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Does Pak-Rupee Exchange Rate Respond to Monetary Fundamentals? A Structural Analysis

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This study empirically examines the contribution of monetary fundamentals in explaining nominal exchange rate movements in the case of Pak-rupee *vis-à-vis* US-dollar over the period 1982Q2 to 2014Q2. The empirical results support the existence of cointegration relationship between nominal exchange rate and monetary fundamentals. The results reveal that relative money stocks and real income are the key drivers of exchange rate determination in Pakistan in the long-run. For dynamic interaction, the Structural Vector Autoregressive (SVAR) method is applied. Results from the SVAR show that the responses of exchange rate to shocks, originated from money supply, income, interest rate and inflation differentials, are consistent with the predictions of the flexible-price variant of the monetary model of exchange rate in the short-run. More specifically, the results indicate that inflation and interest rate differential explain maximum variations in exchange rate in the short-run. In essence, results suggest that monetary fundamentals are the key drivers of exchange rate fluctuations in Pakistan, especially in the short-run.

JEL Classification: F31, F33, C32, F41
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1. INTRODUCTION

The exchange rate being a vital pillar of macroeconomic stability has received an extensive consideration by the analysts, policy-makers and researchers, especially after the Asian contagion in 1997 and global financial crisis (GFC) in 2008. However, economic policies in developing countries like Pakistan are undermined by deficiencies in the exchange rate policies. Inept exchange rate policies have contributed to debt crisis and worsened external balances which have subsequently led to an overall economic slowdown. Pakistan replaced fixed exchange rate regime in 1982 with managed floating exchange rate, which subsequently changed into floating exchange rate in 2000.[1] With a shift in exchange rate regime from managed to floating, exchange rate stabilisation has remained a matter of concern for policy-makers in Pakistan [Khan and Qayyum (2008)]. In addition, Pakistan has introduced reforms in trade and financial sectors over the last two and half decades. These reforms have introduced variations in the foreign exchange market with significant implications for macroeconomic stability and economic growth.

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[1]An analysis of exchange rate regimes is beyond the scope of this study. However, analysis of Pakistan's exchange rate regime can be seen in Rizvi, *et al.* (2014).

Pakistan has faced a decline in foreign capital inflows, exports, equity flows and a substantial depreciation of exchange rates after the GFC [Amjad and Din (2010)].[2] Exchange rate depreciation has increased external debt burden and made external borrowing more expansive, which has severe implications for corporate sector that relies heavily on external capital flows.[3] It is argued that disequilibrium in exchange rate, especially in the long-run, may cause substantial welfare loss. Edwards (1988) argued that a stable exchange rate is a key element in successful outward-oriented and export-based development strategies, while poorly aligned exchange rate with economic fundamentals, such as money supply and real income, interest rates, can lead to widespread macroeconomic and financial instability in developing countries [Dumrongrittikul and Anderson (2016)]. Being an important transmission channel of monetary policy strategy, the exchange rate is also used as an important instrument for measuring the currency over and/or under valuation. Therefore, a proper understanding of exchange rate dynamics is required for macroeconomic stability, economic growth and implementation of efficient monetary policy strategy in Pakistan.

The literature has shown that macroeconomic consequences of exchange rate variation can be analysed using the traditional monetary models of exchange rate [Groen (2000**)**; Rapach and Wohar (2002)]. These models show that depreciation in exchange rate is a monetary phenomenon and monetary fundamentals, such as money supply, income, inflation and interest rate are the key drivers to explain exchange rate dynamics. However, Kim, *et al.* (2010) and Meese and Rogoff (1983) show that traditional exchange rate models have failed to predict exchange rate behaviour, especially the short-run dynamics, despite the significant contribution of monetary fundamentals in the long-run macroeconomic policy discourse. These studies show that inflation, interest rates and economic growth are important determinants of Dollar/Euro exchange rate movements. Similarly, Junttila and Korhonen (2011) conclude that traditional economic factors are important determinants of short-run dynamics of exchange rates. Despite a vital role of monetary fundamentals in exchange rate determination, short-run contemporaneous relationship between exchange rate and monetary factors has remained unexplored. Hence, it is pertinent to investigate the dynamics of exchange rate and monetary variables in the short-run as well as in the long-run in Pakistan.

The empirical literature that has investigated the relationship between exchange rate and monetary fundamentals in developing countries, like Pakistan has been scant. The reason could be that majority of these countries have opted floating exchange rate regime until recently. Restrictions on capital mobility and on domestic financial transactions in these countries have created a different macroeconomic environment for exchange rate dynamics, particularly for testing the monetary model of exchange rate determination. An empirical test for such models in countries with binding constraints on capital flows and under developed domestic financial sectors can help to understand the

[2]Pakistan rupee was depreciated as much as 69 percent from 62.72 per US dollar in 2008Q1 to 106.00 per US dollar in 2013Q3. Thereafter, the rupee was appreciated by about 7.78 percent from 106 rupee per US dollar in 2013Q3 to 98.81 per US dollar in 2014Q2.

[3]Pakistan's exports growth reduced from 12.23 percent in 2008 to –7.16 percent in 2009. Net portfolio equity inflows decreased from $451 million to $272 million. Similarly, foreign direct investment was decreased from $5492 to $2338 from 2007 to 2009. During the GFC, exchange rate depreciated from 62.5/$ to 78.0/$, registering 20 percent depreciation against US dollar. Foreign exchange reserves declined from $14.2 billion in 2007 to $3.4 billion in 2008. Pakistan's economic growth also reduced from 6.3 percent in 2007 to 1.2 percent in 2009.

role of monetary and exchange rate policies in developing countries [Kletzer and Kohli (2000)].

The empirical literature associated with the monetary approach to exchange rate determination is sparse in Pakistan and does not cover recent exchange rate fluctuations and its interaction with monetary fundamentals. The available literature mainly considered the role of external factors, like terms of trade and remittances in studying the exchange rate behaviour [Haque and Montiel (1992); Chisti and Hasan (1993); Afridi (1995); Siddiqui, *et al.* (1996); Bhatti (1996**)**; Zakaria, *et al.* (2007); among others]. Few studies have examined the behaviour of nominal exchange rate, by considering the PPP hypothesis or variant of monetary and Keynesian models of exchange rate determination [Hina and Qayyum (2015**)**; Khan and Qayyum (2011**)**; Zakaria and Ahmad (2009); among others]. However, majority of these studies do not analyse dynamic interaction between exchange rate and monetary fundamentals, which give important policy implications about the reaction of exchange rate with regard to the monetary factors.

Pakistan followed a fixed-peg exchange rate regime up to the early 1980s. The State Bank of Pakistan (SBP) decided to replace pegged exchange rate regime when it started working on comprehensive financial sector reforms in the late 1980s. As a consequence of this initiative, the de jure exchange rate regime shifted to a managed float till 2000 and thereafter to a free float, after a two year transition period of multiple exchange rates.[4] Changes in the exchange rate regime are expected to eliminate deviation from parity conditions [Khan and Qayyum (2008)]. Besides, trade and financial sector liberalisation and loosening of restrictions on capital flows over the past two decades have reduced many distortions. The floating exchange rate regime provides motivation to study the role of monetary fundamentals in the determinations of exchange rate process in Pakistan.

Against the above backdrop, the present study contributes to the existing literature, by analysing the long-run and short-run relationships between exchange rate and monetary fundamentals in Pakistan, using quarterly data over the period 1982-2014. Second, this study uses the cointegration and Structural Vector Autoregressive (SVAR) approaches for empirical analysis. These approaches are useful as they allow estimating the short-run contemporaneous correlations among monetary fundamentals and nominal exchange rate, while considering the existence of cointegration between exchange rate and monetary factors [Loria, *et al.* 2010)]. Third, we consider Impulse Response Functions (IRFs) and Forecast Error Variance Decomposition (FEVD) analysis to trace out how nominal exchange rate has responded to changes in monetary fundamentals. Particularly, this study analyses the dynamic reaction of exchange rate to monetary policy shocks. Fourth, this paper imposes sign restrictions and a zero restriction on IRFs, based on economic theory to trace out meaningful policy shocks. Fifth, the present study takes care of structural break in the data by employing Lumsdaine and Papell (1997) test.[5] As

[4]Following nuclear tests in 1998, the SBP introduced a number of measures to rescue the economy from crisis. The authorities adopted a two-tier exchange rate system. For example, exports proceeds, home remittances, invisible flows and non-essential imports can be traded at the floating inter-bank rate (FIBR), the official rate fixed by SBP while FIBR was determined in the inter-bank market. However, this arrangement was transitory and therefore, replaced with unified floating exchange rate system with effect from May 19, 1999 [Khan (2008)].

[5]The structural breaks associated with nuclear tests in 1998, Asian financial crisis in 1997, global financial crisis in 2007-08, financial liberalisation and changes in exchange rate regimes from fixed to managed and free float.

Gregory, *et al.* (1994) points out that conventional cointegration tests are biased towards accepting the null hypothesis of no cointegration in the presence of structural breaks.

The rest of the paper is structured as follows: Section 2 reviews the literature review on monetary model of exchange rate determination. Section 3 describes methodology and the data sources. Section 4 reports and discusses empirical results, while Section 5 concludes along with some policy implications.

2. LITERATURE REVIEW

The exchange rate is considered as an important component of transmission mechanism of monetary policy because movements in exchange rate have significant impacts on the overall economy **[**Demir (2014)]. The exchange rate may influence macroeconomic fundamentals through three main channels. First, the exchange rate appreciation may decrease economic growth, by switching expenditures and slow adjustment of prices of imported goods owing to low inflation [Taylor (2001)]. Second, changes in the exchange rate induce wealth effects that subsequently effect consumption and investment which are important ingredients of overall economic development. Since, households are assumed to have inter-temporal smoothing behaviour; a direct decrease in net wealth may lead to a drop in consumption. Third, the exchange rate depreciation may increase the value of collateral, which may reduce external financing constraints and therefore final spending [Demir (2014)]. Taylor (2001) highlighted that exchange rate determines terms of trade and hence influences the overall imports and exports of the country. The exchange rate may also be used for predicting currency crisis [Ahmad and Pentecost (2009**)**; Astley and Garratt (2000)]. This discussion indicates that exchange rate contributes to economic development, enhances external competitiveness and improves social welfare [Chin, *et al.* (2009)]. On the other hand, excessive volatility in exchange rate hampers external capital flows, worsens the trade balance, and impedes economic growth [Effiong (2014)].

