EXCHANGE MARKET PRESSURE AND THE DEGREE OF FOREIGN EXCHANGE MARKET INTERVENTION: EVIDENCE FROM INSTRUMENTAL VARIABLE TECHNIQUE

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ABSTRACT

The paper uses the approach of Weymark (Weymark D.N., 1995) for constructing exchange market pressure of the paper and intervention index for Pakistan and to account for potential endogeneity. The objective is to evaluate Central Bank's monetary policy implemented over the given sample period. The results indicate downward pressure and active Central Bank intervention. Intervention index mean value shows that foreign exchange reserves relieved most of the pressure which is consistent with managed float. Thus our characterization of exchange rate regime based on Central Bank intervention is in conformity with International Monetary Fund (IMF) Reports on Exchange Rate Arrangements and Exchange Restrictions instead of Reinhart and Rogoff (Reinhart, et.al., 2002). The paper is divided into three sections. Section one deals with introduction about Exchange Market Pressure and intervention of IMF. Section 2 reviews the relevant literature and Section 3 deals with weymark exchange market pressure and intervention index is presented. Section 4 describes the data and in section 5 empirical results are presented and section 6 concludes.

Keywords: EMP, intervention index, monetary policy and foreign exchange market.

INTRODUCTION

The Collapse of Bretton Wood system ushered a new era of flexible exchange rate system. The policy makers of most advanced countries believed that adopting such an exchange rate regime will reduce exchange rate volatility. However, few of these countries allowed market forces to determine value of their currencies in foreign exchange market. International Monetary Fund (IMF) Annual Report on Exchange Rate Arrangements and

Exchange Restrictions further confirm this belief (IMF Report 1999-2005).

The IMF Report shows that by the end of 1997, forty- six of 184 countries allowed their currencies to be determined by market forces. Even they established external value of their currency by frequently intervening in foreign exchange market. Rest of countries either fixed or allowed limited flexibility to their currencies in foreign exchange market (Spolander, 1999).

Countries often adopt extreme ends of the spectrum of exchange rate arrangements namely fixed or flexible. Frankel and Fischer support bipolar view and argue that countries that adopt either fixed or flexible rates are less prone to exchange rate crisis (Frankel, J.A., 1999). They support abolishing of intermediate exchange rate arrangements on the basis of IMF official exchange rate classification and exchange rate arrangements.[1] Calvo and Reinhart examined de facto exchange rate regime of forty nine countries and found increased interest rate and foreign exchange reserve volatility, a sign of increased exchange rate stability and foreign exchange intervention of relevant monetary authorities (Calvo, *et.al.,* 2002).

Levy-Yeyati & Sturzenegger, F. (2005) also classified the countries using de facto exchange rate policies. They found wide difference between de facto and de jure exchange rate regimes. Particularly, countries that claimed float frequently intervened in foreign exchange market in an attempt to avoid exposure of their currencies to speculative attacks. They named this kind of exchange rate arrangement 'hidden pegs'. It is apparent that there are wide differences between de facto and de jure exchange rate practices. Hence, it is largely an empirical matter to assess a country's exchange rate regime, rather than trust public policy pronouncements from a Government or Central Bank.

Frenkel and Aizenman first constructed an index that measures the extent of foreign exchange intervention (Frenkel, J.A.

[1] IMF Annual Report (2000) shows that in 1991, there were 16 percent hard pegs, 62 percent intermediate and 23 percent independent float. In 1999, this number reached to 24 percent currency peg, 34 percent intermediate and 42 percent independent float. Frankel (1999, p. 7 footnote) also reports an IMF classification that breaks down as: 25 pegged to a single currency, 13 pegged to composite, 6 crawling pegs, 12 horizontal bands, 10 crawling bands, and 26 managed floats.

