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Is exchange rate pass-through a case for India?

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Abstract

Objectives: To study ERPT- a case for India; to examine the vulnerability of various macroeconomic variables with a unit difference in exchange rate considering the liberalization policies adopted in the economy in 1991.
Methods: The study proposes various time series econometric tools like Johansen co-integration, Vector error correction mechanism (VECM),"impulse response function" and "variance decomposition" in order to test the objectives empirically. The proposed empirical analysis will be based on secondary data. Variables considered for this analysis are exchange rate, inflation, money supply, forex reserves, output and international oil price. And the sample period lies between 1993 April - 2015 December.
Findings: From the co-integration analysis, a long- run relationship between the variables under consideration is found. Further from the error correction table, it has been noticed that all the variables are "mean reverting" and the "speed of adjustment parameter" reveals that forex reserves and prices are likely to be correcting the error more quickly. Further, by utilizing the "impulse response function" it has been observed that a shock to exchange rate pulls down forex reserves drastically; whereas it pushes prices on to the positive region. However, money supply did not respond to the changes in exchange rate much. In addition from the impulse response analysis, it is noticed that shocks in crude oil prices reduces the foreign exchange reserves substantially. Further, the "variance decomposition" analysis advocates that the forecast error variance of exchange rate has largely been explained by oil and forex reserves and prices in the later quarters. From this it is evident that financial sector variables are not in fact fully insulated from the supply side shocks. The forecast error variance of forex reserves is mostly explained by exchange rate and prices. This finding corroborates the earlier empirical evidence obtained from the ECM analysis. However, the "variance decomposition" of prices reveals that its forecast error variance is by and large explained by oil prices, which shows that prices are indeed more vulnerable to the supply side shocks.
Applications: This study enquires into the relevant concern that "is ERPT a case in India?" After conducting a thorough empirical examination, it has been found that the answer to this question is "yes". The fluctuations in exchange rate do have some impact on some of the important macroeconomic variables such as forex reserves and price levels. Therefore, it requires a serious attention of macroeconomic experts and monetary authority of India to redesign exchange rate management policy such a way that monetary instruments of monetary policy will do its best without getting neutralised by inflation and changes in foreign exchange reserves.
Keywords: Exchange rate pass-through, Monetary policy, Inflation targeting, Johansen co-integration, Variance Error Correction Model, Impulse Response Function, Speed of Adjustment Parameters, Variance Decomposition Function.

1. Introduction

In an open economy, flexible exchange rate system it's challenging task for monetary authority to make right decision which will do the best for the economy. By simply applying monetary policy instruments, the authority could not make results as expected. So for the optimal use of monetary policy instruments, understanding about behavior of market is important. They must be well efficient to predict the change that each instrument will result in the economy. Understanding behavior of the market is a little broader thing. One portion of this understanding is related to changes in exchange rate. It's noted that changes in exchange rate are not transmitting to prices of imported goods as it is always. Considering the market conditions sometimes changes in exchange rate will fully reflect in price of imported goods and sometimes only a portion of the change will be reflected in the price of imported goods.

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Suppose if the demand for the imported goods is elastic to price then depreciation of domestic currency may not fully transmit to the price of imported goods. And appreciation of domestic currency may fully transmit to the price of imported goods. But these transmissions would be on opposite direction if demand for imported goods is inelastic or less elastic to prices. These reflections of changes in exchange rate on price of imported goods expressed in domestic currency are studied under the head "Exchange Rate Pass-Through"(ERPT). Understanding ERPT is important in international level for number of reasons. First and important is that understanding speed and degree of pass through will help policy makers to calculate time gap that may occur between policy decisions and its results. Policy decisions such as inflation targeting must be done considering speed and degree of ERPT in the market for effective implementation. Another reason is from the perspective of macro and industrialist. ERPT will give a picture of international market power in a particular industry. A low level of pass through means a smooth flow in foreign trade and higher pass through can result a severe setback in balance of payment due to fluctuation in demand.

