Transmission of Real Exchange Rate Changes to The Manufacturing Sector Performance –Evidence From an Emerging Market.

Abstract

We explore the impact of Real Exchange Rate changes on the performance of Indian manufacturing firms over the period 2000-2012. Our empirical analysis shows that real exchange rate movements have a significant impact on Indian firms' performance through the import cost channel but not the export competitiveness channel. The impact depends upon the degree of market power as reflected in the industry specific Herfindahl index. Further, appreciation and depreciation affect firms' performance differently. Overall, our results point towards the need for an effective reserve management policy to deal with sudden movements in exchange rate in the short run while maintaining a competitive exchange rate in the long run.

JEL Classifications: F1, F4

Keywords*: Real Exchange Rate*, *Manufacturing Performance*, *Mark up*

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I. Introduction

International economics has long been concerned with the effects of exchange rate movements on the real economy. The topic continues to attract theoretical as well as empirical researchers alike. This paper contributes to the large body of empirical literature looking at the impact real exchange rate movements on firm level performance by using a newly compiled dataset of around 250 Indian manufacturing firms.

Exchange rate movements can affect firm performance through a number of channels, such as the cost of imported inputs relative to other factors of production, price of exports relative to foreign competitors or the cost of external borrowing. Although the impact on firm performance is only one component determining how exchange rate changes affect aggregate economic growth, it can be an important and significant determinant of the same. An important advantage of using firm level panel data is that it allows us to control for unobservable firm level effects while studying the impact of real exchange rate changes. These individual idiosyncrasies reflect important characteristics of a firm, which are likely to influence its response to exchange rate movements. Our empirical model uses time varying industry and firm characteristics to capture heterogeneity in response to exchange rate changes.

The main finding of this paper is that real exchange rate changes affect firm level performance through the import cost channel but not the export competitiveness channel, in the short run. The impact is more pronounced in industries with smaller market power. Further, appreciation and depreciation have asymmetric effect on firms' growth with the import cost channel being relatively weaker during episodes of real appreciation as compared to the episodes of real depreciation. These results hold true for alternative measures of firm performance such as output growth and sales growth. Results from Panel Vector Auto-Regression reinforce these findings. Import share declines in response to a real exchange rate shock along with output. At the same time output responds positively to an increase in import share while showing little or no change in response to an export share shock. From policy makers perspective these findings have important implications. The fact that the import cost channel is dominant in the short run indicates that episodes of real depreciation are likely to result in a contraction in the real output growth at least in the short run indicating the need for an effective reserve management policy by the central bank that enables it to deal effectively with episodes of sudden downturns in the value of Rupee. At the same time, specific measures to assist sectors that are more heavily dependent on imported inputs could relieve some of the immediate pressure on output growth due to real depreciation. This, however, does not take away from the need to have a competitive real exchange rate and sound macroeconomic policies for encouraging robust economic growth and maintaining internal and external balance in the long run.

India presents a unique case for studying the impact of exchange rate movements. Prior to the Balance of Payments crisis in 1991, Indian Rupee was pegged to a basket of currencies dominated by the US Dollar. The external payment crisis of 1991 forced the Reserve Bank of

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India (RBI) to implement a set of market oriented financial sector reforms and a paradigm shift from fixed to market-based exchange rate regime in March 1993.[1] Institution of Current Account convertibility in August 1994 and gradual liberalization of Capital Account along with other trade and financial liberalization measures meant a rise in total turnover in the foreign exchange market by more than 150% from USD 73.2 billion in 1996 to USD 130 billion in 2002-03 and further to USD 1100 billion in 2011-12[2]. A direct outcome of these changes has been a rise in the volatility of Indian Rupee. Figure 1 plots average annual volatility of monthly Rupee-USD log returns to illustrate this point.

In this backdrop, RBI's exchange rate management policy has aimed at maintaining orderly conditions in the foreign exchange market by eliminating lumpy demand and supply and preventing speculative attacks, without setting a specific exchange rate target. RBI has used a combination of tools including sales and purchase of currency in both the spot and the forward segments of the foreign exchange market, adjustment of domestic liquidity through the use of Bank Rate, CRR, Repo rate etc. and monetary sterilization through specialized instruments, towards this end[3]. An interesting feature of RBI's intervention during this period has been asymmetry during episodes of appreciation and depreciation.

Figure 2 plots Net Sales of Foreign Exchange Assets by RBI as a percentage of total turn-over in the foreign exchange market[4] along with monthly log returns on Rupee – USD exchange rate[5]. One can see that RBI has been intervening actively in the foreign exchange market during episodes of Rupee appreciation by purchasing foreign exchange while following a hands-off approach during episodes of Rupee depreciation (This has clearly been the case at least until 2009.). Underlying this asymmetry has been the notion that an appreciated Rupee would hurt exporters through a loss in cost competitiveness and by corollary, adversely affect India's growth performance. Empirical evidence on the impact of exchange rate on the performance of Indian firms is however non-existent[6]. Present paper tries to fill this important gap in the literature. The key findings of this paper suggest that, at least in the short run, it is the import cost channel that dominates the transmission of a real exchange rate change rather than the export competitiveness channel.

[1] See the Special edition of RBI's *Reports on Currency and Finance*, Vol. III (2005-06) for detailed discussion on the evolution of India's foreign exchange market. (Link: http://rbidocs.rbi.org.in/rdocs/content/PDFs/89704.pdf) See Sengupta and Sengupta (2012) for a discussion on India's Capital Account Management between 1990-2011.

[2] Table A in Appendix presents the growth in the size of foreign exchange market in India over time.

[3] For instance, RBI resorted to a net purchase of 5.4 billion USD between April-August 1997 to reduce the acute upward pressure on Rupee resulting from buoyant capital inflows and sluggish import demand. Then, as Rupee weakened in the last week of August, partly in response to the East Asian financial crisis, RBI sold foreign exchange worth 978 million USD to strengthen the Rupee. Again, a surge in capital inflows starting 2004 forced RBI to purchase foreign exchange in order to ward off the upward pressure on Rupee. This time around RBI's intervention was sterilized using *Market Stabilization Scheme* bonds issued specifically for this purpose.

[4] Negative net sales implies net purchase of foreign exchange by RBI

[5] Positive return implies appreciation of Rupee.

[6] Recent paper by Rajeswari Sengupta (2012) being the only exception. However their focus is exports performance of the firms.

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The paper is organized as follows – Section 2 provides a brief review of the literature. Section 3 describes the dataset in detail. Section 4 presents the single equation GMM results while section 5 presents Panel VAR analysis. Section 6 concludes.

II. Literature Review

The question of real exchange rate devaluations and its impact on open economies is an old one. In the standard Keynesian framework, devaluation boosts income and output through its impact on aggregate demand. At the same time supply side factors suggest that by increasing the cost of imported inputs, exchange rate devaluations can cause a reduction in output. A vast body of research has made its way in to the literature under the subject heading of *contractionary devaluation*. Countries such as Mexico, where real depreciations were consistently coupled with output contractions, and where real appreciations were associated with output expansions, have become conventional examples of the contractionary devaluation problem.