& Aizenman, J., 1982). It is viewed as fraction of money market disequilibrium that exchange rate eliminates. It takes zero and one value under fixed and flexible exchange rate arrangements. Contrary to Frenkel & Aizenman, Weymark derived an intervention index based on Girton and Roper approach (Girton, L. & Roper, D., 1977). It is defined as the fraction of pressure that Central Bank relieves by changing foreign exchange reserves. In fixed and float, it takes one and zero value. Under managed float, intervention index lies between zero and one.

Exchange rate system in Pakistan has evolved through different phases. At the very beginning, Pakistan followed fixed exchange rate system and switched over to manage float on 8th January, 1982. Such system is characterized by simultaneous changes in exchange rate and foreign exchange reserves. Again a shift in exchange rate system occurred in the year 2000, when Pakistan switched over from managed rate to fully flexible exchange rate (Khan, M.A. & Qayyum, A., 2008).

This paper utilizes Weymark approach for constructing market pressure and intervention index for Pakistan. The intention is to check the direction of pressure and evaluate monetary authority's response to money market. This approach has the advantage that it allows us to evaluate monetary authority's response to money market disequilibrium by constructing intervention index. Intervention index values are then used to confirm whether Pakistan's exchange rate arrangements are in conformity with International Monetary Fund's Annual Reports on Exchange Rate Arrangements and Exchange Rate Restrictions or Reinhart and Rogoff's exchange rate classification. International Monetary Fund's Annual Reports on Exchange Rate Arrangements and Exchange Rate restrictions characterize Pakistan's exchange rate regime as pegged to the US dollar for 1976 to 1982. Post-1982 exchange rate regime is characterized as managed float except for the year 1999.[2] On the other hand, Reinhart and Rogoff, using de

[2] Pakistan introduced multiple exchange rate system on 22nd July, 1998 due to sanctions that were imposed on the country in the wake of nuclear explosions. It comprised of (a) official exchange rate, (b) floating inter-bank rate (FIBR) and composite rate. State Bank of Pakistan determined official exchange rate and market forces determined interbank rate. The composite rate was based on certain specified ratio of official rate and floating inter-bank rate which was initially fixed at 50-50 (50% official and 50% FIBR) and was changed to 20:80 on 21st December, 1998 and further to 5:95 percent on 11th March, 1999 (State Bank Annual Reports 1998-1999, p. 130).

facto exchange rate policy, characterize Pakistan's exchange rate regime as pegged to US dollar for 1971 to 1982. For the post 1982 period, Pakistan's exchange rate regime is characterized as de facto peg to the US dollar with a band width of +/- 2%. Using intervention index mean value, we test whether our characterization of exchange rate regime is in conformity with IMF classification or that of Reinhart and Rogoff.

The results indicate dominant downward pressure and active Central Bank intervention. Most of the interventions leaned against the wind and removed most of the downward pressure on domestic currency. Intervention index mean value suggest that on average Central Bank relieved sixty-one percent of the pressure by selling and purchasing foreign exchange reserves. Exchange rate changes relieved rest of the pressure. Both exchange rate and foreign exchange reserve changes restored foreign exchange market equilibrium. Thus country's exchange rate regime can be characterized as managed float. Hence, our characterization of exchange rate regime on the basis of intervention index mean value is in conformity with International Monetary Fund's Annual Reports on Exchange Rate Arrangements and Exchange Rate Restrictions rather than Reinhart and Rogoff's classification.

LITERATURE REVIEW

Before Girton and Roper, Whiteman argued that under managed float, effective exchange rate and foreign exchange reserve changes reflect the extent of money market disequilibrium although no one has yet constructed a single composite index that measures it (Whitman, M.V.N. Branson, W.H. Fand, D.I. Krause, L.B. & Salant, W.S., 1975). Girton and Roper derived such a measure of money market disequilibrium and named it Exchange Market Pressure. It measures the extent of money market disequilibrium that arises due to non-zero excess demand for domestic currency in foreign exchange market. It is restored by adjustments in exchange rate or foreign exchange reserve changes or any combination of both. Since its development, the Girton and Roper model and its modified versions have been applied in number of countries by some following researchers:

TABLE: 1
APPLICATION OF GRITON AND ROPER MODEL IN COUNTRY

Sr. No.	Research	Application of Griton and Roper model in country
1	Connolly and da Silveira	Brazil
2	Haache and Townend	Sterling sterling's effective exchange rate
3	Kim	Korea
4	Thornton	Costa Rica
5	Burdekin and Burkett	Canada
6	Mah	Korea
7	Pollard	Barbados, Jamaica, Trinidad & Tabago
8	Hallwood & Mash	Pound sterling during the inter-war period, 1925-31
10	Modeste	Guyana

Source: Connolly, *et.al.,* (1979).

Roper and Turnovsky carried forward Girton and Roper's work (Roper, D.E., *et.al.,* 1980). Based on the assumptions of fixed prices and perfect capital mobility, they derived optimum trade-off that monetary authorities face between exchange rate (Δs_t) and foreign exchange reserve (Δf_t) changes for relieving pressure on domestic currency. They allowed intervention to take the form of changes in domestic credit and foreign exchange reserves However, both of them are not equally weighted.

Contrary to above discussed exchange market pressure indices, Eichengreen B., *et.a.l.,* (1996) derived a model independent exchange market pressure index that includes percentage change in exchange rate, relative percentage change in bilateral interest rates and change in relative foreign exchange reserves differential.[3] They assigned weight to exchange market pressure components by equalizing their conditional volatilities. It is called model independent because neither the components of exchange market pressure index nor weights assigned to them are derived from structural macroeconomic model.

[3] Eicehngreen et al. exchange market pressure index is given as:

$\%\Delta s_t + 7[\%\Delta(i_t - i_t^*) - .08[\%\Delta(f_t - f_t^*)$

Contrary to Eichengreen, Pentecost[4]utilized a short-term wealth augmented monetary model of foreign exchange market for constructing market pressure index (Akram, G, M. and Ahmad, C.R., 2014). It consists of exchange rate changes, foreign exchange reserve changes and relative short term interest rate differential between domestic and foreign country. They used principal component approach for assigning weights to exchange market pressure components.

Model independent exchange market pressure indices are criticized due to difficulty in their interpretation. Weymark argued that the magnitude of relative interest rate differential and foreign exchange reserve changes in Eichengreen is determined by the structure of the economy and Central Bank intervention activity, rather than a volatility-smoothing technique that ensures equal weighting of exchange market pressure index components. It is therefore, necessary that exchange market pressure index must be derived from a model that reflects the economy for its proper interpretation Weymark.

Weymark further argued that Girton and Roper were primarily concerned with monetary independence enjoyed by monetary authorities in Canada. They equated monetary independence with relationship between domestic credit and exchange market pressure. The significant correlation between these variables suggests that monetary authorities in Canada were not independent in formulating an independent monetary policy. Similarly, Roper and Turnovsky were concerned with deriving the optimum trade-off monetary authorities' face between domestic credit and foreign exchange reserves for eliminating exchange market pressure. Thus the exchange market pressure indices derived by Girton and Roper and Roper and Turnovsky do not constitute a model independent definition of exchange market pressure. Therefore, Weymark defined exchange market pressure in general terms as excess demand for domestic currency in foreign exchange market that would be relieved by exchange rate changes in the absence of foreign exchange market intervention, given the expectations about actual exchange rate policy implemented.

[4] Pentecost et al. (2001) exchange market pressure index is given as:

$$[s_t + \beta(\Delta i_m - \Delta i_m^*) - f_t] = (d_t - m_t^*) + (1 - \alpha\phi)q_t + (\alpha\lambda + \gamma - \gamma)(\Delta i_t - \Delta i_t^*) - \vartheta(w_t - w_t^*)$$

Based on model-independent definition of exchange market pressure, Weymark constructed an exchange market pressure index that includes exchange rate and foreign exchange reserve changes. The weights assigned to components of exchange market pressure are derived from a small open economy stochastic macroeconomic model. Contrary to other indices, Weymark also constructed an intervention index that measures the fraction of pressure that central bank relieves through the purchase and sale of foreign exchange reserves.

