Original Scinetific Paper

*Testing of Balassa-Samuelson Model Functionality: Empirical Research in Case of Serbia and European Monetary Union **

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Summary:
This paper shows the results of empirical testing of Balassa-Samuelson model functionality in case of Serbia and European Monetary Union. The research for Serbia pertains to the period between 2004 and 2010, while in the case of EMU, due to unavailability of data about employment per sector, the period is somewhat shorter, covering 2005 to 2010. Applying both methods of cointegration analysis (Johansen and Engle-Granger's one), we have reached the results which show that internal transmission mechanism does not function in Serbia.

Key words:
Balassa-Samuelson model, internal transmission mechanism, open sector, relative prices of non-tradable goods, open sector relative productivity.

Rezime:
Ovaj rad prikazuje rezultate empirijskog testiranja funkcionalnosti Balaša-Semjuelsonovog modela u slučaju Srbije i Evropske monetarne unije. Istraživanje za Srbiju odnosi se na vremenski period 2004-2010. godine, dok je vremenski period u slučaju EMU, zbog nedostupnosti podataka o zaposlenosti po sektorima, nešto kraći i proteže se od 2005. do 2010. godine. Primenom oba metoda kointegracione analize (Johansenov i Engl-Grejndžerov) došli smo do rezultata koji pokazuju da interni transmisioni mehanizam u Srbiji ne funkcioniše.

Ključne reči:
Balaša-Semjuelsonov model, interni transmisioni mehanizam, otvoreni sektor, relativne cene nerazmenjivih dobara, relativna produktivnost otvorenog sektora.

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1. INTRODUCTION

The Balassa-Samuelson (BS) model has become particularly actual over the past twenty years, with a real boom in researches dedicated to this very phenomenon (see /24/ page 4). There are several reasons for its actualisation. One of them is certainly the development of a rich database and time series which were long enough toenable empirical testing. Without these prerequisites, researches of BS model would be nothing more but mere mathematical formaisation of a descriptive economic theory. Second very important reason, giving a comprehensive context to the formation of a critical mass of data, is a fast development of econometric techniques, which has provided for a methodological framework for empirical researches to a great extent. Yet, it is deemed that the European Union (EU) enlargement process was a crucial event that affected the increase of research interest for the BS effect.

The EU enlargement process has generated numerous controverses in terms of functioniality and intensity of the BS effect in the accession countries. Actually, the essence of this problem is the effect that can enable faster growth of productivity in the accession countries compared to productivity of the European Monetary Union (EMU) member states, to the nominal convergence criteria referred to in the Maastrict Treaty. This potential problem particularly attracted attention of researchers from late 1990s, exactly at the approximation of Central and Eastern Europe transitional countries to the full EU membership. If we assume that a long-term perspective of transitional countries is not to achieve the EU membership only, but also the EMU membership status, a question is naturally imposed whether it is possible to implement simultaneously the nominal and real convergence towards the EMU member states. If this problem really exists, then there is an open question whether *trade off* between the real convergence and the EMU membership is really needed and inevitable.

In other words, the emphasis of this problem, if the BS model has any empirical support in the accession countries refers to difficulties of simultaneous fulfilment of criteria related to inflation and stability of the nominal exchange rate (see /13/ and /3/). If we assume that the BS model has empirical support, then we find ourselves in a situation that real convergence (catch-up effect) leads to an increase of prices of non-tradable goods, overall inflation and convergence in the pricing level between the countries, which is in a conflict with the nominal convergence criterion according to which inflation of a country accessing the EMU must not exceed the average inflation rate in three EMU member states with lowest inflation rate by more than 1.5 percentage points. Meeting of this criterion,

with parallel functioning of the BS model, is possible only of we assume appreciation of nominal exchange rate of the domestic currency, which would, as per the BS model, lead to an increase in relative prices of non-tradable goods, primarily due to the reduction of prices of tradable goods in domestic currency. However, this time the criterion for the stability of nominal exchange rate contained in the ERM II mechanism would not be met.

The expansion of researches addressing the BS effect has led to differentiation of various opinions about its functionality. Actually, there is a considerable consensus about a long-term influence of relative labour productivity of the open sector to relative prices of non-tradable goods. At the same time, the opinions considerably differ when it comes to a long-term influence of the quotient of the relative labour productivity of the open sector to the quotient of the relative prices of non-tradable goods, i.e. to the discrepancy in overall inflation between the countries and appreciation of the real exchange rate of the domestic currency. The appreciation of domestic currency in transitional countries, caused by growth in relative labour productivity in the open sector, ranges between the approximate value of 3% annually (see /13/) and significantly lower 0%-1.5% annually (see /8/ i /11/).

Although Serbia is still quite far from the full EU membership, it seems that in the light of current Euro-integrations, it would be quite interesting to explore functionalities of the BS effect both in Serbia and in the EMU, which actually is a goal of our research. The test we conducted for Serbia pertains to time period between 2004 and 2010, while the interval pertaining to the EMU, due to unavailability fo data, is somewhat shorter and covers the period 2005-2010. During the research, special emphasis was put on the internal transmission mechanism, i.e. on the influence of relative labour productivity in the open sector to relative prices of non-tradable goods.

This Paper is composed of four parts. In the first one, we have tried to explain theoretical basis of the BS model, bearing in mind that this basis is necessary for the implementation of appropriate empirical tests. Most important information about data we used in the analysis is shown in the second part. The third one contains the presentation of empirical results while the final one contains most important conclusions.

