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Exchange Rate and Trade Balance: J-curve Effect

Summary: This paper shows that exchange rate depreciation in Serbia improves trade balance in the long run, while giving rise to a J-curve effect in the short run. These results add to the already existent empirical evidence for a diverse set of other economies. Both Johansen's and autoregressive distributed lag approach are respectively used giving similar long-run estimates showing that real depreciation improves trade balance. Corresponding error-correction models as well as impulse response functions indicate that, following currency depreciation, trade balance first deteriorates before it later improves, i.e. exhibiting the J-curve pattern. These results are relevant for policy making both in Serbia and in a number of other emerging Europe countries as they face major current account adjustments after BoP crises of 2009.

Key words: Exchange rate and trade balance, J-curve, Cointegration, Autoregressive distributed lag approach.

JEL: F31, F32, F40.

The paper explores whether exchange rate depreciation improves trade balance, and whether appreciation worsens it. This issue is resolved in theory in the sense that if the Marshall-Lerner condition holds an improvement in the trade of balance would occur. Nevertheless it is still an open empirical subject, i.e. whether this condition holds in various economies across time. Moreover, even when the condition holds and improvement ultimately occurs, it may be that at the beginning trade balance deteriorates before it subsequently improves. There is some support in theory for this pattern, known as the J-curve effect, but again it is up to empirical evidence to support or reject it.

There are numerous empirical studies exploring both whether currency depreciation leads ultimately, i.e. in the long run, to trade balance improvement, and if so whether a J-curve pattern occurs. These studies cover a very diverse set of economies such as developed countries e.g. the US, Canada and Japan, a number of emerging European and Asian economies, as well as few developing African countries. Their findings, reviewed below (see Section 1), are mixed but still more in favor than not of the proposition that currency depreciation improves trade balance and that J-curve effect takes place.

This paper adds to the above empirical evidence by examining whether and how exchange rate affects trade balance in Serbia, both in the long and short run. The period that is explored covers the 2000s, when Serbia, after international economic isolation in the 1990s, opened up and launched extensive reforms. However this period has broader relevance as it encompasses a large inflow of capital, substantial real exchange rate appreciation and ensuing current account deficit both in Serbia and in a number of transition economies (International Monetary Fund 2008; Abdul Abiad, Daniel Leigh, and Ashoka Mody 2009). These developments have been partly reversed upon eruption of the world financial crisis in September 2008 and consequent balance of payment crises in a number of emerging Europe countries, but the main adjustments are still to come. Therefore it is critical to examine what role exchange rate appreciation played in the run up to balance of payment crisis in Serbia, and consequently what are related policy lessons for the post crisis adjustments. Thus, the results obtained in the 2000s for Serbia could be also relevant for a number of transition and emerging economies that experienced similar developments before and during the world financial crisis.

Moreover, the issue of exchange rate impact on trade balance has been fiercely debated in Serbia while economic reforms of the 2000s were pursued, and policy makers took a rigid stance that the former impact is insignificant. That led them to opt for real currency appreciation to address immediate internal imbalances, specifically inflation, while the resulting huge external imbalance was hoped to be restored with the future growth of the economy. Consequently, Serbia faced the world financial crisis with a current account deficit well above those in other transition countries, being close only to the deficits in Baltic countries. As Serbia, just like other emerging economies, can no longer count on large inflows of capital to finance their vast current account deficit, it should adjust its deficit, and hence the issue of currency depreciation's impact on the trade balance comes to the forefront.

The methodology used while exploring the long run impact of the exchange rate on trade balance is cointegration analysis. Thus Johansen's method (Soren Johansen 1996) is used alongside with the autoregressive distributed lag (ARDL) approach of Hashem M. Pesaran, Yongcheol Shin, and Richard J. Smith (2001). Short term effects and the related J-curve pattern is examined by estimating error-correction models corresponding to the obtained cointegrating relations, and by assessing the impulse response of the trade balance upon the exchange rate shock.

This paper further proceeds as follows. Section 1 offers a review of previous research in a diverse set of countries, both of the J-curve effect in the short run and the long run impact of the exchange rate on the trade balance. Section 2 explains the data used, and looks at their time series characteristics. In Section 3 long run impact of the exchange rate on trade balance is estimated, using both Johansen's and autoregressive distributed lag approach. The presence of a J-curve pattern is explored in Section 4, employing an error correction model and impulse responses. Section 5 concludes.

1. A Review of Previous Research

Empirical examination as to whether a Marshall-Lerner condition holds has a long history, and with changing views[1]. As to the short run effect and J-curve phenomenon it is first advanced by Stephen P. Magee (1973) after the fact that short-run deterioration and long-run improvement after currency depreciation resemble the letter "J". Subsequently a large number of empirical studies appear exploring both long run impact of exchange rate on trade balance, and whether J-curve phenomenon is present.

[1] See Richard E. Caves, Jeffrey A. Frankel, and Ronald W. Jones (2001), pp. 305-308.

