REVIEW OF RESEARCH
IMPACT FACTOR : 5.7631(UIF) UGC APPROVED JOURNAL NO. 48514 ISSN: 2249-894X
VOLUME - 8 | ISSUE - 3 | DECEMBER - 2018

EXCHANGE RATE PASS THROUGH IN INDIA

Dr. Hiranya Lahiri
Assistant Professor , M.U.C. Women's College, Burdwan.

ABSTRACT

Exchange Rate Pass Through (ERPT) in India is a crucial aspect in determining growth and inflation of the nation. In a globalised era, where India is deeply integrated in to the world economy, exchange rate affects inflation through various channels. This paper uses Johanson's Co-integration Analysis to gauge the impact of exchange rate on domestic price level, by controlling for GDP, food inflation, oil price and interest rate. The study finds that though in the short-run there is considerable price stickiness, in the long run, the price level adjusts by almost 74%.

JEL Classification: C22, E00, F41

KEYWORDS: *Exchange rate, Inflation, Cointegration, Error Correction Model.*

1. INTRODUCTION

Exchange rate pass through connotes the effect of exchange rate on price of goods. That is, exchange rate-pass through measures how much impact an increase in exchange rate has on the price level. Different studies target different price indices to capture the effect of change in exchange rate on price level. While some studies examine the impact of exchange rate on Consumer Price Index (CPI), others look at the effect on import prices or producer price.

The objective of this paper is to estimate the degree of pass-through in the Indian economy particularly in the long-run, and also in the short-run. Growth in the Indian economy is highly conditional on the developments in the world market. In recent times, post globalization, the foreign macroeconomic variables have assumed a character of immense importance in determining India's growth and inflation. If one delves into the data, one would discern that India posted high growth figures in those years when exchange rate (hence inflation) fared well, that is rupees per unit of dollar was low. Clearly, low exchange rate had a favourable impact on growth and inflation (see Lahiri et.al. (2015, 2016) for details).

The link through which this occurs is the investment, trade and capital flow channels. Let us elaborate. First, India's major driver of growth has been investment, which is highly dependent on import of oil, capital and intermediate good, and thus, the exchange rate. An improvement in exchange rate (fall in R/$ rate) reduces cost of import, thereby raising profitability of investment (given expectations) and raises the net-worth and reduces their external-finance premium of the firms. Further debt of firms (that has to be serviced in terms of domestic goods) also affects investment. A rise in exchange rate increases value of debt in domestic currency, derogatorily affecting investment. Thus, low exchange is conducive to high growth. Secondly, India's exports are highly import-intensive, and thus, a rise in exchange rate does not lead to much improvement in the net-export of the country. Finally, a rise in exchange rate feeds into the domestic price

level (though imperfectly) and reduces real value of money holding, leading to demand-compression. All these factors elaborate how a rise in exchange adversely affects India's growth.

Since, a rise in exchange rate increases cost of production of firms; price level in the economy is expected to rise. This happens primarily through two channels: investment (and production) and trade. As mentioned before, a rise in exchange rate raises cost of investment, a part of this increase feeds into the final-product price. Thus, a similar movement in exchange rate and domestic price (in this paper, we use Consumer Price Index of Industrial Workers as the index of domestic price) is expected. It alludes to the phenomenon of a long-run stable relation between the two variables, and this is the area of focus of this present paper.

Against this backdrop, it has become extremely important to empirically gauge the magnitude of pass through of exchange rate in domestic prices. Though some earlier estimates are available in the Indian context (which are few in number), they are fraught will some limitations. Particularly, the sample period in these studies is a bit old. They mainly focus on the time prior to 2000 decade. In fact, the objective of the erstwhile studies is to compare the Indian experience pre and post liberalization, excluding observations from recent years, particularly during and after the Great Recession years. Secondly, these studies are parsimonious in nature. The present endeavour tries to remove these limitations and thus, it includes the years of the recent Great-Recession, which the earlier studies do not include in their ambit. Moreover, this paper brings in factors like oil price, call-money rate and trade-openness index as control variables, which are very crucial in determining India's inflation, and the earlier studies have neglected them. The rest of the paper is arranged as follows. In the next section, we provide a brief literature survey. Section 3 delves into data and methodology to examine the extent of pass-through. Section 4 concludes the paper.

