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The Impact of Changes in Exchange Rate on Prices: A Case Study of Pakistan

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Rapid changes in prices are of concern in almost all countries since the 1970s. However, the issue is of serious concern in developing countries where imported inflation is seen to be driving domestic inflation resulting in limited effectiveness of domestic policies to control inflation. Like most developing countries, in Pakistan also, the domestic price level started rising from the mid-1970s. The exchange rate started depreciating continuously from the early 1980s.[1] Continuous devaluation of currency and inflation in the 1980s seems to suggest a correlation between the two variables.

The empirical studies, like Rana and Dowling (1983) suggest that foreign inflation was the most significant factor in explaining changes in the domestic price level in nine Asian less developed countries during 1973–79. This suggests that, while, these countries could do little to control inflation, the policies of other countries, particularly their major trading partners, had a significant impact on their domestic prices. A simultaneous relationship between the inflation rate and the exchange rate changes is viewed by certain researchers to exist. [Cooper (1971) and Krugman and Taylor (1978).]

In most of the developing countries flexibility of exchange rate is favoured on the ground that it depoliticises the problem of devaluation and creates less disruption in the economy. In the empirical literature, the exchange rate regimes are also linked to domestic prices, trade patterns and current account balance. However, "…exchange rate depreciation for a less developed country would be ineffective as an adjustment mechanism to the extent that domestic inflation persists…" [Meier (1984)]. Another adverse impact may be that real exchange rate may remain stable but in some instances lead to anti-export bias.

Table 1 reports percentage change in exchange rates and the price level during 1972–98. The table shows that the nominal devaluation in Pakistan was on average 8.85 percent per annum where as the real devaluation was negligible. Similarly domestic inflation seems to be higher than foreign inflation. In order to examine the effect of imported inflation on domestic price changes, it is important to estimate an appropriate model of price determination. Cost-push and demand-pull factors are blamed for rise in price levels. Expectation formation also plays an important role.

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[1]Pakistan adopted managed floating exchange rate regime in 1982.

Table 1

Percentage Change in Exchange Rates and Price Level

	Exchange Rate		Prices	
	Nominal	Real	Domestic	Foreign (US)
1972–80	1.28	–1.84	14.23	8.86
1980–90	8.17	3.29	6.95	4.71
1990–98	9.55	0.61	11.11	2.81
1972–98	6.41	0.86	10.43	5.37

In this study, first we examine the causality between domestic price level and exchange rate.[2] In the second step we analyse the impact of changes in monetary and real variables on the domestic price level. The order of the study is as follows: The model is discussed in Section 2 and the methodology briefly in Section 3. The empirical results are discussed in Section 4 and conclusions are given in the final section.

2. MODEL

In this section we start with the simple model formulating real exchange rate as a stationary cointegrating vector. Then we extend the analysis to include output, money supply and interest rates in the home country and in the foreign country to see the responsiveness of domestic prices to real and monetary changes in the domestic and foreign country.

(a) Exchange Rate Pass-through Equation

We start with the following exchange rate pass-through equation:

$$P_d = a0 + a1\,E + a2\,P_f \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \qquad (1)$$

where P_d is domestic prices, E is exchange rate and P_f is foreign price level. Assuming no instantaneous adjustment we can write:

$$P_d = a0 + \Sigma\, a3\, P_d\,(t–i) + \Sigma\, a4\, E\,(t–i) + \Sigma\, a5\, P_f\,(t–i) + e1 \qquad \ldots \qquad (2)$$

where $e1$ is the random error term and 'i' is lag length. In Equation (2) some variables are non-stationary but assuming that these variables become stationary after taking the first difference, we can write:

$$\Delta Pd = a0 + \Sigma\, a6 \Delta Pd\,(t–i) + \Sigma\, a7\, \Delta\, E\,(t–i) + \Sigma\, a8\, \Delta\, Pf\,(t–i) + a9$$
$$[E – b1\, Pd + b2\, Pf\,] + e2 \qquad \ldots \quad \ldots \quad \ldots \quad \ldots \qquad (3)$$

and

$$a6 = (a3 – 1)i + a3,\, t+i + \ldots + a3,\, k–1 \qquad \text{for } i=1\ldots K–1$$

$$aj,i = aj,i + aj+1,\, i+1 + \ldots + a5,\, k–1 \text{ for } j= 3, 4, 5 \text{ and } I = 1, \ldots k–1$$

[2]Since the United States is a major trading partner of Pakistan, we will concentrate only on the exchange rate between Pakistani rupee and US $.