2. THEORETICAL BACKGROUNDS OF THE BALASSA-SAMUELSON EFFECT

According to the BS model, roughly speaking, growth in labour productivity in the sectors dealing with production of tradable goods (open sector) usually exceeds the growth in productivity in the sector dealing with

production of non-tradable goods (closed sector). If we assume perfect mobility of workers between the sectors, it is clear that their wages will be almost equal, i.e. they will be formed at a common level. The growth in labour productivity in the open sector significantly reduces its unit labour input creating the conditions that wages will increase proportionally without affecting the labour unit costs. If we accept the *ceteris paribus* circumstances, i.e. the assumption that consumption and prices of other production inputs remain unchanged, it doubtlessly will not change the overall unit costs, thus avoiding cost pressures to the growth of tradable goods prices. The increase of wages in the open sector, taking into account perfect labour mobility, affects the increase of wages in the closed sector as well. However, since the growth of its labour productivity does not follow the growth of the open sector productivity, the increase of wages will put pressure to the increase of absolute and relative prices of non-tradable goods. Therefore, if the growth of labour productivity in the domestic country exceeds the growth of labour productivity in a foreign country, the overall domestic inflation will be higher, respecting the BS model. In addition, if we assume that purchasing power parity (PPP) applies to open sectors' prices, implying that change in the nominal exchange rate will cover the discrepancy between the domestic and foreign growth of prices of tradable goods, higher domestic inflation, caused by the increase in prices of non-tradable goods, will lead to appreciation of the real exchange rate based on consumer prices index as an indicator of the overall inflation.

The BS effect is the basis for the above-mentioned standpoint about the existence of conflict between the nominal and real convergence. Actually, the criteria for nominal convergence are included in the Maastricht Treaty, and they address the need to bring down five economic indicators (inflation, budget deficit, long-term nominal interest rate, public debt and exchange rate) to the level which would make the EMU membership of a country optimal. At the same time, real convergence implies the well-known catch-up effect. If countries, potential EMU members, implement the real convergence, which would mean a considerable growth of productivity compared to the current EMU members, influence of the BS effect would lead to higher inflation in these economies, caused by the growth of absolute and relative prices of non-tradable goods, i.e. to the situation that the convergence criteria pertaining to inflation cannot be satisfied if we have a stable nominal exchange rate. Alternatively, adjustment of relative prices of non-tradable goods is possible even without inflation, but only in the event of appreciation of domestic currency, which would lead to fall in prices of tradable goods expressed in the domestic currency. In this case, we would have deviation from the second criterion of convergence, which pertains to the stability of exchange rate. Hence, real convergence referring to faster growth in productivity in accessing countries will question the possibility of simultaneous fulfilment of both mentioned criteria of convergence.

The whole BS effect mechanism can be decomposed into two sub-mechanisms, such as (a) internal transmission mechanism and (b) external transmission mechanism. The internal transmission mechanism refers to the influence of growth in relative labour productivity in the open sector (quotient of labour productivity in open and closed sectors). Therefore, technically speaking, if the BS effect is functional, relative labour productivity in open sector should affect the dynamics of relative prices of non-tradable goods. On the other hand, if internal transmission mechanism functions, we can expect bigger growth in non-tradable goods prices, and consequently higher overall inflation, in those countries with greater growth in relative labour productivity in the open sector. This should be followed by appreciation of the real exchange rate for their currencies based on consumer prices index; bearing in mind that nominal exchange rate is formed based on PPP, which takes into account the prices of tradable goods. This mechanism, which refers to the convergence of pricing level and appreciation of the real domestic currency exchange rate, is known as external transmission mechanism. In order to understand these mechanisms better and in more details, it is necessary to apply mathematical formalisation.

2.1 Internal transmission mechanism

The Balassa-Samuelson model actually presents a technical formalization of the homonymous effect. In order to determine the relative prices of tradable and non-tradable goods, hence the overall prices level, through supply conditions, i.e. through production functions at the overall economy level, it is necessary to introduce several assumptions (see /10/ page 3). Firstly, every economy produces two kinds of goods (tradable and non-tradable), production of which has been described by the Cobb-Douglas production functions with constant returns to scale and various sectoral production elasticity with respect to individual inputs, which can be formulated as:

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

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

where (Y) stands for overall production of certain goods, (K) for the capital stock employed in the production, (L) for the number of people employed by a relevant sector, (A) for total factor productivity, (b) and (c) for constant elasticity of production with respect to the number of employees ($0<b<1$; $0<c<1$), (t) and (n) for the respective marks for tradable and non-tradable goods. Secondly, elasticity of production of non-tradable goods with respect to labour, is higher than the appropriate elasticity in the open sector ($c>b$).

Thirdly, prices of tradable goods are determined at global market, i.e. they are observed as an exogenous variable. Fourthly, interest rates are also formed in global market. Fifthly, capital stock is fixed one period ahead. Sixthly, labour mobility between the sectors is perfect, while it is very small between the countries. Finally, real salaries in the open sector are determined by marginal product of labour.

If all the listed assumptions are met, relative price for non-tradable goods is completely determined by supply conditions. Such conclusion comes out of microeconomic conditions for profit maximization in both sectors, taking into account that prices of tradable goods and interest rates are exogenous variables. The condition for profit maximization in both sectors is the equality of marginal products of both production factors and their real prices. This would specifically mean that marginal product of labour equals the real wages, while marginal product of capital is equal to the real interest rate. Marginal product of certain inputs are calculated by differentiating the equations (1.1) and (1.2) per both variables, which gives the following:

$$\frac{\partial Y_t}{\partial K_t} = (1-b)A_t L_t^{\,b} K_t^{-b} = (1-b)A_t\left(\frac{1}{K_t/L_t}\right)^b, \quad (1.3)$$

$$\frac{\partial Y_t}{\partial L_t} = bA_t L_t^{\,(b-1)} K_t^{(1-b)} = bA_t\left(K_t/L_t\right)^{(1-b)}, \quad (1.4)$$

$$\frac{\partial Y_n}{\partial K_n} = (1-c)A_n L_n^{\,c} K_n^{-c} = (1-c)A_n\left(\frac{1}{K_n/L_n}\right)^c, \quad (1.5)$$

$$\frac{\partial Y_n}{\partial L_n} = cA_n L_n^{\,(c-1)} K_n^{(1-c)} = cA_n\left(K_n/L_n\right)^{(1-c)}. \quad (1.6)$$

