

## **3ON PAK RUPEE EXCHANGE RATES: WHETHER STOCK OR FLOW MATTERS?**

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### **Abstract**

This paper examines whether the monetary model or the flow model of exchange rate explains the long-run movements in Pak rupee exchange rates vis-à-vis the four major currencies – the US dollar, British pound, Swiss franc and Japanese yen – over the period 1983q1-2009q4. Results obtained by employing the Johansen and Juselius (1990) technique of cointegration are supportive of the monetary model in two Pak rupee exchange rates vis-à-vis the US dollar and the Swiss franc when both short- and long-run interest rates are used and of the flow model in three exchange rates vis-à-vis the British pound, Swiss franc and Japanese yen when the short-run interest rate is used. These results show that both stock equilibrium in capital markets and flow equilibrium in foreign exchange markets determine Pak rupee exchange rates.

**Key Words:** *Balance of payments, exchange rate and open economy*

**JEL Classification:** F30, F31, F41

### **1. INTRODUCTION**

The last several decades have witnessed a tremendous amount work on the theory and empirics of exchange rates. This work can be divided into three main strands. The first strand relates to a wide range of macroeconomic models of exchange rates, which appeared between the early 1960s and the late 1970s, postulating that the equilibrium exchange rate is determined by macroeconomic fundamentals such as relative money supplies, incomes and interest rates and so on, and that the equilibrium rate adjusts immediately to absorb any new information about these fundamentals. These models can be further divided into two main categories – the

flow model of Mundell (1961, 1963) and Fleming (1962) and the monetary models pioneered by Frenkel (1976), Mussa (1976) and Bilson (1978a,1978b)<sup>1</sup> – which are respectively embedded in the open economy versions of the Keynesian and new classical models. The second strand concerns the microstructure model developed by Lyons (1995) and Evans and Lyons (2002) who argue that the information structure and its transmission among market participants, the participants' behavior and their trading mechanisms and the flow of orders among dealers, the heterogeneity of trading volume and their bid-offer spread play a key role in determining the equilibrium exchange rate. The third strand deals with the news models postulating that the news about economic fundamentals significantly affects the exchange rate, even though the fundamentals themselves do not affect the exchange rate in the manner suggested by macroeconomic models. News about the fundamentals affects the exchange rate not only in the macroeconomic models, as examined, *inter alia*, by Dornbusch (1980) and Hoffman and Schlagenhauf (1985), but also in the microstructure models, as examined, among others, by Evans and Lyons (2003), Love and Payne (2003) and Andersen *et al* (2003).

The paper contributes to the first strand by testing whether the flow model or the flexible-price monetary model explains long-run movements in Pak rupee exchange rates vis-à-vis the four major currencies – the US dollar, British pound, Swiss franc and Japanese yen – over the period 1983q1-2009q4. The motivation for this paper goes as follows. The latter model is revisited for the Pak rupee exchange rates over an extended period to determine if the new results are consistent with those obtained earlier by Bhatti (2001). Regarding the former, little attempts have been made so far to examine its relevance for the Pak rupee exchange rates. Yet there is some wisdom suggesting that this model is likely to better explain the behavior of the Pak rupee exchange rates. Two factors may underlie this wisdom. First, some studies<sup>2</sup> have reported evidence supportive of Pakistan of the long-run existence of money demand function and purchasing power parity (PPP), which constitutes two of the fundamental building blocks of the monetary model. Second, financial sector reforms undertaken in the 1990s are expected to have made the commodity, capital and foreign exchange markets in

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<sup>1</sup> The other monetary models include the sticky-price model of Dornbusch (1976b), the real interest differential model of Frankel (1979), the equilibrium real exchange rate model of Hooper and Morton (1982), and the exchange market pressure model of Girton and Roper (1977).

<sup>2</sup> See, for example, Khan (1980), Ahmed and Khan (1990) and Hossain (1994) for the findings supportive stable money demand function and Bhatti (1996, 2000) for PPP.

