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THE J CURVE PHENOMENON: AN EVIDENCE FROM PAKISTAN

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Abstract. Some previous studies that tested J curve phenomenon and M-L condition for Pakistan used OLS, 2SLS, 3SLS and IV techniques. Their results may suffer from spurious regression problems as the models were estimated without incorporating cointegrating property of the variables. The major objective of this paper is to estimate a reduced form trade balance model to establish the empirical validity of the J curve phenomenon using relatively new cointegration technique, ARDL. The J curve hypothesis is tested for Pakistan using quarterly data over 1972-2002 period. The evidence of J curve is found and long-run effect of real depreciation of Pak Rupee appears to be not favourable.

I. INTRODUCTION

Understanding the relationship between the terms of trade and trade balance is the key to a successful trade policy. It is not clear if trade barriers and protectionism based on infant industry arguments have achieved the desired changes in the trade balance. Much of the work centres on the twin concepts of Marshall-Lerner (M-L) condition and the J curve phenomenon. According to the absorption approach, devaluation, through its impact on terms of trade and domestic production, leads to a switch in spending from foreign to domestic goods, and hence an improvement in trade balance. Monetarists, in contrast, argue that devaluation reduces the real value of cash balances and/or changes the relative price of traded and non-traded goods, and thus improves the trade balance as well as the balance of payments. According to the M-L condition, the success of a real devaluation depends on whether the

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sum of import and export demand elasticities exceed unity. Proponents of this approach argue that the M-L condition provides both the necessary and sufficient conditions for an improvement in the trade balance. However, there have been circumstances under which this condition was satisfied yet the trade balance continued to deteriorate (Bahmani-Oskooee, 1985). The focus, thus, shifted to the short-run dynamics that traced the post-devaluation time-path of trade balance to the J curve phenomenon while exchange rates adjust instantaneously, there is lag in the time consumers and producers take to adjust to changes in relative prices (*see*, for example, Junz and Rhomberg, 1973; Magee, 1973 and Meade, 1988). Thus, a short-run deterioration is consistent with a long-run improvement in the trade balance and seems like a necessary feature of devaluation.

There is a vast amount of literature on the relationship between the trade balance and exchange rate. Of primary interest here, however, is whether or not there is any improvement in the trade balance after the currency has been depreciated in the special case of Pakistan. There are two approaches for examining the effect of exchange rate movements on the trade balance: indirectly through the Marshall-Lerner condition, and directly through the J curve phenomenon.

Utilizing J curve phenomenon has two advantages over using Marshall-Lerner condition directly. First, it provides an indirect test of the Marshall-Lerner condition and second, it provides information about the length and depth of deterioration in the trade balance following devaluation. Existing empirical evidence with respect to the satisfaction of M-L condition and J curve phenomenon for Pakistan is mixed (*see*, for example, Khan and Hasan, 1994; Khan and Aftab, 1995; Bahmani-Oskooee, 1998, Akhtar and Malik, 2000). This paper is an attempt to investigate the long-run and short-run impact of exchange rate devaluation on Pakistan's trade performance using aggregate data for Pakistan employing relatively new cointegration technique advanced by Pesaran and Shin (1995) and Pesaran *et al.* (1996), known as Autoregressive Distributive Lag (ARDL) approach.

The plan of the paper is as follows: in Section II the model specification is given. In Section III, ARDL approach is explained. Section IV reports the empirical results and, finally, Section V presents the conclusion and summary. The definition and sources of data are cited in the Appendix.

II. THE MODEL SPECIFICATION

Following Bahmani-Oskooee and Brooks (1999), the following model in log linear form is adopted:

$$\ln TB_t = a + a_1 \ln Y_t + a_2 \ln Y^*_t + a_3 REX_t + \varepsilon_t \qquad (1)$$

Where *TB* is a measure of trade balance defined as the ratio of Pakistan's exports to the world to her imports from the world; Y_t is the Pakistan's real income; and Y^*_t is world real income. *REX* is the real exchange rate.[1]

The trade balance is defined as ratio of exports over imports (*X/M*) for three reasons. First, it enables researchers to express the trade balance in logarithm so that the first differenced variables reflect the rate of change in each variable. Second, the ratio measure is not sensitive to units of measurement (Bahmani-Oskooee and Alse, 1994). Indeed previous research has shown that the results could be sensitive to units of measurement (see evidence in Miles, 1979 versus Himarios, 1985). Finally, the ratio measure reflects the trade balance in real or nominal terms (Bahmani-Oskooee and Brooks, 1999).