Exchange rate pass through is determined by a number of factors including openness of the economy. Import share on consumer goods, size of the economy (small open economies are always price takers), initial inflation level, exchange rate appreciation and depreciation etc. The exchange rate enters directly into the import price, producer price and domestic prices. Exchange rate fluctuation is transferred to domestic price levels through three main channels; (a) Prices of imported consumption goods channels fluctuation in exchange rate directly to domestic prices, (b)Prices of imported intermediate goods channels fluctuation in exchange rate towards domestically produced goods through production cost and (c). Prices of domestic goods priced in foreign currency are the third channel of transmission.

A higher import-GDP ratio is considered as a symbol of high level of pass through to import Prices. When aggregate consumption in total imports increase, it is expected that exchange rates and import prices will significantly explain domestic inflation. Furthermore, if second round pass-through occurs, then a change in import prices may lead to a change in consumer prices that is larger than that indicated by the import share of consumption. For example a positive shock to oil prices and therefore petrol prices may lead to higher wage claims if some wages are indexed to consumer prices, which in turn may feed back into higher domestic inflation. Second round pass-through is more likely to play a significant role when the Central Bank is too slow to respond to import price shocks to prevent inflation persistence [1].

Partial Pass-through reflects the fact that it is typically costly for firms to adjust prices and that they are generally unsure whether import price movements are going to be permanent or just cyclical. Firms therefore delay some or all of their price adjustment until they determine the duration of the shock- thus varying their margins through the cycle. A desire to maintain market share will also encourage firms to delay increasing their price in response to higher import prices until their competitors have committed to a similar price rise, again varying their margins [1].

In order to protect their profit margins, importers will change price of imported goods in domestic currency so that demand may not be affect large. In addition, exchange rates may not fully pass through to prices if Multi-National Companies are involved in internal (intra-firm) trade to dismiss the complete transfer of exchange rate changes to the selling prices in individual markets [2]. The extent to which exchange rate fluctuations are passed through in the general price level depends on the share of imports in the consumption basket. If depreciation results in higher prices for imported goods, demand for domestic goods that are substitutes for imported goods will increase. As demand rises domestic prices and nominal wages shows tendency to shift above original levels. Growing wages will put additional pressure on domestic prices to grow up [3].

Non proportionate change in price of imported goods expressed in domestic currency to the fluctuations in exchange rate where noticed in US market and initial studies where took place their [4,5]. There is enormous body of literature which has helped rationalizing the factors that affect the extent of ERPT into domestic prices. First, at the micro-level is the nature of the goods/industries under consideration. If exporters do not face much competition then such a situation will completely transfer exchange rate changes to the buyer's currency. However if buyers' market is highly competitive, sellers abroad may put their best to protect their market share by not completely transferring exchange rate changes by accepting lower profits. In case of entry and exit of foreign firms from the market exchange rate will be transmitted fully to the price of imported goods and partially in otherwise. Unexpected monetary expansion policies will cause a shoot up inflation and depreciation of the currency.

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How these changes will reflect in imported price is modeled. Expected changes and unexpected changes have different impact on import prices [6-9]. Second is the size of the exchange rate changes. If the size of change in exchange rate is very small foreign trader will show willingness to take lower profit and absorb the change [10-16]. Third is the direction of exchange rate changes. Direction means whether change in exchange rate is an appreciation or depreciation. For a same unit of appreciation and depreciation pass through would not be the same under the condition that other things being same [17-22],[3]. Forth is the duration of exchange rate changes. Duration means the time that impulses of an exchange rate change may persist in the domestic price. If the time is higher obviously pass through also will be high compared to a situation where the time is less. Fifth, the degree of ERPT into aggregate import prices may be affected by various macroeconomic variables. A recognized fact has been the usual decline in the extent of ERPT in many years since the late 1980s for industrial countries. The more stable is a country's monetary policy and the lower its inflation the lower will be the extent of ERPT [23-28].

