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Estimating Long-run Trade Elasticities in Pakistan: A Cointegration Approach

MOHAMMAD AFZAL

I. INTRODUCION

The effects of devaluation or depreciation on the trade balance of a country are usually examined by the Marshall-Lerner [ML] condition, which states that if the sum of the absolute values of imports and exports demand price elasticities is greater than one, devaluation is expected to improve the trade balance of a country.

Some Structural Adjustment Reforms were started with the help of IMF and World Bank in 1982-83 with the objective of improving the efficiency of the economy by increasing the role of the private sector. The reforms included the delinking of the Rupee from US dollar in January 1982, price deregulation of a large number of products, denationalisation of industry, imports liberalisation and export expansion [Khan (1994)]. The successive governments have taken a number of steps to pursue an extensive liberalisation of the trade regime in addition to taking a number of export measures. Exchange and payment reforms were also implemented [Pakistan (1991-92)].

The reluctance to use devaluation has been a constant bone of contention in the negotiations between the governments of some developing countries and the International Monetary Fund (IMF). During 1970s IMF emphasis on devaluation was not much strong. However, in 1980s IMF attitude towards currency depreciation became very stringent. There is considerable disagreement among theoreticians concerning the desirability of devaluation in developing countries. The advocates argue that it is an invaluable instrument for strengthening the balance of payments (BOPs) because of its impact on absolute prices and real and monetary variables. Whereas, critics argue that devaluation is stagflationary, reducing real output and increasing domestic rate of inflation and fails to improve the current account of the BOPs [Bird (1983)].

Mohammad Afzal is based at the Department of Economics, Gomal University, D. I. Khan.

It has been argued that devaluation may not be much beneficial because of very low imports and exports elasticities notably in the developing countries [Gylfason and Risager (1984); Edwards (1986); Upadhyaya and Upadhyaya (1999)]. Naqvi, *et al.* [(1983), p. 151] argue that devaluation should not have much effect on exports, even though it will have a definite effect on imports. They recommend that a policy of stimulating domestic production and directly subsidising exports is a sure way of expanding exports rather than a straight devaluation. This means that an adjustment in the effective exchange rate is more important than changes in the nominal exchange rate for BOPs purposes.

Khan (1974) found that for most of the 15 developing countries including Pakistan in his sample showed price elasticities of both import and export demand were close to or greater than one. This implies that the ML condition for successful devaluation would be easily satisfied in a number of developing countries including Pakistan for the period 1951–1969. Arize (1986) reported that the Marshall-Lerner condition for devaluation was satisfied for a majority of countries in his sample that included nine African countries for the period 1960–1982.

Hasan and Khan (1994) have examined the impact of devaluation on Pakistan's trade balance for the period 1972–91. They have reported that Marshall-Lerner condition for devaluation is satisfied for Pakistan and thus devaluation will be successful in improving the trade balance. The absolute sum of exports (–1.32) and import demand elasticities (–0.35) adds up more than one [Afzal (2001, 2001a)]. Neither of these studies has examined the time series properties, which is highly desirable due to the use of time series data otherwise the results are likely to be spurious.

Exchange rate policy has assumed renewed importance, as devaluation is an important component of the traditional stabilisation programme. Because of the divergence of opinion on the desirability of exchange rate depreciation and the more recent advances in time series econometrics like introduction of cointegration and error correction, it is desirable that the import and export elasticities are re-estimated in a developing country like Pakistan using the technique of cointegration.

Therefore, the objective of this paper is to estimate the Marshall-Lerner condition for Pakistan employing cointegration technique using annual data for the period 1960–2003.The rest of the paper is structured as follows. Section II contains model and data sources. Unit Root tests, Johansen cointegration test and error correction results are given in Section III. Section IV deals with Macroeconomic aspects and Pakistan's Devaluation Experience and conclusions are given in the final section.