As far as the signs of coefficients are concerned, it is expected that the estimate of a_1 to be negative or positive. Following traditional argument, if an increase in *Y* raises imports, the estimate of a_1 is expected to be negative. However, if increase in *Y* is due to an increase in the production of import-substitute goods, it is expected that the estimate of a_1 to be positive. The expected sign of a_2 may be positive or negative. As foreign income rises, Pakistan's exports will increase yielding a positive a_2. However, if the increase in foreign income is due to an increase in the production of substitutes made by Pakistan, this will result in a fall in the exports of Pakistan resulting in a negative a_2. Finally, an increase in *REX* means depreciation of Pakistan's currency leads to an increase in exports and a reduction in imports, the estimated value of a_3 is expected to be positive.

Some previous studies that tested J curve phenomenon and M-L condition for Pakistan used OLS, 2SLS, 3SLS and IV techniques. Their results may be biased (*see*, for example, Khan and Hasan, 1994; Khan and Aftab, 1995; Akhtar and Malik, 2000). They estimated the models without incorporating the cointegrating property of the variables. Following Pesaran and Shin (1995) and Pesaran *et al.* (1996), equation (1) is specified in an error-correction modeling format. The error-correction version of ARDL model pertaining to variables in equation (1) is as follows:

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[1]The data definition and sources are cited in the Appendix.

$$\Delta \ln TB_t = a_0 + \sum_{i=1}^{n} a_{1i} \Delta \ln BT_{t-i} + \sum_{i=1}^{n} a_{2i} \Delta \ln Y_{t-i} + \sum_{i=1}^{n} a_{3i} \Delta \ln Y^*_{t-i} + a_{4i} \Delta \ln REX_{t-i} + \delta_1 \ln TB_{t-1} + \delta_2 \ln Y_{t-1} + \delta_3 \ln Y^*_{t-1} + \delta_4 \ln REX_{t-1} + \varepsilon_t \tag{2}$$

A brief description of Autoregressive Distributed Lags (ARDL) approach is given in the next section.

III. AUTOREGRESSIVE DISTRIBUTIVE LAG (ARDL) APPROACH

The cointegration and error correction frameworks have proved to be successful tools in the identification and estimation of J curve phenomenon. This type of approach to J curve phenomenon captures the long-run equilibrium relationship between trade balance and exchange rate, as well as short-run variation and dynamics. It does so by allowing economic theory to specify the long-run equilibrium, while the underlying data-generating process determines the short-term dynamics. It is in the sense that this approach represents a significant improvement over the partial adjustment specifications that severely restrict the lag structure by relying solely on ad hoc economic theory without examining the actual data.

There is growing literature on the application of cointegration and error correction models to the examination of J curve phenomenon. The earlier application tended to be based on the Engle-Granger cointegration approach. Further research, however, suggest we undertake the identification and estimation of J curve phenomenon in a multivariate framework using procedures developed by Johansen and Juselius. In this study we apply a new and comparatively better technique advanced by Pesaran *et al.* (2001), known as the ARDL approach. The important features of this approach are: (*i*) this method can distinguish dependent and explanatory variables (*i.e.* avoiding the problems of endogeneity) and (*ii*) this method can estimate the long and short-run components of the model simultaneously, removing problems associated with omitted variables and autocorrelation. Thus, estimates obtained from the ARDL method of cointegration analysis are unbiased and efficient, since they avoid the problems that may arise due to serial correlation and endogeneity. The main advantage of the ARDL procedure lies in the fact that it can be applied irrespective of whether the regressors are I(0) or I(1). In turn, this avoids the pre-testing problems associated with standard cointegration analysis, which requires the classification of the variables as either I(0) or I(1).

In any ARDL model, regressors include lagged values of the dependent variable and current and lagged values of one or more explanatory variables.