$a9 = a4,i + a4, t+1 + \ldots a5, k$ for $i = 0, \ldots, k$

$b1 = (a3,i + a3, i+1 + \ldots + a3,k)/a9$

$b2 = (a5,i + a5, i+1 + \ldots + a5,k)/a9$

The term in the brackets represents the error-correction term and $e2$ is the random error term. In most cases the coefficients $a6$ to $a8$ are considered to be giving the short-term effect where as the $a9$ gives the long term impact.

(b) Money Supply, Interest Rates and Output

The expected changes in the price level are closely linked with changes in the money supply and rates of interest. According to Krugman and Obstfeld (1991), in the short run, the linkage between a country's money market and foreign exchange market rests on the assumption that price levels and exchange rate expectations are given. Thus, it is important to know how monetary and real factors affect the price level.

Given a fixed price level and output in the long run, the equilibrium in the money market is given by:

$$(M/P)_{sd} = m\,(r, Y)_{sd}$$

where M is money, P is price level, r is interest rate, Y is real output, s is subscript for supply and d subscript denotes the domestic value of a variable, implying that if there are no changes in r and Y, the changes in the money supply will result in changes in price level in the same proportion. Using this relationship we can write:

$$P_d = M_{sd}/\,m\,(r, Y)_{sd} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

The real exchange rate (RER) is defined as:

$$RER = E * (P_f/P_d)$$

where E is nominal exchange rate, P_f is foreign price level and P_d is domestic price level. We can write it as:

$$P_f = M_f/m\,(r, Y)_f \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (5)$$

Assuming PPP, no transport cost, competitive market structure and no difference in the commodity bundles, we can write:[3]

$$P_d = p\,(RER, M_d/M_f, r_d - rf, Y_f/Y_d, \Pi_d\,(e) - \Pi_f\,(e)) \quad \ldots \quad \ldots \quad (6)$$

The price level is affected by *RER*, the ratio of money supply in the foreign and domestic economy (M_d/M_f), the difference in the domestic and foreign rate of interest ($r_d - r_f$), the ratio of foreign to domestic demand (Y_f/Y_d), and the difference in expected inflation in the two countries ($\Pi_d\,(e) - \Pi_f\,(e)$). The expected direction of the coefficients is as follows:

[3]For detailed derivation of Equation (6), see Krugman and Obstfeld (1991).

The changes in *RER* are expected to be correlated with the domestic price level. If the changes in money supply are expected to have a proportionate effect on the price level then the differential in inflation rate will be partially a result of differences in money supply in the domestic and foreign economy. Assuming no change in the real sector of the economy, if the change in money supply in US is bigger than the change in money supply in Pakistan, then the change in P_f will be bigger than change in P_d and the exchange rate will depreciate and the impact on P_d will be strengthened. The expected inflation in the two markets will also affect the price level. The higher the difference in the expected inflation the higher the increase in domestic prices as the rupee will depreciate. Similarly, the interest rate differentials between the two countries may affect the domestic price level also.

3. METHODOLOGY[4]

For the estimation as a first step we test for the normality of the data series. Then unit root test is applied to determine the order of the stationarity. The cointegration test is applied to determine the order of integration and the causality between the domestic price level and exchange rates. The Error Correction Model is applied to estimate the relationship between the variables. A first order auto-regressive model is applied to estimate the second part of the model.

4. EMPIRICAL FINDINGS

(a) Data

For the empirical investigation the main data sources are *International Financial Statistics (1998), Pakistan Economic Survey (1998-99),* and *Fifty Years of Pakistan's Statistics*. The time period for the analysis is from 1972–98. For the domestic prices we are using consumer price index (CPI), for the *Pf* we are using wholesale price index (WPI) in US to compute the real exchange rate and CPI for US to compute foreign inflation. The output in the two countries is the Gross Domestic Product (GDP) in Pakistan and US at constant prices of 1980. For the money supply M2 definition is applied. The rate of interest includes the government bond yield rate in Pakistan and US. We are assuming PPP to develop comparable data series for the two countries.

(b) Results

After testing for normality of data, we have applied the unit root test. The results of the unit root test are reported in Table 2. All the variables are expressed in logarithm form. The Dicky-Fuller (DF) statistics and Augmented Dicky-Fuller statistics (ADF), reported in Table 2, show that all the variables are non-stationary in

[4]Since we are applying standard methodology, we are not discussing it in detail. The interested reader can consult the following: Engle and Granger (1987); Dickey and Fuller (1979) and Granger (1988).