Pakistan relatively more efficient now than they were two decades ago. Both of these factors are thought to have created an economic environment more conducive for the monetary model. The rest of the paper is organized as follows. Section 2 gives a brief account of the theory underlying both models, while Section 3 reviews the existing evidence on these models. Section 4 deals with the sample data used, the methodology employed and the empirical results. The final Section concludes the results.

## **2. SPECIFICATIONS OF THE FLOW AND MONETARY MODELS**

The foundations of the flow model were laid in the early 1960s in the classical writings of Mundell (1961, 1963) and Fleming (1962)<sup>3</sup>. This model makes two key contributions to the open-economy macroeconomics: a systematic analysis of (i) the trade and capital flows in determining the equilibrium exchange rate, and (ii) the impact of the international capital mobility on the effectiveness of monetary and fiscal policies under fixed and flexible exchange rates<sup>4</sup>.

Prior to the flow model, PPP emerged as the earliest dominant approach to exchange rate determination. Since Cassel (1916) first made PPP as an operational theory of foreign exchange, surprisingly few systematic attempts were made to model the exchange rate behaviour in a general macroeconomic equilibrium framework. This theoretical vacuum persisted until the early 1960s when Mundell (1961, 1963) and Fleming (1962) filled it by developing (independently) the flow model. Built on the total absence of PPP, this model postulates that it is the international demand for trade and capital flows (and not the international demand for and supply of money) that plays a key role in exchange rate determination. The model predicts that an expansion in money supply results in depreciation of the home currency, yet it does not specify explicitly the role of stock equilibrium in affecting the equilibrium exchange rate. Perhaps it is assumed that a monetary expansion affects the equilibrium exchange rate only indirectly by the extent to which it first affects the demand for and supply of foreign exchange flows (via its effect on interest rates and real income).

The flow model yields a reduced form equation in which the equilibrium exchange rate is determined by relative prices, relative incomes and relative interest rates. Typically, this equation can be derived from the behavioural

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<sup>3</sup> For a detailed account of this and other models see, for example, Moosa and Bhatti (2010).

<sup>4</sup> This model has influenced the thinking of a generation of economists, e.g., Krueger (1965), Sohmen (1967), and Dornbusch (1976a, b) who have built their work either on this or extended this model to investigate the impact of fiscal and monetary policies under fixed and flexible exchange rates.

equations of the current and capital accounts of the balance of payments<sup>5</sup>. In a general testable stochastic regression form, this equation is given by

$$s_t = \beta_0 + \beta_1 p'_t + \beta_2 y'_t + \beta_3 r'_t + u_t \quad (1)$$

where  $s$  is the logarithm of the exchange rate (defined as the domestic currency value of a unit of the foreign currency),  $p'$  is the logarithm of the ratio of the domestic price index to the foreign price index,  $y'$  is the logarithm of the ratio of domestic real income to foreign real income and  $r'$  is the difference between the domestic and the foreign interest rate. The flow model will be valid if the coefficients of relative prices and relative incomes are significantly positive ( $\beta_1 > 0, \beta_2 > 0$ ), whereas the coefficient of the interest rate differential is significantly negative ( $\beta_3 < 0$ ).

This model was highly influential in the 1960s, particularly in policy-making circles<sup>6</sup>. However, it failed to explain adequately the movements in the major currencies during the 1970s when inflation emerged as a core policy problem and in the 1980s when exchange rates and interest rates became highly volatile and misaligned. This theoretical vacuum was filled by the development of a wide range of monetary models of exchange rates including the flexible-price monetary model developed by Frenkel (1976), Mussa (1976) and Bilson (1978a, b).

The flexible-price monetary model posits that the equilibrium exchange rate is determined by stock equilibrium in money markets, which is achieved very quickly through continuous adjustment of prices in goods and asset markets, maintaining complete neutrality of monetary policy on a continuous basis. For example, due to rapid and instantaneous adjustments across the markets for goods, labor, money and foreign exchange, an incipient fall in the interest rate (which is caused by the liquidity effect following a monetary expansion) induces a rise in aggregate demand. This in turn stimulates inflationary expectations, leading to a rise in the interest rate through the Fisher effect<sup>7</sup>. The nominal interest and

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<sup>5</sup> For derivation, see Bhatti (2001).