Since we have derived marginal products of capital and labour in both sectors, the conditions for profit maximization can be presented in the following equations:

$$(1-b)A_t\left(\frac{1}{K_t/L_t}\right)^b = \frac{I}{P_t}, \quad (1.7)$$

$$bA_t\left(K_t/L_t\right)^{(1-b)} = \frac{W}{P_t}, \quad (1.8)$$

$$(1-c)A_n\left(\frac{1}{K_n/L_n}\right)^c = \frac{I}{P_n}, \quad (1.9)$$

$$cA_n\left(K_n/L_n\right)^{(1-c)} = \frac{W}{P_n}, \quad (1.10)$$

where (*I*), (*P*) and (*W*) denote interest rate, prices of proper products and wages, respectively.

The equation system (1.7)-(1.10) is simple to solve. Since, according to the model assumptions, interest rate and price for tradable goods are exogenously determined, and capital stock is fixed a period ahead, the only unknown variable in equation (1.7) is the employed labour. Calculating the employed labour in the open sector and including it into equation (1.8) results in nominal wages that, due to perfect labour mobility and cross-sectoral equalisation of wages, can be included as an exogenous variable in equation (1.10). The only remaining equations are (1.9) and (1.10), where labour employed in the closed sector and price for non-tradable goods are the only two unknown variables. Solving these two equations with two unknown variables, we have solved the whole equation systems. Therefore, the supply conditions are doubtlessly the only ones to determine the price for non-tradable goods, which in interaction with other variables have to fulfil microeconomic conditions for profit maximization.

If growth of labour productivity in the open sector is higher than the one in the closed sector, according to the BS effect this should result in growth of (relative) prices of non-tradable goods. The confirmation for such standpoint we get from equation systems (1.7)-(1.10). Growth in labour productivity in the open sector (1.8) will not affect the prices of tradable goods formed at the global market, but will be effectuated to the proportional increase of nominal wages that will not affect labour unit costs and pricing competitiveness. Since growth in labour productivity of the closed sector is smaller than in the open one, the pay-off of such increased wages (1.10) will imply the growth of (relative) prices of non-tradable goods. In other words, following the presented model, with all listed assumptions, the growth of relative labour productivity in the open sector will result in the increase of (relative) prices of non-tradable goods and increase of overall inflation to the extent in which non-tradable goods participate in the consumer prices index. This causality actually presents the internal transmission mechanism from the increase in relative labour productivity in the open sector towards the increase of (relative) prices of non-tradable goods and overall inflation.

Yet, although the presented models explain the logics and manner of functioning of the internal transmission mechanism, implementation of the empirical research requires some additional derivations. Actually, equations (1.8) and (1.10) can be written down as:

$$bA_t\left(K_t/L_t\right)^{(1-b)}P_t = W\,, \tag{1.11}$$

$$cA_n\left(K_n/L_n\right)^{(1-c)}P_n = W\,. \tag{1.12}$$

Equalising left sides of equations (1.11) and (1.12), and arranging them subsequently, we get:

$$P_n / P_t = \frac{\partial Y_t / \partial L_t}{\partial Y_n / \partial L_n}. \quad (1.13)$$

Equation (1.13) shows the relation between the relative marginal labour productivity of the open sector and relative price for non-tradable goods. It is obvious that faster increase of marginal labour productivity in the open sector compared to the closed one results in growth of the relative price for non-tradable goods. If we rearrange equations (1.4) and (1.6) to obtain:

$$\frac{\partial Y_t}{\partial L_t} = bA_t L_t^{(b-1)} K_t^{(1-b)} = bA_t \left(K_t / L_t\right)^{(1-b)} = bA_t \frac{L_t^{\,b}}{L_t} K_t^{(1-b)} = b\frac{Y_t}{L_t}, \quad (1.14)$$

$$\frac{\partial Y_n}{\partial L_n} = cA_n L_n^{(c-1)} K_n^{(1-c)} = cA_n \left(K_n / L_n\right)^{(1-c)} = cA_n \frac{L_n^{\,c}}{L_n} K_n^{(1-c)} = c\frac{Y_n}{L_n}, \quad (1.15)$$

then equation (1.13) can be shown as:

$$P_n / P_t = \frac{b}{c} \frac{Y_t / L_t}{Y_n / L_n}. \quad (1.16)$$

This equation shows positive long-term influence of the relative labour productivity in the open sector on the relative price for non-tradable goods with coefficient less than one (*c*>*b*). Equation (1.16) has served us as a theoretical basis for empirical testing of the internal transmission mechanism.