Thus results obtained for Japan tend to support both the positive long run impact of exchange rate depreciation on trade balance, but also the J-curve effect. Thus Anju Gupta-Kapoor and Uma Ramakrishnan (1999) using quarterly data from 1975 through 1996, and employing the Johansen procedure, found a long run (i.e. cointegrating) relation between trade balance, exchange rate, and foreign and domestic GDP, showing that depreciation leads to trade balance improvement. Moreover, by estimating the corresponding error correction model (ECM) as well as impulse response, they demonstrated the existence of a J-curve effect. These estimates suggest that in the first five quarters trade balance deteriorates, and subsequently improves reaching a new equilibrium value in approximately 13 quarters. A previous study of the Japanese economy also at quarterly frequency (Marcus Noland 1989) for the period 1970 through 1985, also supports the results above. Namely it is shown that estimated long-run price elasticities fulfill the Marshall-Lerner condition hence implying that currency depreciation improves trade balance in the long run. A J-curve effect is also found indicating that it takes seven quarters from depreciation for the trade balance to start improving, and that it achieves a new equilibrium after 16 quarters.

Unlike Japan, where research clearly shows the improvement of trade balance in the long run, as well as the existence of the J-curve pattern, results for the US are mixed. Andrew K. Rose and Janet L. Yellen (1989) used quarterly data for the period between 1960 and 1985 at the bilateral level between U.S. and its six largest trade partners. They did not find J-curve pattern or long-run relationship between bilateral exchange rates and trade flows. Kanta Marwah and Lawrence R. Klein (1996) also investigated influence of the real bilateral exchange rate on bilateral trade balance in both the US and Canada with their respective five largest trading partners. Quarterly data cover the period between 1977 and 1992. They maintained that after depreciation, trade balance, both in the US and Canada, follows an S-curve pattern, i.e. after the initial J-curve shape trade balance has a tendency to worsen again by the end. Mohsen Bahmani-Oskoee and Zohre Ardalani (2006) refocused research in the US on the industrial level and estimated its corresponding import and export functions. They employed an Autoregressive Distributed Lag (ARDL) approach to cointegration analysis developed by Pesaran, Shin, and Smith (2001). Their results show that in half of the 66 estimated export functions for US industries, coefficient on exchange rate is as expected significantly negative. However, in the case of import functions only in 13 out of 66 cases estimated coefficients on exchange rate have the correct, positive sign. Thus this study shows that if aggregated data are used, significant exchange rate coefficients in some sectors could be offset by insignificant ones in other sectors and could lead to the wrong conclusion that exchange rate has no impact on trade flows.

Research done for emerging markets covers Thailand, emerging Europe and in Africa - Madagascar and Mauritious. Thus Bahmani-Oskooee and Tatchawan Kantipong (2001) found in case of Thailand versus its five major trading partners (Germany, Singapore, Japan, UK and US) the evidence of the J-curve in bilateral trade with US and Japan only. They used quarterly data from 1973 to 1997 and ARDL cointegration. Ivohasina F. Razafimahefa and Shigeyuki Hamori (2005) examined import and export demand function for Madagascar and Mauritius, and found existence of the cointegration between import, income and exchange rate for both countries. The long-run income elasticities are 0.86 and 0.67 and price elasticities -0.49 and -0.64

for Madagascar and Mauritius, respectively. After estimating export demand functions, they concluded that Marshall-Lerner condition is fulfilled only in Mauritius.

An extensive study for emerging Europe i.e. for Bulgaria, Croatia, Cyprus, Czech Republic, Hungary, Poland, Romania, Russia, Slovakia, Turkey and Ukraine has been done by Bahmani-Oskooee and Ali M. Kutan (2007), while applying ARDL cointegration approach and corresponding ECM. They found empirical support for the J-curve pattern in three countries: Bulgaria, Croatia and Russia - short run deterioration combined with long-run improvement.

Also, Tihomir Stučka (2003) showed the existence of the J-curve in Croatia, i.e. in an economy similar to the Serbian one, since both shared 70 years of common economic history within former Yugoslavia. The ARDL cointegration approach is used employing quarterly data. The obtained long run cointegrating relations show that one percent depreciation improves trade balance on average by 0.9% to 1.3%. Estimated impulse responses indicate that it takes two and half years to achieve the improvement above, while the adverse effect of depreciation seems to be a short lived, just above one quarter.

2. Data Description and their Time Series Characteristics

In empirical analysis logarithms of trade balance (*TB*), real effective exchange rate (*REER*) and gross domestic product (GDP_d) in Serbia are used. These series are at monthly frequency, seasonally adjusted and run from January 2002 to September 2007. After a decade of international isolation and UN embargo in the 1990s, Serbia opened up and initiated reforms in 2001. The latter begins the sample; the availability of data at the time of this research defines its end.

The value in euro terms of total export and import (*M*) of goods are used to obtain the trade balance, defined as ratio of import over export. Thus a decrease in the trade balance variable implies its improvement. The exchange rate is defined as foreign currency per unit of domestic one; hence its increase implies an appreciation of the domestic currency. Following the National Bank of Serbia, the effective exchange rate is calculated by using the weights 70 and 30 for dinar exchange rate with the euro and dollar respectively. The real exchange rate is then obtained by employing the domestic, Euro zone and US price indices. Real gross domestic product is available at quarterly frequencies, since 2002 (another reason for sample start), and we disaggregated it to get the monthly series[2]. Data sources are Statistical Bureau of Serbia, National Bank of Serbia and *Quarterly Monitor* (QM) various issues[3].

