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Devaluation and trade balance in Latin American countries*

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Abstract

The aim of this paper is to examine effectiveness of devaluation on the trade balance in four countries: Argentina, Brazil, Mexico and Peru. We use the Johansen-Juselius cointegration test and impulse response function to estimate the long-run and short-run effects of devaluation on the trade balance. The estimated results suggest that depreciation improve the trade balance in the long run for the case of Argentina and Peru, and in the short-run there has been J-curve in Argentina and Peru. In addition, the cointegration is found among the four variables (trade balance, domestic income, foreign incomes and real exchange rate) in the case of Argentina and Peru. The results also indicate that there is no cointegration relationship between these variables for Brazil and Mexico. The conclusion of the paper is that the evidence of the J-curve pattern was found for Argentina and Peru only.

Key words: *trade balance, J-Curve, Marshal-Lerner condition, cointegration, impulse response analysis, Latin America*

JEL classification: *F30, F32, F41*

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1. Introduction

Since the breakdown of Bretton Wood Accord in 1973, and the advent of floating exchange rates, there has been renewed interest on the effect of devaluation on the trade balance of both developed and developing countries. Currency depreciation is said to worsen the trade balance first before resulting in an improvement, yielding a short-run pattern labelled the J-curve phenomenon. In the international economic literature an important question has centred on the reactions of trade balance to currency depreciations or appreciations. The empirical literature supporting the J-curve is mixed[5]. Some economists argued that a possible way to improve trade balance (TB) would be a devaluation of the real exchange rate. However, real exchange rate devaluations would only improve TB if the well-known Marshall–Lerner (ML) condition holds, then in the long run the TB position would be improved. But in the short-term the TB deficit could worsen if the TB followed the J-curve pattern.

Given the implications of the J-curve for the conduct of macroeconomic stabilization policies, its empirical estimation has been a subject of interest. A number of studies have estimated the effect of a change in the real exchange rate on the balance of trade and have confirmed the existence of the J-curve, such as Artus (1975), Spitaller (1980), Krugman and Baldwin (1987), Wilson (1993), Bahmani-Oskooee and Alse (1994), Demirden and Pastine (1995), Marwah and Klein (1996), Lal and Lowinger (2002), Hacker and Hatemi-J (2003), Narayan and Narayan (2004) and Nadenichek (2006). Evidence of a weak or 'delayed' J-curve has also been found by several authors such as Rosensweig and Koch (1988) and Moffett (1989). Other authors such as Flemingham (1988), Rose and Yellen (1989), Rose (1991), Demeulemeester and Rochat (1995), Shirvani and Wibratte (1997) and Wilson (2001) have not found evidence of a J-curve in their studies.

Using annual data from 14 countries over the period 1956–1972, Miles (1979) finds that devaluations do not improve the trade balance but they do improve the balance of payments through the capital account. Himarios (1985), in his study of 10 countries, shows that in nine of ten countries, devaluations do affect the trade balance in the traditionally predicted direction. Bahmani-Oskooee (1985) studied the effect of devaluation in four developing countries: Greece, India, Korea and Thailand. With the exception of Thailand, his findings indicate that devaluation in the long run deteriorates the trade balance. Interestingly, the long-run impact on the trade balance is favourable only in the case of Thailand. Sundararajan and Bhole (1988) reinforce Miles' finding that devaluation improves the balance of payments

[5] Bahmani-Oskoee and Ratha (2004) is a good survey on the literature about the J-curve and on the ML condition, which shows that the empirical evidence does not indicate a clear picture of both the ML condition validity and J-curve pattern.

of India. Brissimis and Leventankis (1989) studied the effect of devaluation in Greece using quarterly data for covering the period 1975 to 1984. His findings indicate that devaluation in the long run deteriorates the trade balance. Himarios (1989) found that devaluation, in general, improves trade balance in the long run in his study of 15 developing countries. Rose and Yellen (1989), using the data on the U.S. bilateral trade with the G-7 countries as well as the aggregate U.S. trade, did not find any statistically significant evidence for the J-curve. Rose and Yellen's findings are important because theirs is the first time series econometric study that refutes the empirical validity of the J-curve.