<sup>6</sup> At least, three reasons can be put forth in this context. First, the model emphasized the use of an optimal combination of monetary and fiscal policy to manage aggregate demand in the open economy, a prescription that remained unchallenged until the late 1960s. Second, the model was developed at a time when the Bretton Woods system was still in place, and much of the research on the model focused on its predictions under a system of fixed exchange rates. Third, the economic environment that provided the context for this model was one of fixed exchange rates, capital controls, and segmented capital markets.

<sup>7</sup> In this model, expectations play an important role in determining the path of the current and future exchange rate, and are largely induced by monetary forces under the rational expectations hypothesis.

exchange rates rise proportionately to the inflation rate, and eventually the real interest rate, real exchange rate and real income return to their original levels, establishing neutrality of monetary policy.

This model involves a reduced form equation in which the equilibrium exchange rate is determined by relative money supply, relative income, and the interest differential. Typically, this equation can be derived by assuming that prices, nominal interest rates and nominal exchange rates adjust instantaneously to clear goods, money and foreign exchange markets (implying that Fisher closed and open conditions hold at all times), that monetary conditions are stable at both home and abroad (implying that the quantity theory of money holds at all times), that the money demand function is stable, and that PPP holds continuously. In a general testable stochastic regression form, this equation can be written as follows

$$s_t = \gamma_0 + \gamma_1 m'_t + \gamma_2 y'_t + \gamma_3 r'_t + v_t \quad (2)$$

where  $m'$  is the ratio of domestic money to foreign money supply. For the flexible-price monetary model to hold, the coefficients of relative money supply and relative interest rates must be positive ( $\gamma_1 > 0, \gamma_3 > 0$ ), whereas the coefficient of the relative income be negative ( $\gamma_2 < 0$ ). In addition, the coefficient of the relative money supply must be equal to unity ( $\gamma_1 = 1$ ), implying that the exchange rate is proportional to relative money supply.

### 3. EMPIRICAL EVIDENCE

Despite the tremendous amount of theoretical work on the Mundell-Fleming flow model, only little work has been conducted on examining its empirical validity<sup>8</sup>. Pearce (1983) was the first economist to examine the empirical validity of this model for the Canadian dollar exchange rate *vis-à-vis* the U.S. dollar using quarterly data over the period 1971:Q1-1982:Q1 and produced results that were not supportive of the model. Bhatti (2001) tested the model for the Pak rupee exchange rates *vis-à-vis* the US dollar, British pound, Swiss franc, German mark, French franc and Japanese yen using quarterly data over the period 1982:Q1-2000:Q4. By employing the Johansen and Juselius (1990) procedure for cointegration, he obtained results which lent strong support to the Mundell-Fleming model in all cases, except for the exchange rates *vis-à-vis* the French franc and the U.S. dollar when long-term interest rates were used.

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<sup>8</sup> Many studies were conducted, *inter alia*, by Krueger (1965), Sohmen (1967) and Prachowny (1977) on the theoretical and empirical relevance of this model with respect to its predictions regarding the effectiveness of fiscal and monetary policies under fixed and flexible exchange rates.

The flexible-price monetary model appears to fit the data fairly well for the first four years of flexible exchange rates (1973-76). Studies conducted, *inter alia*, by Bilson (1978a, 1978b), Hodrick (1978) and Humphrey and Lawler (1977) produced results supportive of the implication of the model that there is a one-to-one proportionality between the exchange rate and relative money supply. In subsequent studies, however, which tested the model for a slightly larger set of data incorporating the period 1977-78, the performance of this model deteriorated severely. This led to considerable concern with regard to a reconciliation of the flexible-price monetary model with the observed large fluctuations in exchange rates. It was against this backdrop that Dornbusch (1976b) developed the sticky-price version of the monetary model, whose empirical failure in turn resulted in the development of alternative versions including real interest differential and equilibrium real exchange rate sticky-price models.