2. BRIEF LITERATURE SURVEY

Studies relating to India are few in number. Ghosh and Rajan (2007) estimates ERPT to CPI inflation in India during Q1 1980 to Q2 2005 using a cointegration approach. Their estimate hovers around a long-run elasticity of 40% and short-run elasticity of 10% (in case of real exchange rate), and further, a rise in ERPT post liberalization. An oft-cited research in this area is that of Khundrakpam (2007) that endeavours to gauge the asymmetric impact of exchange rate depreciation and appreciation on inflation (Wholesale Price Index). For this purpose, the author uses interaction-dummy variables in a VAR framework. Bhattacharya et.al. (2008) though considers oil price as a control variable in their study, fails to include the effect of food inflation as a control variable. Their sample ranges from 1997 to 2007 and once again, does not cover recent time periods.

Thus, it is clear that recent study in the area of exchange rate pass through is absent. The incumbent studies focus on the earlier time periods, and neglect the phases of unprecedented high growth years of Indian economy and also the stagflationary years of Indian economy (post 2011), where the exchange rate played a very big role in the real sector. Moreover, choice of exogenous variables is also biased. Therefore, it is imperative to execute research in this area. The next section attempts so, by addressing the lacunae of the erstwhile endeavours.

3. DATA AND METHODOLOGY

As already pointed out Section 1, exchange rate pass-through depends on a host of factors. Imported inflation adds to domestic inflation through two channels. First, when the commodity imported is used as final goods, a rise in the exchange rate leads to a direct rise in price level (with unchanged mark-up by domestic sellers), as domestic sellers pass it on to the final good. Secondly, imported goods are also used as intermediate goods in production of domestic good; and this link is very strong for India (RBI 2012). A rise is in exchange rate leads to a rise in cost of imports of intermediate goods, and is passed on to the price of the final good. Now, if one wants to empirically measure the extent of exchange rate pass-through to CPI (Consumer Price Index), one would usually regresses (as evidenced from existing litereature) Log CPI on Log Real Exchange Rate (with Log Foreign Price as another regressor). However, there are to caveats that must

be noted. First, in such a regression procedure, other factors are also to be controlled for, as they too contribute to CPI. Some of these factors are GDP and food inflation. Food inflation must be brought in as an important factor in determination of CPI in India, as agriculture is still heavily dependent on rain, despite seventy years of independence. Agriculture has a constant 15-17% share in India's GDP and can be treated as an exogenous variable in the regression equation, as it is highly dependent on rainfall, pests and other exogenous factors. Disruption in supply of agricultural products, which are caused by rain, has severe effect on CPI inflation in India. Using a log-linear form, the coefficient of Log Real Exchange Rate would give us the estimate of pass-through, which is also the exchange rate elasticity of Consumer Price Index. The second caveat is that, foreign price level is already encompassed in the calculation of REER. Thus, is it is best be avoided in regression exercise. Literature often neglects this aspect, and thus the regression results are often tailor-made. Let us elaborate. From the definition of real exchange rate we have, $e = \frac{EP^*}{P}$, where e and E are real and nominal exchange rates respectively and P and P^* are domestic and foreign price respectively. Thus, P* is already encompassed in the calculation of e (REER). If one delves into other related studies, one would find that many of the studies derives the measure on P^* by using the above-mentioned formula and then uses the same series on e, P and P* to calculate ERPT. This seems to be a biased method for arriving at estimates for ERPT. On the contrary, if at all P* has to be included, the correct method would be to prepare an index by weighing the shares of import from the importing partners (at least the major!) and multiplying them with the PPI of the importing partners and aggregating over all importing partners. However, though theoretically plausible, practically it is a next to impossible task, due to non-availability of data from countries like China (India's largest import partner) UAE and Saudi-Arabia, who are India's other major import partners. Rajan and Ghosh (2007) uses US PPI as measure of foreign price for India, which is highly correlated to foreign price data calculated using the circular method outlined above. However, for the purpose of the present endeavour, we neglect the element on P* in regression to avoid inference emanating from a tailor-made regression and also avoid the problem of multi-collinearity.

Apart from GDP and food inflation, it is important to note the inclusion of other variables like trade-openness index, oil price and call-money rate to include as *exogenous* variables in the regression equation. Let us explain. Trade openness index (ToI) is usually defined as the ratio of the sum of export and import to GDP. Higher the ratio, higher is the degree of integration of the domestic economy with the world economy, and thus a country is expected to show a greater magnitude of pass through. This is because; higher integration with the world economy will produce greater disruption in domestic price through the exchange rate channel. But, this variable should be considered an exogenous variable for the present study. This is because; India's current account balance is determined by the capital account balance. It is the movement of capital flows (primarily FPI and FDI) that determines the exchange rate, which in turn affects the current account. Interest rate differential, tax rates, fiscal deficit are the major determinants of credit rating of the nation, which affects volatile capital inflows that in turn impacts the exchange rate favourably or adversely (see Lahiri et.al (2015, 2016)) for a detailed analysis). Thus, log ToI is used as an exogenous variable in the regression exercise.