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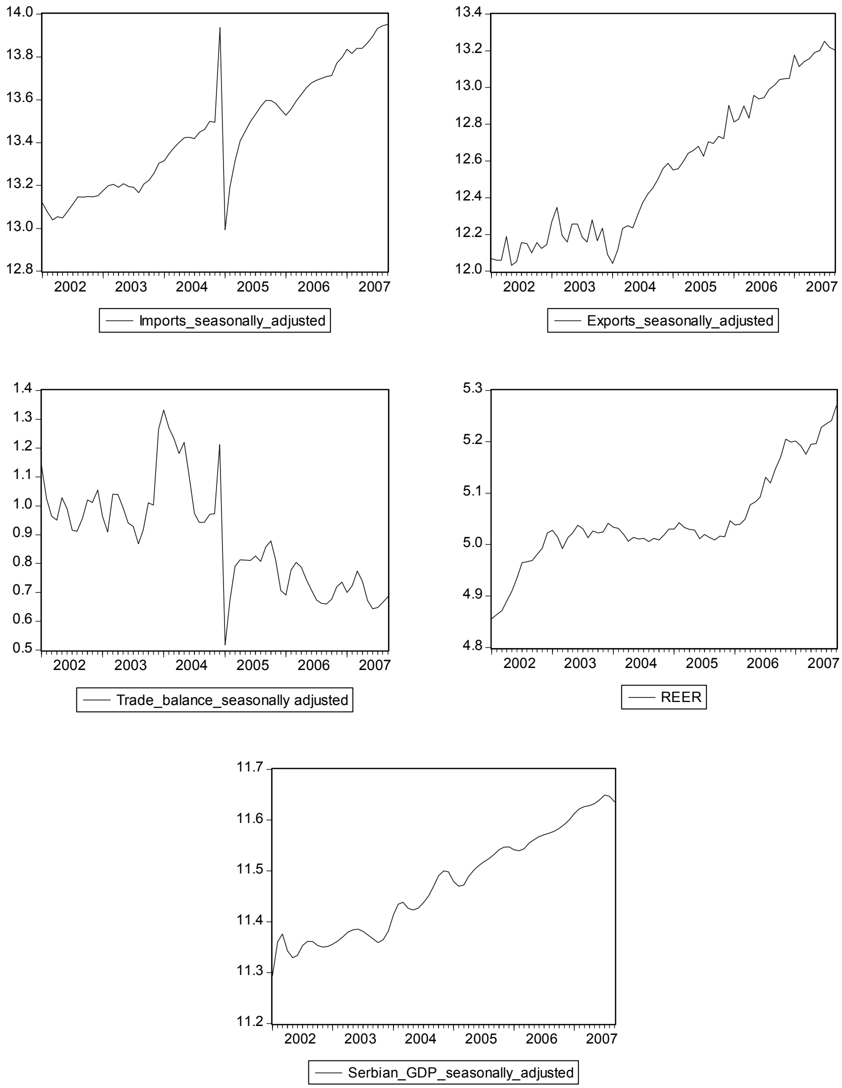
[2] ECOTRIM (program developed by Eurostat) is used for temporal disaggregation of time series. Specifically, *Boot*, *Feibes* and *Lisman* smoothing method is employed to get monthly from quarterly data (minimise the sum of squared first differences between successive disaggregated values (model FD), see John, C.G. Boot, Walter Feibes, and J.H.C. Lisman (1967)), ECOTRIM can be downloaded via: http://circa.europa.eu/Public/irc/dsis/ecotrim/library.

[3] **Foundation for Advancement of Economics**. 2007. Quarterly Monitor. http://www.fren.org.yu/index.php?option=com_content&view=category&layout=blog&id=2&Itemid=5&lang=en (accessed December 15, 2007).

National Bank of Serbia. 2007. Exchange Rates List for a Specific Period. http://www.nbs.rs/export/internet/english/scripts/kl_period.html; http://www.nbs.rs/export/internet/english/80/80_2/foreign_exchange_rates.pdf (accessed December 24, 2007).



Source: Authors' calculations using data of National Bank of Serbia, Statistical office of the Republic of Serbia and Foundation for Advancement of Economics.

Figure 1 Depicts Logarithm of the Series Used in Empirical Analysis

Statistical office of the Republic of Serbia. 2007, 2008. Exports and Imports of Serbia – per period (ST16). http://webrzs.statserb.sr.gov.yu/axd/en/arhiva.php?NazivSaopstenja=ST16 (accessed January 21, 2008).

Statistical office of the Republic of Serbia. 2008. Quarterly Gross Domestic Product, at constant prices 2002 (NR40) - per period. http://webrzs.statserb.sr.gov.yu/axd/en/arhiva.php?NazivSaopstenja=NR40 (accessed January 25, 2008).

As shown in Figure 1, imports have been sharply increasing throughout the whole period, while exports took off only after three years of reforms, i.e. in 2004, and from a very low level. Interestingly enough, domestic output (GDP_d) also followed the export growth pattern, and has accelerated its growth since 2004. In these boom years, specifically throughout 2006 and 2007, domestic currency also appreciated in real terms. While the latter is consistent with the observed surge in imports, coincidence of real currency appreciation and accelerating exports might raise a puzzle. Trade balance did improve as exports took off, albeit still recording great deficits - around 21% of GDP. Finally, imports recorded peak and trough respectively in December 2004 and January 2005, due to the introduction of a value added tax in January 2005.

Inspection of the time series shown in Figure 1 suggests that they are non-stationary I(1) processes. Corresponding unit root testing, i.e. augmented Dickey-Fuller test confirms that all five series in Figure 1 are I(1)[4]. This result clears the way for the cointegration analysis below, i.e. for exploring the existence of trade balance relations both in the long (cointegration) and short run (error correction model: ECM).