2.2 External transmission mechanism

As we have already mentioned, external transmission mechanism implies the convergence at the price level (primarily due to the inflation of prices of non-tradable goods), and appreciation of the real exchange rate for the

domestic currency manifested as a consequence of the catch-up effect, i.e. faster growth of relative labour productivity in the open sector in less developed countries. Testing of the external transmission mechanism is sensible only if the internal transmission mechanism functions in both observed countries. In such a case, discrepancy between relative prices of non-tradable goods in two observed countries is mainly determined by the discrepancy in relative labour productivity in their open sectors. Such dependence can be obtained if we adjust the equation (1.16) to a case in which both domestic and foreign country exists, as follows:

$$P_n / P_t = \frac{b}{c} \frac{Y_t / L_t}{Y_n / L_n}, \tag{1.17}$$

$$P_n^* / P_t = \frac{b^*}{c^*} \frac{Y_t^* / L_t^*}{Y_n^* / L_n^*}, \tag{1.18}$$

where (*) denotes variables which pertain to the foreign country. Dividing the equations (1.17) and (1.18), we get the following:

$$\frac{P_n / P_t}{P_n^* / P_t^*} = \frac{\frac{b}{c} \frac{Y_t / L_t}{Y_n / L_n}}{\frac{b^*}{c^*} \frac{Y_t^* / L_t^*}{Y_n^* / L_n^*}}, \tag{1.19}$$

which has led us to a formal mathematical dependence between the quotient of relative prices of non-tradable goods in the domestic and foreign country on the quotient of their relative labour productivities in the open sector. The equation (1.19) indicates a positive, long-term relationship, since according to the assumptions of the BS model the following inequalities $0<b<1$, $0<c<1$, $0<b^*<1$ and $0<c^*<1$ have been satisfied.

In addition, it is necessary to derive the influence of change in quotient of the relative prices of non-tradable goods on the real exchange rate, which is the other part of the external transmission mechanism. If we define the real exchange rate as:

$$Q = \frac{SP}{P^*}, \tag{1.20}$$

where (S), (P) and (P^*) respectively present the nominal exchange rate (price of one monetary unit of the domestic currency expressed in foreign currency), the level of prices in the domestic country and level of prices in the foreign country. Applying logarithms to (1.20), we get the following:

$$q = s + p - p^*, \tag{1.21}$$

where small letters denote logarithm transformations of the original variables. Increase (decrease) in such constructed real exchange rate indicates its appreciation (depreciation). Almost the same calculation can be used to calculate the real exchange rate, but this time using only the price of tradable goods. In such way, we have the following:

$$q_t = s + p_t - p_t^*. \tag{1.22}$$

Prices referred to in equation (1.21) can be decomposed to prices of tradable and non-tradable goods, so that:

$$p = (1-\alpha)\, p_t + \alpha p_n, \tag{1.23}$$

$$p^* = (1-\alpha^*)\, p_t^* + \alpha^* p_n^*, \tag{1.24}$$

where (α) denotes the contribution of non-tradable goods in gross domestic product. Substituting (1.23) and (1.24) into (1.21), we get:

$$q = s + (1-\alpha)\, p_t + \alpha p_n - (1-\alpha^*)\, p_t^* - \alpha^* p_n^*. \tag{1.25}$$

Arranging of (1.25) equation will give that:

$$q = s + p_t - \alpha p_t + \alpha p_n - p_t^* + \alpha^* p_t^* - \alpha^* p_n^*. \tag{1.26}$$

If we include the equation (1.22) in the equation (1.26), we will have that:

$$q = q_t - \alpha p_t + \alpha p_n + \alpha^* p_t^* - \alpha^* p_n^*, \tag{1.27}$$

which can be put down as:

$$q = q_t - \alpha(p_t - p_n) + \alpha^*(p_t^* - p_n^*). \tag{1.28}$$

Taking into account that all the variables in (1.28) are logarithm transformation of the original variables, the equation (1.28) can be formulated in the following way:

$$LnQ = LnQ_t + \left[-Ln(P_t)^{\alpha} + Ln(P_n)^{\alpha} \right] - \left[-Ln(P_t^*)^{\alpha^*} + Ln(P_n^*)^{\alpha^*} \right], \tag{1.29}$$

i.e., as:

$$LnQ = LnQ_t + \left[Ln\frac{(P_n)^{\alpha}}{(P_t)^{\alpha}} \right] - \left[Ln\frac{(P_n^*)^{\alpha^*}}{(P_t^*)^{\alpha^*}} \right], \tag{1.30}$$

alternatively, as:

$$LnQ = Ln\left[Q_t \frac{\frac{(P_n)^{\alpha}}{(P_t)^{\alpha}}}{\frac{(P_n^*)^{\alpha^*}}{(P_t^*)^{\alpha^*}}} \right]. \quad (1.31)$$

Applying anti-logarithm to (1.31), and replacing (Q_t), we will get that:

$$Q = \left[\frac{SP_t}{P_t^*} \frac{\frac{(P_n)^{\alpha}}{(P_t)^{\alpha}}}{\frac{(P_n^*)^{\alpha^*}}{(P_t^*)^{\alpha^*}}} \right]. \quad (1.32)$$

Taking into account that the BS model is based on the assumption that nominal exchange rate is determined by PPP in the open sector, we will have the following in a long-term:

$$\frac{SP_t}{P_t^*} = 1, \quad (1.33)$$

i.e., it is:

$$Q = \left[\frac{\frac{(P_n)^{\alpha}}{(P_t)^{\alpha}}}{\frac{(P_n^*)^{\alpha^*}}{(P_t^*)^{\alpha^*}}} \right]. \quad (1.34)$$

Equation (1.34) clearly demonstrates that growth in quotient of the relative prices of non-tradable goods, caused by the growth on quotient of the relative labour productivity of the open sector (1.19), by the effects of internal transmission mechanism, will lead to growth (appreciation) of the real exchange rate, which is the second part of the external transmission mechanism.

3. DATA

Table 1 contains the sources, which provided us with data, and description of the construction of time series we used in the empirical research.

Table 1. ***Variables we used in the 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	

Note: Disaggregation of time series was performed with program package ECOTRIM, applying *Boot*, *Feibes*, *Lisman* methods, minimising the sum of squared first differences of disaggregated time series.