The simplest example of an ARDL model is:

$$y_t = m + \gamma_1 y_{t-1} + \beta_0 x_t + \beta_1 x_{t-1} + \varepsilon_t \tag{3}$$

The above equation represents an ARDL (1, 1), since the dependent variable, y_t, and single explanatory variable, x_t, are each lagged once, ε_t is presumed to be white noise. Inverting the lag polynomial in y gives:

$$\begin{aligned} y_t &= (1 + \gamma_1 + \gamma_1^2 + \ldots)\, m + (1 + \gamma_1 L + \gamma_1^2 L^2 + \ldots) \\ &\quad (\beta_0 x_t + \beta_1 x_{t-1}\, \varepsilon_t) \end{aligned} \tag{4}$$

Thus the current value of y depends on the current and all the previous values of x and ε. In other words, this relation shows that the current value of x has an effect on the current and future values of y.

The properties of ARDL relations can often be simply revealed by reparameterizing the equation. Replace y_t by $y_{t-1} + \Delta y_t$ and x_t by $x_{t-1} + \Delta x_t$ in equation (4).

The result is:

$$\Delta y_t = m + \beta_0 \Delta x_t - (1 - \gamma_1)\, y_{t-1} + (\beta_0 + \beta_1)\, x_{t-1} + \varepsilon t \tag{5}$$

Given:

$$a = \frac{m}{1-\gamma}, \quad \delta = \frac{(\beta_0 + \beta_1)}{1-\gamma_1}$$

where δ is the slope coefficient in the long-run relationship between y_t and x_t. The augmented ARDL (p, q_1, q_2, ⋯, q_k) can be written as follows:

$$\alpha(L, P)\, y_t = \alpha_0 + \sum_{i=1}^{k} \beta_i (L, q_i)\, x_{it} + u_t \tag{6}$$

where x_0 is constant; y_t is a dependent variables; L is a lag operator such $L^j y_t = y_{t-j}$ and

$$\begin{aligned} \alpha(L, P) &= 1 - \alpha\, \delta_1 L^1 - \ldots\, \alpha_p L^p,\ \beta_i (L, q_i) \\ &= \beta_{i0} + \beta_{i1} L + \beta_{i2} L^2 + \ldots + \beta_{iqi} L^{qi};\ x_{it} \end{aligned} \tag{7}$$

is the i^{th} independent variable where $i = 1, 2, \ldots, k$. In the long-run, we have $y_t = y_{t-1} = \ldots = y_{t-p}$; $x_{it} = x_{i,t-1} = \ldots = x_{i,t-q}$ where $x_{i,t-q}$ denotes the q^{th} lag of the i^{th} variable.

The long-run equation can be written as:

$$y = \alpha + \sum_{i=1}^{k} \beta_i x_i + v_t \tag{8}$$

with:

$$\alpha = \frac{\alpha_0}{\alpha(1,p)}, \quad \beta_i = \frac{\beta_i(1,q)}{\alpha(1,p)}, \quad v_t = \frac{\mu_t}{\alpha(1,p)}$$

The error correction representation of the ARDL model can be written as follows:

$$\Delta y_t = \Delta \alpha_0 - \sum_{j=2}^{p} \alpha_j \, \Delta y_{t-j} + \sum_{i=1}^{k} \beta_{i0} \, \Delta x_{it} - \sum_{i=1}^{k} \sum_{j=2}^{q} \beta_{i,t-j} \, \Delta x_{i,t-j} - \alpha(1,p) \, ECM_{t-1} + \mu_t \tag{9}$$

with:

$$ECM_t = y_t - \hat{\alpha} - \sum_{i=1}^{k} \beta_i x_{it} \tag{10}$$

where Δ is the first difference operator; $\alpha(1,p)$ measures the speed of adjustment.