3. Exchange Rate and Trade Balance: Long-run Relationship

The trade balance is expected to depend on the real exchange rate and a measure of domestic and foreign income respectively, i.e. on the main determinants of import and export. Upon preliminary testing, it turns out that foreign income is not statistically significant, hence we end up with the following model to be estimated:

$$TB = \alpha + \beta GDP_d + \delta REER + e \qquad (1)$$

As explained above all variables are expressed as logarithms. Our main interest here rests in exploring the effect of the exchange rate (*REER*) on trade balance (*TB*), i.e. whether in the long run real depreciation of currency will improve trade balance, and the other way round in case of appreciation. For this to hold the coefficient on real exchange rate should be positive: $\delta > 0$.

In order to estimate the effect of exchange rate on trade balance, one should control for the effect of domestic income, hence inclusion of gross domestic product (GDP_d) in relation (1). However the impact of GDP_d on *TB*, and hence the sign of coefficient β, is ambiguous. Namely an increase in domestic output raises imports but could also boost exports, and the net effect on the trade balance could either be an improvement or a worsening. It is now well understood that the supply driven output growth, e.g. due to an increase in productivity, leads to an improvement of the trade balance[5]. Historic examples are those of Germany and Japan in the 1960s and the 1970s, as well China in the 1990s and the 2000s. On the other hand, the demand driven increase in output, as in e.g. US in the 1970s and the 2000s, ends up with trade balance deteriorations.

[4] Results are available from the authors upon request.
[5] Caves, Frankel, and Jones (2001), p. 389.

In order to explore the existence of a long run relation for trade balance (1), one can test for the presence of cointegration between the non-stationary I(1) variables above. While doing that the Johansen cointegration tests (Johansen 1996) and autoregressive distributed lag (ARDL) approach of Pesaran, Shin, and Smith (2001) will be respectively used.

3.1 Johansen's Cointegration Analysis

The results reported below, based on the Johansen's tests do confirm the existence of one cointegrating relation between trade balance (*TB*), real effective exchange rate (*REER*) and domestic output (GDP_d).

Thus the trace test reported in Table 1 shows that the null hypothesis of no cointegration is rejected, since the trace statistic is larger than the 5 % critical value (32.42 > 29.80). However, the null stating that there is at most one cointegrating vector can not be rejected as 5.46 < 15.49.

Table 1 Cointegration Rank Test: Trace and Maximum Eigenvalue Statistics

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Max-Eigen Statistic	0.05 Critical Value Trace Statistic	0.05 Critical Value Max-Eigen Statistic	Prob.** Trace Statistic	Prob.** Max-Eigen Statistic
None *	0.335361	32.41950	26.96171	29.79707	21.13162	0.0244	0.0067
At most 1	0.079366	5.457788	5.457751	15.49471	14.26460	0.7584	0.6833
At most 2	5.62E-07	3.71E-05	3.71E-05	3.841466	3.841466	0.9971	0.9971

Note: There are three lags in the VAR model. Both tests indicate 1 cointegrating equation at the 0.05 level.* denotes rejection of the hypothesis at the 0.05 level.**James G. MacKinnon, Alfred A. Haug, and Leo Michelis (1999) p-values.

Source: Authors' calculations.

The same result that there is (only) one cointegrating relation between the variables considered is obtained by employing maximum eigenvalue test. The results are reported in Table 1.

As the variables do cointegrate, we may now proceed and estimate the corresponding cointegrating equation, and the results read as follows[6]:

$$TB = 20.27 + \underset{(0.454)}{0.95\,REER} - \underset{(0.378)}{2.11\,GDP_d} \tag{2}$$

In equation (2) the estimated cointegration vector is normalized in such a way to give a trade balance equation, i.e. coefficient on *TB* is set to be 1. In order to check if the former procedure is justified, we examined whether the trade balance is endogenous while the real exchange rate and domestic output are respectively exogenous variables. This turns out to be the case as the cointegrating vector enters the error

[6] Standard errors are given in parentheses (see Johansen 2000).

correction model (ECM) for trade balance (Table 5, section 5.1 below), while it neither enters ECM for real exchange rate nor ECM for domestic output.

The Granger causality testing, reported in Table 2, also suggests that trade balance is endogenous while real exchange rate and domestic output are respectively exogenous variables.

Table 2 Granger Causality Test in VAR

Variable	TB	GDPd	REER
TB	-	0.70 (0.87)	4.80 (0.18)
GDPd	18.33 (0.00)	-	4.39 (0.22)
REER	10.76 (0.01)	0.59 (0.90)	-
All	25.08 (0.00)	1.36 (0.96)	11.03 (0.08)

Note: There are three lags in VAR.

Source: Authors' calculations.

As can be seen, lagged output (GDP_d) and the real exchange rate ($REER$) significantly affects trade balance (1^{st} column in Table 2), hence 'Granger causing' it. On the other hand neither output (GDP_d) nor exchange rate ($REER$) are 'Granger caused' by respective of other variables (2^{nd} and 3^{rd} column in Table 2). Thus the testing results do show that trade balance is an endogenous variable while output and real exchange rate exogenous variables.

3.2 Autoregressive Distributed Lag (ARDL) Approach

Following the bounds testing approach of Pesaran, Shin, and Smith (2001) we now re-examine the trade balance equation (1). As it turns out practically the same results are obtained as above when Johansen cointegration analysis is applied.