Taking into account that literature does not contain any generally accepted method for classification of economic sectors into open and closed ones (Ibidem, p. 8), we carried out the classification in two ways. Firstly, industry and agriculture were treated as open sectors, while services were classified as non-tradable goods. The second way implied elimination of agriculture from the analysis, so that industrial products are tradable goods, and services remained in the non-tradable status. Quantifying the dynamics of relative prices of non-tradable goods in the case of Serbia has been conducted using proper sectoral retail price indices. The consumer prices index was not used since it was introduced only in 2007. We have obtained the measure of average labour productivity by dividing seasonally adjusted sectoral gross value addedd by total number of employees in the subject sector. The dynamics of relative prices of non-tradable goods in the EMU we quantified in two ways: (a) by sectoral harmonized indices of consumer prices and (b) by sectoral deflators. Sectoral average labour productivity in the EMU we constructed analogously to the case of Serbia, by dividing

seasonally adjusted sectoral gross value added by the number of employees in the subject sector.

4. RESULTS OF EMPIRICAL RESEARCHES

Visual inspection of the time series (Figure 1) suggests that these are non-stationary I(1) processes, as confirmed through Dickey-Fuller and Phillips-Perron tests (test results are available at request). Non-stationarity time series make cointegration analysis an adequate framework for further research.

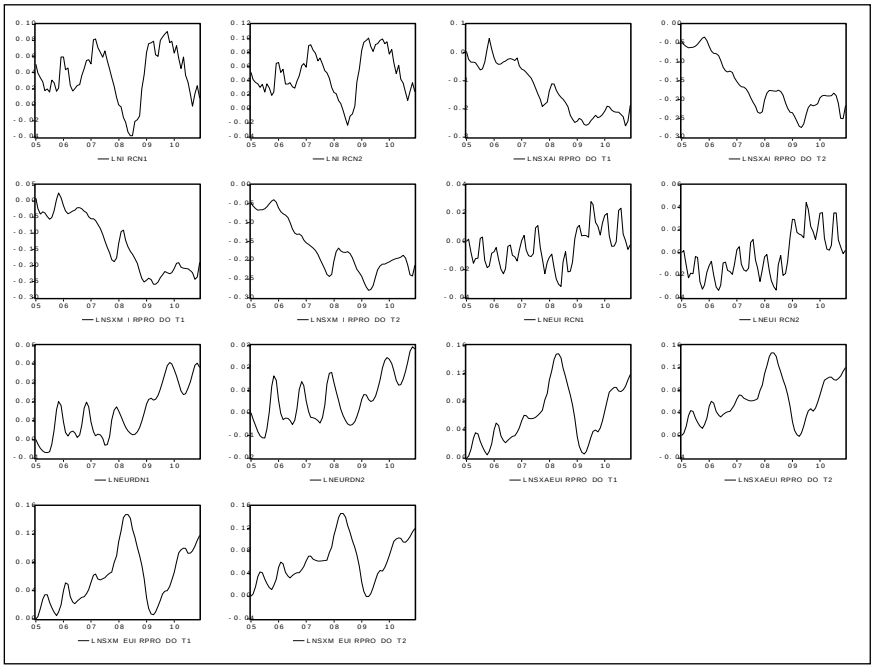

Figure 1. ***Overview of time series used in empirical research***

The BS model testing should be started with internal transmission mechanism, i.e. with its first and doubtlessly key segment. The analysis was based on equation (1.16), indicating a positive long-term impact of relative labour productivity of the open sector to relative prices of non-tradable goods with the coefficient value of which is lower than one. The researches were conducted separately for Serbia and EMU, and the obtained results mainstreamed further analysis.

Table 2. ***Johansen's test: results of internal transmission mechanism testing in Serbia***

INDEPENDENT VARIABLES	LNIRCN1		LNIRCN2	
	(1)	(2)	(3)	(4)
C	-0.072 (0,07504)	0.025 (0,02033)	-0.017 (0,02421)	-0.012 (0,02320)
LNSXAIRPRODOT1	-0.681 (0,47707)	- -	- -	- -
LNSXMIRPRODOT1	- -	-0.080 (0,13617)	- -	- -
LNSXAIRPRODOT2	- -	- -	-0.350 (0,13939)	- -
LNSXMIRPRODOT2	- -	- -	- -	-0.328 (0,13294)
Critical values at the level of significance of 5% (Ho: no cointegration equation)	19.96	19.96	19.96	19.96
Values of LR test statistics (Ho: no cointegration equation)	***13.27***	***10.18***	***14.35***	***14.34***
Critical values at the level of significance of 5% (Ho: at most one cointegration equation)	9.24	9.24	9.24	9.24
Values of LR test statistics (Ho: at most one cointegration equation)	6.17	4.06	6.86	6.56

Note: Detailed results of cointegration tests are available on request. Standard errors are given in parentheses below the coefficients. Econometric analysis was carried out by applying program package EViews 3.1.

This test was based on Johansen and Engle-Granger's cointegration test. The research in the case of Serbia pertains to the period 2004-2010, where we deliberately omitted for previous several years due to the fact that during the first transitional years relative prices were strongly influenced by liberalization process and elimination of pricing disparities, while productivity was greatly influenced by privatization process, which inevitably led to companies' restructuring and rationalization of staffing. Some of the mentioned influences are present even nowadays, but their intensity is however significantly lower. Results obtained in cointegration analysis through Johansen's procedure are presented in Table 2. Based on calculated values of the trace test statistics, we cannot reject the hypothesis of absence of cointegration between the observed time series at the 5% significance level.

Similar findings are achieved by applying the OLS method (Table 3). The estimated values of regression parameters are negative, as in the previous case, and are completely opposite to expectations based on equation (1.16). In addition, visual inspection of residuals of the estimated regression equations (Figure 2) indicates their non-stationarity based on which we can conclude that the observed time series are not cointegrated.