Bahmani-Oskooee and Alse (1994) employed the Engle-Granger cointegration technique on quarterly data from 1971 to 1990 on the trade balance and real effective exchange rate of 19 developed and 22 less developed countries and find that the long-run impact of devaluation on the trade balance is positive for Costa Rica, Brazil, and Turkey; negative for Ireland. For Canada, Denmark, Germany, Portugal, Spain, Sri Lanka, UK and the USA, there is no long-run effect. Buluswar et al. (1996) found that devaluations have had no significant long-run effect on the trade balance for India. Upadhyaya and Dhakal (1997) tested the effectiveness of devaluation on the trade balance in eight developing countries. The estimated results suggest that devaluation, in general, does not improve the trade balance in the long run. In some cases it even had a perverse effect. Bahmani-Oskooee and Brooks (1999) investigated the effect of depreciation on US's bilateral trade with her six trading partners. They found that real depreciation of the dollar has a favourable long-run effect on US trade balance.

Bahmani-Oskooee (2001) investigates long-run response of 11 Middle Eastern countries trade balance to devaluation. He found that devaluation has favourable long-run effect on the trade balance of most non-oil exporting Middle Eastern countries. Bahmani-Oskooee and Goswami (2003) investigate the effect of depreciation on Japan's bilateral trade with her trading partners. The long-run effect of currency depreciation is found to be favourable. Ahmed and Yang (2004) investigate the effect of devaluation on China's bilateral trade with the G-7 countries. They found that devaluation improves the trade balance with some countries. Narayan (2004), tests for the existence of any cointegration relationship between trade balance and real effective exchange rate, foreign income and domestic income for New Zealand during the period 1970-2000. The results indicate that there is no cointegration relationship between the above variables. Gomes and Paz (2005) investigate the effect of real exchange rate depreciation on the Brazilian trade balance in the 1990s. They found that ML condition held in that period. Yiheyis (2006) studied the contractionary devaluation hypothesis in the context of selected 20 African countries. The results of this study indicate that the contemporaneous output effect of nominal devaluation is negative, providing statistical support for the hypothesis that devaluation is contractionary in the short run. On the other hand, the coefficient of the lagged rate of devaluation is found to be positive, implying that the contractionary problem is temporary. It is seen that the empirical evidence has been rather mixed, or inconclusive in the studies mentioned above.

The focus of the paper is on whether or not a J-curve pattern, an initial worsening and later improvement of the trade balance following a depreciation of the exchange rate, exists in four Latin American Countries; namely Brazil, Argentina, Mexico and Peru. This paper is organized as follows. In section 2, we formally define the analytical framework. Section 3 explains econometric methodology. Section 4 describes data and presents empirical results. Section 5 concludes the paper.

2. Analytical framework for testing

Following the literature, to study the effect of devaluation on the trade balance, we employed a reduced form equation for the trade balance (TB) similar to Bahmani-Oskooee (2001), Rose (1991) and Gomes and Paz (2005). As stated in the study of Kalyoncu and Kaplan (2007), the advantage of the formulation proposed in these studies is that it allows a straightforward test of the effect of devaluation on trade balance without estimating the structural parameters of the export and import functions. Simple derivation of the trade balance equation subject to empirical analysis can be shown as follows. The trade balance (TB), in its natural logarithm form, can be defined as the difference between the nominal imports (EP^*M) in terms of domestic currency units minus nominal exports (PX), i.e. $\log(TB) = \log(EP^*M) - \log(PX)$. Using small case letters for the log of variables, TB equation becomes:

$$b_t = m_t - x_t + (e_t - p_t + p_t^*) = m_t - x_t + er_t \tag{1}$$

where x, m, p^*, and p represent the natural logarithm of the volume of exports and imports, foreign import prices and domestic prices respectively. er_t is the log of real exchange rate. Defining the import and exports functions as:

$$x_t = a + by_t^* + \eta_x er_t \tag{2}$$

$$m_t = c + dy_t^* - \eta_m er_t \tag{3}$$

where a and c are constants, b and d are foreign and domestic income elasticity, η_x and η_m are real exchange rate elasticity of exports and imports respectively. Then, substituting the equation (2) and (3) in equation (1), we obtain TB equation subject to empirical analysis of the effectiveness of devaluation on trade balance as follows:

$$b_t = (c - a) - by_t^* + dy_t - (\eta_x + \eta_m - 1)er_t \tag{4}$$

After estimating the equation (4), one can easily test the effectiveness of devaluation by checking the coefficient of er_t variable, which gives the Marshall-Lerner (ML) condition. If the coefficient of er_t is negative then ML holds, indicating that devaluation improves the trade balance by increasing exports and reducing import.

3. Methodology

A necessary condition for testing for a long-run relationship between variables is that these variables are I(1), i.e., stationary in first differences. We, therefore, use the classical unit root tests, namely, the Augmented Dickey-Fuller (ADF) test (see Dickey and Fuller, 1981; Said and Dickey, 1984). ADF test is based on the null hypothesis that a unit root exists in the time series. We use the following ADF tests which include constant (in equation 5), and both constant and trend (in equation 6);

$$\Delta X_t = \alpha + \beta X_{t-1} + \sum_{i=1}^{n} \lambda_i \Delta X_{t-i} + \varepsilon_t \tag{5}$$

$$\Delta X_t = \alpha + \rho t + \beta X_{t-1} + \sum_{i=1}^{n} \lambda_i \Delta X_{t-i} + \varepsilon_t \tag{6}$$

In this equation, X is the variable under consideration; Δ is the first difference operator; α is constant; t is a time trend and ε is a stationary, random error term.

Once it is established that series are I(1), we can proceed to test for a long-run relationship between the series. If such a relationship exists, series are cointegrated. We tested cointegration using the cointegration techniques devised by Johansen and Juselius (JJ) (1990). JJ test can distinguish between the existences of one or more cointegrating vectors and also generate test statistics with exact distributions; it is hereby appropriate to utilize. Thus, assuming a vector autoregressive (VAR) model:

$$\Delta X_t = \sum \Gamma_i X_{t-i} + \Omega X_{t-1} + \mu + \varepsilon_t \tag{7}$$

Where Xt is a vector of endogenous variables p x 1 and (i = 1,…….,k).

The JJ method tests whether the coefficient matrix Ω reflects the fundamentals of long run equilibrium among the non-stationary variables. As a result, if 0 < rank, Ω = r < p, then there are matrices α and β of dimension p x r where Ω = αβ’ and r cointegrating relations among elements of Xt; where α and β are cointegration vectors and error correction parameters, respectively.

In the JJ method, two tests are used to determine the number of cointegrating vectors (*r*): the trace test and the maximum eigenvalue test. In the trace test, the null hypothesis is that the number of cointegrating vectors are less than or equal to *r*, where *r* is 0, 1, or 2. In each case, the null hypothesis is tested against a general alternative. In the maximum eigenvalue test, the null hypothesis r = 0 is tested against the alternative that r = 1 and r = 1 against the alternative r = 2, etc.

Impulse response function is the best way of deriving evidence of the J-curve. Therefore, we use the generalised impulse response function in this study. The generalised impulse response function reveal insights into the dynamic relationships in existence as they portray the response of a variable to an unexpected shock in another variable over a given time horizon.

4. Data and empirical results

4.1. Data

All data are quarterly and gathered from the International Monetary Fund's International Financial Statistics (IMF-IFS) database. Due to the unavailability of data, sample sizes differ for countries. Sample period is from 1991:Q1 to 2005:Q4 for Brazil, 1993:Q1 to 2005:Q4 for Argentina, 1981:Q1 to 2005:Q4 for Mexico and 1979:Q1 to 2005:Q4 for Peru. The following notation applies that *B*, logarithm of the Trade Balance (trade balance is defined as the natural logarithm of import over export), *Y*, logarithm of the home country's GDP, World income (Y*) is defined as natural logarithm of the Industrial production index, *RER*, logarithm of the real exchange rate.