To contextualise the role of monetary factors, in determining the behaviour of nominal exchange rate, various theoretical models have been proposed in the literature.[6] The monetary model of exchange rate and its extended versions are considered as an attractive theoretical tool in understanding the dynamics of exchange rate across the globe [MacDonald (2007**)**; Neely and Sarno (2002**)**; Schroder and Dornau (2002)]. These models show that variations in nominal exchange rate are ascertained by inflation, money supply and interest rate between two trading economies. While real factors, including real income, budget deficit and government consumption do have impact on exchange rate variations but indirectly through money markets. Literature also shows that forecasting of exchange rate may be based on its current values but again it is a largely monetary induced phenomenon [Bhatti (2001**)**; Wilson (2009)]. According to the monetary models, economies that adopted relatively expansionary monetary policy, normally observe depreciation in currencies and vice versa. Therefore, the monetary model predicts a proportional relation between exchange rate and money supply of the trading economies in the long-run. Owing to this, monetary models are considered best to

[6]These models are Purchasing Power Parity (PPP), Covered Interest Rate Parity (CIP), Uncovered Interest Parity (UIP), Sticky Price Variants of the Monetary Model and Real Interest Rate Differential Monetary Model.

explain exchange rate behaviour [Dabrowski, *et al.* (2014)]. These models also give a long-run benchmark for exchange rate between two currencies and set the criteria for determining whether currency is undervalued or overvalued [Rapach and Wohar (2002)].

Despite numerous studies, the outcome remains inconclusive and the empirical validity of the monetary model of exchange rate determination is elusive [Khan and Qayyum (2008**)**; Moosa (1994)]. Majority of empirical studies have examined long-run association between exchange rate and monetary fundamentals, using the Johansen's (1988) cointegration test, while ignoring the short-run dynamics. However, high degree of volatility in exchange rate calls for a short-run analysis. Over the last four decades, extensive surveys were conducted on empirical validity of the monetary model of exchange rate.[7] These surveys provide conflicting evidence on the long-run validity of the monetary model of exchange rate [MacDonald (1995**)**; MacDonald and Taylor (1992)]. Empirical literature can be divided into six main groups. First, a number of studies concerning the interwar and the flexible exchange rate periods, during the 1970s have found supportive results for the validity of the monetary models [Frenkel (1976**)**; Putnam and Woodbury (1979); among others]. Second, studies covering post Breton Woods period have failed to support monetary exchange rate models, owing to its poor performance [Backus (1984**)**; Meese and Rogoff (1983**)**; Rasulo and Wilford (1980)]. Third, studies during the 1990s favour the long-run validity of the monetary exchange rate models along with their forecasting performance [Chinn and Meese (1995**)**; MacDonald and Marsh (1997)]. Fourth, studies carried out beyond the period of 2000 show significant forecasting ability of the monetary fundamentals, in projecting future exchange rates [Chen, *et al.* (2011**)**; Chin, *et al*. (2009**)**; Islam and Hasan (2006)]. Fifth, studies dealing with the issue of transaction costs and non-linear adjustments in exchange rate analysis, supporting the existence of non-linearity [Beckmann, *et al.* (2015**)**; Chen and MacDonald (2015**)**; Junttila and Korhonen (2011**)**; Kim, *et al.* (2010)]. Sixth, studies based on the SVAR methodology show that monetary exchange rate models are powerful tools to study the long-run as well as the short-run dynamics of the exchange rate [Effiong (2014**)**; Heinlein and Krolzig (2012**)**; Loria, *et al.* (2010)].

For example, Loría, *et al.* (2010) found short-run as well as long-run relationships between monetary factors and the exchange rate for Mexican economy using SVAR method. This study concluded that monetary model is very useful for understanding of Mexican exchange rate process. Effiong (2014)**,** used the same methodology and found the evidence of cointegration between exchange rate and monetary factors for Nigerian economy, based on flexible price of variant monetary model. Katusiime, *et al.* (2015) analyses the relation between Uganda Shilling/US$ and monetary fundamentals and finds that hybrid model provides support to analyse the Uganda Shilling/US$ exchange rates behaviors. Similarly, Bahmani-Oskooee, *et al.* (2015) investigated the link between exchange rate and monetary factors for six countries, using the Autoregressive Distributed Lag (ARDL). This study found supportive evidence for the validity of monetary exchange rate model.[8]

[7]The comprehensive survey of empirical studies carried out in the 1970s, 1980s and early 1990s can be found in Levich (1985), Frenkel and Mussa (1985), Isard (1988), MacDonald and Taylor (1992), MacDonald (1995), Odedokun (1997) and Khan (2008).

[8]Countries included are: Canada, France, Germany, Italy, Japan and UK.

Another strand of empirical literature concerning the sign restrictions on IRFs is based on economic theories. Sign restriction has become popular in recent years because it avoids the use of wrong identifying assumptions [Dumrongrittikul and Anderson (2016)]. Studies, inter alia by Farrant and Peersman (2006), Scholl and Uhlig (2008), Bhornland and Halvorsen (2014) and Fisher and Huh (2016) used sign restrictions to examine the monetary policy shocks.

The empirical literature in developing countries with regard to the validity of the monetary exchange rate model is relatively scarce because most of the existing monetary exchange rate models have focused on the industrialised countries. The application of the monetary model of exchange rate for the developing countries include, among others, Afghanistan [Fry (1976)], Peru [Lyons (1992); Edwards (1983)], Sub-Saharan Africa [Odedokun (1997)], East Asian countries [Chin (1998); Chin, *et al.* (2009)]; Asian countries [Husted and MacDonald (1999); Chinn and Azali (2012)], India [Kletzer and Kohli (2000)], South Asian countries [Yunus (2001)], the Philippines [Chin, *et al.* (2007)], Korea [Kim, *et al.* (2010)], Pakistan [Bhatti (2001); Khan (2008); Khan and Qayyum (2011); Bhatti (2013)] and Sri Lanka [Maitra (2010)]. Majority of these studies concluded that money supply, real income, inflation rate, interest rates, trade and budget deficits are the prime determinants of exchange rate dynamics.

3. MODEL, METHODOLOGY AND DATA

3.1. Model and Methodology

The monetary model of exchange rates is an extension of the quantity theory of money [Diamandis, *et al.* (2000)]. It holds that exchange rate is determined by the demand for and supply of domestic and foreign currencies. The basic contention of the monetary exchange rate model is that the national monetary policy is the key driver of the exchange rate. The central feature of the monetary exchange rate model is that it combines the purchasing power parity (PPP) theory with the quantity theory of money. Theoretical literature suggests that the exchange rate is determined by the relative money supply, relative real income, interest rate and inflation differentials. The model assumes that domestic and foreign countries have identical stable money demand functions, such that the money market equilibrium conditions at home and abroad are given. It further assumes that prices, nominal interest rates and exchange rates adjust instantaneously to clear goods, money and foreign exchange markets. It is assumed that aggregate price level is determined according to the quantity theory of money and that PPP holds continuously in the long-run [Chen, *et al.* (2011); Bhatti (2013)]. The monetary exchange rate model further assumes that domestic and foreign capitals are perfect substitutes and the Fisher parity condition holds at home and abroad. Furthermore, real interest rates across countries are assumed to be constant in the long-run. Following Heinlein and Krolzig (2012), the monetary exchange rate model is expressed as follows:[9]

$$s_t = \underset{+}{f}(\underset{+}{m_t^d}, \underset{-}{y_t^d}, \underset{\pm}{I_t^d}, \underset{+}{\pi_t^d}) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

[9]Details can be seen in Pilbeam (2013, Ch. 7). Moreover, details of variable construction can be seen in Khan (2008) and Khan and Qayyum (2011).

Where s_t represents the long-run equilibrium exchange rate (positive value indicate depreciation and vice versa), $m_t^d = m_t - m_t^*$ denotes money supply differential, $y_t^d = y_t - y_t^*$ is the real income differential, $I_t^d = I_t - I_t^*$ shows the short-term interest rate spread, while $\pi_t^d = \pi_t - \pi_t^*$ is the inflation rate differential.

Differences are calculated with reference to the United States (indicated by *). The model presented by Equation (1) shows that an increase in the relative money supply causes depreciation in the exchange rate, while increase in relative real income causes appreciation in the exchange rate [Hallwood and MacDonald (2000**)**; Hunter and Ali (2014**)**; Katusiime, *et al.* (2015)]. The model also indicates that increase in relative short-term interest rate and relative inflation rate causes depreciation of exchange rate.

Empirical analysis starts by examining the long-run relationship between all the variables, using Johansen (1995) reduced rank cointegration test. However, to examine the dynamic interaction between exchange rate and monetary fundamentals, we use the SVAR modelling framework. The main advantage of the SVAR modelling is that it allows identification of structural shocks with respect to economic theory [Khan and Ahmed (2014)]. It provides an opportunity to identify the net effect of unanticipated changes in variables in the system. Unlike Dynamic Stochastic General Equilibrium (DSGE) model, SVAR framework is more data driven, because it is restricted only by the number of variables, lags and prior restrictions used to identify the structural shocks of interest [Bhornland and Halvorsen (2014)]. Fisher and Huh (2016) reported that SVAR can allow for simultaneous interaction between monetary policy and the exchange rate. It is worth mentioning here that specification of SVAR, in terms of relative variables allows the economic activity of a country or region to influence the economic activity of its major trading partner. The SVAR model is equally useful for small open economies, where it is generally perceived to have no significant impact on its trade partners [Fisher and Huh (2016)]. Following Blanchard and Perotti (2002), the impact of monetary fundamentals shocks is estimated from the Vector Autoregressive (VAR) model. The dynamics of the variables $z_t = (s_t, m_t^d, y_t^d, I_t^d, \pi_t^d)'$ are modelled by the following $p-$ dimensional VAR**:**[10]

$$A_0 z_t = A_1 z_{t-1} + \ldots\ldots\ldots A_i z_{t-i} + \Phi D_t + B\varepsilon_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

Where A_0 indicates contemporaneous relationships in the model, $z_t = [z_{t-1}, \ldots\ldots\ldots z_{t-l}]'$ is the vector of lagged variables, i is the number of lags, $A_j's$ is (5×5) matrix of autoregressive coefficients, B is (5×5) matrix of non-singular structural coefficients, D_t is vector of deterministic components and $\varepsilon_t = [\varepsilon_{m_t^d}, \varepsilon_{y_t^d}, \varepsilon_{I_t^d}, \varepsilon_{\pi_t^d}]'$ is vector of structural shocks with $E[\varepsilon_t] = 0, E[\varepsilon_t \varepsilon_t'] = \Sigma, E[\varepsilon_t \varepsilon_s'] = 0 \; \forall s \neq t.$ The reduced form of the SVAR is given as:

$$z_t = \delta_1 z_{t-1} + \ldots\ldots\ldots \delta_k z_{t-i} + \alpha D_t + u_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

[10]The money supply differential (m_t^d) captures money supply shocks, while real income differential (y_t^d) captures the demand shock. Monetary policy instrument (I_t^d) and monetary target variables (π_t^d) are included to captures the effect of monetary policy shocks on exchange rate.