Table 3. ***Serbia: results of the first-step Engle-Granger procedure – the OLS method***

INDEPENDENT VARIABLES	LNIRCN1		LNIRCN2	
	(1)	(2)	(3)	(4)
C	0.012 (0,00536)	0.012 (0,00534)	0.003 (0,00664)	0.003 (0,00670)
LNSXAIRPRODOT1	-0.151 (0,03567)	- -	- -	- -
LNSXMIRPRODOT1	- -	-0.151 (0,03595)	- -	- -
LNSXAIRPRODOT2	- -	- -	-0.252 (0,04023)	- -
LNSXMIRPRODOT2	- -	- -	- -	-0.253 (0,04004)
R^2	0.1798	0.1776	0.3239	0.3266
Adjusted R^2	0.1698	0.1676	0.3157	0.3184
DW	0.1868	0.1962	0.2189	0.2230
F	17.9709	17.7134	39.2908	39.7782

Note: Detailed results of cointegration tests are available on request. Standard errors are given in parentheses below the coefficients. Econometric analysis was carried out by applying program package EViews 3.1.

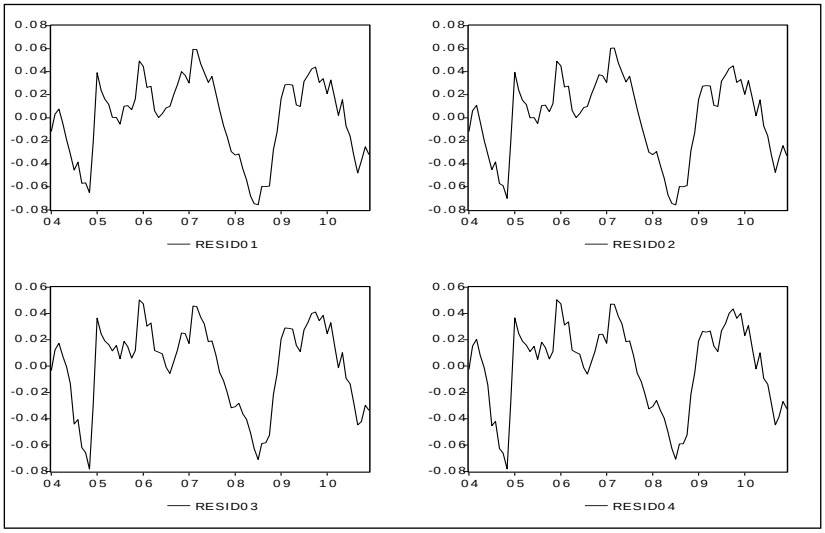

Figure 2. ***Overview of residuals of regression equations shown in Table 3***

Note: Detailed results of the residuals non-stationary tests are available on request

Similar results were obtained in testing of internal transmission mechanism in the EMU for the time period of 2005-2010. In this case, either the estimated coefficients were opposite to expectations, or time series were not cointegrated at all (Table 4). Based on the obtained values of the trace test statistics we did not manage to reject the hypothesis on the existence of maximally one cointegration relation (equations 1, 2, 5 and 6) in the cases when we quantified the relative prices of non-tradable goods by sectoral harmonized consumer prices indices.

Table 4. ***Johansen's test: results of the internal transmission mechanism test in the EMU***

INDEPENDENT VARIABLES	LNEUIRCN1		LNEURDN1		LNEUIRCN2		LNEURDN2	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
C	-0.010	-0.010	-0.139	-0.148	-0.016	-0.017	-0.028	-0.027
	-	-	(0,36614)	(0,41335)	-	-	(0,02109)	(0,01920)
@TREND	0.001	0.001	-	-	0.001	0.001	-	-
	(0,000049)	(0,000048)	-	-	(0,000056)	(0,000049)	-	-
LNSXAEUIRPRODOT1	-0.270	-	1.669	-	-	-	-	-
	(0,02582)	-	(4,02349)	-	-	-	-	-
LNSXMEUIRPRODOT1	-	-0.267	-	1.628	-	-	-	-
	-	(0,02546)	-	(4,17728)	-	-	-	-
LNSXAEUIRPRODOT2	-	-	-	-	-0.335	-	0.443	-
	-	-	-	-	(0,03083)	-	(0,28083)	-
LNSXMEUIRPRODOT2	-	-	-	-	-	-0.312	-	0.434
	-	-	-	-	-	(0,02857)	-	(0,25890)
Critical values at the level of significance of 5% (Ho: no cointegration equation)	25.32	25.32	19.96	19.96	25.32	25.32	19.96	19.96
Values of LR test statistics (Ho: no cointegration equation)	69.23	68.31	***11.89***	***12.23***	78.96	48.63	***13.19***	***13.90***
Critical values at the level of significance of 5% (Ho: at most one cointegration equation)	12.25	12.25	9.24	9.24	12.25	12.25	9.24	9.24
Values of LR test statistics (Ho: at most one cointegration equation)	***11.26***	***10.47***	4.82	4.78	***12.11***	***8.05***	3.38	3.39

Note: Detailed results of cointegration tests are available on request. Standard errors are given in parentheses below the coefficients. Econometric analysis was carried out by applying program package EViews 3.1.

The presence of cointegration is indicated by visual inspection of residuals from these equations (Figure 3). Yet, similarly to the results obtained for Serbia, values of the estimated cointegration coefficients are negative. They demonstrate an opposite impact of relative labour productivity in the open sector to relative prices of non-tradable goods compared to what would expect based on equation (1.16). Such evidence does not corroborate the hypothesis on the functionality of the BS model in the EMU, but they suggest the presence of an opposite effect.