In an attempt to assess the effects of devaluation on output, the literature has taken four different routes. The first is a factual method that compares output performance before with that after the currency devaluation and is commonly known as the 'before-after' approach. Diaz-Alejandro (1965), Cooper (1971), Krueger (1978) are some early examples of this strand of literature. Most papers in this literature do not find a significant recessionary impact of devaluations. One of the problems of this approach is that it does not take in to account problems of simultaneity and endogeneity.

The second approach, known as the *control-group* approach, compares before-after output performance in devaluing countries with output performance in a set of non-devaluing countries (the control group) during the same time span. Assuming that all devaluing and control group countries face the same exogenous external factors, the difference in the output performance of these two groups should only reflect the effect of devaluations. Donovan (1981, 1982), Kamin (1988) and Edwards (1989 a, b) are some examples of this approach. While finding some evidence of an improvement in external balance, this set of papers does not find clear evidence of *contractionary devaluation*. Control group approach suffers from the problem of selection bias. Countries in the *treatment group* (non-control group) are likely to have a rather poor economic performance before the devaluation as compared to those in control group. The control group approach will exaggerate the positive impact of a program/devaluation when past poor economic performance indicates an improvement of the current conditions. The opposite will be true if past poor performance indicates subsequent deterioration.

The third set of empirical studies which is more recent uses time series and panel data techniques to capture the relationship between exchange rate and economic performance. Rogers and Wang (1995), Santaella and Vela (1996), Copelman and Werner (1996), Kamin & Rogers (1997, 2000), Bahmani & Miteza (2006) are examples of this strand of literature. Most of these studies use country level data unlike this paper which uses firm level data. Problem with aggregate data is that it hides sector specific movements in response to exchange rate changes. By using Panel VAR on firm level data, this paper significantly adds to the existing studies in this set.

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Finally, the macro-simulation methodology relies on simulations of economic models to infer the theoretical performance of output after a hypothetical devaluation takes place. Diaz-Alejandro (1963), Krugman and Taylor (1978), Barbone and Rivera-Batiz (1987) are the seminal contributions in this strand of literature. While early studies in this group focus on the demand side , studies such as Bruno (1979), Gylfason and Schrnid (1983), van Wijnbergen (1986), Buffie (1986) Agenor (1991), Gylfason and Radetzki (1991), Taye (1999) look at the supply side too. Buffie (1986), for example, shows that when investment is treated as a composite good produced by combining imported and domestic inputs Marshe-Lerner condition is no longer sufficient for an expansionary devaluation outcome.

This paper is also related to a large body of microeconomic literature looking at the impact of exchange rate fluctuations on firm level performance. A section of this literature looks at the impact of exchange rate changes on firm's value measured by its stock returns. Examples of this literature include Adler and Dumas (1984), Jorion (1990), Bodnar and Wong (2000), Dominguez and Tesar (2006), Parsley and Popper (2006).

Another strand of the same literature looks at the issue of pricing policies in response to currency fluctuations (for e.g. Goldeberg and Knetter (1997)). Finally a small section of this literature looks at the impact of currency fluctuations on firm level variables such as investment or employment (e.g. Goldberg (1993), Campa and Goldberg (1995, 1999), Nucci and Pozzollo (2001), Demir (2010)). While this paper is most closely related to the last strand of literature, most of the existing papers in this literature look at developed countries with little attention being paid to the emerging markets such as India. One of the reasons for this gap is the lack of good quality firm level data. In that respect our paper contributes to the existing literature by putting together a large firm level dataset for an emerging economy that can be used to answer questions regarding impact of macroeconomic variables such as exchange rates on firms.

Finally our paper is also linked to the literature on cost of sharp currency devaluations. While theory has been ambivalent regarding the impact of currency devaluations on real activity, empirical literature has also provided mixed evidence regarding the economic impact of sharp

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currency devaluations (see for example Hutchison and Noy (2005), Hong and Tornell (2005) and Gupta et al (2007)). Unlike most papers in this literature however, we use firm-level longitudinal data set for an emerging market that allows us to take in to account firm level characteristics including firm level export and import shares and firm level mark ups.

III. Data

Our primary source of data is the PROWESS database compiled by the Centre for Monitoring Indian Economy. The original database contains financial and other information on over 27,000 companies. Out of these we include 250 manufacturing firms listed on the Bombay Stock Exchange (BSE) and included in the BSE 500 index over the period 2000-2012. Firms included under the BSE 500 index represent roughly 93 percent of the total market capitalization on the BSE and cover all the major industries in the Indian economy including construction, infrastructure, as well as non-traditional services such as software and ITeS. Since our focus is on manufacturing firms, we only include those in our sample. We also check our sample for potential outliers. One firm for which data appeared obviously misreported was removed from the sample.

To check how well our sample captures fluctuations in aggregate data we plot changes in output growth and investment in the sample and the aggregate macroeconomic data in the figures below. Our sample manages to capture the broad trends in aggregate data reasonably well. After rising steadily between 2004 and 2007, output growth and investment declined in the aftermath of the 2008 crisis. While the output growth recovered quickly before slowing down for a second time 2010, investment maintained a sustained downward trend after 2008.

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Plots of average sales growth, income growth and market capitalization present a similar picture. There is an increase in sales, income and market capitalization between 2004 and 2007 followed by a downturn in 2008 due to global financial crisis that originated in the US.

Text table 1 provides industry wise composition of our sample along with key characteristics such as output and trade shares. The first column gives the total number of observations for each sector in the entire sample followed by the share of each industry in total output in the second column. Paper and Wood products constitute the largest share of our sample in terms of the number of observations followed by Non-Metallic minerals and Chemicals. Metals and metal products constitute the single largest sector in terms of its share of output followed by Chemicals and Transport equipment.

The last two columns give industry wise average share of exports in total sales and share of imports in total intermediate inputs in year 2012. Leather and Leather products have the highest share of exports in total sales while Metal and metal products have the highest share of imports in intermediate inputs amongst all the sectors. Food and food products have the smallest degree of trade openness while leather and leather products have the highest degree of trade openness as measured by the sum of export and import shares. As discussed above, shares of exports and imports have an important bearing on the impact of exchange rate movement on firm's performance. A larger share of exports in total revenue implies that an increase in price competitiveness following currency depreciation is likely to boost revenues, income as well as expected future profits of the firm. Similarly, the larger is the share of imported inputs in total cost, the greater is the increase in cost of production and the decline in current and future profits due to a real depreciation. The empirical model that follows, therefore, incorporates firm specific export and import shares while studying the impact of real exchange rate movements on firms.

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Text Table 1

Industry	No. of Obs.	Share in Output (%)	Average Export Share (%)	Average Import Share
Metal & Metal Products	505	22.9	18	28.1
Chemicals	1030	18.9	17.6	23.1
Machinery	333	8.4	11.4	18.4
Electronics	174	2.5	11.8	22.0
Textiles	237	5.3	17.5	24.9
Transport Equipment	362	16.7	12.0	16.9
Plastic & Plastic Products	207	2.0	17.4	25.6
Rubber	784	0.3	12.8	18.7
Non-Metallic Minerals	1589	9.2	27.1	15.5
Food	341	9.7	8.3	11.8
Paper & Wood	2044	2.7	2.7	19.3
Footwear	415	0.55	26.2	2.2
Leather	337	0.5	42.1	17.2

The next section describes in detail the construction of our real exchange real exchange rate measure.