Where $\delta_j = A_0^{-1}A_j$ $(j = 1,\ldots\ldots i)$ and $\alpha = A_0^{-1}\Phi$. Moreover, $u_t = A^{-1}B\varepsilon_t$ are the reduced form residuals. In the SVAR modelling approach, the reduce-form residuals $u_t = [u_{m_t^d}, u_{y_t^d}, u_{I_t^d}, u_{\pi_t^d}]'$ are assumed to be linearly correlated with the underlying structural shocks $\varepsilon_t = [\varepsilon_{m_t^d}, \varepsilon_{y_t^d}, \varepsilon_{I_t^d}, \varepsilon_{\pi_t^d}]'$. The estimates α, δ and $E[\varepsilon_t\varepsilon_t']$ can be obtained by using the Ordinary Least Squares (OLS) method, but B and ε_t are not identified. Enders (2015) and Amisano and Giannini (1997) combine the restrictions for matrices A and B such that $Au_t = B\varepsilon_t$.

To identify structural coefficients, it is essential to define identification restrictions on A and B which is 5^2. For identification of the full system $5^2 - [(5^2 + 5)/2] = (5^2 - 5)/2 = 10$ restriction is required. Following Christiano, *et al.* (2007), we impose only short-run restriction as SVAR performs well, based on short-run restrictions. Following Alom, *et al.* (2013) and Kim and Roubini (2000), we define restrictions on the contemporaneous structural parameters, based on theoretical underpinning of the variant of the monetary exchange rate model which are given as follow:

$$\begin{bmatrix} 1 & a_{12} & a_{13} & a_{14} & a_{15} \\ 0 & 1 & a_{23} & a_{24} & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & a_{45} \\ 0 & a_{52} & a_{53} & 0 & 1 \end{bmatrix} \begin{bmatrix} u_{s_t} \\ u_{m_t^d} \\ u_{y_t^d} \\ u_{I_t^d} \\ u_{\pi_t^d} \end{bmatrix} = \begin{bmatrix} b_{11} & 0 & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 & 0 \\ 0 & 0 & b_{33} & 0 & 0 \\ 0 & 0 & 0 & b_{44} & 0 \\ 0 & 0 & 0 & 0 & b_{55} \end{bmatrix} \begin{bmatrix} \varepsilon_{s_t} \\ \varepsilon_{m_t^d} \\ \varepsilon_{y_t^d} \\ \varepsilon_{I_t^d} \\ \varepsilon_{\pi_t^d} \end{bmatrix} \quad \ldots \quad \ldots \quad (4)$$

Where $\varepsilon_{s_t}, \varepsilon_{m_t^d}, \varepsilon_{y_t^d}, \varepsilon_{I_t^d}$ and $\varepsilon_{\pi_t^d}$ are structural innovations and $u_{s_t}, u_{m_t^d}, u_{y_t^d}, u_{I_t^d}$ and $u_{\pi_t^d}$ are residual generated from reduced form VAR. First two rows represent variants of monetary exchange rate model and relative money demand function; third row indicated exogenous shocks from domestic income, relative to foreign income and fourth row shows monetary reaction function in terms of the Fisher hypothesis.[11] Fifth row gives domestic price setting behaviour. The short-run form of monetary model of exchange rate is given as:

$$u_{s_t} = a_{12}u_{m_t^d} + a_{13}u_{y_t^d} + a_{14}u_{I_t^d} + a_{15}u_{\pi_t^d} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (5)$$

Where $a_{12}, a_{15} > 0, a_{13} < 0$ and $a_{14} \gtrless 0$. The model is uniquely indentified and the shocks are orthogonalised. These restrictions allow contemporaneous interactions

[11]The Fisher hypothesis states that the nominal interest rate (I_t) equals the real interest rate R_t plus inflationary expectations (π_{t+1}^e). That is $I_t = R_t + \pi_{t+1}^e$. The Fisher hypothesis motivates real interest rate parity condition which hypothesises that real interest rate at home and abroad should equalise in the long-run, that is; $R_t - R_t^* = (I - \pi_t^e) - (I_t^* - \pi_t^{e*})$ where * indicate foreign country. According to the Uncovered Parity Condition or Fisher Parity Condition $I_t - I_t^* = E_t(s_t - s_{t-1}) = (\pi_t^e - \pi_t^{e*})$. The short-run form of the Fisher hypothesis can be written as $u_{I_t^d} = a_{45}u_{\pi_t^d}$.

between exchange rate and monetary fundamentals. The short-run dynamics of exchange rate can be examined using IRFs, based on the structural identification and FEVD.

3.2. Data

To achieve the aforesaid objectives, quarterly time series data has been used over the period 1982Q2-2014Q2. The data on money supply is defined as M2 (currency plus demand deposits plus time deposits plus other deposits), Six-month Treasury bill rate and Consumer Price Index (2000=100) are taken from the International Financial Statistics (IFS), published by International Monetary Fund (IMF). The quarterly data on GDP is not available for Pakistan. To construct quarterly series of GDP, we have used Goldstein and Khan (1976) methodology. Relative income is calculated, by taking the difference of Pakistan and the US real incomes, while relative money supply is calculated by taking the difference of Pakistan and the US money stocks. Similarly, interest rate differential is calculated by considering the difference between six-month Treasury bill rate of Pakistan and the US Treasury bill rate. The four quarter inflation rate (π_t) is calculated as $\pi_t = (\ln P_t - \ln P_{t-4}) \times 100$, where P_t is the consumer price index. All the data is expressed in logarithmic form except for the interest rate. An increase in exchange rate represents a nominal depreciation.

4. EMPIRICAL RESULTS AND DISCUSSION

4.1. Unit Root Analysis

To examine the stationarity of the data, the Augmented Dickey Fuller (ADF) test is used with seasonal dummies. The results are reported in Table 1. The results show that all series are stationary at first difference, that is the variables are integrated of order one. The results remain same even when seasonal dummies are included in the unit root test.

Table 1

Unit Root Analysis

	With Constant and Seasonal Dummies		With Constant only	
Series	Log-level	Log-difference	Log-level	Log-difference
s_t	–1.296 (1)	–9.229 (0)***	–1.270 (1)	–9.465 (0)***
m_t^d	–1.390 (2)	–5.269 (1)***	–1.491 (4)	–4.853 (4)***
y_t^d	–1.737 (2)	–3.243 (2)***	–1.765 (2)	–3.280 (1)***
I_t^d	–2.105 (3)	–5.551 (2)***	–2.100 (3)	–5.685 (2)***
π_t^d	–1.656 (4)	–5.788 (4)***	–1.680 (4)	–5.868 (4)***

Note: *** and ** indicates significance at the 1 percent and 5 percent level. Numbers in brackets show lag length. Critical values are –2.88 at 5 percent and –3.48 at 1 percent.

It is worth mentioning here that data sample is subject to several economic shocks, including Asian financial crisis of 1997, nuclear tests of 1998, changes in exchange rate regime in 2000, 9/11 event, global financial crisis of 2007-08, along with

business cycle. These events may produce structural breaks in the data. Given the possibility of structural breaks, we apply unit root test with structural breaks, proposed by Lumsdaine and Papell (1997), called LP test which allows two endogenous breaks. The results of LP test are reported in Table 2. The results show that all the variables are stationary at first difference, in the presence of two endogenous structural breaks. In essence, the results of the ADF and LP tests confirm that all the series are integrated of order one. Hence, cointegration analysis is suitable.

Table 2

Unit Root Test with Two Structural Breaks

Variables	Test Statistic	TB1	TB2
s_t	–2.06 (16)	2001Q3	2007Q4
m_t^d	–2.24 (17)	2001Q3	2007Q4
y_t^d	–2.48 (18)	2001Q3	2008Q4
I_t^d	–4.71 (22)	2003Q3	2008Q4
π_t^d	–2.80 (16)	2003Q3	2008Q4

Note: Critical values for LP Test are –7.19 at 1 percent and –6.75 at 5 percent and are taken from Ben-David, *et al*. (2003, Table 3).

4.2. Cointegration Analysis

Reduced rank maximum likelihood technique proposed by Johansen (1995) is used for cointegration analysis. The vector of five endogenous variables including $z_t = (s_t, m_t^d, y_t^d, I_t^d, \pi_t^d)'$, seasonal dummies and unrestricted constant are included in the Vector Error Correction Model (VECM). To control the impact of structural breaks, three impulse dummies (D_{98Q2}, D_{00Q2}, D_{07Q3}), covering the events of nuclear test (1998), flexible exchange rate regime (2000) and GFC (2007)[12] are incorporated. The lag length for VAR is set to be 6 quarters.[13]

To determine the number of stable long-run cointegrating relationships, trace statistic for the cointegration rank is reported in Table 3.[14] The result confirms the existence of a single cointegration relationship between the exchange rate and the monetary fundamentals for Pakistan. The existence of unique cointegrating relationship indicates that the relationship is tied up in a single direction.

[12]Though LP test does not support the presence of structural break, we have incorporated the impulse dummies (D_{98Q2}, D_{00Q2}, D_{07Q3}) due to their significant impacts in the VAR model. We exclude seasonal dummies, owing to no effect on cointegration rank.

[13]Lag length of order 6 quarters is supported by the LM test of serial correlation and Hannan-Quinn Criterion (HQC).

[14]On the basis of the diagnostic results, reported in Appendix Table 1, it can be inferred that the estimated VAR model does not suffer from error autocorrelation. The heteroscedasticity test also confirms that residuals are homoscedastic. Hansen and Rahbek (1999) argued that cointegration estimates are not very much sensitive to the heteroscedasticity. Normality test reject the null hypothesis that residuals are non-normal. Gonzalo (1994) shows that the performance of Johansen test is little effected by non-normal residuals. MacDonald and Marsh (1997), report that trace test is found to be more robust in the presence of non-normal residuals.

Table 3

Johansen Coingtegration Test of $H_0 : rank < r$

r	Eigenvalue	Trace Test	p-value
0	0.2401	67.79*	0.070
1	0.1332	34.84	0.463
2	0.1001	17.68	0.598
3	0.0253	5.03	0.806
4	0.0161	1.95	0.163

Note: * Indicate significance at the 10 percent level.

For the normalised coefficients of nominal exchange rate, based on the reduced rank, maximum likelihood estimation is presented in Equation (6). Equation (6) shows that inflation rate differential is not significant in determining exchange rate in the long-run; hence zero restriction is imposed on the coefficient of inflation rate differential, which cannot be ignored.

$$\begin{matrix} s_t = 0.78 m_t^d - 1.01 y_t^d + 0.06 I_t^d - 0.01 \pi_t^d \\ (2.60)^{***} \ (-5.32)^{***} \ (3.00)^{***} \ (0.50) \end{matrix} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

The restricted monetary exchange rate model is presented in Equation (7). The results indicate that coefficients are broadly aligned with the Bilson-type flexible-price exchange rate model.

$$\begin{matrix} s_t = 0.69 m_t^{\,d} - 1.06 y_t^{\,d} + 0.06 I_t^{\,d} \\ (2.76)^{***} \ (-6.63)^{***} \ (3.00)^{***} \end{matrix} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (7)$$

The patterns of dynamic adjustment are presented in Equation (8). The adjustment of coefficients of all variables, except real income differential has significant feedback effect to restore equilibrium in the long-run. The feedback coefficient of Δs_t possesses expected negative sign, indicating that long-run relationship between exchange rate and monetary fundamentals pushes exchange rate towards equilibrium. The coefficient of coefficient is –0.04, implies that changes in nominal exchange rate are correct around 4 percent of the deviations in each quarter in the long-run. This implies weaker response of exchange rate. The feedback coefficient of Δy_t^d is insignificant, which suggests that real income differential is weakly exogenous and plays no role in the adjustment process in the short-run.[15]

[15]The long-run weak exogeneity test shows that Δy_t^d is weakly exogenous, implying that Δy_t^d acts as a unique common stochastic trend in the system (see appendix Table 2a)

$$\begin{array}{lll} \Delta s_t = -0.04 & \Delta m_t^d = 0.06 & \Delta y_t^d = 0.04 \\ \quad (-2.31)^{**} & \quad (2.96)^{***} & \quad (1.08) \\ \Delta I_t^d = 2.45 & \Delta \pi_t^d = 1.54 & \\ \quad (2.66)^{***} & \quad (2.03)^{**} & \end{array} \quad \ldots \quad \ldots \quad \ldots \quad (8)$$

The long-run weak exogeneity test (Table 5 appendix) also confirms that real income differential is the only variable that is weakly exogenous in the system. Thus, real income differential acts as unique common stochastic trend in the system.