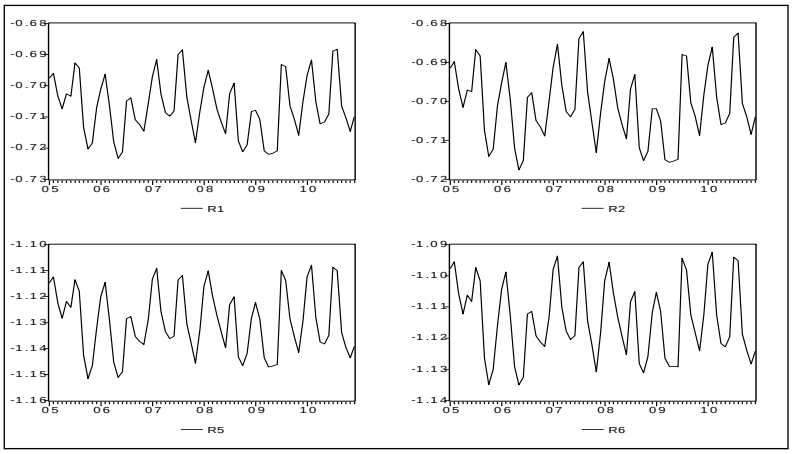

Figure 3. ***Overview of residuals of regression equations 1, 2, 5 and 6 shown in Table 4***

Similar results were obtained by applying the OLS method (Table 5, equations 1, 2, 5 and 6). Testing of residuals non-stationarity, as well as their visual inspection (Figure 4) shows that these are I(0) time series. Therefore, the estimated cointegration coefficients have again confirmed the unexpected negative impact of relative labour productivity on relative prices.

Table 5. ***EMU: results of the first-step Engle-Granger's procedure – the OLS method***

INDEPENDENT VARIABLES	LNEUIRCN1		LNEURDN1		LNEUIRCN2		LNEURDN2	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
C	-0.009 (0,002310)	-0.009 (0,002303)	0.010 (0,002902)	0.010 (0,002889)	-0.015 (0,003184)	-0.016 (0,003155)	0.002 (0,002333)	0.002 (0,002316)
@TREND	0.001 (0,000063)	0.001 (0,000062)	- -	- -	0.001 (0,000080)	0.001 (0,000079)	- -	- -
LNSXAEUIRPRODOT1	-0.219 (0,032671)	- -	0.059 (0,040868)	- -	- -	- -	- -	- -
LNSXMEUIRPRODOT1	- -	-0.218 (0,032400)	- -	0.058 (0,040723)	- -	- -	- -	- -
LNSXAEUIRPRODOT2	- -	- -	- -	- -	-0.268 (0,043351)	- -	0.064 (0,031702)	- -
LNSXMEUIRPRODOT2	- -	- -	- -	- -	- -	-0.270 (0,043014)	- -	0.063 (0,031680)
R^2	0.5186	0.5203	0.0290	0.0280	0.6195	0.6235	0.0555	0.0538
Adjusted R^2	0.5047	0.5064	0.0152	0.0141	0.6084	0.6126	0.0420	0.0403
DW	0.9300	0.9230	0.0869	0.0871	0.9368	0.9359	0.1574	0.1571
F	37.1665	37.4201	2.0931	2.0160	56.1607	57.1319	4.1140	3.9834

Note: Detailed results of cointegration tests are available on request. Standard errors are given in parentheses below the coefficients. Econometric analysis was carried out by applying program package EViews 3.1.

In other words, regardless of which procedure we apply (Johansen or Engle-Granger's), if relative prices in the EMU are quantified by the means of harmonized consumers prices index, the research results show negative impact of relative labour productivity in the open sector to relative prices of non-tradable goods, which is completely opposite to the BS model.

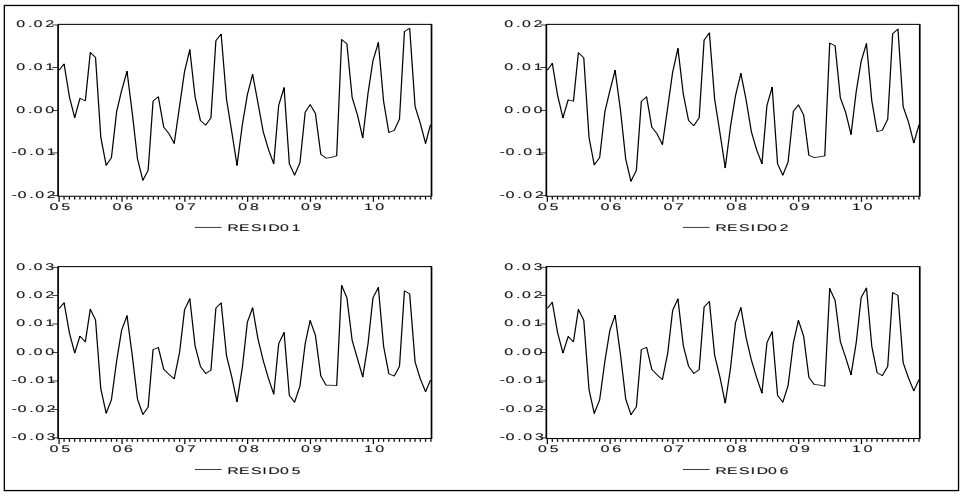

Figure 4. ***Overview of residuals of regression equations 1, 2, 5 and 6 shown in Table 5***

Note: Detailed results of the residuals non-stationary tests are available on request

Yet, robustness of these findings can be seriously questioned if relative prices of non-tradable goods are quantified by sectoral deflators. Doing so, we could not locate a long-term impact of relative labour productivity to relative prices of non-tradable goods, i.e. bearing in mind the calculated values of the trace test statistics, we were not in position to reject the hypothesis on zero number of cointegration equations (Table 4, equations 3, 4, 7 and 8).