IV. EMPIRICAL RESULTS

Since the J curve phenomenon is a short-run phenomenon, an appropriate method to test it would be to employ error-correction modeling and cointegration techniques. The first step in applying these techniques is to determine the order of integration of each variable. However, depending on the power of unit root tests, different tests yield different results (Bahmani-Oskooee, 1998). Due to this uncertainty, ARDL approach introduced by Pesaran and Shin (1995) and Pesaran *et al.* (1996) is quite appropriate for the estimation of the model. The major advantage of this approach is that there is no need of the classification of variables into I(0) or I(1) and it does not require the unit root pre-testing. The ARDL approach is applied and the long-run coefficients and short-run dynamics are estimated using quarterly data over 1972I-2002IV period. Two steps are involved in the ARDL procedure. First, the null of no cointegration defined by H_0: $\delta_1 = \delta_2 = \delta_3 = \delta_4 = 0$ is tested against the alternative of H_1: $\delta_1 \neq 0$, $\delta_2 \neq 0$, $\delta_3 \neq 0$, $\delta_4 \neq 0$ by the means of familiar F-test. However, the asymptotic distribution of this F-statistic is non-standard irrespective of whether the variables are I(0) or I(1). Pesaran *et al.* (1996) have tabulated two sets of appropriate critical values. One set assumes all variables are I(1) and the other assumes that they are all

I(0). This provides a band covering all possible classifications of the variables into I(1) and I(0) or even fractionally integrated. If the calculated F-statistic lies above the upper level of the band, the null is rejected, indicating cointegration. If the calculated F-statistic falls below the lower level of band, the null cannot be rejected, supporting lack of cointegration. If, however, it falls within the band, the result is inconclusive. Bahmani-Oskooee and Brooks (1999) have demonstrated that this will depend upon the number of lags imposed on each different variable. Thus, F-test by imposing two, four, six, eight, ten and twelve lags of each first differenced variable is employed. An F-statistic 5.27 is obtained which is higher than the critical value of 3.84.[2] This provides a strong evidence in support of cointegration. Now it is justified to retain the lagged value of all four variables (a linear combination of which is denoted by error-correction term EC_{t-1}) in the ARDL model, we re-estimate the model using an appropriate lag selection criterion such as AIC, R bar-squared criterion.[3] The full results are reported in Tables 1 and 2.

TABLE 1

Full Information Estimate of Equation (2)
Where Lags are Selected by Akaike Information Criterion

Exogenous Variables	Coefficient Estimate	t Ratio (absolute value)
Constant	–5.01	2.98
ΔLTB_{t-1}	–0.098	1.16
ΔLY	–0.18	3.05
ΔLY_{t-1}	0.02	0.29
ΔLY_{w}	–0.35	0.47
ΔLY_{wt-1}	0.39	0.49
$\Delta LREX$	–0.03	0.43
$\Delta LREX_{t-1}$	–0.08	1.15
LY	–1.25	3.60
LY_{w}	2.37	4.33
$LREX$	–5.17	2.35

[2]For each lag, F-statistic is higher than its critical value supporting cointegration.

[3]In this paper both AIC and R bar-squared criteria are employed.

From Table 1, it can be concluded that the real depreciation of Pak Rupee worsened Pakistan's overall trade balance in the short-run. This is due to the fact that lagged coefficient of $\Delta LREX$ variable carry negative coefficient. The long-run effect of devaluation is negative and significant. This indicates that the long-run impact of real depreciation of Pak Rupee has adverse impact on the overall Pakistan's trade balance. Akaike Information Criterion has selected only one lag which does not provide much information about the short-run dynamics. R bar-squared criterion which usually selects more lags than AIC or SBC is employed. Table 2 presents the estimates of equation (2) when R bar-squared criterion is employed.

TABLE 2

Full Information Estimate of Equation (2)
Where Lags are Selected by R Bar-Squared Criterion

Regressor	Coefficient Estimate	t Ratio (absolute value)
ΔLTB_{t-1}	–0.41	3.87
ΔLTB_{t-2}	0.08	0.93
ΔLTB_{t-3}	0.11	1.21
ΔLTB_{t-4}	–0.04	0.42
ΔLTB_{t-5}	–0.09	0.96
ΔLTB_{t-6}	–0.15	1.57
ΔLTB_{t-7}	–0.12	1.32
ΔLY	–0.43	2.34
ΔLY_{t-1}	–0.62	2.74
ΔLY_{t-2}	0.44	1.93
ΔLY_{t-3}	0.50	2.03
ΔLY_{t-4}	0.60	2.41
ΔLY_{t-5}	0.31	1.31
ΔLY_{t-6}	–0.25	1.07
ΔLY_{t-7}	–0.51	2.40
ΔLY_{t-8}	–0.28	1.31
ΔLY_{w}	–0.84	1.07
ΔLY_{wt-1}	1.16	1.36
ΔLY_{wt-2}	–1.23	1.48
$\Delta LREX$	–0.08	1.12
$\Delta LREX_{t-1}$	–0.18	2.32