Industry Specific Real Exchange Rate

Choice of the right exchange rate measure is crucial for analyzing the relationship between exchange rate and firm level performance. At the national level, discussions of exchange rate movements often rely on aggregate trade-weighted exchange rates, such as the carefully constructed measures computed by the Reserve Bank of India or Bank of International Settlements. However, focus on national aggregates necessarily omits industry-specific distinctions concerning trade partners, market competition etc. The importance of particular countries as competitors /trading partners within an industry can differ substantially from their importance in the aggregated trade of the economy. As a consequence, aggregate trade-weighted indexes may be less effective than industry-specific real exchange rate indexes in capturing changes in industry competitiveness induced by movements in bilateral exchange rates[7].

To address this issue we construct industry specific trade weighed indices of real exchange rates using annual data on key trading partners' trade share in each industry and bilateral exchange rates from *UNCOMTRADE* and IMF's *International Financial Statistics*. Each industry is denoted by an index *i* and each country/trade partner of that industry by an index c. The industry-specific real exchange rate indices depart from the aggregate indices in that the

[7] See Campa and Goldberg (2001) and Klein et al (2003) for discussion.

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weights of each trading partner's bilateral exchange rate vary by industry and are equal to the share of that country in India's trade of that specific industry. In contrast, aggregate indices use the weights of each trading partner in the total international trade activity of the entire Indian economy.

Formula for trade weighed industry specific real exchange rate is given by:

$$ter_i = \sum_c \left(\frac{x_{i,c} + m_{i,c}}{\sum_c \left(x_{i,c} + m_{i,c} \right)} \right) \times rer_{i,c} \quad (1)$$

Where $x_{i,c}$ and $m_{i,c}$ are respectively exports and imports of industry *i* to country *c* and $rer_{i,c}$ is the bilateral real exchange rate between India and country *c*[8]. Consumer Price Indices are used to calculate bilateral real exchange rates as they are available for all the countries in our sample.

Figure 6 plots the 61 country aggregate trade weighted real exchange rate of INR calculated by BIS along with the average of industry specific real exchange rates calculated above. While the two series seem to follow broadly similar long-term trend there are also clear episodes of divergences between the two[9]. The average correlation coefficient between the different industry specific real exchange rate series is 0.56 indicating significant differences in industry specific exchange rates thereby justifying our use of industry specific real exchange rates. Next section elaborates our empirical methodology[10].

IV. GMM Estimates of Exchange Rate Elasticity

a) The Model

The key motivation behind our empirical analysis is to study the relationship between real exchange rate movements and firm level performance as measured by output growth. In particular we would like to distinguish between the export competitiveness and imported input cost channels of transmission. Towards this end we use a baseline model with lagged dependent variable along with other determinants of output growth. This equation is augmented with changes in sector specific real exchange rates calculated above. Change in industry specific real

[8] We use trade and exchange rate data for top 130 trading partners to calculate industry specific real exchange rate indices. An increase in *rer* implies real depreciation.

[9] Simple correlation between the two series is 0.40.

[10] Though we use industry specific exchange rates, using aggregate real effective exchange rate measure created by *BIS* leaves our results unchanged.

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exchange rates are multiplied with time varying import and export shares of each firm to capture the cost and revenue channels of transmission separately. Equation 2 presents our base line specification:

$$\Delta y_{t,i} = \beta_0 + \beta_1 \Delta y_{t-1,i} + \beta_2 \alpha_{t-1,i} \Delta e_{t,k} \times hrfndhl^{=1}_{k,t-1} + \beta_3 \eta_{t-1,i} \Delta e_{t,k} \times hrfndhl^{=1}_{k,t-1} + \beta_4 \alpha_{t-1,i} \Delta e_{t,k} + \beta_5 \eta_{t-1,i} \Delta e_{t,k} + \beta_6 \alpha_{t-1,i} + \beta_7 \eta_{t-1,i} + \beta_8 \Delta e_{t,k} + \beta_9 hrfndhl^{=1}_{k,t-1} + b' Z_{t,i} + \tau_t + \upsilon_{t,i} \quad (2)$$

$\Delta y_{t,i}$ is the growth rate of output of firm i defined as the difference in log of output. The first term $\alpha_{t-1,i} \Delta e_{t,k}$ is the product of log difference in annual real effective rate of industry k (SREER from now on), $\Delta e_{t,k}$ [11] and $\alpha_{t-1,i}$ - lagged share of imports in intermediate inputs of firm *i*. Firms with a higher share of imported inputs are likely to be hurt more from real depreciation on account of higher variable cost. One therefore expects the coefficient on this term to be negative. Using similar logic, one would expect the coefficient on $\eta_{t-1,i} \Delta e_{t,k}$ - product of lagged export share and real exchange rate change - to be positive. Use of lagged import and export shares is done to avoid endogeneity bias induced by the possible correlation of these shares with exchange rate changes.

An important determinant of firm's response to exchange rate movements is the degree of industry concentration. Firms in industries with lower degree of market concentration are likely to experience a greater impact of exchange rate movement on their output growth on account of smaller market power. Controlling for differences in trade orientation, the more significant effects of exchange rate changes in low-concentration industries may arise because producers in these industries are less able to absorb shocks to their overall profitability on account of exchange rate changes as compared to the producers in high-concentration industries. Consequently, the link between changes in real exchange rates and producer profitability and output growth would be weaker in industries with greater market concentration. We therefore incorporate this effect in our baseline model.

The Herfindahl-Hirschman index, better known as the Herfindahl index, is a statistical measure of industry concentration. The Herfindahl index can be used to measure concentration in a variety of contexts such as the concentration of income in households and also market concentration. Other things being equal, the concentration of firms in a market is an important element of market structure and a determinant of the degree of competition and market power in an industry. The HHI accounts for the number of firms in a market, as well as concentration, by incorporating the relative size (that is, market share) of all the firms in an industry. It is calculated by squaring the market shares of all firms in a market and then summing the squares, as follows:

[11] REER index is defined so that an increase denotes appreciation of Rupee.

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$$HHI = \sum_{i=1}^{n} \left(MS_i^2 \right) \quad (3)$$

Where MS_i represents the market share of firm *i* and there are n firms in the market. HHI captures the simple economic notion that the greater the concentration of output in a small number of firms (a high HHI), the greater the likelihood that, other things equal, competition in a market will be weak and the price-cost mark-up will be higher. In contrast, if concentration is low, reflecting a large number of firms with small market shares (a low HHI), competition will tend to be vigorous and price-cost mark-up will be lower[12]. While the degree of market power depends on a lot of things besides the market share, empirical evidence shows that higher HHI value indicates higher price-cost margin and hence greater market power (see Viscusi et al., 2005)[13]. We therefore use it as a proxy for measuring industry level market power.

Text Table 2 presents industry wise average HHI for the period 2000-2012 for thirteen Indian industries in our sample. Chemicals industry has the smallest industry concentration ratio while leather industry has the largest as measured by average HHI.