There is no significant difference when testing is conducted by applying the Engle-Granger's procedures (Table 5, equations 3, 4, 7 and 8). Residuals of these equations are non-stationary processes, which is indicated by their visual appearance (Figure 5), but also by the results of a formal test. Non-stationarity of residuals disqualifies every assumption about the existence of cointegration relation between the relative labour productivity and relative prices of non-tradable goods in the EMU.

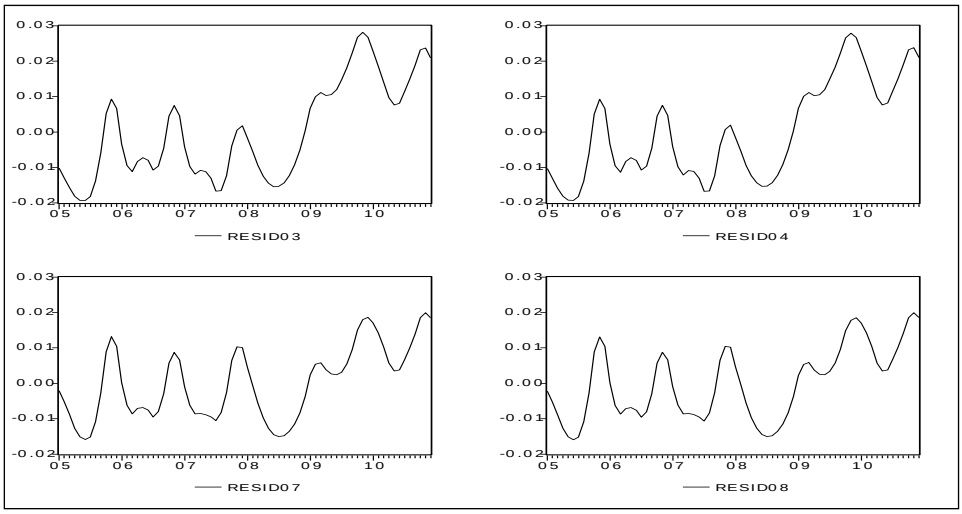

Figure 5. ***Overview of residuals of regression equations 3, 4, 7 and 8 shown in Table 5***

Note: Detailed results of the residuals non-stationary tests are available on request

Generally speaking, applying the Johansen and Engle-Granger's procedure, we have not managed to reveal any impact of relative labour productivity in the open sector to relative prices of non-tradable goods in Serbia. Reasons for such findings may be searched in administrative pricing control for some types of services. As for the EMU, the results are contradictory. Namely, if relative prices of non-tradable goods are statistically quantified by a harmonized consumer prices index, the application of Johansen and Engle-Granger's procedure will reveal negative, actually completely opposite impact compared to the one of the BS model. If we quantify relative prices by proper sectoral deflators, cointegration analysis will show absence of any impact. Therefore, the results of our research, depending whether it was conducted for Serbia or for the EMU, suggest that either relative labour productivity does not affect at all the relative prices of non-tradable goods, or such impact is negative and contradictory to the BS model. In other words, the results of the conducted empirical research in Serbia and EMU do not provide for proper evidence that internal transmission mechanism functions at all.

The assumption for functioning of the external transmission mechanism is functioning of the internal transmission mechanism in both countries. Growth in relative labour productivity in the open sector affects the growth of relative prices of non-tradable goods, which is effectuated in higher overall inflation, convergence of price level and appreciation of real exchange rate. Yet, if the internal transmission mechanism does not function, i.e. if growth of relative labour productivity in the open sector is not transferred to the growth of relative prices of non-tradable goods, then there is no sense in expecting that growth in relative labour productivity of the

open sector will be transferred to higher overall inflation, convergence of pricing levels and appreciation of real exchange rate. Since our results have shown that internal transmission mechanisms in Serbia and EMU does not function, we deem that it would make no sense to test equations of the external transmission mechanism (1.19 and 1.34).

5. CONCLUSION

We have conducted testing of the BS model in the case of Serbia and EMU by previously decomposing it into two mechanisms: (a) internal transmission mechanism and (b) external transmission mechanism. Research conducted for Serbia pertains to the period of 2004-2010, while in the case of EMU, due to unavailability of data on employment per sector, this period is somewhat shorter and takes place between 2005 and 2010. The central position in our analysis was given to the internal transmission mechanism, i.e. impact of the relative labour productivity in the open sector to relative prices of non-tradable goods.

The first part of the empirical research pertains to the case of Serbia, where we have quantified relative prices of non-tradable goods by the means of retail prices index. By applying both methods of cointegration analysis (Johansen and Engle-Granger's), we have obtained the results showing that internal transmission mechanism does not function in Serbia. In other words, based on the conducted research, we were not able to reveal any impact of relative labour productivity in the open sector to relative prices of non-tradable goods. We deem that administrative pricing control for certain services could at least partially explain the absence of the mentioned impact.

The second part of the analysis pertains to the EMU, where obtained results are a little more diverse than in the case of Serbia. Actually, in the case of EMU, relative prices of non-tradable goods were quantified in two ways: (a) sectoral harmonized consumer prices index, and (b) sectoral deflators. If we include relative prices of non-tradable goods into the cointegration analysis, whereat such prices are based on pricing indices, the obtained results indicate negative impact of relative labour productivity in the open sector to relative prices of non-tradable goods, which is completely contrary to the BS model. On the other hand, if we express relative prices by the means of sectoral deflators, the findings we get challenge any dependence of relative prices on the relative labour productivity. Hence, depending on the way we apply in statistical quantification of relative prices, cointegration analysis for EMU shows either opposite effect to the BS model, or it denies any relation between the relative labour productivity in the open sector and relative prices of non-tradable goods.

We have deliberately omitted the functionality testing of external transmission mechanism, taking into account that the effects thereof require the presence of internal transmission mechanism, and the results obtained in our research do not confirm that.

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