$\Delta LREX_{t-2}$	−0.11	1.40
$\Delta LREX_{t-3}$	−0.22	2.84
$\Delta LREX_{t-4}$	−0.14	1.58
$\Delta LREX_{t-5}$	−0.06	0.67
$\Delta LREX_{t-6}$	−0.19	2.49
$\Delta LREX_{t-7}$	0.02	0.30
$\Delta LREX_{t-8}$	0.12	1.50
$\Delta LREX_{t-9}$	0.07	1.01
LY	−1.82	3.89
LY_w	2.86	4.64
$LREX$	−0.89	2.50
Constant	−4.61	2.14
EC_{t-1}	−0.28	4.66
Adjusted R^2	0.48	
$LM\left(\chi_4^2\right)$	3.06	
Reset $\left(\chi_1^2\right)$	2.85	

It is clear from Table 2 that there is evidence of the J curve phenomenon as it is evident from the short-run pattern. Inspecting the short-run dynamics in Table 2, it is gathered that the real depreciation of Pak Rupee worsens Pakistan overall trade balance in the short-run. This is due to the fact that first six lagged coefficients of $\Delta LREX$ variable carry negative coefficient and afterward all the remaining lagged coefficients of $\Delta LREX$ variable carry positive coefficients. The long-run coefficient of $LREX$ is negative and significant, indicating that real depreciation of Pak Rupee has adverse impact on Pakistan's trade balance.

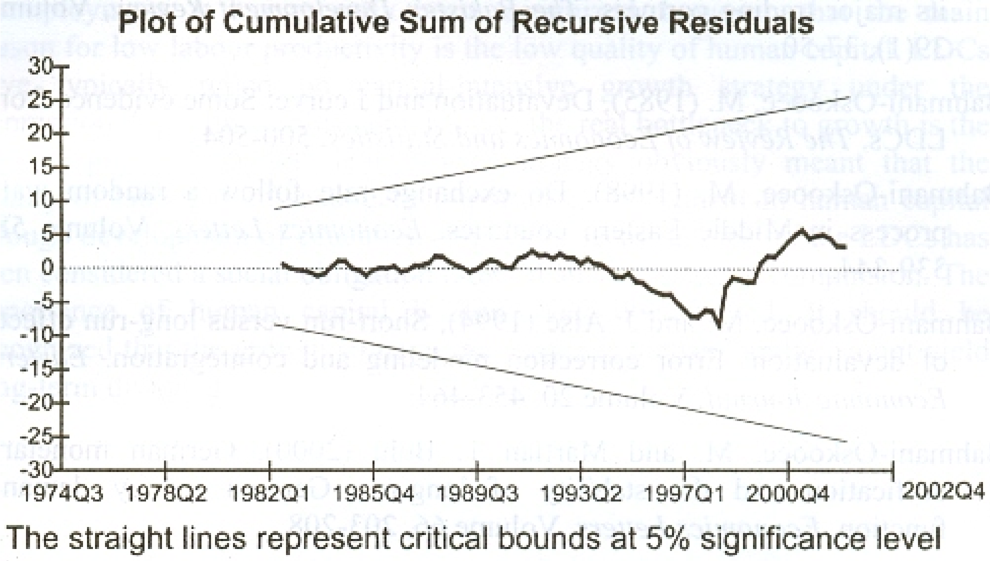
Reported in Table 2 are several other statistics that could be useful. First the Lagrange Multiplier (LM) test of residual serial correlation which has a χ^2 distribution with 4 degrees of freedom is reported as LM. Since the LM statistic is less than its critical value, it is concluded that there is a lack of serial correlation. Second, Ramsey's RESET test statistic for functional form specification is reported as RESET. This statistic is distributed as χ^2 with 1 degree of freedom. It is clear that the RESET statistic is less than its critical value indicating the fact that the model is correctly specified. The EC_{t-1}, the lagged error correction term carries its expected negative sign and highly significant coefficient supporting our earlier findings that variables are cointegrated. Furthermore, following Bahmani-Oskooee and Bohl (2000), the stability of short-run as well as long-run coefficients is investigated by applying CUSUM and CUSUMSQ tests proposed by Brown *et al.* (1975) to the residuals of error correction model. The CUSUM and CUSUMSQ statistics are updated recursively and plotted against break points. For stability of all coefficients, the plot of these two statistics must stay within 5% significance level (portrayed by two straight lines). Figure 1 clearly reveals that the stability of coefficient estimates is not supported because the plot of CUSUMSQ does not fall within the critical values.