Pesaran, Shin, and Smith (2001) have developed a bounds testing procedure which incorporates the long-run trade balance equation (1) into an error correction model (ECM). This enables simultaneous evaluation of long- and short-run coefficients, which represents one of the main advantages of this approach. Although this method is often used in studies exploring the existence of the J-curve effect, it is not as widely known as the Johansen cointegration analysis. Hence we offer a bit more detailed exposition of this approach.

Let $X_t = \left(TB_t, REER_t, GDP_{d_t}\right)' = \left(TB_t, x_t'\right)'$. Then an ARDL representation of equation (1) reads as follows:

$$\Delta TB_t = a_o + a_1 t + a_2 \Delta x_t + a_3 V\_VAT + \sum_{i=1}^{p} b_{1i}\Delta TB_{t-i} + \sum_{i=1}^{p} b_{2i}\Delta REER_{t-i} + \sum_{i=1}^{p} b_{3i}\Delta GDP_{d\,t-i} + c_1 TB_{t-1} + c_2 REER_{t-1} + c_3 GDP_{d\,t-1} + v_t \quad (3)$$

Note: Δ denotes first difference, *t* is trend and *V_VAT* is dummy variable capturing the introduction of value added tax: V_VAT=1 for 2004:12, -1 for 2005:1-2005:2 and 0 otherwise.

This approach lends opportunity to the estimated long run trade balance equation regardless of whether the exchange rate and/or the gross domestic product are purely I(0), purely I(1) or mutually cointegrated. It is only required that the dependent variable, i.e. trade balance, be I(1) process. If trade balance (*TB*) does not affect the explanatory variables output (GDP_d) and/or exchange rate (*REER*), as Granger causality testing suggested above (Table 2), ordinary least squares (OLS) could be used to estimate the equation (3). If cointegration exists, the coefficients c_1, c_2 and c_3 in (3) give a cointegration vector that captures the long run relation, while *b* coefficients encompass short run dynamics.

Pesaran, Shin, and Smith (2001) method implies two steps. The first step is testing for the existence of a long-run equilibrium relationship (cointegration) between observed variables, while the second step is estimation of model (3), in particular the cointegrating vector (c_1, c_2, c_3).

The cointegration among trade balance (*TB*), real effective exchange rate (*REER*) and gross domestic product (GDP_d) exists if the coefficients c_1, c_2 and c_3 in (3) are different from zero. Therefore the null hypothesis, stating that there is no long-run equilibrium relationship: $H_0: c_1 = 0, c_2 = 0, c_3 = 0$ is tested against an alternative hypothesis $H_1: c_1 \neq 0, c_2 \neq 0, c_3 \neq 0$ implying the presence of cointegration. Testing is performed by Wald statistics in the form of the F-test. If the calculated value of F statistic is significant (higher than the upper bound), one rejects H_0 in favor of H_1 thus showing that the long-run equilibrium relationship between trade balance, real effective exchange rate and gross domestic product exists[7].

In order to perform the testing above, we estimated, by OLS, model (3), with and without linear trend and with and without Δx_t (first difference of current exogenous variables). In this first step, number of lags is the same across variables, and we varied it from 1 to 8, i.e. $p = 1, 2, ..., 8$. Namely, one should strike a balance between too few lags when problem of serial correlation in residuals may emerge, and too many lags which lead to the loss of a large number of observations. Upon inspecting results and corresponding testing, we found that the trend is not significant ($a_1 = 0$), which is consistent with the results obtained above using Johansen's procedure. Table 3 summarizes results reporting values for Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SC) for lags' length selection, as well as F and t tests for cointegration testing.

[7] Critical values depend on the k (number of regressors) and whether intercept and trend are restricted or not. Tables with critical values could be found in Pesaran, Shin, and Smith (2001), tables CI, pp. 300 and 301.

Table 3 Statistics for Selecting Lag Order (SC and AIC) and F- and t- Statistics for Testing the Existence of a Levels Trade Balance Equation

p	SC	AIC	$\chi^2(1)$	$\chi^2(4)$	F_{III} (3.79,4.85)	t_{III} (-2.86,-3.53)
	$a_1=0, a_2=0$					
1	**-2.016***	**-2.279***	16.13	4.79	**7.210**	**-4.326**
2	-1.883	-2.248	25.14	8.93	7.432	-4.428
3	-1.706	-2.175	27.20	7.26	6.322	-4.128
4	-1.526	-2.100	21.12	5.74	4.270	-3.435
5	-1.448	-2.127	13.27	3.52**	1.861	-2.334
6	-1.228	-2.017	13.66	3.84**	1.570	-2.144
7	-1.210	-2.110	7.76	3.45**	2.319	-2.202
8	-1.220	-2.232	2.13**	2.43***	2.284	-1.412
	$a_1=0, a_2\neq0$					
1	**-1.986***	-2.315	13.73	4.64	**6.563**	**-4.279**
2	-1.950	**-2.382***	11.10	2.90**	**8.901**	**-4.770**
3	-1.818	-2.353	21.35	5.85	7.298	-4.392
4	-1.649	-2.290	15.20	4.39	3.913	-3.327
5	-1.447	-2.195	15.23	4.79	2.407	-2.661
6	-1.246	-2.104	9.00	2.73***	2.407	-2.665
7	-1.282	-2.251	3.72***	1.69***	3.631	-2.973
8	-1.293	-2.375	0.55***	2.08***	3.844	-2.364

Note: F_{III} is the F statistic when $a_1 = 0$ and $H_0 : c_1 = 0, c_2 = 0, c_3 = 0$;* indicate minimum values of SC and AIC; $\chi^2(1)$ and $\chi^2(4)$ are LM statistics for testing no residual serial correlation against orders 1 and 4, **and ***denote no correlation at 1% and 5% significance level, respectively.