4.2. Empirical results

Firstly, we investigate the time series properties of the series in each country. The results of the ADF test on the levels and first differences of the variables are presented in Table 1. The lag length was selected using the Schwarz Criterion.

The results show that except Argentina's trade balance series, all countries *B, Y, Y** and *RER* series have unit roots in their levels, but no unit roots in their first difference forms. Overall, results suggest that Argentina's *B* series is I(0) and all other series are I(1).

Table 1: Unit root test results

Country and Series	Level τ_μ		First difference τ_μ	
	τ_τ	τ_μ	τ_τ	τ_μ
Brazil				
B	-0.954(2)	-1.013(2)	-8.374(1)*	-8.207(1)*
Y	-1.688(4)	-1.482(3)	-9.759(2)*	-4.448(3)*
Y*	-1.293(9)	-0.013(9)	-3.463(8)***	-3.373(8)**
RER	-1.100(0)	-1.182(0)	-6.165(0)*	-6.175(0)*
Argentina				
B	-3.403(4)***	-2.837(4)***		
Y	-2.890(4)	-2.311(4)	-6.278(1)*	-6.258(1)*
Y*	-1.573(5)	-0.478(5)	-4.047(4)**	-3.973(4)*
RER	-2.813(1)	-1.304(1)	-4.202(0)*	-4.239(0)*
Mexico				
B	-2.255(0)	-1.682(0)	-6.697(0)*	-6.712(0)*
Y	-2.428(2)	0.688(2)	-5.391(4)*	-2.689(7)***
Y*	-2.394(5)	-0.872(5)	-4.973(4)*	-5.030(4)*
RER	-2.509(6)	-2.235(0)	-8.966(0)*	-8.908(0)*
Peru				
B	-1.683(1)	-1.938(1)	-10.29(0)*	-10.19(0)*
Y	-1.763(4)	-1.986(4)	-3.212(3)***	-3.088(3)**
Y*	-3.111(6)	-2.021(5)	-4.532(4)*	-4.623(4)*
RER	-1.466(0)	-1.555(0)	-8.358(1)*	-8.339(1)*

Note**:** The t statistics refer to the ADF tests. The subscripts μ and τ indicates the models that allow for a drift term and both a drift and a deterministic trend, respectively. Asterisks (*,** and ***), shows significance at 1%, 5% and 10% levels respectively. Figures in parentheses indicate the lag length.

Source: Author's calculations

When the dependent variable is integrated of I(0) and independent variables are integrated of I(1), it is still possible for these variables to be cointegrated if the linear combination of independent variable have I(0) process. In this case error term will be stationary, since both the dependent variable and the linear combination of independent variables are stationary (Charemza and Deadman, 1997, p.126-127). Considering the discussion given above, we precede with the Johansen multivariate cointegration tests for the four countries.

Before undertaking cointegration tests, let us first specify the relevant order of lags (p) of the vector autoregression (VAR) model. The Schwarz's information criterion (SIC) is used to determine the optimal lag length. The SIC criterion yield a VAR (5) for Argentina and Mexico, VAR (1) for Brazil and a VAR (3) for Peru. The results obtained from the JJ method are presented in Table 2.