Liberalisation policies in 1991 changed economic environment of India. India became friendlier to the foreign traders and encouraged more foreign trade. This resulted a boost to the Indian economy. Also this openness brought some external factors that affect our economy. During Asian crisis in 1997 and World debt crisis in 2008 impact on exchange rate were notable. Exchange rate pass-through became an important concern for India over this period. A continuous check on Exchange Rate Pass Through is more important for vulnerable and developing countries. India is a country which is so vulnerable with its inconsistent growth rate, unmanageable number of population, lack of sufficient infrastructure and investment, low per capita GDP and poor standard of living but with a large growth potential where policy makers and government has a lot to do. But it is noted that exclusive study on ERPT of India is not done much. This study explores the relationship between changes in exchange rate and domestic price levels in recent decades in India to check whether ERPT a case of India and to understand vulnerability of important macroeconomic variables to the fluctuations in exchange rate. The data used for the study is monthly data from 1993:M4 to 2015:M12. The data on WPI, IIP, M3 and exchange rate has been imported from Handbook of Indian Economy, Reserve Bank of India whereas data on international oil price (Dollar per barrel) has been collected from Index Mundi. The study proposes various time series econometric tools like Johansen co-integration, Vector error correction mechanism (VECM)," impulse response function" and" variance decomposition" in order to test the objectives empirically.

2. Empirical results

Empirical analysis is carried out to check the time series properties of the data and to check the presence of exchange rate pass-through in India. Descriptive statistics and Unit Root tests will explain the time series properties of the data and co-integration test, Granger causality test, Vector Error Correction model, Impulse Response function and Variance Decomposition function will explain the relationship between exchange rate and other macro-economic variables.

1. Descriptive statistics

The Table 1 shows the descriptive statistics for the variable exchange rate (exn), Oil Price (oil), forex reserves (frx), Money supply (m3), inflation (π) and output (y) over the period April 1993 and December 2015.

Table 1. Descriptive statistics

	Exn	oil	frx	m3	π	y
Mean	3.748969	3.595351	8.112936	9.794937	4.545893	4.542176
Median	3.795576	3.401210	8.199863	9.765379	4.526217	4.466809
Maximum	4.017335	4.816722	9.700908	11.33751	5.146209	5.167949
Minimum	3.435153	2.310227	5.777888	8.225166	3.925150	3.765262
Std. Dev.	0.152783	0.729099	1.180812	0.913215	0.320920	0.409690
Skewness	-0.718050	0.211884	-0.172589	0.036164	0.100943	0.079474
Kurtosis	2.624859	1.666646	1.653507	1.828455	2.073697	1.733481

Exn, oil, frx, m3, π and y represent exchange rate,Oil Price, forex reserves, money supply, inflation and output respectively.
Sample Period: 1993 April to 2015 April
Source: Authors' Calculation using data collected from Handbook of Indian Economy, Reserve Bank of India

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The Table 1 shows that none among the variables are symmetrically distributed and all variables are peaked more than Gaussian distribution (see skewness and kurtosis)

2. Unit root test

The order of integration of the variables was checked using ADF and Phillips Perron unit root tests and the results are presented in Table 2. The results confirm that variables under consideration contain unit root. As the variables follow the same order of integration, i.e., I (1), Johansen co-integration can be employed to examine the long run equilibrium relationship among the six variables under scrutiny.

Table 2. Unit root test

Variable	ADF	PP
exn	-1.25 (0.65)	-1.17 (0.69)
oil	-0.62 (0.86)	-0.83 (0.81)
frx	-1.17 (0.91)	-1.24(0.90)
m3	-0.55 (0.88)	-1.50(0.83)
π	-0.70(0.84)	-0.65(0.86)
y	-0.67 (0.85)	-0.71 (0.84)

*Figures in parenthesis are p- values. * and ** indicate significance at the 1% and 5% levels respectively*
Source: Authors' Calculation using data collected from Handbook of Indian Economy, Reserve Bank of India

3. Co-integration test

Table 3 and 4 indicate that trace test statistics as well as the maximum Eigen value test confirm the presence of one co-integrating vector at 5% significance level.

