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What Explains Real and Nominal Exchange Rate Fluctuations?: Evidence from SVAR Analysis for India

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Abstract

This study empirically analyzes the sources of the exchange rate fluctuations in India by employing the structural VAR model. The VAR system consists of three variables, i.e., the nominal exchange rate, the real exchange rate, and the relative output of India and a foreign country. Consistent with most previous studies, the empirical evidence demonstrates that real shocks are the main drives of the fluctuations in real and nominal exchange rates, indicating that the central bank cannot maintain the real exchange rate at its desired level over time.

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1. Introduction

As part of the extensive economic liberalization beginning in 1991, India experienced structural changes in the exchange rate regime during the first half of the 1990s. From 1975 to 1991, the Indian rupee had been adjustably pegged to a currency basket of major trading partners. Subsequently, after a transitional period of dual exchange rates, India shifted to a market-based exchange rate system in March 1993. Although the value of the rupee remained stable vis-à-vis the US dollar for a while, it has also been largely determined since the middle of 1995 by demand and supply conditions in the market.

Figure 1 traces the time path of the 36-currency trade-based real and nominal effective exchange rates (1993-94=100) from 1993 to 2008. The real effective exchange rate (REER) appears to have fluctuated around a constant trend or performed according to the mean-reversion process during this period; meanwhile, the nominal effective rate (NEER) depreciated until the middle of 2006, and since then it has displayed a tendency to appreciate. Formally, the Reserve Bank of India (RBI) states that, as the central bank, its primary objective in the foreign exchange market is to manage volatility with no fixed target for the exchange rate, which is determined by market forces. However, empirical studies have not supported this official statement and have pointed out that the RBI has managed to target the real exchange rate (Kohli, 2003; Jha, 2008).

There are several reasons why policymakers in emerging countries like India have paid considerable attention to the real exchange rate volatility, one of the most important reasons being that the real exchange rate has a substantial impact on export price competitiveness. In April 1997, the Indian government announced that it would achieve a 1.0% share in world trade by 2002, and in April 2008, it also declared a medium-term target of achieving a 5.0% share of world trade in both goods and services by 2020. As Srinivasan and Wallack (2003) and Veeramani (2008) among others found, there exists a negative and significant relationship between the real exchange rate and exports in India. Therefore, in the context of external competitiveness, it is worthwhile to investigate the sources of the exchange rate fluctuations for India.

There is a growing body of literature that empirically analyzes the sources of the exchange rate fluctuations. Examples include Lastrapes (1992), Clarida and Gali (1994), Enders and Lee (1997), Rogers (1999), Chen (2004), and Hamori and Hamori (2007) for industrialized countries, and Dibooglu and Kutan (2001), Chowdhury (2004), and Wang (2005) for less developed countries.

The relevant prior research on India consists of Pattnaik et al. (2003) and Moore and Pentecost (2006). Both of them applied a bivariate vector autoregressive (VAR) model of the nominal and real exchange rates, and they examined which real or nominal shocks are the main sources of the real exchange rate movements.[1] They employed the restriction of Enders and Lee (1997), which assumes that nominal shocks have a lasting effect on the nominal exchange rate but not on the real exchange rate. Pattnaik et al. (2003) used data from the period between April 1993 and December 2001, whereas Moore and Pentecost (2006) used data from the period between March 1993 and January 2004. From the empirical results, they both concluded that real shocks are the main sources of the fluctuations in both nominal and real exchange rates for India.

The purpose of this paper is to investigate the sources of exchange rate fluctuations in India by applying the structural VAR (SVAR) model. This paper differs from the prior literature in the following ways. First, we employ the trivariate VAR model composed of the relative output of India and a foreign country, the nominal exchange rate, and the real exchange rate between India and a foreign country. Unlike Clarida and Gali (1994) and others, by using the nominal exchange rate instead of the relative price level, this paper enables easier comparison of its results with prior studies on India. Second, considering the close trade relations, we alternately use the US or the euro area as a foreign country in the VAR system, and this enables us to confirm the robustness of the empirical results. Finally, this paper examines the more recent period of January 1999 to February 2009, whereas previous studies on India examined the period from 1993 to the early 2000s. The sample period in this paper corresponds roughly to the period of large capital flows to India.

In continuation, the second section provides the definitions and the data sources. The third section presents a brief explanation of the empirical techniques, and the fourth section shows the empirical results for India and the US and for India and the euro area, respectively. The concluding remarks summarize the main findings of this study and educe several interpretations.