Text Table 2

Industry	Average Herfindahl Index
Metal & Metal Products	0.17
Chemicals	0.05
Machinery	0.21
Electronics	0.35
Textiles	0.16
Transport Equipment	0.16
Plastic & Plastic Products	0.15
Rubber	0.06
Non-Metallic Mineral Products	0.07
Food	0.18
Paper & Wood	0.17
Footwear	0.16
Leather	0.49

In order to capture the effect of market power on the relationship between firm's performance and exchange rate changes, we multiply the reciprocal of lagged industry level Herfindahl index, $hrfndhl_{k,t-1}^{-1}$, with the two exchange rate terms ($\alpha_{i,t-1} \times \Delta e_{k,t}$ & $\eta_{i,t-1} \times \Delta e_{k,t}$) and include those in

[12] In the absence of data for calculating separate concentration indices for domestic and foreign markets we use a single measure for industry concentration based on total output.

[13] The literature has examined several drawbacks of the HHI index, for example Kwoka (1977), Borenstein et al. (1999), Foncel et al. (2008), Liaukonyte (2007). Further, using a single measure of market power based on the share of output does not allow us to distinguish between market-power in domestic versus foreign markets. Yet, given the data availability it is the best possible indicator of market power for Indian firms.

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our baseline specification. $Z_{t,i}$ is a set of industry specific trends and size dummies. In addition, we use lagged domestic and world growth rates to capture the effect of domestic and global macroeconomic shocks[14].

With lagged dependent variable in the equation, standard estimators are rendered inconsistent due to correlation between unobserved panel level effects and the lag of the dependent variable. We therefore use Arellano and Bond (1991)/ Blundell and Bond (1998) type GMM estimator to estimate equation 2. To check the robustness of our results we replace output growth with sales growth.

b) Results

Benchmark Model

Table 1 presents the results from this exercise. Estimated coefficient of the import share term is negative and significant, suggesting that for a given share of imported inputs in total costs and a constant path of currency depreciation, higher market concentration is associated with a smaller reduction in output and sales. At the same time, the adverse impact of real depreciation due to higher import cost increases with the share of imported inputs. Opposite is of course true in case of a currency appreciation. On the revenue side the coefficient on the export share term is positive indicating a positive impact of real depreciation through the export competitiveness channel. However the coefficient is insignificant. This can be either due to a weak pass through of exchange rate changes to export prices or because any increase in exports due to real depreciation is accompanied by a decline in domestic absorption due to higher inflation. Since we do not have data on export prices and volumes we cannot test this hypothesis at this stage. Coefficients on other variables carry expected signs. Shares of exports and imports do not have a significant impact on the output growth (though both have a positive coefficient) while trend in IIP and world GDP growth are positively correlated with firm's output growth. Changes in exchange rate have a small, positive but insignificant effect on output growth. [15]

Table 2 presents the elasticity of output growth with respect to real exchange rate for different industries. We use average import shares along with average Herfindahl index for different industries to calculate these elasticity measures[16] [17]. The positive sign indicates a decrease in output growth in response to a real depreciation on account of increased cost of imported inputs. Chemicals industry has the highest elasticity of output growth with respect to real exchange rate (a one percent real depreciation causing output growth to decline by12.5 basis points for an average firm) while the Footwear industry has the smallest elasticity (0.38). It is important to

[14] We use the growth rates of India's index of industrial production and world GDP for domestic and global shocks respectively.

[15] We also try the specification with lags of exchange rate changes but that does not change our main results. Besides, coefficients on the lagged terms are insignificant.

[16] Overall impact of any real exchange rate movement would also incorporate its effect on the firm's balance sheet and the degree of competition faced by the import competing firms.

[17] We do not use export shares since export competitiveness channel appears insignificant throughout.

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keep in mind that these elasticity measures do not include the impact of exchange rate change on output growth through the balance sheet and import competitiveness channel.

Asymmetric Effects of Appreciation and Depreciation

It is possible that appreciation and depreciation of exchange rate affect the firms differently. It may happen, for example, that real depreciation of Rupee has a much stronger effect on firm's output growth through the channel of higher import costs as compared to real appreciation. This could be the case, for example, when firms are borrowing constrained. Similarly, there is evidence that exports respond differently to exchange rate appreciation and depreciation[18]. To test this hypothesis we split the sample between appreciation and depreciation episodes separately. Results from this exercise are presented in Table 3. Two key results emerge out of this exercise – i. Real depreciation has a highly significant and negative impact on firm level output growth through the import cost channel while real appreciation does not affect output growth similarly. ii) Looking at the export competitiveness channel, both appreciation and depreciation do not affect firm's performance significantly.

These results are in line with our earlier findings and have important implications for government policy. Overall, real exchange rate depreciation affects the firm's output growth through the channel of higher input costs in the short run. On the other hand, the export competitiveness channel does not seem to have a significant impact on firm performance in the short run. Thus, in the short run at least, one is likely to see firm level output growth declining in response to a real depreciation on account of higher cost of imported inputs. At the same time, real appreciation does not affect output growth significantly either through the import cost

[18] See Cheung and Sengupta (2012)

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channel or the export competitiveness channel in the short run indicating that real depreciation is likely to be a more serious problem in the short run as compared to real depreciation.

Exchange Rate and Overvaluation

One aspect of firm performance in the face of exchange rate change is the degree of exchange rate misalignment. If exchange rate is misaligned to begin with then currency fluctuations are likely to affect firm performance more strongly. We test this implication by incorporating a measure of exchange rate overvaluation in our baseline model. Exchange rate overvaluation is defined with respect to deviations from the Hodrik-Prescott filtered trend. The `Overvaluation` dummy takes a value one whenever the actual REER is above its Hodrik-Prescott filtered trend and zero otherwise. To incorporate overvaluation in the model we split our sample in to two parts. Table 4 presents the results from this exercise.

Once again, import cost channel has an adverse impact on firm's output growth but the impact is stronger in the presence of an overvalued exchange rate. This is in line with the findings of Razin & Collins (1997), Easterly (2001), Fajnzylber et al. (2002) that find exchange rate misalignment to be significant in explaining growth performance.

Exchange Rate Regime

Impact of exchange rate regime on growth is theoretically ambiguous. While a pegged exchange rate provides greater certainty regarding the value of foreign currency denominated transactions and policy regime which, in turn, is likely to promote productivity growth and trade (both conducive to faster output growth), the loss of flexibility under a peg leaves the economy less resilient to external shocks. That can encourage protectionist behavior, price distortions and misallocation of resources in the economy thereby having an adverse impact on growth.

It is therefore interesting to ask whether exchange rate regime has an impact on the relationship between output growth and exchange rate. To accomplish this we use a dummy variable to capture pegged exchange rate regime. In this we take the help of Shah et al (2011).

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Using a linear regression model and Perron & Bai (2003) methodology extended to a more general *maximum likelihood* setting they identify structural breaks in eleven Asian economies including India over the period 1991-2009. According to their analysis, the period between 1999 and 2003 saw Rupee being tightly pegged to the USD[19] followed by a period of much greater exchange rate flexibility. We therefore split our sample in to two parts – 2000-03 (pegged regime) and 2004-11 (flexible regime). Table 5 provides the results from this exercise. Import cost channel is negative in both the samples but is significant only in the case of flexible exchange rate regime. It does appear that stable exchange rate helps offset the negative impact of exchange rate changes through the import cost channel[20]. Other coefficients in the model remain unchanged in sign and significance.