Table 2: Johansen-Juselius maximum likelihood cointegration tests

Argentina							
Trace test				Maximum eigenvalue test			
Null	Alternative	Statistic	95 % C.V.	Null	Alternative	Statistic	95 % C. V.
r = 0	r ≥ 1	56.705*	47.856	r = 0	r = 1	34.439*	27.584
r ≤ 1	r ≥ 2	22.265	29.797	r ≤ 1	r = 2	14.459	21.132
r ≤ 2	r ≥ 3	7.806	15.494	r ≤ 2	r = 3	7.802	14.265
r ≤ 3	r ≥ 4	0.003	3.841	r ≤ 3	r = 4	0.003	3.841
Brazil							
Trace test				Maximum eigenvalue test			
Null	Alternative	Statistic	95 % C.V.	Null	Alternative	Statistic	95 % C. V.
r = 0	r ≥ 1	29.859	47.856	r = 0	r = 1	17.657	27.584
r ≤ 1	r ≥ 2	12.202	29.797	r ≤ 1	r = 2	6.806	21.132
r ≤ 2	r ≥ 3	5.396	15.494	r ≤ 2	r = 3	3.693	14.265
r ≤ 3	r ≥ 4	1.704	3.841	r ≤ 3	r = 4	1.704	3.841
Mexico							
Trace test				Maximum eigenvalue test			
Null	Alternative	Statistic	95 % C.V.	Null	Alternative	Statistic	95 % C. V.
r = 0	r ≥ 1	31.878	47.856	r = 0	r = 1	21.426	27.584
r ≤ 1	r ≥ 2	13.452	29.797	r ≤ 1	r = 2	7.988	21.132
r ≤ 2	r ≥ 3	6.464	15.494	r ≤ 2	r = 3	3.765	14.265
r ≤ 3	r ≥ 4	1.199	3.841	r ≤ 3	r = 4	1.199	3.841
Peru							
Trace test				Maximum eigenvalue test			
Null	Alternative	Statistic	95 % C.V.	Null	Alternative	Statistic	95 % C. V.
r = 0	r ≥ 1	58.902*	47.856	r = 0	r = 1	47.261*	27.584
r ≤ 1	r ≥ 2	11.641	29.797	r ≤ 1	r = 2	8.238	21.132
r ≤ 2	r ≥ 3	3.402	15.494	r ≤ 2	r = 3	3.174	14.265
r ≤ 3	r ≥ 4	0.228	3.841	r ≤ 3	r = 4	0.228	3.841

Notes: Asterisks (*) denotes statistical significance at 5%. *r* stands for the number of cointegrating vectors. We have employed the Schwarz's information criterion (SIC) in the determination of lag length in the VAR model.

Source: Author's calculations

For the case of Argentina and Peru, the null hypothesis of no cointegration, i.e., r=0 can be rejected in both equations either using the maximum eigenvalue or the trace statistic. They are both greater than their critical value. However the null of r=1 cannot be rejected in favor of r=2. Thus, there is one cointegrating vector among these countries series.

For the case of Brazil and Mexico, the null hypothesis of no cointegration, i.e., r=0 can not be rejected in both equations either using the maximum eigenvalue or the trace statistic. Thus there is no cointegrating vector among these countries series.

Table 3 reports the cointegration equation. Table 3 shows that the real exchange rate variable coefficient (RER) is smaller than zero, which implies that the ML condition holds in the case of Argentina and Peru. Domestic real income coefficient is negative and foreign income coefficient is positive as expected. I remind that we define trade balance series as import revenues minus export revenue. So when the coefficient of RER is negatif, we interpret this devaluation improves the countries trade balance by increasing exports and reducing import.

Table 3: Cointegration equation

Dependent variable (B)	Y	Y*	RER
Argentina	1.684 (0.28)	-6.714 (1.54)	-1.210 (0.11)
Peru	0.416 (0.35)	-5.109 (0.78)	-1.415 (0.34)

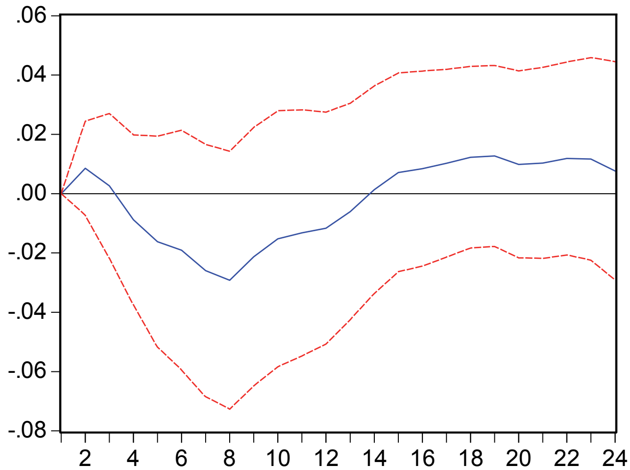
Notes: Number inside the parentheses is standard errors.