Table 3. Unrestricted co-integration rank test (Trace)

Null hypothesis	Eigen values	Trace statistics	5% critical value	Prob.
$\gamma = 0$	0.40	208.69*	103.85	0.00
$\gamma \leq 1$	0.14	86.16*	76.97	0.01
$\gamma \leq 2$	0.09	50.48	54.07	0.10
$\gamma \leq 3$	0.06	27.68	35.19	0.26
$\gamma \leq 4$	0.04	14.21	20.26	0.28
$\gamma \leq 5$	0.19	4.54	9.16	0.34

**and ** indicate significance at the 1% and 5% levels respectively.*
Source: Authors' Calculation using data collected from Handbook of Indian Economy, Reserve Bank of India

Table 4. Maximum eigen value

Null hypothesis	Eigen values	Trace statistics	5% critical value	Prob.
$\gamma = 0$	0.16	41.42*	40.08	0.00
$\gamma \leq 1$	0.14	35.67*	34.80	0.04
$\gamma \leq 2$	0.09	22.80	28.59	0.23
$\gamma \leq 3$	0.06	13.47	22.30	0.51
$\gamma \leq 4$	0.04	9.67	15.89	0.37
$\gamma \leq 5$	0.02	4.54	9.16	0.34

**and ** indicate significance at the 1% and 5% levels respectively*
Source: Authors' Calculation using data collected from Handbook of Indian Economy, Reserve Bank of India

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4. Vector error correction

Table 5 shows the normalized co-integrating vector and the "speed of adjustment" parameters. After normalizing the exchange rate, the co-integrating relationship suggest that oil and exchange rates exhibit a positive relationship, which means whenever an oil price hike occurs the absolute value of exchange rates increases i.e. the domestic currency depreciates. For a country like India which imports oil in large, this relationship is justifiable. See the relationship of foreign exchange reserves with exchange rate, it is negative which means whenever there is increase in foreign exchange reserves(more domestic currency is demanded by supplying foreign currency) there is an apparent appreciation of domestic currency(decrease in exchange rate). It is found a positive relationship for money supply i.e. in response to an increase in money supply there will be a corresponding increase in exchange rate (depreciation of currency). Regarding inflation also found a positive relationship. That means a depreciation of currency in response to increase in inflation. Relationship is negative for output and exchange rate. Increase in output will cause appreciation of currency.

From the error correction table, it is evident that only forex reserves and inflation are turned out to be significant and among these two the" speed of adjustment parameter" suggest that forex reserves correct the short run disequilibrium more quickly than other variables.

Table 5. The normalized co-integrating vector and the "speed of adjustment" parameters

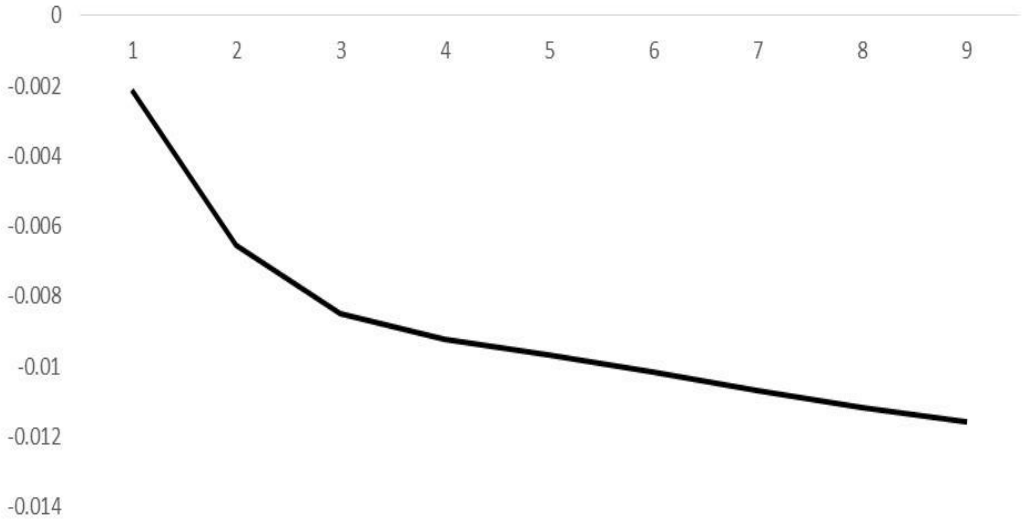
exn	oil	frx	m3	π	y
1	0.99 (3.05)	-1.26 (-2.94)	7.76 (5.25)	-3.48 (-4.39)	-5.07 (-2.93)
		Speed of adjustment parameters			
0.00 (1.64)	-0.01 (-0.13)	-0.11(-3.22)	-0.00 (-1.14)	0.02(3.98)	-0.00 (-0.28)