Table 2

Unit Root Tests

Variables	DF		ADF	
	(C, 0)	(C, T)	(C, 0)	(C, T)
LPd	–2.341	–4.801	–1.704[1]	–1.336[3]
LREER 0.911	–2.304	1.489[1]	–2.181[1]	
LRER	–0.446	–2.883	0.614[1]	–3.009[1]
LE	0.534	–1.325	2.101[2]	–2.577[2]
LGDP	–0.820	–1.022	–0.846[1]	–0.993[1]
DLPd	–3.985	–3.545	–4.378[2]	–3.970[2]
DLREER–6.023	–6.628	–3.384[1]	–3.877[1]	
DLRER –4.251	–4.146	–2.810[1]	–2.728[1]	
DLE	–5.990	–7.240	–5.602[1]	–6.584[1]
DLGDP –4.970	–4.894	–3.262[1]	–3.245[1]	
Critical				
Values 5%	–2.991	–3.612	–2.985	–3.603
10%	–2.635	–3.242	–2.632	–3.237

Notes: Number in the brackets are number of lags.

REER = Real Effective Exchange Rate.

RER = Real Exchange Rate = (Nominal Exchange Rate)* (WPI US/CPIPK).

E = Nominal Exchange Rate.

GDP = Gross Domestic Product.

Pd = Consumer Price Index.

L ⇒ Log.

D ⇒ 1st Differences.

(C, 0) ⇒ Constant with no trend.

(C, T) ⇒ Constant with trend.

level forms. However, the tests on first difference reject the null hypothesis of non-stationarity. All the test statistics are greater than the critical value. These results show that all variables are integrated of the same order, i.e., one.

After determining the stationarity of the error term, we can test for the order of integration. The results reported in Table 3 show that variables are not cointegrated. The results show that P_d and GDP are cointegrated with REER (real effective exchange rate). However, these tests do not support the hypothesis of cointegration of P_d and GDP with E. This seems to support the hypothesis that the devaluation may not be an important reason for the domestic inflation and other variables are also important. This supports the view that inflation in Pakistan may not be totally imported.

After establishing the cointegration of variables, we detect the causality by applying the Error Correction Model. The results reported in Table 4 show that there is no evidence of short run uni-directional or bi-directional causality between domestic price level and the real effective exchange rate. However, there is some evidence of short run causality between domestic prices and real exchange rate. Furthermore, we find some evidence of causality from output to exchange rate. These results show that the relationship between changes in exchange rate changes

Table 3

Cointegration Test

Cointegration Equation		DF (C, 0)	DF (C, T)	ADF (C, 0)	ADF (C, T)
LPd = f(LREER)	–4.543*	–2.227	–2.803[1]	–2.499[2]	
LREER = f(LPd)	–3.212*	–3.241	–1.112[2]	–1.979[2]	
LPd = f(LRER)		–2.689	–2.904	–3.531 [1]**	–2.880[1]
LRER = f(LPd)		–2.079	–2.679	–2.674[1]	–2.450[3]
LPd = f(LE)		–1.849	–2.539	–3.022[1]	2.024[3]
LE = f(LPd)		–1.933	–2.798	–2.519[1]	–2.892[2]
LGDP = f(LREER)	–3.815*	1.227	–1.889[1]	–1.332[1]	
LREER = f(LGDP)	–3.196	–3.613	–1.363[1]	–1.780[1]	
LGDP = f(LRER)	–2.719	–2.376	–3.371 [1] **	–2.244[1]	
LRER = f(LGDP)	–2.415	–3.189	–2.956[1]	–3.726[1]	
LE = f(LGDP)		–2.506	–3.220	–2.374[1]	–3.775[2]
LGDP = f(LE)		–2.218	–1.573	–2.446[2]	–1.478[3]
Critical Values 5%		–3.580	–4.166	–3.591	–4.182
10%		–3.211	–3.779	–3.218	–3.790

Notes: Number in the brackets are number of lags.
* implies significant at the 5 percent level.
** implies significant at the 10 percent level.
REER = Real Effective Exchange Rate.
RER = Real Exchange Rate = (Nominal Exchange Rate)* (WPI US/CPIPK).
E = Nominal Exchange Rate.
GDP = Gross Domestic Product.
Pd = Consumer Price Index.
L ⇒ Log.
D ⇒ 1st Differences.
(C, 0) ⇒ Constant with no trend.
(C, T) ⇒ Constant with trend.