WEYMARK MODEL

In order to measure exchange market pressure, Weymark provided following formula:

$$EMP_t = \Delta s_t + \eta \Delta f_t \qquad (1)$$

Where s_t is the logarithm of exchange rate expressed in terms of the domestic currency cost of one unit of foreign currency? Δf_t is percentage change foreign exchange reserves and $\eta = \frac{\partial s_t}{\partial f_t}$ is the elasticity. EMP can be interpreted as the exchange rate change required for removing market pressure in the absence of Central Bank intervention. Based on EMP, intervention index is defined as:

$$\omega_t = \frac{\eta \Delta f_t}{EMP_t} = \frac{\eta \Delta f_t}{\Delta s_t + \eta \Delta f_t} = \frac{\Delta f_t}{\frac{1}{\eta}\Delta s_t + \Delta f_t} = \qquad (2)$$

An intervention index takes values between $-\infty < \omega < \infty$. Interpretation of intervention index values is given as under:

$\omega_t = 1$ indicates fixed exchange rate regime.

$\omega_t = 0$ implies flexible exchange rate system

$0 < \omega_t < 1$ implies managed float exchange rate regime.

$\omega_t > 1$ suggests ($\omega_t > EMP_t$). Exchange rate moves in the direction opposite to that warranted by pressure Akram and Rafiq (Akram, G. M. & Ahmad, C.R., 2014).

$\omega_t < 0$ implies that central bank leans with the wind – that is Central Bank purchases foreign exchange reserves when there is already a downward pressure on domestic currency in foreign exchange market and vice versa. The paper utilizes Weymark structural macroeconomic model for estimating η.

DATA FOR ANALYSIS

Logged quarterly data from 1976Q1 to 2005Q2 is used for constructing exchange market pressure and intervention index for Pakistan. The data on all variables except monetary aggregate m_1 and nominal Gross Domestic Product is taken from Thomson Reuter's data stream and State Bank of Pakistan. Both m_1 and nominal GDP were seasonally adjusted using X-12 ARIMA seasonal adjustment programme.

RESULTS

Prior to estimating equations of interest, time series prosperities of the data are analyzed using Augmented Dicky Fuller (ADF) test. The regression test feature intercept and intercept and trend. Based on Akaike Information Criterion (AIC), four lags were used for testing the integrating order of the variables of interest. Table 1 shows that null of unit root cannot be rejected for all variables except foreign price in constant plus trend specification. However, all variables appear to be stationary at first difference. Hence, we conclude that all variables are non-stationary in levels in at least one specification and stationary at first difference.

TABLE: 2
ADF UNIT ROOT TEST

	Levels		**First Difference**	
	Constant	**Constant and Trend**	**Constant**	**Constant and Trend**
i_t	-1.442	-1.673	-10.837[a]	-10.810[a]
m_t	-1.750	-2.950	-12.268[a]	-12.377[a]
P_t	-0.6071	-1.010	-9.987[a]	-9.981[a]
P^*_t	-2.853	-3.89[a]	-3.791[a]	-4.897[a]
s_t	-0.453	-2.496	-9.386[a]	-9.531[a]
y_t	-1.399	-2.571	-10.287[a]	-10.289[a]

Note: superscript a shows significance of variables at 5% level. * denotes the foreign counterparts of the domestic variables. Lag lengths in parentheses (.) are determined by the Akakike Information Criterion with maximum number of 4 lags. Variables used are defined as: i_t = Treasury Bill Rate, m_t = M1 in Pakistan, p_t = CPI in Pakistan, p_t^* = US CPI, s_t = spot exchange rate, and y_t = gross domestic product adjusted with GDP deflator. 5% one-sided critical values are taken from McKinnon (1996). Quarterly data for the period 1976:Q1 to 2005:Q2 is used:

Equation (3) and (4) shows two stage least square estimates (Two stage least square approach is adopted due to endogeneity problem that arises due to simultaneous determination of dependent and one or more of the independent variables. In such a situation, ordinary least square estimates yield inconsistent estimates of behavioural parameters in regression equation.