Figures in parenthesis are t-statistics. exn, oil, frx, m3, π and y represent exchange rate,Oil Price, forex reserves, money supply, inflation and output respectively.
Source: Authors' Calculation using data collected from Handbook of Indian Economy, Reserve Bank of India

5. Impulse response function

Figure 1 captures the response of forex reserves to one standard deviation shock in exchange rate. From the figure it is evident that shocks in exchange rates may cause huge dip in forex reserves. And the trend persists even after three quarters. This shows that exchange rates act as a key determinant of foreign exchange reserves.

Figure 1. Response of forex reserves to one standard deviation shock in exchange rate



Source: Authors' calculation using data from Handbook of Indian Economy, Reserve bank of India

As per Figure 2, the money supply does not respond to exchange rate much. Apparently, only after the first quarter, a small dip is visible otherwise the money supply stays in the positive value. In digesting language we could say at least in Indian context, exchange rate does not have an important role in determination of money supply.

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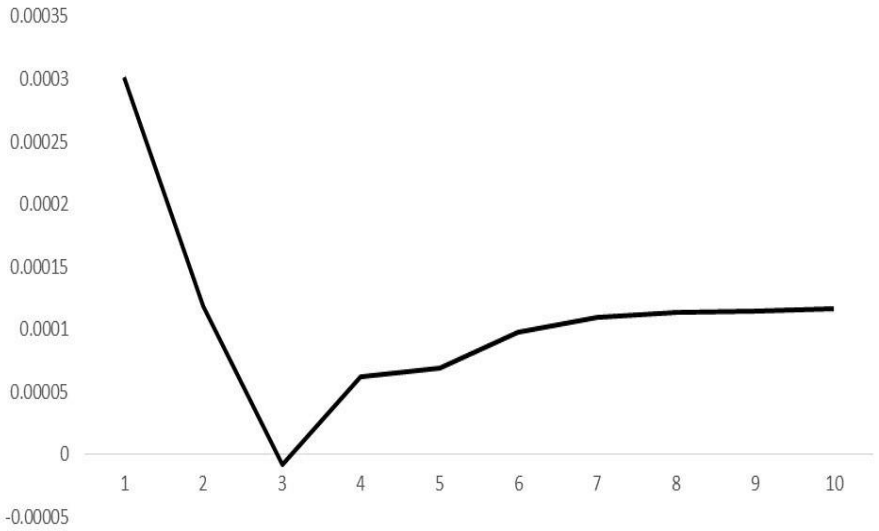
Figure 2. Response of money supply to one standard deviation shock in exchange rate



Source: Authors' Calculation using data from Handbook of Indian Economy, Reserve bank of India

Figure 3 captures the response of inflation. From the figure it is evident that a shock in exchange rates immediately pushes inflation on to the positive region and remains there at least for one quarter before it reverts back to the negative region. This reiterates the empirical results obtained from the VECM analysis that the price exchange rate nexus is found to be strong in the Indian. Figure 4 shows that forex reserves are in fact greatly affected by the oil price (supply shocks). A shock to the oil price have visibly negative ramifications on the forex reserves, it pulls down the forex reserves even before one quarter and the effect seems to be persisting over a long time period. Figure 1 captures the response of forex reserves to one standard deviation shock in exchange rate. From the figure it is evident that shocks in exchange rates may cause huge dip in forex reserves. And the trend persists even after three quarters. This shows that exchange rates act as a key determinant of foreign exchange reserves Figure 2. It is money supply does not respond to exchange rate much. Apparently only after the first quarter a small dip is visible otherwise the money supply remains in the positive region. This shows that exchange rate is not a key determinant in the determination of money supply in the Indian context.