II. MODEL AND DATA SOURCES

Following literature [Khan (1974); Hasan and Khan (1994); Afzal (2001)] we specify export and import demand equations. The export demand is expected to depend on relative price, world income and nominal exchange rate variables. The import demand depends upon domestic economic activity represented by GDP, relative prices of imports to domestic prices, and nominal exchange rate. These equations are as under:

$$LnX_d = \alpha_0 + \alpha_1 Ln\,[UVXp/UVXw] + \alpha_2 LnZW + \alpha_3 LnNER \quad \ldots \quad (1)$$

$$LnM_d = \phi_0 + \phi_1\, Ln\,[PM/Pd] + \phi_2\, Ln\, GDP + \phi_3\, LnNER \quad \ldots \quad (2)$$

Where

Ln = Natural logarithm.
X_d = Real value of exports demand.
$UVXp$ = Unit value of exports in USA $.
$UVXw$ = Unit value of world exports in US $.
ZW = World real income.
NER = Nominal exchange rate (domestic price of the foreign currency).
M_d = Real value of imports.
PM = Unit value of imports.
Pd = Wholesale Price Index (WPI) of Pakistan.
GDP = Pakistan's real GDP (1990=100).

The expected signs of the coefficients are: α_1, $\phi_1 < 0$; and α_2, $\phi_2 > 0$. The expected sign of the coefficient of the nominal exchange rate for exports is positive and for imports it is negative.

Data Sources

Data on GDP, Consumer Price Index (CPI), Wholesale Price Index (WPI), value of imports and exports have been taken from Government of Pakistan (GOP) Economic Survey (1987-88 statistical supplement, 1997-98 Statistical appendix, and 2002-03 Statistical appendix). Real world Income data were obtained from the *World Tables* (various issues). The data regarding export unit value index for Pakistan and the world in US$, unit value of imports in domestic currency were collected from *International Financial Statistics (IFS) Yearbooks* (various years). Data on nominal exchange rate were taken from IFS for the early years 1960s and 1970s and for 1980–2003 from *State Bank of Pakistan Annual Reports* (various Reports). To reconcile the financial year and the calendar year data, taking 1959-60 =1960 and so on, adjusted data. All the variables are in natural logarithm and are in constant 1990 = 100 prices. Using annual data the period of the study is 1960–2003.

III. JOHANSEN COINTEGRATION TEST

Before we apply the cointegration technique, we must determine the order of integration of each variable. We used both ADF (Augmented Dickey-Fuller) and PP

(Phillips-Perron) unit root tests. The lag length of the ADF tests was selected on the basis of AIC (Akaike Information Criteria) and SIC (Schwarz Information Criteria) to ensure that the residuals were white noise and the optimal lag length was 1.

Table 1 shows that except World income, nominal exchange rate and wholesale price index in pure random walk case in both ADF and PP unit root tests, all the variables have a unit root in both level and first difference stationary forms. Therefore, the variables under consideration are non-stationary and are integrated of order 1. Now we apply Johansen (1988, 1991) and Johansen and Juselius (1990) technique of cointegration. The Johansen's technique is a multivariate generalisation of the Dickey-Fuller test. The Maximum Likelihood procedure tests how many of the cointegration vectors are significant that is what rank the cointegration matrix has. This method has the following Vector Autoregressive (VAR) representation:

$$X_t = \mu + \Pi X_{t-1} + \Pi X_{t-2} + \Pi X_{t-3} + \ldots\ldots\ldots\ldots\ldots\ldots + \Pi X_{t-k} + \varepsilon_t \quad \ldots \quad (3)$$

Where ε_t are the independent, normal innovations of the VAR process with mean zero and non-singular, but not necessarily diagonal, covariance matrix Λ. Johansen estimates the rank of the matrix Π that is the rank of the coefficient matrix of the lagged variables. This rank mirrors the number of cointegrating relationships.