To examine the validity of Johansen (1995) cointegration test, Autoregressive Distributed Lag (ARDL) cointergation test proposed by Pesaran, *et al.* (2001) is used.[16] Dreger and Wolters (2015) have demonstrated that estimates based on cointegrated VAR model are useful only to explore stability of the system. Belke and Czudaj (2010) argue that estimates based on the single-equation approach are more reliable and close to economic theory, as single-equation estimates save degrees of freedom and assume a unique cointegration vector. Thus, we utilise the bounds testing approach to cointegration, which begins with the estimation of following conditional vector-error correction model [Hassler and Wolters (2006)].

$$\Delta y_t = c + \gamma y_{t-1} + \theta x_{t-1} + \sum_{i=1}^{n-1} \alpha_i \Delta y_{t-i} + \sum_{i=0}^{p-1} \phi_i \Delta x_{t-i} + \delta D_t + v_t \quad \ldots \quad \ldots \quad (9)$$

Where $y_t = [s_t, x_t]'$, $x_t = [m_t^d, y_t^d, I_t^d, \pi_t^d]'$, D is vector of impulse dummies and v_t is error term. We estimated Equation (9) and tested for the presence of cointegration between the exchange rate and monetary fundamentals, by setting the coefficients of the lag-level variables equal to zero.

The estimated results of the bounds cointegration test are reported in Table 4. Based on Lagrange Multiplier (LM) test of serial correlation and HQC, 6 lags were chosen. The results (Table 4) show that there exists a cointegration relationship between exchange rate and monetary fundamentals when s_t, y_t^d and I_t^d are used as dependent variables. The presence of cointegration confirms the findings, deduced from the Johansen's (1995) reduced rank cointegration test. We, on the other hand, do not find cointegration relationship when m_t^d and π_t^d are used as dependent variables, indicating weak exogenous nature of these variables. It is worth mentioning here that unlike Johansen's cointegration test, we obtained three cointegrating relationships: exchange rate equation, relative real income equation and equation for interest rate differential. The presence of multiple relationships implies that exchange rate and monetary fundamentals are tied up in more than one direction and the system is relatively more stable in multiple directions.

[16]The ARDL model is considered to be superior over Johansen's (1995) cointegration test. The Johansen's test selected same lag order for all the variables, while ARDL can take different lags for different variables [Bahmani-Oskooee, *et al.* (2015)]. This approach is directly applicable, irrespective of whether the variables are I(0), I(1) or mutually integrated. However, in Johansen cointegration test I(0) variables are excluded from the estimation, under the assumption that I(0) variables belong to cointegrating space. In finite sample models, ARDL is superior to other cointegration methods, including Johansen's method because other approaches suffer from truncation bias [Panopoulou and Pittis (2004)]. Furthermore, unlike Johansen approach estimates based on the ARDL approach can be tested for structural stability, directly in terms of Cumulative Sum of Squares Residuals (CUSUM) and CUSUM Squares of Residuals.

Table 4

Bounds-Cointegration Tests

Model	Lags	F-statistic	Outcome
$F(s_t \mid m_t^d, y_t^d, I_t^d, \pi_t^d, D)$	6	33.68^{***}	Cointegration
$F(m_t^d \mid s_t, y_t^d, I_t^d, \pi_t^d, D)$	6	1.54	No cointegration
$F(y_t^d \mid s_t, m_t^d, I_t^d, \pi_t^d, D)$	6	8.70^{***}	Cointegration
$F(I_t^d \mid s_t, m_t^d, y_t^d, \pi_t^d, D)$	6	4.27^{**}	Cointegration
$F(\pi_t^d \mid s_t, m_t^d, y_t^d, I_t^d, D)$	6	1.64	No cointegration

Note: D is vector of impulse dummies.

4.2.1. Monetary Exchange Model: Short-run and Long-run Estimates

Given the presence of cointegration between exchange rate and monetary fundamentals, we have obtained the short-run and long-run estimates of monetary exchange model using the ARDL method. The long-run estimates of the monetary exchange rate model are given by Equation (10).

$$\underset{\quad (4.43)^{***}}{s_t = 0.63m_t^d} \underset{\quad (8.09)^{***}}{-1.62y_t^d} \underset{\quad (1.17)}{-0.05I_t^d} \underset{\quad (1.56)}{+0.08\pi_t^d} \underset{\quad (-2.58)^{**}}{-0.74D_{98Q2}} \underset{\quad (1.93)^{**}}{+2.10D_{00Q3}} \underset{\quad (-1.70)^{***}}{-0.69D_{07Q3}} \quad \ldots (10)$$

Equation (10) reveals that m_t^d and y_t^d are the core drivers of exchange rate in the long-run. The positive sign of m_t^d indicates that an increase in domestic money stock relative to foreign money stock causes depreciation in the Pak-rupee exchange rate in the long-run. This suggests that increase in domestic money supply induces an increase in domestic price level, which in turn reduces competitiveness of domestic goods and hence deteriorates trade balance. The result is in line with previous studies [Kletzer and Kohli (2000); Khan (2008); Khan and Qayyum (2011)]. The estimated elasticity of money supply differential is 0.63, which indicates that a 1 percent increase in domestic money relative to foreign money results in a depreciation of Pak-rupee exchange rate by 0.63 percent in the long-run. The reason could be that over the past two decades an excessive money growth due to fiscal deficit exerted depreciation pressure on the Pak-rupee exchange rate. The estimated coefficient of y_t^d, which is significant and negative (–1.62), is consistent with the prediction of monetary exchange rate model. This suggests that increase in the relative real income increases demand for real money balances, which leads to an appreciation of Pak-rupee exchange rate in the long-run. Bilson (1978) noted that an appreciation of exchange rate, following increase in real income will only hold in the case of export-led growth. However, our finding is consistent with the Monetarist view that an increase in domestic output increases exports which would improve the trade balance. The estimated elasticity of y_t^d is greater than the estimated elasticity of m_t^d, which is consistent with the Blassa-Samuelson (BS) effect.[17] The estimated

[17]Large income elasticity could be the result of the productivity differential across countries.

coefficient of y_t^d is quite consistent with the earlier findings of Kletzer and Kohli (2000), Khan and Qayyum (2011) and Bhatti (2013) in case of Pakistan. The long-run semi-elasticity of exchange rate with respect to I_t^d is negative and insignificant; demonstrating that a rise in domestic interest rate, relative to foreign interest rate may not induce changes in exchange rate, which may be owing to lack of integration of Pakistan's financial market with the rest of the world. Various studies support these findings [for example, Katusiime, *et al.* (2015); Chen, *et al.* (2011); among others]. The coefficient of I_t^d is insignificant, indicating no impact of inflation differential on the exchange rate. The coefficient of D_{98Q2} is negative and significant, indicating that after nuclear tests in 1998 Pak-rupee exchange rate significantly appreciated in the long-run. The reason of this appreciation could be that after nuclear tests world community imposed sanctions on Pakistan. However, due to financial support of the Arab and other Muslim countries, Pakistan's economy recovered successfully.[18] The regime dummy D_{00Q3} has a positive and significant coefficient, implying that over the period of flexible exchange rate regime, Pak-rupee exchange rate depreciated significantly. The coefficient of D_{07Q3} is negative and significant. One reason of this result could be that it is due to large inflows of worker's remittances.[19] The other reason could be the global oil price uncertainty since 2008.[20]

To examine the dynamic interaction between exchange rate and monetary fundamental, an error-correction model based on the ARDL (1, 2, 2, 1) long-run estimates is estimated. Equation (11) presents the results:

$$\begin{aligned}\Delta s_t = {} & -0.19\,\Delta m_t^d - 0.11\Delta m_{t-1}^d - 0.55\Delta y_t^d + 0.15\Delta y_{t-1}^d - 0.00\Delta I_t^d + 0.003\Delta I_{t-1}^d \\ & (-6.81)^{***} \quad (-4.05)^{***} \quad (-16.79)^{***} \quad (4.45)^{***} \quad (-0.01) \quad (5.39)^{***} \\ & -0.001\Delta\pi_t^d - 0.00\Delta D_{98Q2} + 0.04\Delta D_{00Q3} - 0.01\Delta D_{07Q3} - 0.02EC_{t-1} \\ & (-2.04)^{**} \quad (-0.08) \quad (4.19)^{***} \quad (-1.33) \quad (-13.82)^{***} \qquad (11)^{21}\end{aligned}$$

$$Q-stat = 15.09[0.236] \qquad LM(F-stat) = 0.80[0.526]$$

$$RESET(F-stat) = 4.03E-05[0.995] \quad ARCH(F-stat) = 3.44[0.060]$$

$$NO(\chi^2-stat) = 0.74[0.692]$$

[18]The imposition of economic sanctions, following the nuclear tests in 1998, the SBP introduced a number of measures, such as freezing of foreign currency accounts, adoption of two tier exchange rate systems from July 1998 and channeling the foreign exchange from Kerb market to interbank market through Kerb purchases, to steer the economy from the crisis [Khan (2008)].

[19]For example, worker's remittances increased from US$ 5,998 in 2007 to US$ 17,060 in 2014 registering 65 percent growth. The reason could be depreciation of domestic currency from Rs. 60.63/US$ in 2007-08 to Rs 96.73/US$ in 2012-13.The other reason of remittances growth could be because of civil conflict and unrest related to 'Arab Spring'.

[20] In August 2008 oil price was more than $147 per barrel. However, due to global economic recession oil price declined to $33 per barrel in December 2008. In February 2009, oil price increased from $35 per barrel to $71 per barrel in June 2009 and reached to $114 per barrel in mid-2014. Thereafter, oil price collapse again and reached to $28 per barrel by February 2016.