Firm level controls and Other Robustness Checks

We include additional firm level control variables that are likely to influence output /sales growth to check the robustness of our results. These are i. Debt ratio measured as the ratio of firm's total debt to its total assets and ii. Firm collateral measured as the ratio of its net fixed assets to its total assets. Table 6 presents the result from this exercise. Including these additional variables does not affect out main results. Further, none of the additional variables significantly affects output growth[21]. To check if our results change in the presence of exchange rate volatility we add a measure of exchange rate In the last section we use a panel VAR model to study the impact of exchange rate on output, exports and imports. Estimating the relationship between real exchange rate and growth is fraught with problems of endogeneity volatility estimated using a GARCH (1, 1) process estimated using monthly effective exchange rate data from *BIS*. Table 7 presents the results from this exercise. Our main results remain unchanged with this change while volatility of exchange rate has a negative and significant coefficient.

V. Panel VAR Analysis

and simultaneity. To overcome these we use a five variable VAR approach applied to panel data that allows us to treat all variables as endogenous. This technique combines the traditional VAR approach, which treats all the variables in the system as endogenous, with panel-data approach, which allows for unobserved individual heterogeneity.

[19] In a regression of Rupee on USD, British Pound, Japanese Yen and Euro; USD has a coefficient of 0.98 with the R^2 of 0.97 indicating that the Rupee was closely tracking USD during this period.

[20] Given the relatively small sample size of pegged exchange rate regime one should view these results with some caution.

[21] Only the share of foreign currency borrowing appears as significant in the equation for sales growth

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For the benchmark model we specify a five variable VAR model of order two as follows:

$$x_{i,t} = \Gamma_0 + \Gamma_1 \times x_{i,t-1} + f_i + \varepsilon_t \qquad (5)$$

Where $x_{i,t}$ is a five-variable vector {RER, firm level mark-Up, import Share, export share, Output}.

The endogenous variables in the VAR include sector specific real exchange rate, firm level mark-up, share of imports and exports and log of output[22]. Fisher's panel unit root test suggests that all the series are stationary at one percent level of significance. We use the `orthogonalized` impulse response functions from the above VAR for our analysis. By orthogonalizing the response we are able to identify the effect of one shock at a time, while holding other shocks constant. Since the actual variance-covariance matrix of the errors is unlikely to be diagonal, to isolate shocks to one of the VAR errors it is necessary to decompose the residuals in such a way that they become orthogonal. However, before we can do that we need to specify the `order` of variables to be used for Cholesky decomposition. Our identifying assumption is that real exchange rate changes are the most exogenous followed by changes in firm level mark-ups while changes in firm's output are the most endogenous. Average import and export shares lie in between these two extremes. In other words, real exchange rate affects the other variables in the VAR instantaneously though it is affected by them only with a lag. Output growth is affected by real exchange rate and imported input changes instantaneously though it affects them in turn only with a lag. This makes intuitive sense since real exchange rate changes are determined by the changes in industrywide demand and supply conditions that are likely to be beyond the control of individual firms. Further, changes in output are likely to be slow as compared to changes in the share of imported inputs and exports as installing new capacity to increase production takes time. Similarly, mark-ups affect import, exports and output instantaneously but are affected by them with a lag.

In applying the VAR procedure to panel data, one needs to impose the restriction that the underlying structure is the same for each cross-sectional unit. Since this constraint is likely to be violated in practice, one way to overcome the restriction on parameters is to allow for "individual heterogeneity" in the levels of the variables by introducing fixed effects, denoted by f_i in the model. Since the fixed effects are correlated with the regressors due to lags of the dependent variables, the mean differencing procedure commonly used to eliminate fixed effects will create biased coefficients. To avoid this problem Inessa and Love (200) use forward mean-differencing, also referred to as the Helmert procedure (see Arellano and Bover 1995). This procedure removes only the forward mean, i.e. the mean of all the future observations available for each

[22] Domowitz, Hubbard and Petersen (DHP) (1986) methodology is used to construct annual firm level mark-up. Mark-up variable is defined as $AMKP = \frac{\text{payroll} + \text{cost of materials}}{\text{sales} + \text{change in inventories}}$ so that an increase in mark-up reflects a decline in firm's price cost margin.

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firm-year. Since this transformation preserves the orthogonality between transformed variables and lagged regressors, lagged regressors can be used as instruments to estimate the coefficients by system GMM.

Figure 7 presents impulse response functions from this exercise[23]. Key points that emerge from these responses are the following: Output declines as a result of real depreciation while the firm's mark-up increases or firm's price-cost margin declines. It indicates that the impact of a real exchange rate change is spread over firm's output and profit margins. Share of imported inputs declines while the share of exports increases in response to a real depreciation as expected.

Looking at the other impulse responses we find that output increases in response to an increase in import share and declines in response to an increase in mark-up (or a decline in the price-cost margin). Export share does not appear to have a significant impact on firm's output. Given that import share declines in response to a real depreciation, a positive response of output to import shock indicates that real depreciation adversely affects output through the import cost channel. Same cannot be said about the export channel.

We re-estimate the P-VAR using permanent component of exchange rate changes.[24] Figure 8 presents the impulse response functions from this exercise. Using permanent component of exchange rate instead of the actual exchange rate leaves our results unchanged (though permanent changes in exchange rate explain a larger share of variation in imports, exports and output when we look at the variance decomposition). Overall these results point towards possibility of contractionary devaluations in case of emerging markets like India.

VI. Conclusion

This paper lays out the stylized facts regarding the transmission of industry specific real exchange rate shocks to firm level performance using data on 250 Indian firms. Our paper finds that real exchange rate movements have a significant effect on firm's growth performance through the import cost channel but not through the export competitiveness channel. The impact depends upon the degree of market power as measured by the industry specific Herfindahl index but remains unaffected by the presence of real exchange overvaluation and the choice of exchange rate regime. Appreciation and depreciation episodes have asymmetric impact on output growth with the former being less powerful. These results remain robust to alternative choices of

[23] Standard error bands are obtained using Monte Carlo simulation.

[24] We obtain the permanent component of exchange rate changes using the band-pass filter suggested by Christiano and Fitzgerald (2003)

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exchange rate and output growth measures and introduction of firm level controls. Impulse responses from Panel Vector Auto Regression reinforce these findings.

For policy makers trying to assess the impact of exchange rate movements on the real economy these results provide various important insights. Firstly, the short run impact of a real depreciation on firm's output growth is likely to be negative since it is the import cost channel that dominates in the short run. Further, the impact is asymmetric, with real depreciation having a stronger impact as compared to real appreciation. This indicates the need for an effective reserve management policy that allows monetary authorities to meet the challenges posed by sudden episodes of sharp Rupee depreciation as has happened recently. It also implies that the call for the Central Bank to 'assist' with the revival of economic growth in the presence of uncertainties in domestic and external policy environment is likely to be counterproductive if it leads to a downward pressure on the domestic currency. At the same time, maintaining a competitive real exchange rate is imperative for boosting intermediate and long-term economic growth and maintaining the external balance. Thus, using scarce foreign exchange reserves to prevent currency depreciation in the face of sustained downward pressure on the currency due to growing fiscal deficit and/ or massive capital outflows would also be problematic apart from being unsustainable.