Source: Authors' calculations.

For the specification: $a_1 = 0$ and $a_2 = 0$, both AIC and SC values in Table 3 show that the optimal number of lags is one (p=1). Thus we can use the corresponding values for F = 7.210 and t = -4.326 statistics to test for the presence of cointegration. Since in both cases their absolute values are above the respective upper 5% bounds in absolute terms (4.85 and 3.53)[8] one accepts $H_1 : c_1 \neq 0, c_2 \neq 0, c_3 \neq 0$, i.e. that cointegration between *TB*, *REER* and GDP_d exists.

The same result is also obtained for the specification: $a_1 = 0$ *and* $a_2 \neq 0$. Namely, although SC points to one lag while AIC chooses two lags, in both cases the corresponding F and t statistics are higher, in absolute terms, than the respective upper bounds, hence showing the presence of cointegration (see Table 3).

Once cointegration has been found, the next step is to estimate the cointegration vector. Therefore model (3) is re-estimated this time using the optimal number of lags for each variable. Again SC and AIC are used for lags' length selection, while the specification: $a_1 = 0$ and $a_2 = 0$ of the model (3) is estimated (see Table 4). However similar results are found for the alternative specification: $a_1 = 0$ *and* $a_2 \neq 0$.

[8] See Pesaran, Shin, and Smith (2001), tables CI, pp. 300 and 301.

Table 4 Estimated ARDL Model (3): a_1=0 and a_2=0

Variables	Coefficients	t-statistics
Constant	8.05	4.87
TB_{t-1}	-0.40	-5.22
$REER_{t-1}$	0.37	1.89
GDP_{dt-1}	-0.83	-4.42
ΔTB_{t-1}	-0.27	-2.96
$\Delta REER_{t-1}$	-1.46	-2.28
$\Delta REER_{t-2}$	-1.36	-2.08
V_VAT	0.31	7.18

Note: R^2=0.64; Adj. R^2=0.59; Sum sq. resids=0.29; S.E. equation=0.07; F-statistic=14.57; Log likelihood=85.16; AIC=-2.34; SC =-2.07; Mean dependent=-0.00; S.D. dependent=0.11; JB=16.71; $\chi^2(1)$=25.89; $\chi^2(4)$=8.74; RESET=7.07; CUSUM=stable.

Source: Authors' calculations.

Both information criteria have suggested the optimal model specification to be ARDL (2,3,0), i.e. one lag in ΔTB, two lags in ΔREER, while lagged ΔGDP is not significant (see Table 4).

The estimated ARDL (2,3,0) model in Table 4 gives the following cointegration coefficients (with t-ratios in the brackets): c_1 = -0.40 (5.22), c_2 = 0.37 (1.89) and c_3 = -0.83 (4.42). The long run trade balance equation is then obtained by re-normalizing the obtained cointegration vector, by dividing it with c_1, hence one finally gets:

$$TB = 20.01 + 0.92REER - 2.07GDP_d \qquad (4)$$

Moreover, the obtained estimates of ARDL (2,3,0) model above enables one also to asses whether the J-curve effect of the exchange rate on trade balance is present. However, we shall look at this issue in section 5.

3.3 Role of the Exchange Rate and Domestic Output on the Trade Balance Relation

Estimates of the long run trade balance relation obtained above either with the Johansen procedure (2) or ARDL approach (4) are almost equal, suggesting that they are sound. As to the main issue, it is found that in the long run real depreciation of the currency leads to an improvement in the trade balance. The estimated elasticity: 0.92 and 0.95, shows that a one percent real depreciation invokes almost the same improvement in trade balance, and the other way round when currency appreciates.

An additional result emerging from our estimates of the trade balance equation is that an increase in domestic output (GDP_d) improves the trade balance. Thus the estimates (2.07 and 2.11) suggest that a one percent increase in GDP_d leads to a two percent improvement in the trade balance. The above then implies that supply side factors have been important in driving output growth in Serbia, and consequently enhancing its export. However, as shown below, this finding should just be taken as preliminary.

A closer look at the impact of GDP_d on import and export respectively shows that it is significant in the former case while somewhat inconclusive in the latter. Thus employing the Johansen procedure, we obtained the following cointegrating relation for import[9]:

$$M = 0.99 + \underset{(0.462)}{0.86} GDP_d + \underset{(0.142)}{0.46} REER + \underset{(0.003)}{0.01} @TREND \tag{5}$$

Granger causality tests confirm that import (M) is the dependent variable in the obtained cointegrating relation, as import turns out to be an endogenous variable, whereas GDP_d and real effective exchange rate ($REER$) are weakly exogenous variables.

As expected import increases with GDP_d growth and a real appreciation of the currency, the corresponding long run elasticity being 0.86 and 0.46 respectively. A long term trend, suggesting that additional factors are driving an increase in imports, might capture the effects of Serbia's abrupt opening in the early 2000s after a decade of isolation.