#### **4. DATA, METHODOLOGY AND EMPIRICAL RESULTS**

Empirical testing of flow and flexible-price monetary models is carried out by estimating Equations (1) and (2). To this end, quarterly data were obtained from the IMF CD-ROM on consumer prices, money supply (M1)<sup>9</sup>, industrial production, short-term (call money) interest rates, long-term interest rates (bond yield) and exchange rates of the UK pound, Swiss franc, Japanese yen and Pak rupee measured vis-à-vis the US dollar. The sample covers the period 1983:01-2009:04.

Testing for unit root is conducted on the basis of the Dickey-Fuller (1979) and the Phillips-Parron (1988) test statistics. The two statistics, as shown in Table 1, are consistent in indicating that all the variables, except relative prices in the case of Switzerland and Japan when the ADF statistic is used, are I(1) in their levels but I(0) in their first difference.

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<sup>9</sup> The only exception is the Pak rupee rate vis-à-vis the pound, in which case data are used on M2.

Table 1: Unit Root Tests

	ADF		PP			ADF		PP	
	$x$	$\Delta x$	$x$	$\Delta x$		$x$	$\Delta x$	$x$	$\Delta x$
PR/UD					PR/SF				
$s$	-0.79	-8.72*	-0.77	-8.73*	$s$	-0.88	-10.96*	-0.72	-11.00*
$p'$	1.11	-3.31*	1.28	-6.44*	$p'$	-0.79	-1.61	1.76	-7.16*
$m'$	0.12	-10.66*	0.49	-11.11*	$m'$	-1.19	-9.98*	-1.30	-10.43*
$y'$	0.73	-3.77*	-2.87	-15.12*	$y'$	-0.37	-3.38*	-2.93	-15.80*
$r'_C$	-0.62	-9.05*	-2.29	-14.73*	$r'_C$	-1.96	-9.71*	-2.81	-15.11*
$r'_B$	-1.52	-8.69*	-1.35	-9.99*	$r'_B$	-1.59	-8.71*	-1.05	-9.00*
PR/BP					PR/JY				
$s$	-1.79	-10.13*	-1.13	-11.15*	$s$	-1.72	-4.59*	-1.52	-10.34*
$p'$	0.87	-3.04*	1.63	-6.88*	$p'$	-0.82	-0.71	1.87	-6.94*
$m'$	-0.79	-10.85*	-1.05	-10.75*	$m'$	-0.39	-10.51*	-0.32	-11.12*
$y'$	-0.74	-3.85*	-1.45	-15.28*	$y'$	-1.20	-4.21*	-1.29	-18.84*
$r'_{CR}$	-0.51	-8.71*	-1.84	-13.92*	$r'_C$	-1.99	-9.00*	-2.25	-14.52*
$r'_{BY}$	-1.40	-8.57*	-1.35	-8.97*	$r'_B$	-1.62	-8.68*	-1.77	-9.071*

\* Significant at the 5% level;  $r'_{CR}$  ( $r'_{BY}$ ) is the call rate (bond yield);  $x(\Delta x)$  is level (first difference) in the underlying variable.

Table 2: Cointegration Tests of the Flow Model of Exchange Rate

	PR/UD		RP/BP		RP/JY		RP/SF	
	CR	BY	CR	BY	CR	BY	CR	BY
$\beta_0$	2.483	2.716	6.090	7.096	7.074	1.669	6.353	-2.580
$\beta_1$	1.960	2.054	2.417	1.507	1.307	1.940	3.280	3.487
$\beta_2$	-2.480	-2.388	0.396	1.242	1.720	-2.945	1.487	-4.164
$\beta_3$	0.025	0.051	-0.056	0.020	-0.035	-0.333	-0.039	-0.0238
Max								
$r=0$	48.76*	52.34*	61.99*	69.43*	43.48*	42.71*	38.30*	39.30*
$r=1$	24.15*	29.12*	23.69*	29.69*	19.83*	11.75	17.49	10.70
$r=2$	17.13*	15.96*	13.78	15.01	8.31	9.50	8.90	7.62
Trace								
$r=0$	93.09*	100.13*	102.77*	117.17*	75.69*	67.35*	69.52*	63.68*
$r=1$	44.33*	47.68*	40.79*	47.74*	32.21	24.63*	31.22	24.38
$r=2$	20.8*	18.56	17.10	18.05	12.38	12.88	13.72	17.67