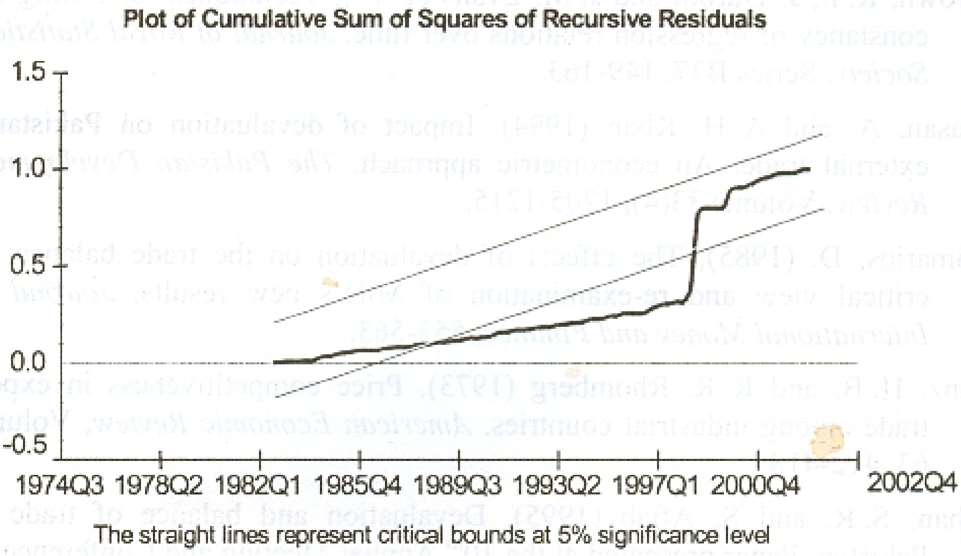
V. CONCLUSION

The major objective of this paper is to estimate a reduced form trade balance model to establish the empirical validity of the J curve phenomenon. The long-run impact of real depreciation of Pak Rupee on Pakistan's trade balance using aggregate data is investigated. The evidence of J curve is found and the long-run effect of real depreciation of Pak Rupee appears to be not favourable. One major limitation of this paper is that it has used aggregate data in order to test the J curve phenomenon for Pakistan. The major problem that might come up is aggregation bias. Marquez (1990) suggested that the direction of trade is sensitive to changes in income and prices. Therefore, using disaggregated data is consistent with the literature and suitable to address questions involving multilateral trade. It is left on the interested readers to investigate the J curve phenomenon between Pakistan and its major trade partners by employing recent advances in dynamic modeling.

FIGURE 1

CUSUM and CUSUMSQ Test Results





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APPENDIX

DATA DEFINITION AND SOURCES

For Pakistan quarterly data over 1972-2002 are used to carry out the empirical work. The data are collected from International Financial Statistics of IMF (CD-ROM) and OECD Bulletin, various issues.

Variables

The variables are as under:

TB	=	Pakistan's trade balance and is defined as the ratio of its exports to its imports.
Y	=	Index of industrial production of Pakistan is used as a proxy for its real income.
*Y**	=	Index of industrial production of US is used as a proxy for world real income.
P	=	Consumer price index of Pakistan
*P**	=	Consumer price index of US is used as proxy of world price index.
REX	=	Real exchange rate defined as $\frac{e \cdot P^*}{P}$ where e is the official exchange rate measured by the number of Pak Rupee per US dollar.