Figure 3. Response of inflation to one standard deviation shock in exchange rate

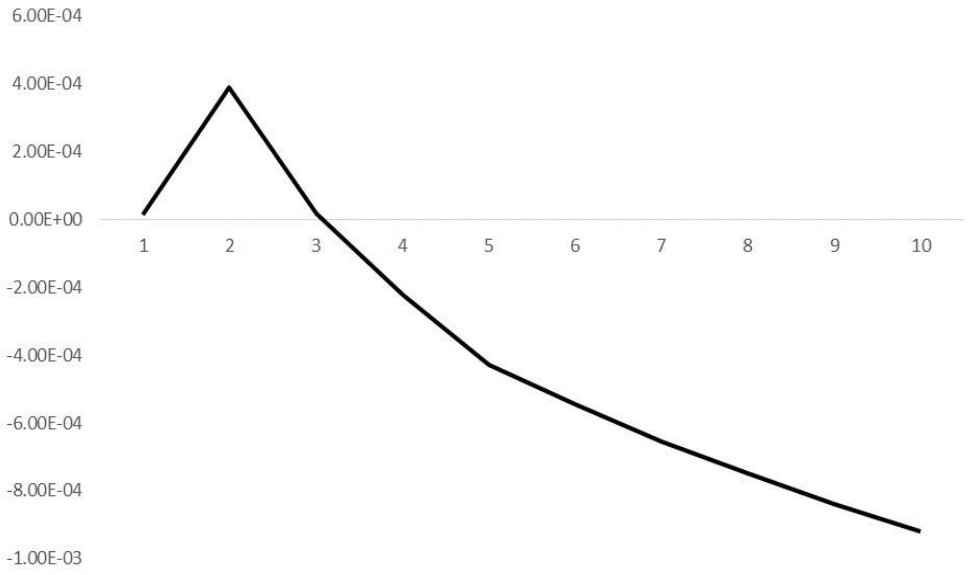


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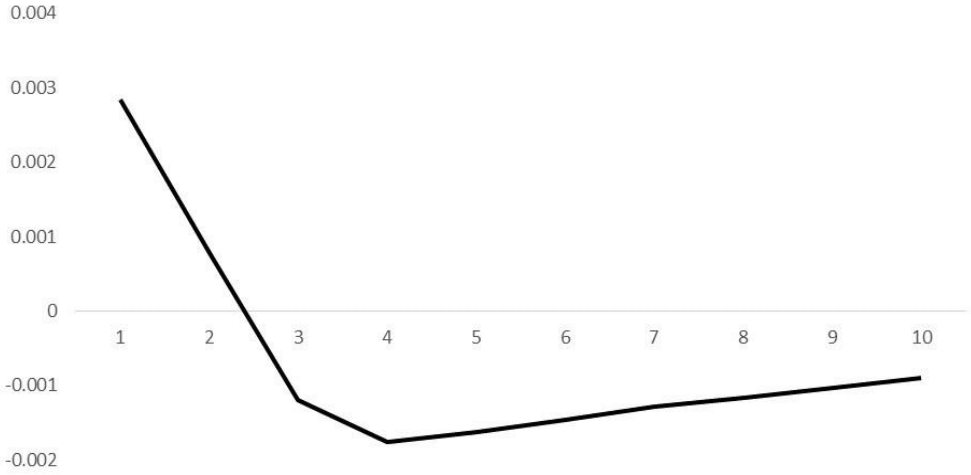
Figure 4. Response of forex to one standard deviation shock in oil price



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6. Variance decomposition

Table 6 provides information regarding the “forecast error variance” of exchange rate. Apparently, the “forecast error variance” of exchange rates has largely been explained by three variables namely oil price, forex reserves and prices. This makes sense as India is one of the major oil importing countries.