As discussed by Barry Eichengreen (2009), real exchange rate is not a policy variable directly controlled by the policy makers. Being the relative price of non-traded goods, real exchange rate is determined by the supply and demand of these goods (just like the price of any other commodity) except in the case of a planned economy. In the long run real exchange rate will tend to move towards its equilibrium value as determined by the fundamentals. However, price rigidities imply that monetary policy and other shocks could push real exchange rate away

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from its long-run value in the short-run there by having an impact on output growth and other real variables. The impact will vary across firms depending upon the degree of their reliance on imported inputs apart from other things. For countries relying on volatile foreign capital inflows to finance their consumption and investment needs, a careful reserve management policy along with a sound fiscal policy are necessary to balance the multiple objectives of stable growth and external sector balance in the long run.

One drawback of the current study is that it only focuses on publicly listed firms which are likely to be larger in size and have access to finance. It is possible that non-listed firms, which are smaller in size and have poorer access to outside finance, are affected more severely by exchange rate changes. It is equally possible that smaller firms respond to greater competitive pressure by lowering their mark up while bigger firms with greater market power reduce their volume of sales while maintaining their profit margins. Another important line of inquiry is the impact of exchange rate on firm level employment and difference in response of firms with different levels of productivity. We aim to cover these questions in future research.

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References

Adler, M. and B. Dumas, 1984, ``Exposure to Currency Risk: Definition and Measurement," *Financial Management*, Vol. 13, 41-50.

Bodnar, G. M. and M. H. F. Wong, 2000, "Estimating Exchange Rate Exposures: Some "Weighty" Issues," Technical Report, NBER, 2000

Demir, F., 2010, `` Exchange Rate Volatility and Employment Growth in Developing Countries: Evidence from Turkey,`` *World Development*, Vol. 38, No. 8, 1127-1140

Dominguez, K. M. and L. L. Tesar, 2006, "Exchange rate exposure," *Journal of International Economics*, Volume 68, January 2006, 188-218.

Domowitz, I., Hubbard, R.G. and Peterson, C., 1986, `` Business cycles and the relationship between concentration and profit margins, `` Rand *Journal of Economics*, Vol. 17, 1-17

Dornbush, R., ``Exchange Rates and Prices, 1987, `` *American Economic Review*, Vol. 77, 93-106

Goldberg, P. and M.M. Knetter, 1997," Goods Prices and Exchange Rates: What Have We Learned?" *Journal of Economic Literature*, Vol. 35, issue 3, 1243-1272

Goldber, L., 1993," Exchange Rates and Investment in United States Industry," *The Review of Economics and Statistics*, Vol. 75, No. 4, November 1993, 575-588

.

Goldberg, L. and J.M. Campa, 1995," Investment in Manufacturing, Exchange Rates and External Exposure," Journal *of International Economics*, Volume 38, Issues 3‐4, May 1995, 297‐320

Goldberg, L. and J.M. Campa, 1999," Investment, Pass-Through and Exchange Rates: A Cross-Country Comparison" *International Economic Review*, Vol. 40, No. 2, May 1999, 287-314

Gupta, P., D. Mishra and R. Sahay, 2007,"Behavior of Output During Currency Crisis," *Journal of International Economics* , Volume 72, Issue 2, July 2007, 428-450

Hong, K. and A. Tornell, 2005," Recovery from a Currency Crisis: Some Stylized Facts," *Journal of Development Economics*, Volume 76, Issue 1, February 2005, 71‐96

Hutchinson, M.M. and I. Noy, 2005," How Bad Are Twins? Output Costs of Currency and Banking Crises," *Journal of Money, Credit, and Banking*, Volume 37, Number 4, August 2005, 725-752

Jorion, P., 1990,"The Exchange-Rate Exposure of U.S Multinationals," *The Journal of Business*, Volume 63, July 1990, 331-345

Nucci, F. and A.F. Pozzolo, 2001," Investment and the Exchange Rate: An Analysis with Firm-Level Panel Data," *European Economic Review*, Volume 45, Issue 2, February 2001, 259‐283

.

Parsley, D. C. and H. A. Popper, 2006,“Exchange rate pegs and foreign exchange exposure in East and South East Asia," *Journal of International Money and Finance*, Volume 25, October 2006, 992-1009.

Shah, Ajay and Ila Patnaik, 2010,“Does the Currency Regime Shape Un-hedged Currency Exposure?”, *Journal of International Money and Finance*, Volume 29, Issue 5, September 2010, 760‑769

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Table [1] Adding Market Power (Sectorial REER)

Dependent Variable:	Output Growth	Sales Growth
$Outputgrowth_{t-1}$	-0.00 [0.1]	-0.03 [0.1]
$\alpha_{i,t-1} \times \Delta e_{k,t} \times hrfndhl_{k,t-1}^{-1}$	-0.07*** [0.0]	-0.06*** [0.0]
$\eta_{i,t-1} \times \Delta e_{k,t} \times hrfndhl_{k,t-1}^{-1}$	0.00 [0.0]	0.00 [0.0]
$\alpha_{i,t-1} \times \Delta e_{k,t}$	0.56 [0.3]	0.53 [0.3]
$\eta_{i,t-1} \times \Delta e_{k,t}$	-0.00 [0.0]	-0.0 [0.0]
$\alpha_{i,t-1}$	0.19 [0.0]	0.18 [0.1]
$\eta_{i,t-1}$	0.00 [0.0]	0.0 [0.0]
$\Delta e_{k,t}$	0.05 [0.0]	0.03 [0.0]
hrfndhl	0.72 [0.4]	0.7 [0.3]
$iiptrend_{[\_t-1]}$	1.4* [0.7]	1.3* [0.7]
World GDP Growth $_{[\_t-1]}$	2.6*** [0.6]	2.4*** [0.5]
No. of Observations	1972	1972

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Sargan's test for Over identifying restrictions	0.99	0.99

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Table [2] Elasticity With Respect to Real Exchange Rate

Industry	Exchange Rate Elasticity
Metal And Metal Products	5.1
Chemicals	12.5
Machinery	2.6
Electronics	1.9
Textiles	4.8
Transport Equipment	3.3
Plastic	5.4
Rubber	9.8
Food	2.1
Non-Metallic Minerals	6.1
Paper & Wood	3.5
Footwear	0.38
Leather	1.1

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Table 3 Asymmetric Effect

Dependent Variable: Output Growth	Appreciation	Depreciation
$Outputgrowth_{t-1}$	-0.28*** [0.1]	-0.15* [0.0]
$\alpha_{i,t-1} \times \Delta e_{k,t} \times hrfndhl_{k,t-1}^{-1}$	-0.02 [0.0]	-0.11*** [0.0]
$\eta_{i,t-1} \times \Delta e_{k,t} \times hrfndhl_{k,t-1}^{-1}$	-0.00 [0.0]	0.00 [0.0]
$\alpha_{i,t-1} \times \Delta e_{k,t}$	-0.41 [0.5]	1.2 [0.3]
$\eta_{i,t-1} \times \Delta e_{k,t}$	0.00 [0.0]	-0.00 [0.0]
$\alpha_{i,t-1}$	0.26 [0.1]	0.42*** [0.1]
$\eta_{i,t-1}$		0.00 [0.0]
$\Delta e_{k,t}$	0.00 [0.0]	0.02 [0.0]
$hrfndhl_{k,t-1}$	0.10 [0.4]	1.4 `[0.6]
$iiptrend_{[\_t-1]}$	0.64 [1.6]	0.44 [1.0]
World GDP Growth $_{[\_t-1]}$	3.1*** [0.6]	2.45*** [0.6]
No of Observations	854	1118
Sargan's test for Over identifying Restrictions	0.76	1.00