Johansen method uses two test statistics for the number of cointegrating vectors: the Trace test (λ-trace) and Maximum Eigenvalue (λ-max) test. According to Johansen [(1991), p.1566], the choice of lag length is more important, but simulations indicate that for moderate departures (which could not be detected in the

Table 1

Unit Root Tests: Level Form and First Difference Stationary

	ADF Level		ADF First Difference		PP Level		PP First Difference	
Variables	τ_μ	τ_τ	τ_μ	τ_τ	Z (t_{b1}*)	Z (t_b)	Z (t_{b1}*)	Z (t_b)
LnGDP	–0.87	–2.15	–4.98	–5.11	–0.89	–2.28	–6.75	–6.75
LnX	–1.94	–3.11	–7.72	–8.45	–1.01	–2.63	–7.53	–8.12
LnUVXp	–1.16	–1.93	–6.09	–6.07	–1.17	–2.54	–8.88	–8.83
LnUVXw	–1.22	–1.87	–3.95	–4.05	–1.21	–1.31	–3.49	–3.54
LNZW	0.79	–2.74	–4.62	–4.74	0.86	–2.50	–5.96	–6.03
LnNER	0.38	–2.93	–4.41	–4.80	0.67	–2.68	–5.51	–5.55
LnM	–0.29	–3.22	–5.11	–5.13	–0.17	–2.70	–5.90	–5.94
LnPM	–0.47	–3.74	–5.01	–4.95	–0.34	–3.04	–5.53	–5.46
LnPd	0.02	–3.38	–3.25	–3.40	0.40	–2.72	–3.45	–3.44
LnTB	–1.54	–3.55	–7.32	–7.41	–0.58	–3.37	–7.55	–7.43

Note: The MacKinnon (1991) critical values for rejection of hypothesis of a unit root for both ADF and PP for 1 percent, 5 percent and 10 percent respectively are, –2.62, –1.94, and –1.62 for pure random walk [τ, Z (t_a*)]; –3.61, –2.93 and –2.60 for random walk with drift [τ_μ, Z (tb_1*] and –4.20, –3.53 and –3.19 for drift and linear time trend [τ_τ, Z (t_b)].

initial statistical analysis) the inference does not seem to change. The choice of lag length was based on AIC and the optimal lag length was 1 and Eviews 3.1 obtained the results of Johansen cointegration technique. Table 2 and Table 3 give the results of exports and imports functions.

Table 2

Export Function: LnX LnY Ln [UVXp/UVXw] LnNER

Null Hypothesis	λ-max	95%CV	Hypothesis	λ-trace	95%CV
H_0: r = 0 H_1: r = 1	27.84*	27.07	H_0: r = 0 H_1: r ≥ 1	48.13*	47.21
H_0: r ≤ 1 H_1: r = 2	14.19	20.97	H_0: r ≤ 1 H_1: r ≥ 2	20.29	29.68
H_0: r ≤ 2 H_1: r = 3	5.41	14.07	H_0: r ≤ 2 H_1: r≥ 3	6.10	15.41
H_0: r ≤ 3 H_1: r = 4	0.69	3.76	H_0: r ≤ 3 H_1: r≥ 4	0.69	3.76

Note: Critical values of the Table 1 and Table 2 are from Osterwald-Lenum (1992).

Table 3

Import Function: LnM LnY Ln [PM/Pd] LnNER

Null Hypothesis	λ-max	95%CV	Hypothesis	λ-trace	95%CV
H_0: r = 0 H_1: r = 1	51.89*	27.07	H_0: r = 0 H_1: r ≥ 1	94.46*	47.21
H_0: r ≤ 1 H_1: r = 2	28.63*	20.97	H_0: r ≤ 1 H_1: r ≥ 2	42.57*	29.68
H_0: r ≤ 2 H_1: r = 3	13.88	14.07	H_0: r ≤ 2 H_1: r≥ 3	13.94	15.41
H_0: r ≤ 3 H_1: r = 4	0.064	3.76	H_0: r ≤ 3 H_1: r≥ 4	0.064	3.76

The null hypothesis of no cointegration is rejected on the basis of both λ-max and λ-trace tests. The cointegration results (Table 2 and Table 3) show that there is one cointegrating vector in the export function and two cointegrating vectors for import function. Since we aim at estimating long-run export and import elasticities, we normalise the cointegrating vectors following the common practice on the *LnX* in the export function and on the *LnM* in the import function. Although many Normalisations are possible, economists usually find that the interpretation of the cointegrating vectors suggests that one of the coefficients in each vector should be set equal to 1 [Patterson (2000)].