On the other hand, the clear cut effects of GDP_d on exports has not been found for the whole period, i.e. since 2002. Nonetheless, an inspection of Figure 1 shows that since 2004 exports and GDP_d surged together. Preliminary estimates indicate that the cointegration between exports and GDP_d might be present, with GDP_d being weakly exogenous. This further suggests that domestic output (GDP_d) growth can account for the increasing exports. Moreover, a preliminary estimate of GDP_d impact on exports is far above the one in the import function (5), hence rendering support for the estimated TB equation (2 and 4), where an increase in GDP_d improves the trade balance.

There are good reasons to focus further research on the period from 2004 onwards. Namely, upon initiating serious economic reforms in 2001, it took Serbia several years to start reaping benefits, particularly those from privatization and foreign direct investments. Only then supply side effects could emerge leading to the surge both in output and export. As in other transition countries, anecdotal evidence in Serbia also suggests that large foreign direct investments have led to a significant increase in exports. Thus we would conjecture that stable import and export relations might emerge in the Serbian economy since 2004.

4. Short-run Impact of Exchange Rate on Trade Balance: J-curve Effect

As explained above, in the short run currency depreciation might first worsen the trade balance before subsequently improving it, hence creating the J-curve effect. Empirical evidence for a number of countries does support the presence of this effect (Section 2).

[9] Standard errors are given in parentheses (see Johansen 2000).

We shall examine the J-curve effect by inspecting the estimates of ECM that corresponds to the long run trade balance equation above, and by calculating the impulse response of the trade balance following a shock from the real exchange rate.

4.1 Error-correction Model

The estimates of the cointegrating trade balance equation (2) and (4) above are used to get corresponding ECMs. Thus Table 5 gives an ECM based on the cointegrating vector found with Johansen's procedure (2), while the Table 6 ECM corresponds to the estimated ARDL (2,3,0) model (4).

Table 5 ECM for Trade Balance (ΔTB) Based Johansen's Procedure (eq. 2)

Variables	Coefficients	t-statistics
$(TB-20.27-0.95REER+2.11GDP_d)_{t-1}$	-0.40	-4.81
ΔTB_{t-1}	-0.27	-2.73
$\Delta REER_{t-1}$	-1.46	-2.26
$\Delta REER_{t-2}$	-1.37	-2.07
V_VAT	0.31	6.78

Note: R^2=0.64; Adj.R^2=0.59; Sum sq. resids=0.29; S.E. equation=0.07; F-statistic=12.53; Log likelihood=85.17; AIC=-2.31; SC=-2.00; Mean dependent=-0.00; S.D. dependent=0.11; JB=15.16; χ^2 (1)=32.13; χ^2 (4)=5.61.

Source: Authors' calculations.

Table 6 ECM for Trade Balance (ΔTB) Based on ARDL(2,3,0)

Variables	Coefficients	t-statistics
$(TB-20.01-0.92REER+2.07GDP_d)_{t-1}$	-0.40	-5.11
ΔTB_{t-1}	-0.25	-2.73
$\Delta REER_{t-1}$	-1.32	-2.05
$\Delta REER_{t-2}$	-1.18	-1.79
V_VAT	0.31	7.04

Note: R^2=0.61; Adj. R^2=0.58; Sum sq. resids=0.31; S.E. equation=0.07; F-statistic=18.82; Log likelihood=82.80; AIC=-2.33; SC=-2.13; Mean dependent=-0.00; S.D. dependent=0.11; JB=37.46; χ^2 (1)=29.70; χ^2 (4)=8.76; RESET=7.15; CUSUM=stable.

Source: Authors' calculations.

The two estimates of ECM are almost equal as are the underlying cointegrating relations (2) and (4). The short term effect of the exchange rate on trade balance can be captured by the coefficients on lagged $\Delta REER$. Being significantly negative in both specifications (i.e. -1.46 and -1.37; and -1.32 and -1.18 respectively), they show that the immediate impact of currency depreciation is to worsen the trade balance (and the other way round in case of appreciation). The same could be seen from the estimated ARDL (2,3,0) (see Table 6).

Now combining these short term results with previous long run ones one gets a J-curve effect. Namely, while in short run currency depreciation worsens trade balance (Tables 5 and 6), ultimately trade balance improves in the long run (eqs. 2 and 4).

As a side result, the existence of ECM, i.e. the significance of adjustment coefficient: -0.40 (-5.11) in Table 6, is used in ARDL approach to confirm that the cointegration between *TB*, *REER* and GDP_d exists.

4.2 Impulse Response

Impulse response enables one to track the evolution of the trade balance over time subsequent to an exchange rate shock, e.g. a real depreciation of the currency. Thus it explicitly gives an estimate of the J-curve, if present, i.e. its shape and the timing. The latter encompasses both the period in which trade balance deteriorates ('short run'), and the ensuing phase when trade balance improves ('long run').

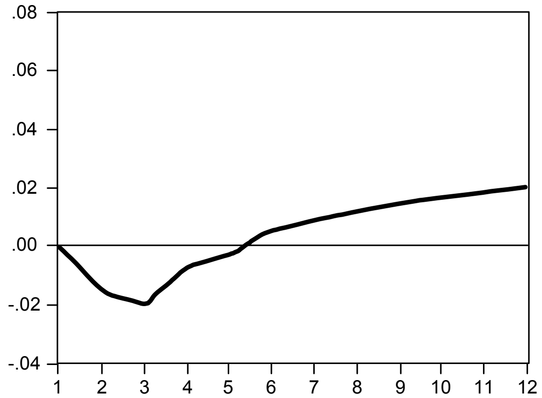
Impulse response could be calculated either by using the estimated ECM above, e.g. in Table 5, or directly from (unrestricted) VAR model of the three variables considered: *TB, REER* and GDP_d. The results are presented in Table 7 and Figures 2 and 3.