[21] $EC_t = s_t - 0.63m_t^d + .62y_t^d + 0.05I_t^d - 0.08\pi_t^d + 0.74D_{98Q2} - 2.10D_{00Q3} + 0.69D_{07Q3}$

The results shown in Equation (11) implies that the impacts of Δm_t^d and Δm_{t-1}^d are negative in the short-run which are inconsistent with the hypothesised relationship predicted by the monetary exchange rate model. This result supports the liquidity puzzle hypothesis that monetary expansion causes to appreciate exchange rate. The contemporaneous effect of economic growth, relative to foreign economic growth on exchange rate changes is negative and significant; while one quarter lagged effect of output differential is positive in the short-run. However, cumulative effect of domestic economic growth is negative that causes exchange rate to appreciate in the short-run, which is in line with the hypothesised relationships implied by the monetary model of exchange rate.

The cumulative effect of interest rate differential is positive and significant, suggesting that tight monetary policy depreciates exchange rate through its impact on money demand in the short-run. The short-run effect of inflation rate differential on the exchange rate changes is negative and significant, confirming the presence of price puzzle hypothesis. Furthermore, nuclear tests and global financial crisis have no significant effect on exchange rate changes, while changes in exchange rate regime from managed floating to free floating exerts depreciating impacts on the exchange rate in the short-run. Finally, the adjustment coefficient of exchange rate is –0.02, implying that the long-run relationship between exchange rate and monetary fundamentals drags down exchange rate towards long-run equilibrium. The speed of adjustment towards long-run equilibrium is about 2 percent per quarter, which indicates that the response of exchange rate is weaker and it takes about twelve and half years to achieve long-run equilibrium path. This pattern of adjustment may be due to the non-linearities in the exchange rate adjustment process, asymmetric information, trade barriers, transaction costs, foreign exchange rate intervention, imperfect competition, structural changes in exchange rate regimes, less developed domestic markets and productivity differential across countries. These factors may prevent the economic agents from getting profits from arbitrage, as a consequence, exchange rate exhibit sluggish behaviour. Various studies have shown similar results [Alquist and Chinn (2008); Chinn and Meese (1995); Junttila and Korhonen (2011); Mark (1995); Taylor and Peel (2000)].

Pakistan has made remarkable progress in reforming its exchange rates and payments system during the past two decades. Domestic financial markets are now more integrated with international financial markets as compared to the 1990s. However, monetary policy fails to reduce exchange rate volatility and inflation. The existence of transaction costs, interaction of heterogeneous market participants, sharp swings in the Pak-rupee exchange rate during 1980s and 1990s, ineffective domestic monetary policy and insufficiently developed domestic financial markets cause weak adjustment of exchange rate in Pakistan. Another possibility of slow adjustment could be that besides monetary fundamentals, real factors such as worker's remittances, foreign direct investment and government debt to GDP ratio, net foreign assets and relative price of non-tradable goods and terms of trade also determine the exchange rate [Cheung, *et al*. (2005)].

4.2.2. *Long-run and Short-run Relative Income Differential Model*

The long-run parameters with regard to real income differential can be depicted by Equation (12):

$$y_t^d = -0.05 s_t + 0.67 m_t^d - 0.17 I_t^d + 0.10 \pi_t^d - 1.87 D_{98Q2} + 5.19 D_{00Q3} - 1.34 D_{07Q3} \quad (12)$$
$$(-0.04) \quad (1.72)^{**} \quad (-0.56) \quad (0.51) \quad (-0.66) \qquad (0.58) \qquad (-0.64)$$

The results show that only m_t^d exerts significant positive impact on relative income differential in the long-run, indicating that an expansion in domestic money supply, relative to foreign money supply increases domestic real income in the long-run. For short-run analysis, an error-correction model based on the selected ARDL (4, 1, 0, 4, 1) model is estimated (Equation 13):

$$\begin{aligned}
\Delta y_t^d &= 0.14 \Delta y_{t-1}^d - 0.13 \Delta y_{t-2}^d - 0.11 \Delta y_{t-3}^d - 1.13 \Delta s_t - 0.05 \Delta m_t^d + 0.00 \Delta I_t^d \\
&\quad (3.31)^{**} \quad (-3.12)^{***} \quad (-2.55)^{***} \quad (-19.45)^{***} \quad (-1.30) \qquad (0.07) \\
&\quad + 0.005 \Delta I_{t-1}^d + 0.00 \Delta I_{t-2}^d - 0.003 \Delta I_{t-3}^d - 0.005 \Delta \pi_t^d - 0.01 \Delta D_{98Q2} \\
&\quad (5.50)^{***} \qquad (1.14) \qquad (-3.31)^{***} \qquad (-5.06)^{***} \qquad (-1.34) \\
&\quad + 0.06 \Delta D_{00Q3} - 0.02 \Delta D_{07Q3} - 0.01 EC_{t-1} \qquad \ldots (13)^{22} \\
&\quad (4.27)^{***} \qquad (-1.53) \qquad (-8.14)^{**}
\end{aligned}$$

$$Q - stat = 9.08[0.696] \qquad LM(F - stat) = 1.47[0.216]$$
$$RESET(F - stat) = 3.05[0.084] \quad ARCH(F - stat) = 30.01[0.915]$$
$$NO(\chi^2 - stat) = 38.48[0.000]^{*}$$

The short-run impact of exchange rate changes is negative and significant, implying that depreciation of Pak-rupee exchange rate exerts negative impact on the economic growth in the short-run. The possible reason could be that depreciation of exchange rate causes to increase imports bill and domestic prices of crude oil which in turn increases costs of production. Consequently, domestic production tends to decrease. Furthermore, the effect of monetary expansion on economic growth is insignificant in the short-run, while the interest rate and inflation differentials appear to be significant in the output growth equation, however pass-through effects are too small producing negligible effect on output growth in the short-run. The possible reason could be perhaps the weak transmission mechanism of monetary policy in Pakistan. The dummy variables D_{98Q2} and D_{07Q3} have insignificant effect on relative income differential, while the dummy variable D_{00Q3} is positive and significant. This reveals that flexible exchange rate regime produces significant positive impact on the economic growth. The error-correction term is negative and significant, showing 1 percent adjustment towards long-run equilibrium.

4.2.3. *Long-run and Short-run Interest Rate Differential Model*

The long-run and short-run estimates of interest rate differential are presented in Equations (14) and (15) respectively.

$$I_t^d = 8.14 s_t - 2.82 m_t^d + 9.14 y_t^d + 0.63 \pi_t^d + 15.79 D_{98Q2} - 7.31 D_{00Q3} + 1.59 D_{07Q3} \quad (14)$$
$$(1.33) \quad (-0.58) \quad (0.91) \qquad (2.71)^{**} \quad (5.14)^{***} \qquad (-2.20)^{**} \qquad (1.22)$$

[22] $EC_t = y_t^d + 0.05 s_t - 0.67 m_t^d + 0.17 I_t^d - 0.10 \pi_t^d + 1.87 D_{98Q2} - 5.19 D_{00Q3} + 1.34 D_{07Q3}$

$$\Delta I_t^d = -0.23\Delta I_{t-1}^d - 0.02\Delta I_{t-2}^d + 0.29\,\Delta I_{t-3}^d + 4.31\Delta s_t + 16.54\Delta s_{t-1} + 1.55\Delta m_t^d$$
$$(-2.61)^{**} \quad (-0.20) \quad (3.49)^{***} \quad (0.50) \quad (3.40)^{***} \quad (0.39)$$
$$+ 4.39\Delta y_t^d + 0.19\Delta\pi_t^d + 3.04\Delta D_{98Q2} - 2.62\Delta D_{00Q3} - 0.08\Delta D_{07Q3} - 0.22EC_{t-1}$$
$$(0.61) \quad (1.93)^{**} \quad (2.68)^{***} \quad (-2.10)^{**} \quad (-0.08) \quad (-4.44)^{***} \quad (15)^{23}$$

$$Q-stat = 18.73[0.095] \qquad LM(F-stat) = 2.93[0.024]$$

$$RESET(F-stat) = 1.57[0.120] \quad ARCH(F-stat) = 16.64[0.000]^{***}$$

$$NO(\chi^2 - stat) = 663.74[0.000]^{***}$$

The results reveal that exchange rate; real output and inflation rate differentials have positive impact on the interest rate differential in the long-run. This indicates that a 1 percent increase in domestic inflation, relative to foreign inflation rate causes to increase domestic interest rate for a given foreign interest rate by 0.63 percent in the long-run. The reason could be that the SBP has taken aggressive monetary policy stance against domestic inflation so as to keep real interest rate at constant level since 2004. This finding validates the Fisher hypothesis in the case of Pakistan. The long-run effect of D_{98Q2} is positive and significant on domestic interest rate. The reason could be that after the May 1998 nuclear tests, Pak-rupee exchange rate slid down immediately from Rs. 45 per US dollar to Rs. 70 per US dollar. This sharp depreciation of exchange rate together with economic sanctions imposed by the world community has created uncertain economic environment which encouraged capital flight. To cope with this situation, some drastic measures were taken by the Government of Pakistan, including tight monetary policy, freezing of foreign currency accounts, etc. Furthermore, changes in exchange rate regime exert negative impact on the domestic interest rate, while the effect of GFC on domestic interest rate remains insignificant.

In the short-run, interest rate differential significantly determined by its own past lags; past lags of nominal exchange rate, inflation rate differential and a stable self-feedback mechanism. It also reacts positively to exchange rate changes and inflation rate differential in the short-run. This reveals aggressive monetary policy stance of the SBP against exchange rate depreciation and inflation in the short-run. It also indicates that the SBP focuses more on exchange rate management and price stability in the short-run. The dummy variables D_{98Q2} and D_{00Q3} have significant positive and negative impact on interest rate differential in the short-run. This confirms tight monetary policy stance after the nuclear tests and exchange rate depreciation after the change in exchange rate regime. The adjustment coefficient is negative and significant, implying that 22 percent of the deviations are eliminated in exchange rate through changes in domestic interest rates to achieve long-term equilibrium.

4.3. The SVAR Analysis

To study the dynamic response of exchange rate to monetary fundamentals shocks, generalised impulse response functions based on SVAR model are estimated. The contemporaneous coefficient estimates of the SVAR model are given in Table 5. These

[23] $EC_t = I_t^d - 8.14s_t + 2.82m_t^d - 9.14y_t^d - 0.63\pi_t^d - 15.79D_{98Q2} + 7.31D_{00Q3} - 1.59D_{07Q3}$

contemporaneous coefficients indicate immediate response of exchange rate with respect to shocks originating from the money supply, real income and interest rate and inflation rate differentials.