Table 3: Cointegration Tests of the Monetary Model of Exchange Rate

	PR/UD		RP/BP		RP/SF		RP/JY	
	CR	BY	CR	BY	CR	BY	CR	BY
$\gamma_0$	-3.84	-5.97	7.23	6.21	-18.61	-23.10	-19.05	-4.95
$\gamma_1$	1.162	1.40	0.94	2.33	2.38	2.84	2.52	0.62
$\gamma_2$	-2.36	-3.93	4.61	3.42	-3.10	-4.07	-0.49	0.85
$\gamma_3$	0.040	0.07	-0.36	-0.60	0.04	0.35	-0.12	0.14
$\chi^2(\gamma_1=1)$	0.25	1.01	0.106	0.498	9.24*	13.93*	1.53	0.11
<b>Max</b>								
$r=0$	37.48*	39.01*	46.40*	65.59*	37.81*	32.23*	30.42*	25.76
$r=1$	22.57*	31.45*	8.42	17.10	16.06	14.60	13.26	12.18
$r=2$	10.80	11.02	6.88	9.36	10.36	10.85	9.69	7.39
<b>Trace</b>								
$r=0$	74.43*	84.77*	64.45*	94.36*	66.67*	66.67*	56.87*	48.43
$r=1$	36.95*	45.76*	18.05	28.77	28.86	28.10	26.39	22.68
$r=2$	14.38	14.31	9.63	11.77	12.80	13.50	13.14	3.11

\* Significant at the 5% level.

Testing for cointegration is carried out on the basis of the Johansen and Juselius (1990) *Max* and *Trace* test statistics. The results, as reported in Tables 2 and 3, lend strong support to both the models as the null hypothesis of no cointegration between exchange rates and the underlying variables is significantly rejected in all cases, except for the Pak rupee exchange rate vis-à-vis the Japanese yen when the long-term interest rate is used in the monetary model. The results lending support to the presence of a long-run relationship is just a necessary condition for these models to hold in the long run. A sufficient condition requires the numerical estimates of the coefficients of the variables underlying both the models to be correctly signed. In two out of the four Pak rupee exchange rates (vis-à-vis the US dollar and the Swiss franc) the coefficients of the variables are consistent with the monetary model when both short-term and long-term interest rates are used. The results are also consistent with the prediction of the monetary model that there is one-to-one proportionality between the exchange rate and relative money supply because the hypothesis  $\gamma_1 = 1$  cannot be rejected in all cases, except for the Swiss franc. On the other hand, in three out of the four Pak rupee exchange rates (vis-à-vis the British pound, the Swiss franc and the Japanese yen) the coefficients are consistent with the flow model when only the short-term interest rate is used. These results show that both stock and flow variables are important in determining Pak rupee exchange rates vis-à-vis the major currencies.

## 5. CONCLUDING REMARKS

In this paper two models of exchange rates – the flow model and the monetary model – were tested for four Pak rupee exchange rates vis-à-vis the US dollar, British pound, Swiss franc and Japanese yen. Out of eight cases, cointegration results are supportive of the monetary in four cases and of the flow model only in three cases. Tests based on non-nested model selection criteria were also conducted to determine whether stocks or flows better explain the movement in Pak rupee exchange rates. Results from the non-nested model selection tests failed to provide unambiguous support to any of the two models, indicating that perhaps both stocks and flows are important in explaining the behavior of Pak rupee exchange rates.

Work in future needs to be conducted to examine whether a hybrid model based on stock and flow variables can better explain the behavior of Pak rupee exchange rates.

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