2SLS uses instruments for obtaining unbiased estimates of endogenous variables. Instrumental variable is assumed to be uncorrelated with model's error term but correlated with endogenous variable. Following Weymark (1995), we used the US CPI, three-month US Treasury Bill Rate and real domestic income as first stage instruments in real money demand equation. For price equation, we used US CPI, the three-month Treasury Bill rate and lagged exchange rate as first stage instruments) of real money demand and price equation.

$$\Delta m_t = -0.08 i_t + 0.129 y_t \qquad LM_{(4)} \qquad ARCH_{(4)} \qquad (3)$$

-1.46 1.95^a 4.406 0.04

$$\Delta p_t = 0.287 p_t^* + 828 s_t \qquad LM_{(4)} \qquad ARCH_{(4)} \qquad (4)$$

0.58 1.65 5.761 (0.22) 0.11 (0.98)

Real money demand and price equation estimates show that all parameters have signs consistent with the literature. However, they are not significantly different from zero except domestic real income[5]. Equation 3 shows that interest rate and real domestic income estimates are of negative and positive signs. The positive domestic real income estimate suggest that as income goes up, people demand more money to finance their transactions. On the other hand, a negative interest rate estimate suggests that with the rise in opportunity cost of holding money, people prefer to hold their cash balances in terms of assets that earn interest instead of holding them in cash balances). This behavior of individuals and firms suggests a negative sign of interest rate in real money demand equation[6]. $\overline{R}^2$ is negative in both equations[7]. Residual tests show that null of no serial correlation and heteroscedasticity cannot be rejected in both real money demand and price equations[8]. Exchange market pressure mean value implied that on average domestic currency faced depreciating pressure over the entire sample period. Central Bank actively intervened in foreign

[5] It is argued that instruments may be strongly correlated with endogenous variable but may be uncorrelated with dependent variable. This may result insignificant estimates of endogenous variable(s) in the estimated regression equation

[6] Abe Shigeyuki *et.al.,* (1975), Mangla (1979), Khan (1980, 1982, 1994), Ahmad and Khan (1990), Hossain (1994), and Qayyum (2001, 2005) estimated money demand function for Pakistan. Arize (1989) examined demand for money in four Asian economies: Pakistan, the Philippines, South Korea and Thailand. Bahmani-Oskooee and Rehman (2005) examined the stability of the money demand function in Asian developing countries that include India, Indonesia, Malaysia, Pakistan, the Philippines, Singapore and Thailand

[7] (R^2 and $\overline{R}^2$ values are not taken into account due to lack of consensus on the unique definition of the coefficient of variation if the model is estimated by the method other than ordinary least square approach. Furthermore, the objective of using instrumental variable approach is to obtain consistent estimates of the causal effects of endogenous variables on regress and and the use of instruments instead of endogenous variables fulfill this task (Verbeek 2008, p.150).

[8] ($LM_{(4)}$ and $ARCH_{(4)}$ denotes Breusch Godfrey Langrange Multiplier test and autoregressive conditional heteroscedasticity test respectively. Probability values given in parenthesis shows that null of no autocorrelation and heteroscedasticity cannot be rejected. Although, it is somewhat dissatisfying that parameters of interest are statistically insignificant except domestic real income, yet it is more re-assuring that residual properties are satisfied).

exchange market and relieved sixty one percent of the pressure by purchasing and selling foreign exchange reserves. Exchange rate changes relieved rest of the pressure.