Table 4

Error Correction and Granger Causality Tests

Dependent Variable	F-Statistic for t-Statistic for EC_{t-1}	For $\sum DLPd_{(t-I)}$	$\sum DLREER_{(t-i)}$	$\sum DLRER_{(t-i)}$	$\sum DLGDP_{(t-i)}$	$\sum DLE_{(t-i)}$
DLPd	–1.306	1.078[3]	1.780[3]			
DLREER	–0.987	0.508[1]	1.090[1]			
DLPd	0.761	1.498[3]		2.189[3]		
DLRER	–2.688*	6.114*[1]		3.276*[1]		
DLPd	–1.520	1.587[4]				0.879[3]
DLE	–1.293	0.957[2]				1.156[2]
DLGDP	1.190		0.888[1]		1.628[2]	
DLREER	–2.346*		2.356[1]		2.753[1]	
DLGDP	–0.137			0.534[1]	0.033[1]	
DLRER	–2.579*			4.909* [1]	4.310*[4]	
DLGDP	–1.102				0.923[1]	1.023[3]
DLE	–1.737				1.380[2]	2.004[2]

Notes: *Implies significant at the 5 percent level.
Number in the brackets are the number of lags.
EC = Error Correction Term.
REER = Real Effective Exchange Rate.
RER = Real Exchange Rate = (Nominal Exchange Rate)* (WPI US/CPIPK).
E = Nominal Exchange Rate.
GDP = Gross Domestic Product.
Pd = Consumer Price Index.

and domestic prices exist only in the short run. In the long run the real exchange rate remains stable. The solution to pass-through equation also shows that the impact of P_f on E and on P_d is negligible. Thus, the argument of imported inflation, in the present form, may not hold for Pakistan for the period 1972–98.

However, in order to examine the impact of changes in other monetary and real sector variables on domestic inflation, we have estimated a simple model (e.g., Equation (6)) including the monetary and real variables in the two countries (Pakistan and US). The results are reported in Table 5. We can see from these results that changes in monetary balances affect inflation in Pakistan. If domestic monetary expansion is bigger than foreign monetary expansion then domestic prices will rise. Furthermore, as expected, the results also show that rise in output lowers the domestic prices. We can also see that the rate of interest and expected inflation have no impact on prices. These results do not support the hypothesis of imported inflation in case of Pakistan but changes in monetary and real variables do affect prices. Thus, in order to control sharp fluctuations in prices implementation of domestic policies to regulate money supply and enhance economic activity will be more effective.

Table 5

Least Square Estimates of the Impact of Monetary and Real Sector Variables on Prices

LRER	Dependent Variable	Constant	LRMS	DIR	LRGDP	DEWP	R^2	R^{-2}	D.W
–3.342	LP_d	–3.375					0.563	0.546	0.218
(5.676) *		(2.300)							
–0.402	LP_d	11.174					0.996	0.996	0.644
(2.526) *		(3.258)							
–0.291	LP_d	11.478	–0.225				0.997	0.996	0.724
(1.896) *		(1.677)	(3.716)*						
–0.442	LP_d	–16.315	–0.146	–0.002			0.998	0.997	1.608
(2.977) *		(3.272)	(0.682)	(0.682)					
–0.470	LP_d	24.118	–0.124			0.0003	0.997	0.997	1.157
(3.508) *		(0.600)	(1.961)**			(0.121)			
–0.310	LP_d	–7.343	–0.033		–0.070	0.002	0.998	0.998	1.497
(2.761)		(0.342)	(0.503)		(3.706)	(0.927)			

Notes: Figures in the brackets are "t" statistics.
* Implies significant at the 5 percent level.
** Implies significant at the 10 percent level.
RER = Real Exchange Rate.
P_d = Consumer Price Index.
RMS = Rato of MSd to Msus.
DIR = Difference between domestic and US interest rates.
RGDP = Ratio of GDPus to GDPpk.
DEWP = Difference between domestic and US expected inflation.

5. CONCLUSIONS

The main objective in this study is to examine the impact of changes in foreign prices and changes in monetary and real variables on domestic prices. In this study we do not find any significant uni-directional or bi-directional causal relationship between changes in exchange rate and domestic prices. However, we find that money supply and the level of activity affect the domestic prices. This suggests that the argument of imported inflation may not be valid in case of Pakistan but the control on domestic money supply and efforts to promote domestic economic activity may be the major determinants of domestic prices. However, in order to accept or refute this argument, we need to disaggregate changes in energy prices and the price of imported capital.

Furthermore, these results are for one foreign currency, i.e., Rupee Vs. US dollar. The exchange rate variation with respect to other major currencies will also be examined in a later study.

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