Table 5

Contemporaneous Structural Coefficients

	Coefficient	z-statistic	p-value
a_{12}	0.27	7.69***	0.000
a_{13}	0.54	14.30***	0.000
a_{14}	–0.001	–1.84*	0.066
a_{15}	0.002	2.15**	0.032
a_{23}	–0.69	–9.80***	0.000
a_{24}	0.001	0.82	0.411
a_{45}	–0.10	–0.91	0.362
a_{52}	–5.16	–1.28	0.202
a_{53}	15.42	3.70***	0.000
b_{11}	0.01	15.49***	0.000
b_{22}	0.03	15.49***	0.000
b_{33}	0.03	15.49***	0.000
b_{44}	1.41	15.49***	0.000
b_{55}	1.14	15.49***	0.000
$LR-\chi^2(1)^a$	49.40E-05		[0.992]

Note: a = LR test for over-identifying restrictions. ***, ** and * represent 1 percent, 5 percent and 10 percent level of significance respectively.

Table 5 shows that the short-run estimates of m_t^d (a_{12}), I_t^d (a_{14}) and π_t^d (a_{15}) have expected signs and consistent to the real interest rate differential variant of the monetary exchange rate model. The short-run coefficient of y_t^d shock is positive, contrary to the theoretical prediction of the monetary exchange rate model. This finding is consistent with the prediction of the Mundell-Fleming "Traditional Flow" model which hypothesises that an increase in domestic income, relative to foreign income increases the demand for imports, which in turn worsens trade balance and hence a depreciation in exchange rate in the short-run. Bhatti (2001) also found similar results in the context of Pakistan. The positive coefficients of m_t^d, I_t^d and π_t^d innovations indicate that a positive one unit shock to m_t^d and π_t^d would lead to a depreciation of Pak-rupee exchange rate, while negative sign of I_t^d innovation would cause an appreciation in the Pak-rupee exchange rate in the short-run. In terms of significance, m_t^d, I_t^d and π_t^d are the key factors in explaining the nominal exchange rate movements in Pakistan. The significance of inflation rate differential reveals the importance of inflationary expectations in the determination of Pak-rupee exchange rate in the short-run. Based on these SVAR coefficients, we have computed IRFs of the exchange rate with respect to four innovations: m_t^d, y_t^d, I_t^d and π_t^d shocks. A positive one unit standard deviation shock is applied for each fundamental up to a limit of twenty four quarter horizon. Figure 1 shows the IRFs of the nominal exchange rate.

Fig. 1. Responses of the Nominal Exchange Rate to Monetary Fundamentals Shocks

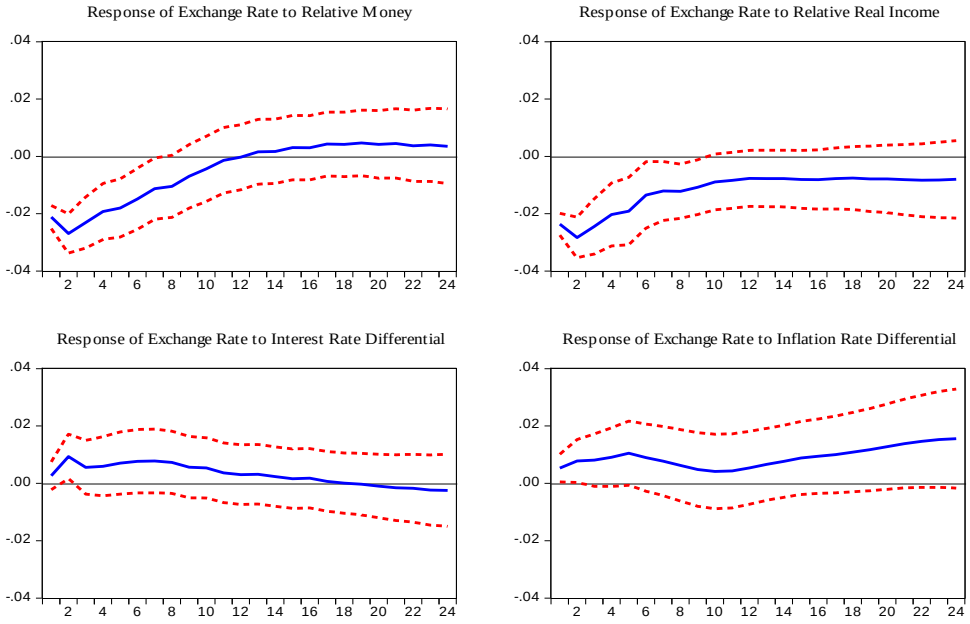

Figure 1 shows that a shock to domestic money supply for given foreign money, causes an appreciation of nominal exchange rate up to the eleventh quarter. Afterwards, the exchange rate touches the long-run path and starts depreciation. The point estimate shows that the impact effect is about –2.7 percent and this effect reached to 0.00 percent at the end of the eleventh quarters. Thereafter, the exchange rate starts depreciating slowly and at the end of twenty-fourth quarter it remains 0.03 percent. This hump-shaped adjustment pattern of nominal exchange rate confirms that exchange rate is deriving force from the transmission mechanism of monetary policy. However, this pattern of exchange rate adjustment confirms the existence of liquidity puzzle in Pakistan. A positive shock to domestic income, relative to foreign income causes a short-run exchange rate appreciation, as predicted by the monetary exchange rate model. Thereafter the response starts increasing up to the twelfth quarter and afterward it remains constant with point estimate of about –0.08 percent over the entire forecast horizon. However, it remains below the long-run steady state path over the entire forecast horizon. This implies that exchange rate has experienced persistent long-run appreciation following economic growth. A positive shock to domestic interest rate for given foreign interest rate leads to immediate jump in the nominal exchange rate in the first two quarters; thereafter it decreases up to the third quarter. Afterwards, it depreciates slowly and is seen peaked in the eighth quarter. After eighth quarter, it starts decreasing and becomes negative by the end of twenty-fourth quarter. This implies that an increase in domestic interest rate exerts depreciating effect on nominal exchange rate in the short-run. The slow response of exchange rate to interest rate differential shock implies a delayed overshooting and the depreciation process is too sluggish, thus violating the "uncovered interest rate parity" (UIP) condition. This pattern of exchange rate adjustment in response to tight monetary policy provides weak support for the Dornbusch's overshooting hypothesis. We observe

no exchange rate puzzle. Finally, the exchange rate responds positively to a one unit positive shock to inflation differential in the first five quarters after the shock. Thereafter, the response slowly decreases up to the tenth quarter, and then the response turns to be positive and increases slowly over the remaining forecast horizon. The point estimate shows that the impact reached to 1.6 percent in the twenty-fourth quarter. The slow response of nominal exchange rate with respect to inflation differential could be due to price stickiness, tariffs and transaction costs, insufficient developed domestic markets, productivity differential and asymmetric information.

We have computed generalised FEVD of exchange rate and results are reported in Table 6. The exchange rate itself explains 100 percent variation on the impact period, but it decreased to 84.54 percent in the twelfth quarters. The contribution of relative money supply shock to nominal exchange rate movements is 62.83 percent on the impact and on average the contribution remains 62.34 percent in the first three quarters. Afterwards, the impact of relative money decreased from 58.52 percent in the fourth quarter to 31.90 percent in the 12th quarter. This reveals that relative money supply shock significantly explains short-run fluctuations in the nominal exchange rate, however, the contribution gradually decreases over the longer horizon. Similarly, the share of income shock is 78.42 percent in the first quarter and has gradually decreased to 62.54 percent in the twelfth quarter. One standard deviation positive shock to the interest rate differential explains maximum variation within the first four quarters. From 0.98 percent in the first quarter, it rose to 24.16 percent in the fourth quarter, thereafter the contribution of interest rate differential gradually decreases and reaches 15.47 percent in the twelfth quarter. This implies that interest rate is an important factor that influences nominal exchange rate movements in Pakistan in the short-run. Finally, the contribution of inflation rate differential in exchange rate variation was 3.98 percent in the impact period which reaches to 7.73 percent in the third quarter. Thereafter, the impact gradually decreased and reached 6.94 percent in the sixth quarter. Afterwards, the impact of inflation differential on exchange rate reversed and reached 8.18 percent by the end of twelfth quarter. This implies that inflationary expectations play key role in explaining nominal exchange rate in the short-run.

Table 6

Generalised Forecast Error Variance Decompositions of Exchange Rate

Horizon	ε_{s_t}	$\varepsilon_{m_t^d}$	$\varepsilon_{y_t^d}$	$\varepsilon_{i_t^d}$	$\varepsilon_{\pi_t^d}$
1	100.00	62.83	78.41	0.98	3.98
2	96.16	62.83	77.44	16.08	7.71
3	96.12	61.37	75.87	20.44	7.73
4	95.23	58.52	72.88	24.16	6.86
5	94.07	51.69	72.66	23.61	6.31
6	92.32	46.93	72.30	22.18	6.94
7	91.00	42.84	70.94	20.79	8.37
8	90.19	40.28	70.49	19.28	9.30
9	89.33	37.33	69.02	17.90	9.48
10	88.32	35.12	67.15	17.04	9.04
11	86.57	33.15	64.91	16.09	8.53
12	84.54	31.90	62.54	15.47	8.18

5. CONCLUDING REMARKS AND POLICY IMPLICATIONS

This study examines the contribution of monetary fundamentals in explaining Pak-rupee *vis-à-vis* US-dollar exchange rate over the period of 1982Q2 to 2014Q2, using the cointegration and SVAR modelling techniques. The Johansen (1995) cointegration test supports the presence of unique cointegration relationship between exchange rate and monetary fundamentals, while three cointegration relationships were obtained using the ARDL-bounds cointegration test. The results reveal that money supply and real income differentials are the key drivers of exchange rate in the long-run, while money stocks, real income and interest rate differential are the key determinants of nominal exchange rate in the short-run. The results from the error-correction model reveal that exchange rate, money supply, interest rate and inflation rate differentials are important in the adjustment process in order to achieve long-run equilibrium path. The results further suggest that speed of adjustment towards long-run equilibrium is too weak. Finally, IRFs and FEVD analysis reveal that money supply, real income, interest rate and inflation differentials are the key factors that explain short-run variations in nominal exchange rate in Pakistan.

The policy implications that emerge from this analysis are: First, the existence of significant long-run and short-run relationships between exchange rate and monetary fundamentals indicate the effectiveness of monetary fundamentals, in explaining exchange rate movement in Pakistan. Policy-makers, therefore, may use these fundamental variables as stabilising tool for the prediction of Pak-rupee exchange rate in the long-run and in the short-run. Particularly, policy-makers can use monetary policy to induce changes in international competitiveness, by manipulating exchange rate. Exchange rate does in fact exert a significant influence on the direction and volume of international trade and capital flows. Second, money supply is another important determinant of exchange rate in Pakistan; therefore, any policy aimed at reducing monetary expansion would promote exchange rate stability in Pakistan. Among the monetary fundamentals, interest rate and inflation rate, differentials explain most of the variations in exchange rate in the first four quarters. Therefore, interest rate could be a more powerful tool in stabilising Pak-rupee exchange rate in the short-to-medium-run. This is because the rise in the domestic interest rates for given real money demand causes reduction in money supply. The rise in domestic interest rates results in capital inflows and causes nominal exchange rate to appreciate in the short-run. Therefore, tight monetary policy is needed to stabilise Pak-rupee exchange rate. The only caution is that the effectiveness of such policy stance will depend on the SBP's discipline and the coordination between fiscal and monetary authorities. To this end, there is a need for coordinated monetary and fiscal policies to enhance the exchange rate stability and external competitiveness. Stability of Pak-rupee exchange rate would also be helpful to encourage trade and investment linkages between Pakistan and regional economies under the China-Pakistan Economic Corridor (CEPC), as depreciation of exchange rate will increase external debt burden in the coming years.