Source: Author's calculations

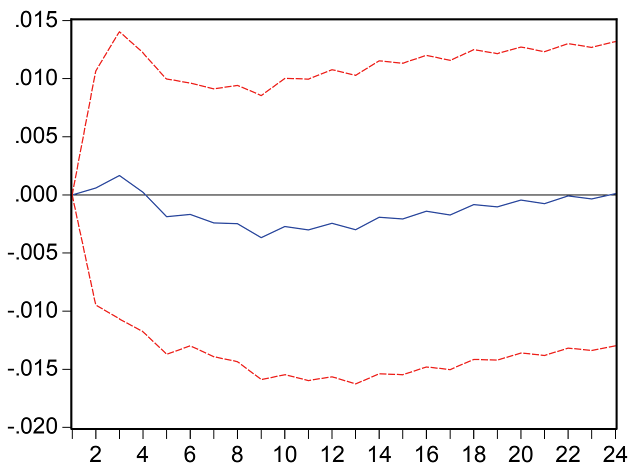
According to theory, it is expected that real exchange rate devaluations improve the trade balance only after some time due to the "J-Curve" effects. To examine the J-curve pattern the generalized impulse response function of trade balance was calculated for a one standard-deviation real exchange rate innovation. The results reported in Figure 1 for Argentina and Peru suggest that in the first 3,5 periods (quarters) the effect is positive for Argentina and in the first 4 periods (quarters) the effect is positive for Peru. Thus evidence in favour of the J-curve pattern was found for two cases.

Figure 1: Response of trade balance to generalized one standard deviation real effective exchange rate innovation

Argentina



Peru



Source: Author’s calculations

5. Conclusion

In this paper we investigate whether or not a J-curve pattern, an initial worsening and later improvement of the trade balance following a depreciation of the exchange rate, exists in four Latin American Countries; namely Brazil, Argentina, Mexico and Peru. Thus, the short run and long run impact of devaluation on the trade balance is analyzed for these countries by using quarterly data. The methodology used is based on the Johansen-Juselius cointegration test and generalized impulse response function.

The estimated results indicate the evidence of cointegration among the trade balance, domestic income, foreign incomes and real exchange rate variables only in the case of Argentina and Peru. For these countries, devaluation of the currencies improved the trade balance in the long-run. However, the results indicate that there is no cointegration relationship between these variables for Brazil and Mexico. In other words, J-curve pattern was not confirmed in Brazil and Mexico. The generalized impulse response analysis results also indicate that in the short-run there has been J-curve in the case of Argentina and Peru. Real exchange rate devaluations improve the trade balance only after first 3,5 periods (quarters) for Argentina and first 4 periods (quarters) for Peru.

The conclusion of the paper is that the evidence of the J-curve pattern was found for Argentina and Peru only. Also, there are certain limitations which need to be addressed in any future studies. These restrictions simultaneously provide future research opportunities. At last, we are aware that there are some other variables influencing the aforementioned conclusions and reason that further international studies and in-depth analyses are needed.

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Devalvacija i trgovačka bilanca u zemljama Latinske Amerike

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Sažetak

Cilj ovoga rada je ispitati djelotvornost devalvacije na trgovačku bilancu u četiri zemlje: Argentini, Brazilu, Meksiku i Peruu. Primijenjen je Johansen-Juselius kointegracijski test i funkcija spontane reakcije da bi se procijenili dugoročni i kratkoročni učinci devalvacije na trgovačku bilancu. Dobiveni rezultati pokazuju da deprecijacija, dugoročno, poboljšava trgovačku bilancu u slučaju Argentine i Perua, te da je u istim zemljama, kratkoročno prisutna J – krivulja. Nadalje, postoji kointegracija četiriju varijabli (trgovačke bilance, domaćeg prihoda, stranih prihoda i stvarnog intervalutnog tečaja) u slučaju Argentine i Perua. Rezultati također pokazuju da u slučaju Brazila i Meksika nema kointegracijskog odnosa ovih varijabli. Stoga se u ovom radu zaključuje da je dokaz o J-krivulji prisutan samo u Argentini i Peruu.

Ključne riječi*: trgovačka bilanca, J-krivulja, Marshal-Lerner uvjet, kointegracija, analiza spontane reakcije, Latinska Amerika*

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