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Table 4 Overvaluation and Effects of REER change

Dependent Variable: Output Growth	Overvaluation	No Overvaluation
$Outputgrowth_{t-1}$	-0.15 [0.1]	-0.22** [0.02]
$\alpha_{i,t-1} \times \Delta e_{k,t} \times hrfndhl_{k,t-1}^{-1}$	-0.15* [0.0]	-0.04** [0.0]
$\eta_{i,t-1} \times \Delta e_{k,t} \times hrfndhl_{k,t-1}^{-1}$	0.00 [0.0]	0.00 [0.0]
$\alpha_{i,t-1} \times \Delta e_{k,t}$	1.1 [0.9]	0.07 [0.3]
$\eta_{i,t-1} \times \Delta e_{k,t}$	-0.00 [0.0]	0.00 [0.0]
$\alpha_{i,t-1}$	0.33 [0.2]	0.34* [0.2]
$\eta_{i,t-1}$	-0.00 [0.0]	0.00 [0.0]
$\Delta e_{k,t}$	0.23 [0.1]	0.06 [0.0]
$hrfndhl_k$	-0.27 [0.9]	1.3 [1.0]
liptrend $_{[t-1]}$	4.7** [2.2]	0.75 [1.4]
World GDP Growth $_{[t-1]}$	2.7*** [0.5]	2.6** [0.9]
No of Observations	735	1236
Sargan's test for Over identifying Restrictions	0.63	0.19

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Table 5 Exchange Rate Regime

Dependent Variable:	No Peg	Peg
$Outputgrowth_{t-1}$	-0.03 [0.1]	-0.07 [0.3]
$\alpha_{i,t-1} \times \Delta e_{k,t} \times hrfndhl_{k,t-1}^{-1}$	-0.08*** [0.0]	-0.10 [0.2]
$\eta_{i,t-1} \times \Delta e_{k,t} \times hrfndhl_{k,t-1}^{-1}$	0.0 [0.0]	0.00 [0.0]
$\alpha_{i,t-1} \times \Delta e_{k,t}$	0.68 [0.3]	-0.63 [2.6]
$\eta_{i,t-1} \times \Delta e_{k,t}$	-0.0 [0.0]	0.01 [0.0]
$\alpha_{i,t-1}$	0.23 [0.1]	0.14 [0.4]
$\eta_{i,t-1}$	-0.0 [0.0]	
$\Delta e_{k,t}$	0.05 [0.0]	-0.15 [0.3]
$hrfndhl$	0.92* [0.5]	-0.3 [1.5]
$iiptrend_{[\_t-1]}$	1.4 [0.9]	16.2 [11]
World GDP Growth $_{[\_t-1]}$	2.5*** [0.5]	
No of Observations	1651	320
Sargan's test for Over identifying Restrictions	1.0	0.87

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Table 6 Firm Level Controls

Dependent Variable:	Sales Growth	Output Growth
$Outputgrowth_{t-1}$	-0.03	0.01
	[0.1]	[0.0]
$\alpha_{i,t-1} \times \Delta e_{k,t} \times hrfndhl_{k,t-1}^{-1}$	-0.06**	-0.07**
	[0.0]	[0.0]
$\eta_{i,t-1} \times \Delta e_{k,t} \times hrfndhl_{k,t-1}^{-1}$	0.00	0.00
	[0.0]	[0.0]
$\alpha_{i,t-1} \times \Delta e_{k,t}$	0.46	0.48
	[0.4]	[0.3]
$\eta_{i,t-1} \times \Delta e_{k,t}$	-0.00	-0.00
	[0.0]	[0.0]
$\alpha_{i,t-1}$	0.27	0.21
	[0.1]	[0.1]
$\eta_{i,t-1}$	0.00	0.00
	[0.0]	[0.0]
$\Delta e_{k,t}$	0.03	0.05
	[0.0]	[0.0]
hrfndhl	0.86	0.75
	[0.4]	[0.4]
$Debt\ Ratio_{t-1}$	0.00**	0.00**
	[0.0]	[0.0]
$Collateral_{t-1}$	-0.00*	-0.00*
	[0.0]	[0.0]
$iiptrend_{[\_t-1]}$	1.2	1.4
	[0.8]	[0.7]
World GDP Growth $_{[\_t-1]}$	2.4***	2.7***
	[0.6]	[0.6]
No. of Observations	1972	1972
Sargan's test for Over identifying Restriction	0.99	0.99

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Table [7]: Adding Volatility

Dependent Variable:	Output Growth	Sales Growth
$Outputgrowth_{t-1}$	0.05 [0.1]	0.08 [0.1]
$\alpha_{i,t-1} \times \Delta e_{k,t} \times hrfndhl_{k,t-1}^{-1}$	-0.06*** [0.0]	-0.05*** [0.0]
$\eta_{i,t-1} \times \Delta e_{k,t} \times hrfndhl_{k,t-1}^{-1}$	0.00 [0.0]	0.00 [0.0]
$\alpha_{i,t-1} \times \Delta e_{k,t}$	0.48 [0.3]	0.44 [0.3]
$\eta_{i,t-1} \times \Delta e_{k,t}$	-0.00 [0.0]	-0.0 [0.0]
$\alpha_{i,t-1}$	0.21 [0.1]	0.27 [0.1]
$\eta_{i,t-1}$	0.00 [0.0]	0.0 [0.0]
$\Delta e_{k,t}$	0.05 [0.0]	0.03 [0.0]
Volatility of Exchange Rate	-0.02*** [0.0]	-0.02*** [0.0]
hrfndhl	0.72 [0.4]	0.35 [0.3]
$iiptrend_{[\_t-1]}$	0.7 [0.7]	0.45 [0.7]
World GDP Growth $_{[\_t-1]}$	3.5*** [0.6]	3.3*** [0.5]
No. of Observations	1972	1972
Sargan's test for over identifying Restrictions	0.99	0.99

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Figure 1 Average Volatility of Monthly Rupee-USD Returns