2. Data

The data are obtained from the International Financial Statistics (IFS) published by the International Monetary Fund (IMF). Our empirical analysis is conducted on the basis of monthly observations during the period between January 1999 and February 2009. We use the exchange rates, consumer price indexes, and industrial production indexes

[1] Regarding the exchange rate, Pattnaik et al. (2003) used India’s effective exchange rate, while Moore and Pentecost (2006) used the Indian rupee rate against the US dollar.

(seasonally adjusted) for India, the United States, and the euro area. The exchange rate is expressed per unit of the foreign currency (US dollar or euro).

The log of the real exchange rate (re_t), the log of the relative output (y_t), and the log of the nominal exchange rate (e_t) are used for empirical analysis. The log-level real exchange rate, re_t, can be expressed as follows:

$$re_t = e_t + p_t^F - p_t^{Ind} \tag{1}$$

where p_t^{Ind} is the logarithm of the price level in India and p_t^F is the logarithm of the price level in a foreign country (the United States or the euro area). The real exchange rate thus measures the relative price of foreign goods in terms of home goods. Moreover, $y_t (= y_t^{Ind} - y_t^F)$ is the difference between the real incomes in India and a foreign country. As a preliminary exercise, the presence of a unit root in the univariate representations of the relative output, real exchange rates, and nominal exchange rates are tested for by using the augmented Dickey-Fuller (ADF) tests (Dickey and Fuller, 1979). For the log-level of each varaible, the null hypothesis of a unit root is not rejected at conventional significance levels. For the first difference of each variable, the null hypothesis of a unit root is rejected at the conventional significance level. Thus, all variables are found to be I(1) series.

3. Empirical Techniques

We use the trivariate system for empirical analysis given by,

$$x_t = [y_t, re_t, e_t]'. \tag{2}$$

Let us consider the following infinite-order vector moving average (VMA) representation:

$$\Delta x_t = C(L)\varepsilon_t, \tag{3}$$

where L is a lag operator, Δ is a difference operator, and $\varepsilon_t = [\varepsilon_{s,t}, \varepsilon_{d,t}, \varepsilon_{n,t}]'$ is a (3×1) vector for the covariance matrix of structural shocks Σ. The error term can be interpreted as the relative supply shocks, relative real demand shocks, and relative nominal shocks. We assume that structural shocks have no contemporaneous correlation or autocorrelation. This implies that Σ is a diagonal matrix.

To implement the econometric methodology, it is necessary to estimate the following finite-order VAR model:

$$[I - \Phi(L)]\Delta x_t = u_t, \qquad (4)$$

where $\Phi(L)$ is a finite-order matrix polynomial in the lag operator and u_t is a vector of disturbances. If the stationarity condition is satisfied, we can transfer Equation (3) to the VMA representation

$$\Delta x_t = A(L)u_t, \qquad (5)$$

where $A(L)$ is a lag polynomial. Equations (3) and (5) imply a linear relationship between ε_t and u_t as follows:

$$u_t = C_0\varepsilon_t. \qquad (6)$$

In Equation (6), C_0 is a 3×3 matrix that defines the contemporaneous structural relationship among the three variables. Moreover, it is necessary to identify for the vector of structural shocks so that it can be recovered from the estimated disturbance vector. We require nine parameters to convert the residuals from the estimated VAR into the original shocks that drive the behavior of the endogenous variables. Since six of these nine are given by the elements of $\Sigma = C_0C_0{}'$, three more identifying restrictions need to be added. According to Blanchard and Quah (1989), economic theory can be used to impose these restrictions. Thus, using the methodology of Clarida and Gali (1994), we impose three additional restrictions on the long-run multipliers while freely determining the short-run dynamics. These three restrictions are as follows:

(i) Nominal (monetary) shocks have no long-run impact on the levels of output.
(ii) Nominal (monetary) shocks have no long-run impact on the real exchange rate.
(iii) Real demand shocks have no long-run impact on the levels of output.

The long-run representation of Equation (3) can be written as,

$$\begin{bmatrix} \Delta y_t \\ \Delta re_t \\ \Delta e_t \end{bmatrix} = \begin{bmatrix} C_{11}(1) & C_{12}(1) & C_{13}(1) \\ C_{21}(1) & C_{22}(1) & C_{23}(1) \\ C_{31}(1) & C_{32}(1) & C_{33}(1) \end{bmatrix} \begin{bmatrix} \varepsilon_{s,t} \\ \varepsilon_{d,t} \\ \varepsilon_{n,t} \end{bmatrix}, \tag{7}$$

where $C(1) = C_0 + C_1 + C_2 + \cdots$ are long-run multipliers in our SVAR model (long-run effect of Δx_t). Following the methodology of Clarida and Gali (1994), we stipulate that the long-run multipliers C_{12}, C_{13}, and C_{23} are equal to zero, thus making the matrix a lower triangular matrix.