Now it is necessary to ascertain which of the variables are cointegrated. For this purpose we can use likelihood ratio test. Making the coefficient of each variable equal to zero in turn can perform this test. Johansen [(1988), p. 237] and Johansen and Juselius [(1990), p. 194] have shown that likelihood ratio test of excluding a variable is given as:

$$-2Ln(Q) = -T \sum_{i=1}^{r} Ln\,[(1 - \lambda^{*}i)/(1 - \lambda i)] \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

Where r is the number of cointegrating vector, λ_i is the Eigenvalue of the of the ith vector of the original cointegrating space and λ_i^* is the Eigenvalue of the of ith vector of the new cointegrating space obtained by excluding a variable. Johansen and Juselius have shown that the expression (4) is distributed as χ^2 with degrees of freedom equal to r $(p–s)$ where r is the number of cointegrating vectors, p is the dimension of the original cointegrating space and s is the dimension of the new cointegrating space. Since the latter space is obtained by restricting the coefficient of a variable equal to zero, $s = p–1$ and the degrees of freedom of each χ^2 is equal to r $(p–p+1) = r$ [see, Bahmani-Oskooee (1996)].

The likelihood ratio test for the exclusion of each variable has been reported in the bracket next to each coefficient in Table 4 and Table 5. These coefficients are significant as the χ^2 value exceeds $\chi^2(1) = 3.84$ for export function and χ^2 $(2) = 5.99$ for import function. These expression show that export and import elasticities are sufficiently high and in absolute terms they add up to more than unity as ML condition postulates. Marshall-Lerner condition is concerned with long-run trade elasticities and the estimation of these elasticities using cointegration analysis dealing with long-run relationship among economic variables, supports the Marshall-Lerner condition. And this implies that the devaluation should improve the trade balance in Pakistan in the long-run.

Table 4

Cointegrating Vectors Normalised on LnX

LnX	– Ln [UVXp/UVXw]	+LnZW	+LnNER
1.0[12.08]*	2.92[5.45]*	–3.78 [5.36]*	0.043 [5.36]*

Note: The χ^2 statistics in the export function has one degree of freedom. The critical value of χ^2 (1) is 3.84 at the 5 percent level of significance.

Table 5

Cointegrating Vectors Normalised on LnM

LnM	+LnGDP	– Ln [PM/Pd]	– LnNER
1.00 [11.02]*	3.19 [12.56]*	–5.26 [9.26]*	–2.27 [14.14]*

Note: The χ^2 statistics in the import function has two degrees of freedom. The critical value of χ^2 (2) is 5.99 at the 5 percent level of significance.

Now it is pertinent to see what happens to the impact of devaluation in the short run? Estimating error correction model will answer this question, as it will throw light on the short run dynamics. The existence of cointegration between a set of economic variables provides a statistical foundation for the use of error correction model (ECM). The converse of this statement is also true: if an ECM provides an adequate representation of the variables under consideration, then they must be cointegrated [Granger (1986), pp. 216-217]. Following Arize (1994), we define the trade balance (TB) as the ratio of exports to imports. The ECM model is:

$$\Delta TB = \alpha_1 + \gamma_1 Z_{t-1} + \sum \beta_i \Delta TB_{t-i} + \sum \phi_i \Delta LnNER_{t-i} + \varepsilon_t \quad \ldots \quad \ldots \quad (5)$$

Where Δ is the first difference operator. Z_{t-1} is the error correction term and the parameter γ_1 is the error correction coefficient that measures the response of the regress and in each period to departures from equilibrium. Since all the variables in the above equations are stationary [I (0)], OLS could be used for estimation and the standard t-ratios for testing the significance of each term. F-statistic is used to test the joint significance of the lagged independent variables and the t-statistic is used to estimate the significance of the error correction term. Lagged explanatory variables represent short-run impact and the long-run impact is given by the error correction term. To select an appropriate lag length, we used both AIC and likelihood ratio (LR) test. The optimal lag length was 1. The results of Equation 5 are as under:

$$\begin{array}{llll} \Delta(LnTB) = 0.06 & -1.004Z_{t-1} & +\,0.84\Delta LnTB_{t-1} & -0.58\Delta LnNER_{t-1} \\ \quad(1.24) & (-1.70)^{**} & (1.95)^{*} & (-2.38)^{*} \end{array}$$

$$DW = .98,\ \psi_1(2,42) = 1.32\ (0.28),\ \psi_2 = 2.09(0.05)^{*}$$
$$\psi_3 = .65(0.20),\ \psi_4 = 1.25(0.53),\ \text{Skewness} = -0.38,\ \text{Kurtosis} = 3.34$$
$$F_1 = 2.98(0.02)^{*},\ F_{TB} = 3.80\ (0.05)^{*},\ F_{NER} = 5.68(0.05)^{*}$$