Table 7 Impulse Response of Trade Balance Following Exchange Rate Shock

Response of TB:			
Period	REER[1]	REER[2]	S.E.
1	-0.000929	-0.001237	0.00898
2	-0.015580	-0.015487	0.00993
3	-0.019888	-0.018703	0.01068
4	-0.007635	-0.005438	0.00780
5	-0.003075	-0.000337	0.00766
6	0.004820	0.007656	0.00715
7	0.008262	0.010720	0.00747
8	0.011938	0.014031	0.00790
9	0.014407	0.015975	0.00825
10	0.016392	0.017304	0.00856
11	0.017964	0.018053	0.00887
12	0.019145	0.018240	0.00921
Cholesky Ordering: REER GDPd TB			

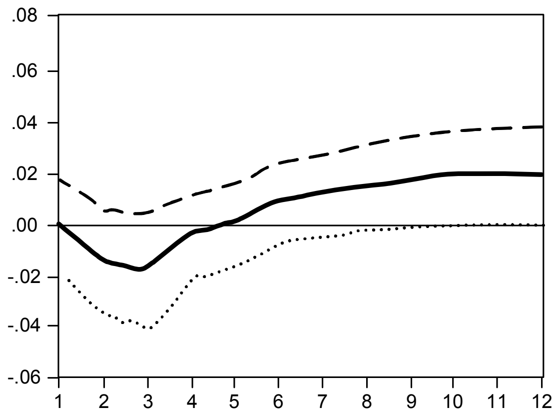
Note: [1] Obtained from ECM, [2] Obtained from unrestricted VAR.
S.E. Standard errors corresponding to unrestricted VAR estimates.

Source: Authors' calculations.



Source: Authors' calculations.

Figure 2 Evolution of Trade Balance Following Real Currency Depreciation: J-curve in Serbia (Based on ECM in Table 5)



Note: Two standard errors bound is included in this Figure, hence giving 95% intervals for corresponding trade balance values.

Source: Authors' calculations.

Figure 3 Evolution of Trade Balance Following Real Currency Depreciation: J-curve in Serbia (Based on Unrestricted VAR)

The results given in Table 7 and Figures 2 and 3 show that trade balance in Serbia after real depreciation of currency follows J-curve pattern[10]. Specifically the obtained estimates suggest that upon real depreciation in the first five months trade balance deteriorates ('short run') and only subsequently improves, reaching new equilibrium value sometime after a year time[11].

The two sets estimates of impulse response above are very close to each other (Table 7) suggesting that they are quite robust. In the case of unrestricted VAR, estimate of impulse response standard errors are reported (Table 7) and two standard errors (95%) band drawn in Figure 3. The latter also supports the presence of J-curve.

5. Conclusions

The main findings of the paper are that a real exchange rate depreciation has a significant positive long run impact on the trade balance in Serbia, and that in the short run trade balance first deteriorates before it later improves.

Thus, as in a number of other economies, a long run cointegrating trade balance relation is found for Serbia showing that a one percent real depreciation leads to a 0.92 to 0.95 percent improvement in trade balance. The corresponding error-correction models (ECM) of trade balance capture its short run movements and indicate the existence of the J-curve effect. Namely, the estimated ECMs show that an exchange rate depreciation has negative impact on the trade balance in the first few months. Combining this result with the one in the long run (i.e. an improvement of trade balance), one obtains the J-curve effect of depreciation on the trade balance.

Moreover, one can directly estimate the J-curve by calculating the impulse response of the trade balance upon the exchange rate shock. The estimates of the J-curve obtained for Serbia, both based on ECM and unrestricted VAR model, show that the trade balance hit by exchange rate depreciation deteriorates in the first five months and subsequently improves, reaching a new equilibrium value in somewhat more than a years time. Although these estimates should not be taken literally, they do however strongly support the existence of the J-curve pattern in trade balance movement.

Thus the results obtained for Serbia add to evidence found in other countries that currency depreciation improves trade balance in long run, and does so with the J-curve effect. Furthermore, these results bear essential immediate policy implication for Serbia as it faces large current account adjustments in the post 2008 - 09 crisis period.

A side result of this paper is that domestic output growth (GDP_d) leads to an improvement of the trade balance. This implies that output growth boosts export

[10] The results do not change with alternative Cholesky ordering; e.g. another ordering: REER TB GDPd, gives the same results.

[11] Strictly speaking since in this paper trade balance is defined as ratio of import over export, Table 7 and Figures 2 and 3, represent evolution of trade balance following real exchange rate appreciation. Therefore the results above show that after appreciation, trade balance first improves ('decreases') and subsequently deteriorates ('increases'). Nevertheless, the same Table 7 and Figures 2 and 3 would be obtained if trade balance is determined as export over import, and hit by real exchange rate depreciation. So we opted for this latter interpretation as a more insightful one.

more than it increases import. Some preliminary estimates of export and import functions tentatively support the result above, but additional research is necessary to conclusively resolve this issue.

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