological framework makes a good starting point for further analysing of HBS effect, which would be based on different varieties of HBS model and modified data set. The main limitations of our research, which might somewhat affect the results,

lay in the facts that: (a) the time series used in the research are not long enough, since the consistent data available refer to a period of only six or seven years (b) prices of some important services (non-tradable goods) are still under administrative control, which can significantly reduce or even completely eliminate the effect of the relative labor productivity in the open sector on the real exchange rate. We are of the opinion that it would be beneficial to conduct further research in the future based on a more comprehensive data collection, as well as to extend the analysis so that it would include other determinants of exchange rate mentioned in the relevant empirical literature such as the real interest rate differential, the net international investment position, the fiscal balance differential, etc. Regardless the point in time when the membership of Serbia in the EU would be on the agenda, the risk of conflict between the nominal and the real convergence should not exist.

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Harod – Balassa – Samuelsonov učinak i uloga distribucijskog sektora: empirijska studija slučaja Srbije i EMU[1]

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Sažetak

Cilj istraživanja jest testiranje funkcionalnosti standardnog i modificiranog HBS modela, s namjerom da se utvrdi da li sektorske razlike u produktivnosti rada utječu na realni tečaj dinar-euro. Prvi dio analize zasnovan je na standardnom HBS modelu koji matematički formalizira ovisnost realnog valutnog tečaja od razlike u relativnoj produktivnosti rada otvorenog sektora između Srbije i EMU. Drugi dio istraživanja oslanja se na modificiranu verziju HBS modela koji se razlikuje od standardnog HBS modela po tome što se učinak distribucijskog sektora zasebno analizira. Empirijsko testiranje oba modela izvršeno je primjenom Johansenovog i Engl-Grangerovog testa. Rezultati dobiveni analiziranjem standardnog HBS modela pokazuju da nema pouzdanih dokaza na temelju kojih bi se moglo zaključiti da se razlika u relativnoj produktivnosti rada otvorenog sektora između Srbije i EMU prenosi na razliku u relativnim cijenama nerazmjenjivih dobara, niti da razlika u cijenama utječe na realni tečaj dinar-euro. Štoviše, ni analiza modificiranog HBS modela ne utječe na prethodne rezultate. Na temelju ovakvih nalaza zaključuje se da realni tečaj dinar-euro nije determiniran isključivo sektorskim razlikama u produktivnosti rada, te da Srbija u daljoj perspektivi neće morati odlučiti da li želi dinamičan ekonomski rast ili članstvo u EMU.

***Ključne riječi**: Harrod-Balassa-Samuelsonov model, otvoreni sektor, distribucijski sektor, relativne cijene nerazmjenjivih dobara*

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