For residual autocorrelation Breusch-Godfrey *LM* (ψ_3) test do not reject the hypothesis of no autocorrelation and DW is also satisfactory. Heteroskedastcity was a problem because of significant F-statistic (ψ_2). This problem was corrected using Heteroskedastcity-Consistent Covariance Matrix Estimators (HCCME) suggested by White (1980) and the result shown above in Equation 5 has been reported after correcting for Heteroskedastcity.

The Bera and Jarque (ψ_4) statistic did not reject the hypothesis that the residuals originate from a normal distribution. Ramsey RESET Test (ψ_1) shows that the equation is not mis-specified. F_1 statistic for the joint significance of all right-hand variables except the constant term, and for the lagged *TB* and *NER* are all-significant. Thus all of the diagnostic tests [for detail see Hamilton (1994) and Patterson (2000)] support the statistical appropriateness of the equation.

The ECM result indicates the validity of an equilibrium relationship among the variables in the cointegrating equation. In Equation 5, Z_{t-1} is significant besides the significant lagged terms of *TB* and exchange rate. The error correction term exerts the largest influence as measured by its coefficient and supports our earlier finding that there is a long-run relationship among the variables under consideration. The significance of the lagged variables indicates the short-run dynamics.

IV. MACROECONOMIC ASPECTS

The satisfaction of ML condition is not a sufficient condition for successful devaluation because it has both microeconomic and macroeconomic aspects that can make difficult the BOPs adjustment process. The main objective of devaluation is to change relative prices in a way that will promote exports and discourage imports. From microeconomic perspective, the success of devaluation depends on how elastic imports and exports demand are? If both elasticities are higher, the success of devaluation has better prospects. If elasticities are extremely low, devaluation can worsen the trade balance. The satisfaction of ML condition implies that both elasticities are quite adequate.

Given that ML condition is satisfied, it is pertinent to ask why the balance of payments (BOPs) continues to deteriorate after devaluation? A possible explanation is that expansionary monetary policy following the devaluation may be partly responsible for the worsening of the BOPs. Devaluation may fail not because of microeconomic issues but because of macroeconomic effects.

Monetary approach to the balance of payments posits that the devaluation must be accompanied by a reduction in the money supply through reduction in public spending. This can generate contractionary effects leading to unemployment, social unrest and a fall in the standard of living. The inherent conflict between the balance of payments equilibrium and the internal balance explains why some governments make resort to trade and foreign exchange restrictions, multiple exchange rates and even operating an artificially overvalued exchange rate. This can be explained as follows.

The open economy national income identity is

$$Y = C + G + I + (X - M) \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \qquad (6)$$

Assuming G =T, we can write Equation 6 as follows:

$$Y = C + T + I + (X - M) \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \qquad (7)$$

After algebraic manipulation, we have

$$\Delta\,(X - M) = \Delta S_t - \Delta I \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \qquad (8)$$

Where

Δ = Change,
Y = national income,

C = consumption,
I = investment,
G = government spending,
X = exports,
M = imports,
T = taxes,
Sp = private savings, and
Sg = government saving = $T - G$, and $S_t = Sp + Sg$.

Equation (8) makes a simple but very important point that a country's trade balance can improve if savings rise relative to investment. This implies total savings must grow rapidly or severe restraints are put on the investment if devaluation is to succeed. Discouraging investment notably in the export sector is an unpalatable idea. The sector of savings over government can exercise control is (T – G). This implies that restrictive fiscal policy (G $\downarrow$ or T$\uparrow$ or both) becomes inescapable in order to make devaluation a success.