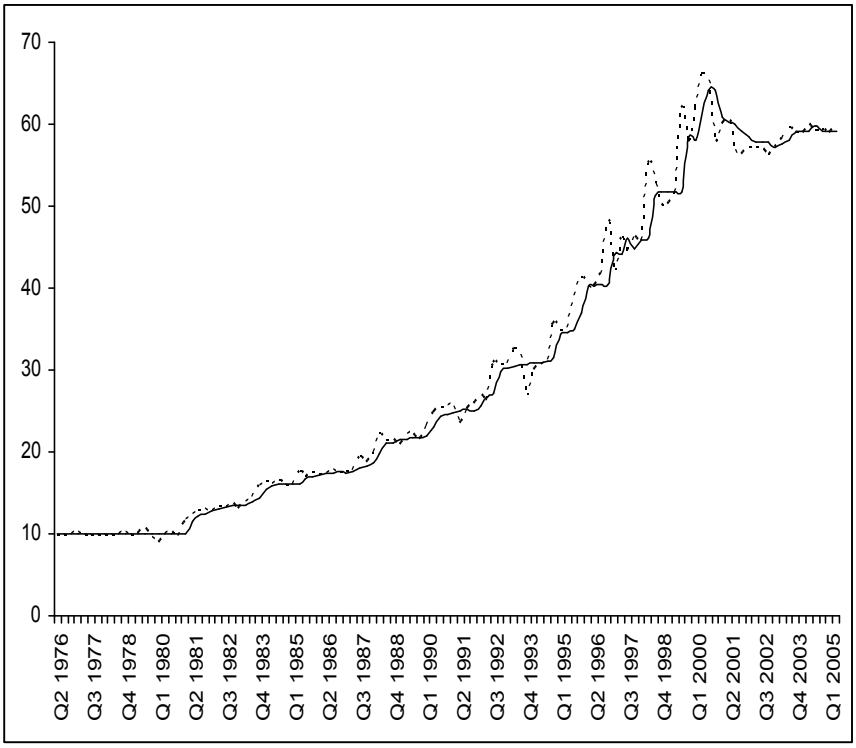
Exchange market pressure shows the extent of money market disequilibrium that exchange rate changes restore in the absence of central bank intervention. Hence actual exchange rate that would prevail in the absence of central bank intervention can be calculated using last period's observed exchange rate:

$$S_t^{predicted} = (1 + EMP_t)S_{t-1}^{observed} \quad (5)$$

$S_t^{predicted}$ = unlogged imputed exchange rate that would prevail in the absence of Central Bank intervention.

$S_{t-1}^{observed}$ = unlogged one period lagged exchange rate.

Comparison of predicted and unobserved exchange rates gives an idea of the extent of foreign exchange intervention. Figure 1 show that predicted exchange rate is more volatile than observed Figure 1 Imputed ($S_t^{predicted}$) and observed exchange rate (S_{t-1}^{actual}):



Note: The dotted line denotes the observed exchange rate, which is less volatile. Solid lines, on the other hand, denote the predicted exchange rate that would have prevailed in the absence of Central Bank intervention. This is more volatile.

Exchange Rate: Predicted and observed exchange rate standard deviations of 18.449 and 18.386 further confirm this interpretation. Hence, we conclude that Central Bank's foreign exchange intervention is successful in achieving its objective of reducing exchange rate volatility.

CONCLUSION

The paper utilized Weymark approach for constructing exchange market pressure and intervention index for Pakistan. The objective was to check the direction of pressure and evaluate monetary policy implemented over the given time period. Results indicate downward pressure and active Central Bank intervention. However, Central Bank's response is not uniform and varies with

the direction of pressure. Central Bank intervention exceeds its unity value whenever there was an appreciating pressure on domestic currency in foreign exchange market. Intervention index mean value shows that exchange rate and foreign exchange reserve relieved thirty nine and sixty one percent of the pressure. Actual exchange rate is more volatile than the predicted exchange rate suggesting that foreign exchange market intervention is successful in achieving its objective of reducing exchange rate volatility. Based on the intervention index's mean value, Pakistan's exchange rate regime can safely be characterized as managed float over the given sample period. Thus our characterization of country's exchange rate regime on the basis of central bank intervention index mean value is in conformity with IMF's rather than Reinhart and Rogoff's.

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