Table 6. Variance decomposition of exchange rate

Period	S.E.	exn	oil	frx	m3	π	y
1	0.0	100.00	0.00	0.00	0.00	0.00	0.00
5	0.04	85.84	3.28	5.42	0.10	4.20	1.16
10	0.06	60.09	10.28	10.79	0.11	7.66	1.05
15	0.08	60.46	15.28	13.59	0.13	9.58	0.92

S.E., exn, oil, frx, m3, π and y represent Standard Error, exchange rate, Oil Price, forex reserves, money supply, inflation and output respectively

Source: Authors’ Calculation using data collected from Handbook of Indian Economy, Reserve Bank of India

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Variance decomposition of forex reserves given in Table 7 reveals that, exchange rates and prices play crucial role in explaining the forecast error variance of forex reserves. This is in line with the established empirical literature that apart from exchange rates, domestic inflation can also act as a determining factor regarding forex inflows.

Table 7. Variance decomposition of forex reserves

Period	S.E.	exn	oil	frx	m3	π	y
1	0.02	0.87	1.40	97.72	0.00	0.00	0.00
5	0.07	11.42	0.34	80.22	1.83	0.98	5.20
10	0.01	13.74	0.20	65.33	2.91	10.24	7.61
15	0.14	15.86	0.12	55.47	3.48	14.85	9.20

S.E., exn, oil, frx, m3, π and y represent Standard Error, exchange rate, Oil Price, forex reserves, money supply, inflation and output respectively
Source: Authors' Calculation using data collected from Handbook of Indian Economy, Reserve Bank of India

Variance decomposition of inflation (Table 8) gives us the crucial information that it is the oil prices that explain the maximum "forecast error variance" of prices, which means that it is the supply side shocks that mostly determine inflation in the Indian context.

Table 8. Variance decomposition of Inflation

Period	S.E.	exn	oil	frx	m3	π	y
1	0.01	0.00	1.50	0.54	0.55	97.40	0.00
5	0.01	0.18	16.35	0.99	0.56	80.69	1.21
10	0.02	0.85	22.66	1.05	1.36	70.55	3.52
15	0.02	1.82	27.14	1.11	2.27	61.60	6.22

S.E., exn, oil, frx, m3, π and y represent Standard Error, exchange rate, Oil Price, forex reserves, money supply, inflation and output respectively
Source: Authors' Calculation using data collected from Handbook of Indian Economy, Reserve Bank of India

3. Summary and Conclusions

The study examines the extent of exchange rate pass-through in India in order to gauge the country's vulnerability to external shocks. From the co-integration analysis a long- run relationship between the variables under consideration are found. Further from the error correction table it has been noticed that all the variables are "mean reverting" and the "speed of adjustment parameter" reveals that forex reserves and prices are likely to be correcting the error more quickly. Further, by utilizing the "impulse response function" it has been observed that a shock to exchange rate pulls down forex reserves drastically whereas it pushes prices on to the positive region. However, money supply did not respond to the changes in exchange rate much. In addition from the impulse response analysis it is notice that shocks in crude oil prices reduces the foreign exchange reserves substantially. Further, the "variance decomposition" analysis advocates that the forecast error variance of exchange rate has largely been explained by oil and forex reserves and prices in the later quarters, from this it is evident that financial sector variables are not in fact fully insulated from the supply side shocks.

The forecast error variance of forex reserves is mostly explained by exchange rate and prices, this finding corroborates the earlier empirical evidence obtained from the ECM analysis. However, the "variance decomposition" of prices reveals that its forecast error variance is by and large explained by oil prices, which shows that prices are indeed more vulnerable to the supply side shocks. After conducting a thorough empirical examination, it has been found that Exchange Rate Pass-through is serious concern for India. The fluctuations in exchange rate do have some impact on some of the important macroeconomic variables such as forex reserves and price levels.

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Therefore it requires a serious attention of macroeconomic experts and monetary authority of India to redesign exchange rate management policy such a way that monetary instruments of monetary policy will do its best without getting neutralized by inflation and changes in foreign exchange reserves.

4. Acknowledgment

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