The results of this study provide useful insights for understanding exchange rate dynamics in other countries of the South Asian region. Since, majority of South Asian countries are broadly similar in the sense that they are developing countries from the same geographical region and experience similar influence from the outside world. Particularly, these countries are homogenous in terms of their development strategies and

face similar issues with regard to monetary and exchange rate policies. The regional economies are struggling to establish stable a macroeconomic environment, which is necessary to enhance their ability to attract Foreign Direct Investment and promote trade and financial linkages in Asian region. Therefore, policy-makers can consider the monetary exchange rate model as a useful benchmark to understand the evolution of exchange rate movements. The findings of this study do provide support for the regional trade and financial integration, and monetary and exchange rate policy coordination in South Asia, as majority of Asian countries are using US dollar as base currency. Asian countries can reap the benefits from pursuing coordinated approach with regard to monetary and exchange rate policies in the core areas of trade, manufacturing and services through elimination of restrictions on regional trade. Furthermore, coordinated policies will also reduce harmful spillover effects from a country's unsound macroeconomic policies on neighbouring countries through exchange rates, interest rates and trade and capital flows. Regional economic policy coordination could also be helpful in lowering exchange rate fluctuations and keeping inflation rates low and stable [Rajan (2012); Kwack (2005)]. The results of this study can also be helpful for investors and financial managers in understanding the linkages between exchange rate and monetary fundamentals and for designing policies related to investment, hedging and risk management.

APPENDIX

Table 1a

Misspecification Tests for the Single Equation and VAR Estimation

Series: $z_t = (s_t, m_t^d, y_t^d, I_t^d, \pi_t^d)'$

Single Equation	Portmanteau (12)	AR (5)	Normality	ARCH (4)	Hetero
s_t	6.76	0.31 [0.904]	30.81 [0.000]***	0.10 [0.982]	0.27 [0.999]
m_t^d	6.55	0.32 [0.901]	4.36 [0.113]	0.69 [0.599]	0.31 [0.999]
y_t^d	4.15	1.87 [0.110]	133.16 [0.000]***	28.83 [0.000]***	0.99 [0.536]
I_t^d	14.20	2.21 [0.061]	65.39 [0.000]***	1.61 [0.180]	0.48 [0.990]
π_t^d	23.01	5.53 [0.000]***	1.13 [0.569]	0.29 [0.883]	0.29 [0.999]
VAR Statistic	185.689	1.28 [0.084]	578.22 [0.000]***	–	0.34 [0.999]

Note: Residuals diagnostics include AR (errors autocorrelation) test, Autoregressive Conditional Heteroscedasticity (ARCH), Normality of the distribution of the residuals and Heteroscedasticity (Hetero test). *** indicate significant at the 1 percent level and [.] indicates p-values.

Table 2a

Weak Exogeneity Test

	s_t	m_t^d	y_t^d	I_t^d	π_t^d
$\chi^2(4)$	15.27 [0.004]***	19.67 [0.001]***	5.38 [0.251]	17.77 [0.001]***	10.18 [0.038]**

Note: p-values are in parenthesis *** and ** indicate significant at the 1 percent and 5 percent levels respectively.

REFERENCES

Afridi, U. (1995) Determining Real Exchange Rates. *The Pakistan Development Review* 34, 263–276.

Ahmad, A. H. and E. J. Pentecost (2009) Sources of Real Exchange Rate Fluctuations: Empirical Evidence from Nine African Countries. *The Manchester School* 77:(s1), 66–84.

Alom, F., B. D. Ward, and B. Hu (2013) Macroeconomic Effects of World Oil and Food Price Shocks in Asia and Pacific Economies: Application of SVAR Models. *OPEC Energy Review* 37:3, 327–372.

Alquist, R. and M. D. Chinn (2008) Conventional and Unconventional Approaches to Exchange Rate Modelling and Assessment. *International Journal of Finance and Economics* 13:1, 2–13.

Amisano, G. and C. Giannini (1997) *Topics in Structural VAR Econometrics.* Springer.

Amjad, R., and M. Din (2010) Economic and Social Impact of Global Financial Crisis: Implications for Macroeconomic and Development Policies in South Asia. Pakistan Institute of Development Economics, Islamabad. (PIDE Monograph Series).

Astley, M. S. and A. Garratt (2000) Exchange Rates and Prices: Sources of Sterling Real Exchange Rate Fluctuations 1973–94. *Oxford Bulletin of Economics and Statistics* 62:4, 491–509.

Backus, D. (1984) Empirical Models of the Exchange Rate: Separating the Wheat from the Chaff. *Canadian Journal of Economics* 17, 824–846.

Bahmani-Oskooee, M., A. Hosny, and N. K. Kishor (2015) The Exchange Rate Disconnect Puzzle Revisited. *International Journal of Finance and Economics* 20:2, 126–137.

Beckmann, J., T. Berger, and R. Czudaj (2015) Does Gold Act as a Hedge or A Safe Haven for Stocks? A Smooth Transition Approach. *Economic Modelling* 48, 16–24.

Belke, A. and R. Czudaj (2010) Is Euro Area Money Demand (Still) Stable? Cointegrated VAR Versus Single Equation Techniques. *Applied Economics Quarterly* 56, 285–315.

Ben-David, D., R. L. Lumsdaine, and D. H. Papell (2003) Unit Roots, Postwar Slowdowns and Long-run Growth: Evidence from Two Structural Breaks. *Empirical Economics* 28:2, 303–319.

Bhatti, R. H. (1996) A Correct Test of Purchasing Power Parity: The Case of Pak Rupee Exchange Rates. *The Pakistan Development Review* 35, 671–682.

Bhatti, R. H. (2001) Determining Pak Rupee Exchange Rates *vis-à-vis* Six Currencies of the Industrial World: Some Evidence Based on the Traditional Flow Model. *The Pakistan Development Review* 40:4, 885–897.

Bhatti, R. H. (2013) Some Evidence on the Monetary Model of Exchange Rates. *Journal of International Economic Studies* 27, 93–105.

Bhornland, H. C. and J. I. Halvorsen (2014) How Does Monetary Policy Respond to Exchange Rate Movements? New International Evidence. *Oxford Bulletin of Economics and Statistics* 76:2, 208–232.

Bilson, J. F. O. (1978) The Monetary Approach to the Exchange Rate: Some Evidence. *IMF Staff Papers* 25, 48–75.

Blanchard, O. and R. Perotti (2002) An Empirical Characterisation of the Dynamic Effects of Changes in Government Spending and Taxes on Output. *Quarterly Journal of Economics* 117:4, 1329–1368.

Chen, H., D. K. Fausten, and W.-K. Wong (2011) Evolution of the Trans-Atlantic Exchange Rate Before and After the Birth of the Euro and Policy Implications. *Applied Economics* 43:16, 1965–1977.

Chen, X. and R. MacDonald (2015) Measuring the Dollar–Euro Permanent Equilibrium Exchange Rate using the Unobserved Components Model. *Journal of International Money and Finance* 53, 20–35.

Cheung, Y.-W., M. D. Chinn, and A. G. Pascual (2005) Empirical Exchange Rate Models of the Nineties: Are Any Fit to Survive? *Journal of International Money and Finance* 24, 1150–1175.

Chin, L. and M. Azali (2012). Testing the Validity of the Monetary Model for ASEAN With Structural Break. *Applied Economics* 44, 3229–3236.

Chin, L., M. Azali, and A. M. M. Masih (2009) Tests of the Different Variants of the Monetary Model in a Developing Economy: Malaysian Experience in the Pre- and Post-Crisis Periods. *Applied Economics* 41:15, 1893–1902.

Chin, L., M. Azali, B. Zulkornain, and M. B. Yusoff (2007) The Monetary Model of Exchange Rate: Evidence from the Philippines. *Applied Economics Letters* 14, 993–997.

Chinn, M. D. (1998) On the Won and other Asian Currencies. (NBER Working Paper No. 6671).

Chinn, M. D. and R. A. Meese (1995) Banking on Currency Forecasts: How Predictable is Change in Money? *Journal of International Economics* 38:1, 161–178.

Chishti, S. and M. A. Hasan (1993) What Determines the Behaviour of Real Exchange Rate in Pakistan? *The Pakistan Development Review* 32, 1015–1028.

Christiano, L. J., M. Eichenbaum, and R. Vigfusson (2007) Assessing Structural VARS. *NBER Macroeconomics Annual 2006, 21*. 1–106: MIT Press.

Dabrowski, M. A., M. Papiez, and S. Smiech (2014) Exchange Rates and Monetary Fundamentals in CEE Countries: Evidence from a Panel Approach. *Journal of Macroeconomics* 41, 148–159.

Demir, İ. (2014) Monetary Policy Responses to the Exchange Rate: Empirical Evidence from the ECB. *Economic Modelling* 39, 63–70.

Diamandis, P. F., D. A. Georgoutsos, and G. P. Kouretas (2000) The Monetary Model in the Presence of I(2) Components: Long-Run Relationship, Short-Run Dynamics and Forecasting of the Greek Drachma. *Journal of International Money and Finance* 19, 917–941.

Dreger, C. and J. Wolters (2015) Unconventional Monetary Policy and Money Demand. *Journal of Macroeconomics* 46, 40–54.

Dumrongrittikul, T. and H. M. Anderson (2016) How do Shocks to Domestic Factors Affect Real Exchange Rates of Asian Developing Countries? *Journal of Development Economics* 119, 67–85.

Edwards, S. (1988) Real and Monetary Determinants of Real Exchange Rate Behaviour: Theory and Evidence from Developing Countries. *Journal of Development Economics* 29:3, 311–341.

Effiong, E. L. (2014) Exchange Rate Dynamics and Monetary Fundamentals: A Cointegrated SVAR Approach for Nigeria. *Global Business Review* 15:2, 205–221.

Enders, W. (2014) *Applied Econometric Time Series.* 4th Edition. Wiley.

Farrant, K. and G. Peersman (2006) Is the Exchange Rate a Shock Absorber or a Source of Shocks? New Empirical Evidence. *Journal of Money, Credit and Banking* 38:4, 939–961.

Fisher, L. A. and H.-S. Huh (2016) Monetary Policy and Exchange Rates. Further Evidence using a New Method for Implementing Sign Restrictions. *Journal of Macroeconomics* 49, 177–191.

Frenkel, J. A. (1976). A Monetary Approach to the Exchange Rate: Doctrinal Aspects and Empirical Evidence. S*candinavian Journal of Economics* 78:2, 200–224.