Our analysis differs from the analyses from Clarida and Gali (1994). Our system consists of the relative output level, real exchange rate, and nominal exchange rate, while the system from Clarida and Gali (1994) consists of the relative output level, real exchange rate, and relative price level. By using the nominal exchange rate instead of the relative price level, this paper focuses on the effect of various shocks on both real and nominal exchange rates.

4. Empirical Results

4.1 Results of India and the United States

Let us start with the case of India and the United States. In empirical analysis, using the Akaike Information Criterion (AIC) and Schwarz Bayesian Information Criterion (SBIC) to choose the optimal lag length of VAR, we find that the VAR(1) model is the most appropriate for the system. To shed light on the sources of each variable, we calculate the forecast error variance decomposition. Variance decomposition is a convenient measure of the relative importance of such shocks with respect to the overall system.

Table 1 focuses on the results of the forecast error variance for real and nominal exchange rates that can be attributed to each shock at different horizons in the system. Throughout the time horizons, real demand shocks – the most important factor in the variation in the forecast error of the real exchange rate – account for more than 97% of the variance in the real exchange rate. The remaining variance is attributed to real supply and nominal shocks. Real supply shocks, meanwhile, account for less than 1% of the forecast error variance in the real exchange rate. Nominal shocks account for about 2% of the variation in the forecast error of real exchange rate. To summarize, real demand shocks are responsible for most of the forecast error variance of the movement in the real exchange rate.

Forecast error variance decomposition for the variation in nominal exchange rates suggests that real demand shocks explain most nominal exchange rate movements as well. Real demand shocks, which are the most important factor, account for approximately 79% of the variation in nominal exchange rate movements. Nominal shocks, meanwhile, account for about 20% of the forecast error variance. On the other hand, real supply shocks account for less than 1.3% of nominal exchange rate fluctuations.

To summarize, real demand shocks are the source of a substantial share of the forecast error variance of real and nominal exchange rate movements between India and the United States. The significance of real shocks in explaining real and nominal exchange rate movements is consistent with the evidence presented by Pattnaik et al. (2003) and Moore and Pentecost (2006) for India as well as studies such as Lastrapes (1992), Enders and Lee (1997), and Chowdhury (2004) for other countries.

4.2 Results of India and the Euro Area

Next, we move on to analyze the case of India and the euro area. Using the AIC and SBIC, we again find that the VAR(1) model is the most appropriate for the system. The results of forecast error variance decomposition are reported in Table 2.

Variance decompositions in the real exchange rate suggest that real demand shocks explain most of the movement in the real exchange rate. Real demand shocks, which are the most important factor, account for more than 96% of the real exchange rate variation. Real supply shocks, meanwhile, explain about 2% of the forecast error variance. Nominal shocks account for about 1% of the real exchange rate movements. To summarize, real demand shocks account for most of the forecast error variance of the movement in the real exchange rate.

Forecast error variance decompositions for nominal exchange rates indicate that real demand shocks are responsible for about 93% of the variation in the changes of nominal exchange rates. Real supply shocks account for about 1.5% of the variation in nominal exchange rates. Nominal shocks account for about 5.4% of the variation in nominal exchange rate movements.

To summarize, real demand shocks are the source of a substantial share of the forecast error variance of the real and nominal exchange rate movements between India and the euro area. These empirical results for the euro area are consistent with those for the United States.

5. Some Concluding Remarks

Some empirical studies have stated that the RBI has managed to target the real exchange rate. The time path of REER seems to support this result, although the RBI itself has not formally acknowledged it. In addition, there are some arguments that the Indian central bank should keep the real exchange rate at a constant level. For example, the Committee on Fuller Capital Convertibility repeatedly recommended to the RBI that it should monitor the exchange rate within a band of +/- 0.5% around the neutral REER, and that it should ordinarily intervene when the REER moves beyond the band (RBI, 2006).

This paper analyzed the sources of the exchange rate fluctuations in India from 1999 to 2009. The analysis employed the trivariate VAR model, which is composed of the relative output of India and a foreign country and the nominal exchange rate and real exchange rate between India and a foreign country. The results demonstrated that real shocks have a persistent effect on both real and nominal exchange rate movements, which is consistent with the relevant literature. Moreover, in this paper, we observed that real demand shocks play a key role among real shocks. These results were obtained by using either the US or the euro area as a foreign country, so they were robust in this sense.