Oil price is yet another factor that has to be incorporated as an exogenous variable. India is crucially dependant on oil imports for its domestic production and investment. Oil enters as an imported intermediate input in production process. In fact, oil price severely affects domestic price. Whenever there is an oil shock, domestic CPI shoots up. This is because oil component in domestic production (GDP) is very high. India's oil import is highly price inelastic (0.1 as per RBI (2012) estimate). This is due to the fact that substitution possibility for oil is very poor in India even in the long run. Moreover, oil is one of the major imported items. However, India is a small player in the world oil market, and cannot impact international oil price significantly. Thus, oil price should be included as an important regressor (exogenous) in the estimation of exchange rate pass through.

Lastly, India embarks interest rate targeting through the operation LAF and MSF. This aims at keeping the call money rate within a corridor. Whenever inflation breaches the comfortable limit, RBI

intervenes in the interest rate corridor to affect the interest rate (used synonymously with call-money rate) by changing the MSF, Repo and Reverse Repo rates, which in turn limits the call-money rate within this corridor. Inflation thereafter responds to interest rate with some lags. Hence, call-money rate should also be used as an exogenous variable in the estimation procedure.

As is standard in Time-Series Econometrics literature, the first stage in such an empirical estimation starts with identifying whether the series are stationary or not. We consider the following variables: CPI (IW), 36-country Trade-Weighted Real Effective Exchange Rate, India's GDP, Food Price, Oil Price, Call-Money rate, Trade-GDP Ratio (synonymous with Trade Openness Index). We consider these variables in their logarithmic forms. The sample under study involves quarterly data ranging from Q1 1996 to Q1 2014, a total for 73 samples. The source of all these series, is Data Book on Indian Economy (DBIE) published by RBI, barring oil price whose source is EIA. Since two separate series for GDP data are published by RBI; the old series up to Q4 2010 (at 1999-00 prices) and the new series from Q1 2004-05 onwards (at 2004-05 prices), the two series have been matched and scaled accordingly to make them comparable at 1999-00 prices (old series). The same procedure has adopted for four other series- CPI, Food Inflation, Export and Import (and hence ToI).
The tests of stationarity are done using ADF and PP test, where, in both the cases the null hypothesis is that the variable has a unit-root, versus the alternate hypothesis that the variable does not have any unit-root. In case of any discrepancy in the conclusions by the two tests, KPSS test is done as a confirmatory test, whose null hypothesis that of staionarity versus the alternate hypothesis of non-stationarity. Barring Log Call Money Rate and Log of Trade Openness Index (ratio of the sum of export and import to GDP), all variables are found to be I(1), while the latter two series are stationary or I(0) variables.

3.1 Cointegration and VECM

We shall consider two alternate models that can plumb the magnitude of ERPT. The first is in line with Pyne (2008) and the second being a modified and refined regression over the first. As pointed out in equation 1, ERPT depends primarily on REER, foreign price, GDP and food inflation, controlling for factors like trade-openness, oil price and call money rate. In order to accomplish the task of quantifying the degree of ERPT, we must be sure about the existence of a long-run stable relation among these variables. Engel-Granger's methodology outlines a two-step procedure, which however, is fraught with limitations. We thus, follow Johanson's Cointegration test. The first stage of this test is to check for the number of cointegrating vectors. Trace test and Eigen-value tests are used to determine the optimal number. Since the latter is stronger than the former, we use results obtained from Eigen-value test to decide the rank of the cointegrating matrix or the number of cointegrating vectors. If the number of cointegrating vectors is greater than zero but lower than the total number of variables, then a long-run relation exists among the variables, which can be captured in level form of the variables. The long-run relation is given by the cointegration equation. What is to be noted is that, there also exists a short-run relation captured by Vector Error Correction Model, given by variables in their first difference and error-correction term.

We now proceed to empirically estimate the extent of ERPT. Consider the baseline model (say Model 1) which is given by equation 1:

$$LogCPI = Const + \alpha(Log\ REER) + \beta(Log\ GDP) + \gamma(\ Log\ Food\ Price\ Inflation) + lags\ of\ these\ variables + controlling\ for\ Log\ ToI, Log\ Oil\ Price\ and\ Log\ Call\ money \quad (1)$$

The coefficient of α measures the extent of pass-through in equation (1). Johanson's co-integration test reveals that there is one cointegrating relation (by Eigen-value test as well as by Trace test at 5% level of significance) among these

Thus, we can be sure of the existence of at least one long-run stable relation among these variables. The estimated coefficients of the equation are given in Table 1[1]:

Table 1: Estimates of Coefficients of regression Equation (1)