When the economy is closed to full employment and the domestic output could not be increased to improve trade balance, it is essential that significant resource mobilisation is undertaken by the government implying that maximum revenue is generated though taxation so that trade balance improves to make devaluation a success. Many LDCs find the implications of the Absorption approach very painful. They already have very low absorption levels meaning real suffering and balance of payments adjustment means reducing absorption further. All this shows that why LDCs governments are reluctant to follow orthodox BOPs adjustment programmes and why they often do not succeed to adopt policies that make devaluation successful [see Ingram and Dun (1996); Alexander (1959); Clark (1959)].

Generally speaking, it is difficult to isolate the impact of devaluation on imports because what happens to import demand depends crucially on what other policies are simultaneously pursued, It is quite possible that import liberalisation and expansionary demand management policies will result in an increase in import volume even though the initial effects of the devaluation through increased import prices and reduced real expenditures would tend to cause a contraction. Also the substitution effect away from imports may be neutralised if additional export earnings cause income and therefore, imports to rise. And increased export supply may of course, lead directly to an increase in imported inputs. It is because of such reasons that an increase in real imports has been observed following devaluation in some cases [Bird (1983), p. 467].

Pakistan's Devaluation Experience

During 1950s export growth remained negative for many years. Exports increased by more than 45 percent in 1955-56 because of 30 percent devaluation in

June 1955. The Export Bonus Scheme (EBS) was introduced in January 1959 to promote manufactured exports and it was in fact "piecemeal" devaluation. The scheme compensated for the overvalued exchange rate and stimulated exports. The exports of cotton and jute textiles increased from 8.3 to 35 percent and the exports of other manufactures increased from 2 to 20 percent during 1958-59.

Pakistan devalued its currency in May 1972 by 57 percent. Exports recorded phenomenal increase of 40.2 percent and 24.3 percent (in terms of dollar) in 1972-73 and 1973-74 respectively and BOPs showed a surplus of $152.5 million in 1972-73 [Pakistan (1974-75)]. After 1972 devaluation those products that were never exported earlier contributed 15 percent of the increase in exports. Pakistan maintained a fixed exchange rate till January 1982. The appreciation of dollar in 1981 implied a corresponding revaluation of rupee and rupee became overvalued at the 1973 rate. The rupee was de-linked from US dollar in January 1982. The managed floating exchange rate established in 1982 remained in operation till May 1999 when a unified floating exchange rate was introduced [Pakistan (1999-2000), p.126]. After delinking in 1982, the share of other exports increased from 17.7 percent in 1980-81 to 21.3 percent in 1985-86 [Pakistan (1986-87), p. 61]. According to Pakistan (1999-2000), the unified floating exchange was instrumental in the sharp recovery of exports during 1999-2000.

During 1984-85, export growth was negative (–7.9 percent) despite depreciation of 12.3 percent of Pakistan's rupee in the first nine months of 1984-85 [Pakistan (1984-85)]. Between 1993 and 1996 rupee was devalued in 1993 (9.5 percent), 1995 (7.5 percent) and 1996 (3.79 percent) apart from normal depreciation under managed float. But export growth was negative in 1993-94 and 1996-97. Thus Pakistan's history of economic development that spans over more than half century presents a mixed scenario of the success of devaluation. However, devaluation experience has been of moderate success for the most part of the country's history. Therefore, conclusions of this paper are in agreement with Pakistan's experience of devaluation.

V. CONCLUSIONS

Cointegration being concerned with long-run relationship among economic variables was used to estimate the long-run Marshall-Lerner condition. Cointegration approach has supported the Marshall-Lerner condition. This suggests that devaluation should improve the trade balance in Pakistan. But despite this, the trade balance does not improve significantly. It may be that devaluation sets in motion other forces that tend to neutralise the positive effects of devaluation.

Studies differ in their results. Some studies have reported that devaluation would improve trade balance in LDCs and is expansionary; other studies have concluded that devaluation is contractionary and will not improve trade balance. However, devaluation is an important macroeconomic policy that could be used accompanied by appropriate fiscal and monetary policies to stabilise the economy.

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