Frenkel, J. A. and M. Mussa (1985) Asset Markets, Exchange Rates, and the Balance of Payments. In Jones, R. B. and P. B. Kenen (eds.) *Handbook of International Economics.* Vol. 2. New York; Amsterdam: North Holland.

Fry, M. J. (1976) A Monetary Approach to Afghanistan's Flexible Exchange Rate. *Journal of Money, Credit and Banking* 8:2, 219–225.

Goldstein, M. and M. S. Khan (1976) Large Versus Small Price Changes and the Demand for Imports. *IMF Staff Papers* 23:1, 200–225.

Gonzalo, J. (1994) Five Alternative Methods of Estimating Long-run Equilibrium Relationships. *Journal of Econometrics* 60:1, 203–233.

Gregory, A. W., J. M. Nason, and D. G. Watt (1994) Testing for Structural Breaks in countegrated Relationships. *Journal of Econometrics* 71, 321–341.

Groen, J. J. J. (2000) The Monetary Exchange Rate Model as a Long-Run Phenomenon. *Journal of International Economics* 52:2, 299–319.

Hallwood, C. P. and R. MacDonald (2000) *International Money and Finance.* Wiley.

Hansen, E. and A. Rahbek (1999) Stationarity and Asymptotics of Multivariate ARCH Time Series with an Application to Robustness of Cointegration Analysis: Department of Theoretical Statistics, University of Copenhagen.

Haque, N. U. and P. J. Montiel (1992) *Exchange Rate Policy in Pakistan: Recent Experience and Prospects*. In A. Nasim (eds.) *Financing Pakistan's Development in the 1990s.* Karachi: Oxford University Press.

Hassler, U. and J. Wolters (2006) Autoregressive Distributed Lag Models and Cointegration. *Advances in Statistical Analysis* 90, 59–74.

Heinlein, R. and H.-M. Krolzig (2012) Effects of Monetary Policy on the US Dollar/UK Pound Exchange Rate. Is There a "Delayed Overshooting Puzzle"? *Review of International Economics* 20:3, 443–467.

Hina, H. and A. Qayyum (2015) Re-estimation of Keynesian Model by Considering Critical Events and Multiple Cointegrating Vectors. *The Pakistan Development Review* 54:2, 123–146.

Hunter, J. and F. M. Ali (2014) Money Demand Instability and Real Exchange Rate Persistence in the Monetary Model of USD–JPY Exchange Rate. *Economic Modelling* 40, 42–51.

Husted, S. and R. MacDonald (2000) The Asian Currency Crash: Were Badly Driven Fundamentals to Blame? *Journal of Asian Economics* 10:4, 537–550.

Isard, P. (1988) The Empirical Modelling of Exchange Rates: An Assessment of Alternative Approaches. In R. Bryant, D. Henderson, G. Holtham, P. Hooper, and S. Symansky (eds.) *Empirical Macroeconomics for Interdependent Economies*. Washington, DC: Brookings Institutes.

Islam, M. F. and M. S. Hasan (2006) The Monetary Model of the Dollar-Yen Exchange Rate Determination: A Cointegration Approach. *International Journal of Business and Economics* 5:2, 129–145.

Johansen, S. (1988) Statistical Analysis of Cointegrating Vectors. *Journal of Economic Dynamic and Control* 12, 231–254.

Johansen, S. (1995) *Likelihood-based Inference in Cointegrated Vector Autoregressive Models.* Oxford University Press.

Junttila, J. and M. Korhonen (2011) Nonlinearity and Time-Variation in the Monetary Model of Exchange Rates. *Journal of Macroeconomics* 33:2, 288–302.

Katusiime, L., A. Shamsuddin, and F. W. Agbola (2015) Macroeconomic and Market Microstructure Modelling of Ugandan Exchange Rate. *Economic Modelling* 45, 175–186.

Khan, M. A. (2008) Testing the Monetary Approach to Exchange Rate Determination: The Case of Pakistan. Unpublished PhD Dissertation. Pakistan Institute of Development Economics, Islamabad.

Khan, M. A. and A. Qayyum (2011) Exchange Rate Determination in Pakistan: Role of Monetary Fundamentals. *Journal of Economic Cooperation and Development* 32:2, 67.

Khan, M. A. and A. Ahmed (2014) Revisiting the Macroeconomic Effects of Oil and Food Price Shocks to Pakistan Economy: A Structural Vector Autoregressive (SVAR) Analysis. *OPEC Energy Review* 38:2, 184–215.

Khan, M. A., and A. Qayyum (2008) Long-Run and Short-Run Dynamics of the Exchange Rate in Pakistan: Evidence FromUnrestricted Purchasing Power Parity Theory. *Lahore Journal of Economics* 13:1, 29–56.

Kim, B.-H., H.-G. Min, and Y.-K. Moh (2010) Nonlinear Dynamics in Exchange Rate Deviations from the Monetary Fundamentals: An Empirical Study. *Economic Modelling* 27:5, 1167–1177.

Kim, S. and N. Roubini (2000) Exchange Rate Anomalies in the Industrial Countries: A Solution with a Structural VAR Approach. *Journal of Monetary Economics* 45:3, 561–586.

Kletzer, K. and R. Kohli (2000) Exchange Rate Dynamics with Financial Repression: A Test of Exchange Rate Models for India. Indian Council for Research and International Economic Relations. (Working Paper No. 52).

Kwack, S. Y. (2005) Exchange Rate and Monetary Regime Options for Regional Cooperation in East Asia. *Journal of Asian Economics* 16, 57–75.

Levich, R. (1985) Empirical Studies of Exchange Rates: Price Behaviour, Rate Determination, and Market Efficiency. In R. Jones and P. Kenen (eds.) *Handbook of International Economics.* Vol. 2, Amsterdam: North Holland.

Loría, E., A. Sánchez and U. Salgado (2010) New Evidence on the Monetary Approach of Exchange Rate Determination in Mexico 1994–2007: A Cointegrated SVAR Model. *Journal of International Money and Finance* 29:3, 540–554.

Lumsdaine, R. L. and D. H. Papell (1997) Multiple Trend Breaks and the Unit-Root Hypothesis. *Review of Economics and Statistics* 79:2, 212–218.

Lyons, R. K. (1992) Floating Exchange Rates in Peru, 1950–1954. *Journal of Development Economics* 38:1, 99–118.

MacDonald, R. (1995) Long-run Exchange Rate Modeling: A Survey of the Recent Evidence. *IMF Staff Papers* 43:3, 437–489.

MacDonald, R. (2007) *Exchange Rate Economics: Theories and Evidence*: Psychology Press.

MacDonald, R. and I. W. Marsh (1997) On Fundamentals and Exchange Rates: A Casselian Perspective. *Review of Economics and Statistics* 79:4, 655–664.

MacDonald, R. and M. P. Taylor (1992) Exchange Rate Economics: A Survey. *IMF Staff Papers* 39, 1–57.

Maitra, B. (2010) Money Supply and Exchange Rate Variations in Sri Lanka in the Independent Float Regime—A Time Domain Study. *South Asia Economic Journal* 11:1, 111–129.

Mark, N. C. (1995) Exchange Rates and Fundamentals: Evidence on Long-Horizon Predictability. *The American Economic Review* 58, 201–218.

Meese, R. A. and K. Rogoff (1983) Empirical Exchange Rate Models of the Seventies: Do they Fit Out of Sample? *Journal of International Economics* 14:1, 3–24.

Moosa, I. A. (1994) The Monetary Model of Exchange Rates Revisited. *Applied Financial Economics* 4:4, 279–287.

Neely, C. J. and L. Sarno (2002) How Well Do Monetary Fundamentals Forecast Exchange Rates? *Federal Reserve Bank of St. Louis Working Paper Series (2002–007).*

Odedokun, M. O. (1997) The Monetary Approach to Analysing Floating Exchange Rate Behaviour in Developing Countries: Evidence from Sub-Saharan African Countries, 1986–1992. *Journal of Development Economics* 52:2, 463–481.

Panopoulou, E. and N. Pittis (2004) A Comparasion of Autoregressive Distributed Lag and Dyunamic OLS Cointegration Estimators in the Case of Serrially Correlated Cointegration Error. *Econometric Journal* 7, 585–617.

Pesaran, M. H., Y. Shin, and R. J. Smith (2001) Bounds Testing Approaches to the Analysis of Level Relationships. *Journal of Applied Econometrics* 16:3, 289–326.

Pilbeam, K. (2013) *International Finance*. (4th Ed.). Palgrave Macmillan Basmgstoke.

Putnam, B. H. and J. R. Woodbury (1979) Exchange Rate Stability and Monetary Policy. *Review of Financial Economics* 15:2, 1–10.

Rajan, R. S. (2012) Management of Exchange Rate Regime in Emerging Asia. *Review of Development Finance* 2, 53–68.

Rapach, D. E. and M. E. Wohar (2002) Testing the Monetary Model of Exchange Rate Determination: New Evidence from a Century of Data. *Journal of International Economics* 58:2, 359–385.

Rasulo, J. A. and D. S. Wilford (1980) Estimating Monetary Models of the Balance of Payments and Exchange Rates: A Bias. *Southern Economic Journal* 47, 136–146.

Rizvi, S. K. A., B. Naqvi, and N. Mirza (2014) From Fear of Floating to Benign Neglict: The Exchange Rate Regime Roller Coaster in Pakistan. *The Lahore Journal of Economics* 19, 17–34.

Scholl, A. and H. Uhlig (2008) New Evidence on the Puzzles. Results from an Agnostic Identification on Monetary Policy and Exchange Rates. *Journal of International Economics* 76, 1–13.

Schroder, M. and R. Dornau (2002) Do Forecasters use Monetary Models? An Empirical Analysis of Exchange Rate Expectations. *Applied Financial Economics* 12:8, 535–543.

Siddiqui, R., U. Afridi, and Z. Mahmood (1996) Exchange Rate Determination in Pakistan: A Simultaneous Equation Model. *The Pakistan Development Review* 35, 683–692.

Taylor, J. B. (2001) The Role of the Exchange Rate in Monetary Policy Rules. *The American Economic Review* 91:2, 263–267.

Taylor, M. P. and D. A. Peel (2000) Nonlinear Adjustment, Long-run Equilibrium and Exchange Rate Fundamentals. *Journal of International Money and Finance* 19:1, 33–53.

Wilson, I. (2009) The Monetary Approach to Exchange Rates: A Brief Review and Empirical Investigation of Debt, Deficit, and Debt Management: Evidence from the United States. *The Journal of Business Inquiry* 8:1, 83–99.

Yunus, M. (2001) Monetary Interpretation of Exchange Rates in the South Asian Countries. *The Bangladesh Development Studies* 27, 73–102.

Zakaria, M. and E. Ahmad (2009) Testing the Monetary Models of Exchange Rate Determination: Some New Evidence from Modern Float. *Chulalongkorn Journal of Economics* 21:3, 125–145.

Zakaria, M., E. Ahmad, and M. M. Iqbal (2007) Nominal Exchange Rate Variability: A Case Study of Pakistan. *Journal of Economic Cooperation* 28:1, 73–98.