Parameter	α	β	γ
Estimates	0.4073[2]	0.3138[2]	0.5903[2]

All the variables are significant at 1% level of significance. Thus, we may discern that ERPT to CPI is to the tune of 0.41. This is the long-run estimate. That is, in the long-run, when exchange rate depreciates by 1%, CPI rises by 0.41%. Vector Error Correction Model gives us a stable relationship among these variables in the short-run (in first difference), where variables are given in their first difference (I(0), and hence, stationary) and an error correction term (which is also stationary). Using this baseline model, we see that the short-run pass-through is estimated to be -0.037. That is, a one percent increase in the exchange rate leads to 0.037% percentage increase in CPI (the negative sign implies that a shock on exchange rate is temporary in nature). However, the estimate turns out to be insignificant, even at 10% level of significance. Thus, we may conclude that ERPT in the short-run is not statistically significant, and there is considerable price-rigidity in the Indian economy.

Hence, we see that there is in complete pass-through to CPI both in the short-run and in the long-run, with considerable price-stickiness in the short-run, and the extent of price stickiness falls from the short-run to long-run.

One important caveat of our baseline model is that it contains Log of trade openness index as an explanatory variable. This series is highly correlated to Log GDP and Log of Oil price. Hence, our baseline model suffers from the problem of multicollinearity. Let us explain. Over time as a nation's GDP rises, it gets more involved in international trade and finance flows. In fact, a larger country exhibits larger trade-GDP ratio. Moreover, for India, Trade openness index and oil price are also highly correlated. This is primarily due to the dependence of the country on oil import. India's imports are highly oil intensive and further, oil inelastic. India's exports too, are oil intensive. Hence, a degree of high correlation exists between oil price and trade-openness index. Since, oil enters the domestic production system directly in the form an intermediate good, it is prudent to exclude Log ToI from the regression exercise (Log of ToI shows more than 95% correlation with Log GDP and Log Oil Price). Thus, we consider another regression equation, where we keep Log Oil price as an exogenous factor, along with call-money and estimate the following regression and exclude ToI:

$$LogCPI = Const + \alpha(Log\ REER) + \beta(Log\ GDP) + \gamma(\ Log\ Food\ Price\ Inflation) + lags\ of\ these\ variables + controlling\ for\ Log\ Oil\ Price\ and\ Log\ Call\ money \qquad (2)$$

Trace test and Eigen Value test once again indicate at the presence of only one cointegrating vector. The estimates are shown in Table 2. Thus, once again we discern that all the estimates are significant at 1% level of significance. ERPT now rises to 0.744. That is, a one percent depreciation of the exchange rate leads to 0.744% rise in the CPI. This is undoubtedly, quite a high degree of pass through that point to the inglorious dependence of the domestic economy on international economy. The VECM result suggests that in the short-run, the pass-through is to the tune of 0.0958, but insignificant even at 10% level of significance. This once again alludes to short-run rigidity of domestic price.

The estimated coefficients are given in the table below:

[1] The complete regression table are available with the author on request.
[2] All estimates are significant at 1% level of significance.

Table 2: Estimates of Coefficients of regression Equation (2)

Parameter	α	β	γ
Estimates	0.7440[3]	0.2640[3]	0.6613[3]

Hence one can conclude that ERPT in India is as high as 74% in the long run. However, pass through in the short-run is limited. This might be an outcome of oligopolistic interdependence among firms that severely limits domestic price adjustment due to change in import costs. However, with the passage of time, adjustments follow in. Though the adjustment is incomplete (that is exchange rate pass through is less than one), it is undoubtedly quite high by Indian parlance. Hence, needless to say, one cost of globalization of the Indian economy has been exposure to inflation risks originating from world economy. The issue of price stability as envisaged by the RBI becomes more daunting in nature due to this exposure.

4. CONCLUSION

This paper brings in various dimensions to the measurement of exchange rate pass through in India, something, which was not considered by the earlier studies. The study estimates that ERPT is quite high for India, almost three-fourth. Further, since VECM estimates turn out to be insignificant, it suggests that there is considerable price-stickiness in the economy. However, when producers adjust in the long run, they internalize almost 74% of the exchange rate rise in its product price. Under this scenario, price management has become all the more challenging due to volatile exchange rate movement. The government has therefore, a daunting task at hand to ensure growth by arresting the eroding of real-wealth in the economy, triggered by exchange rate rise. Needless to say, a decline in the exchange will have a growth-inducing effect on the Indian economy.

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Dr. Hiranya Lahiri
Assistant Professor , M.U.C. Women's College, Burdwan.

[3] All estimates are significant at 1% level of significance.