The results of this paper suggest that the RBI should not attempt to target the real exchange rate over time. Since real shocks are the dominant explanation for real exchange rate fluctuations, it is impractical for the RBI to attempt to maintain the real exchange rate at a predetermined level in the long run, although there is some room for monetary and exchange rate policies to manage the real exchange rate fluctuations in the short to medium term. Consequently, based on these results, we conclude that the Indian central bank cannot influence international competitiveness through its exchange rate policy and that, in order to improve external competitiveness, the policymakers should focus on the real side of the economy, such as the improvement of efficiency, technologies, and productivity in the Indian economy.

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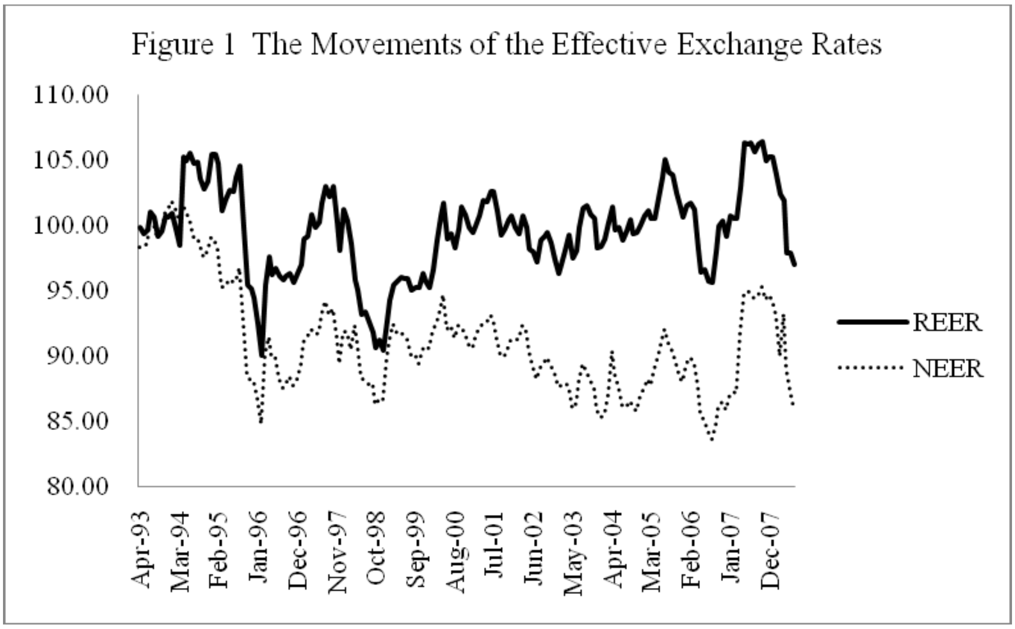

Figure 1 The Movements of the Effective Exchange Rates

Source: RBI (2008).

Table 1 Forecast Error Variance Decomposition (India and the United States)

(a) Real Exchange Rate

Horizon (months)	Real Supply Shocks (%)	Real Demand Shocks (%)	Nominal Shocks (%)
1	0.561	97.566	1.873
3	0.727	97.171	2.102
6	0.736	97.089	2.175
9	0.736	97.087	2.177
12	0.736	97.087	2.177
18	0.736	97.087	2.177
24	0.736	97.087	2.177
36	0.736	97.087	2.177

(b) Nominal Exchange Rate

Horizon (months)	Real Supply Shocks (%)	Real Demand Shocks (%)	Nominal Shocks (%)
1	0.007	84.965	15.028
3	1.174	79.543	19.282
6	1.255	79.120	19.625
9	1.256	79.114	19.630
12	1.256	79.113	19.630
18	1.256	79.113	19.630
24	1.256	79.113	19.630
36	1.256	79.113	19.630

Table 2 Forecast Error Variance Decomposition (India and the Euro Area)

(a) Real Exchange Rate

Horizon (months)	Real Supply Shocks (%)	Real Demand Shocks (%)	Nominal Shocks (%)
1	1.522	97.746	0.732
3	2.003	96.940	1.056
6	2.022	96.918	1.060
9	2.023	96.918	1.060
12	2.023	96.918	1.060
18	2.023	96.918	1.060
24	2.023	96.918	1.060
36	2.023	96.918	1.060

(b) Nominal Exchange Rate

Horizon (months)	Real Supply Shocks (%)	Real Demand Shocks (%)	Nominal Shocks (%)
1	0.553	95.145	4.302
3	1.430	93.205	5.364
6	1.467	93.162	5.371
9	1.468	93.161	5.371
12	1.468	93.161	5.371
18	1.468	93.161	5.371
24	1.468	93.161	5.371
36	1.468	93.161	5.371