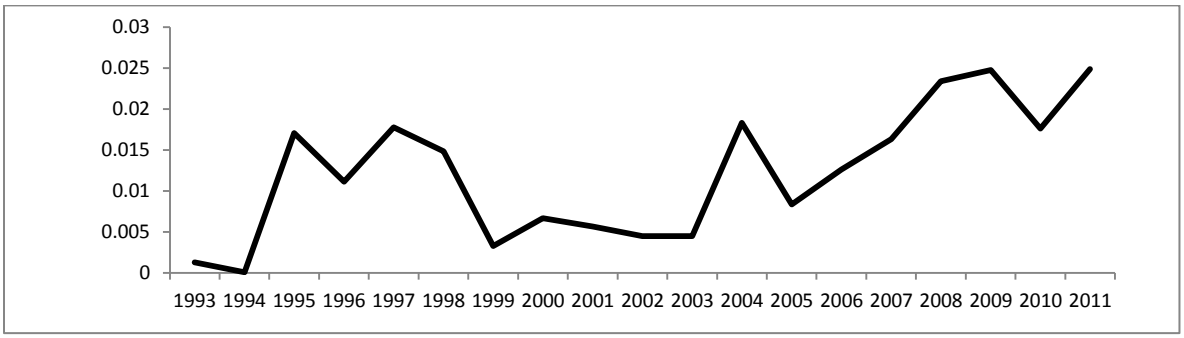

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Figure 2 RBI Intervention in Forex Market

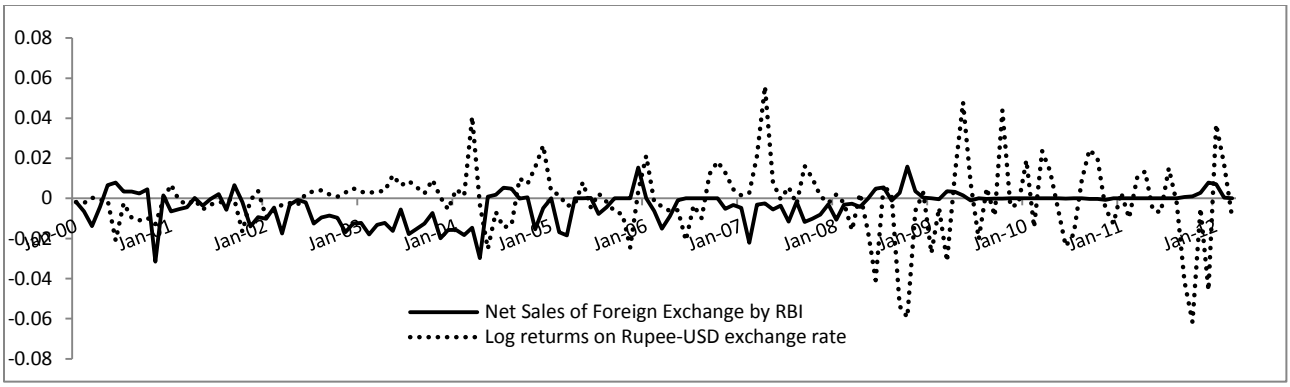

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Figure 3 Sample Versus Aggregate Data

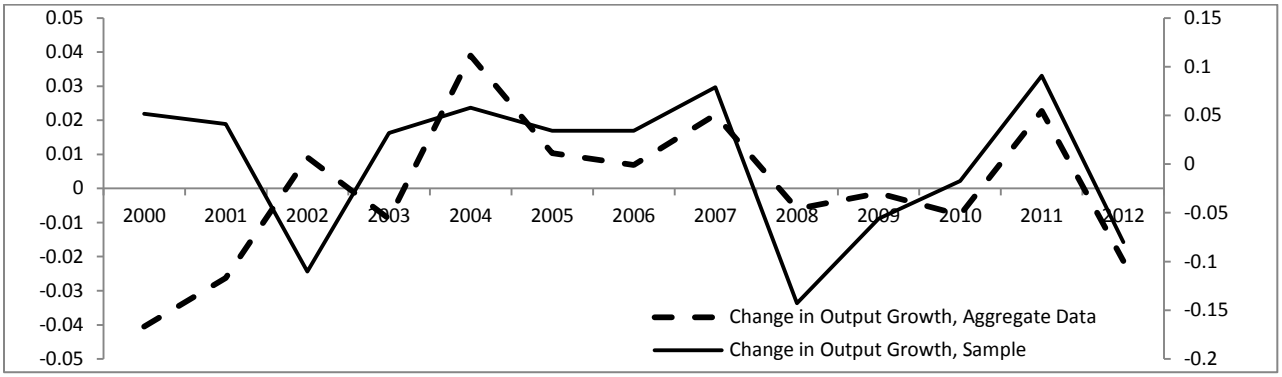

Figure 4 Sample Versus Aggregate Data

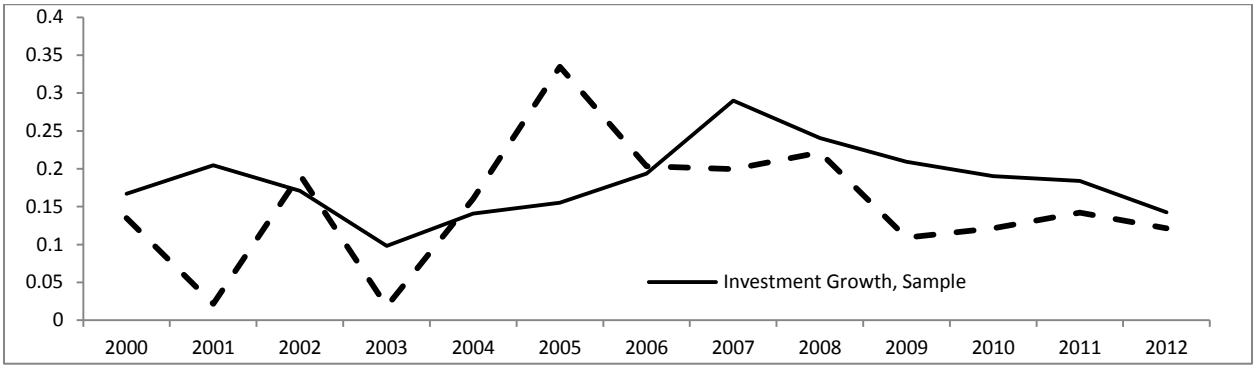

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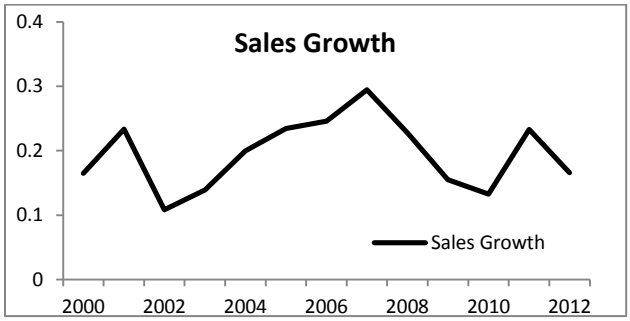
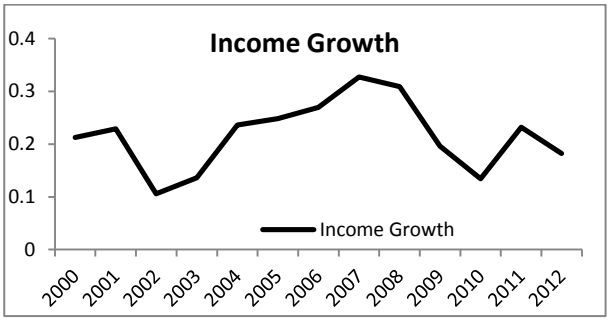
Figure 5 Sales, Income Growth and Market Capitalization





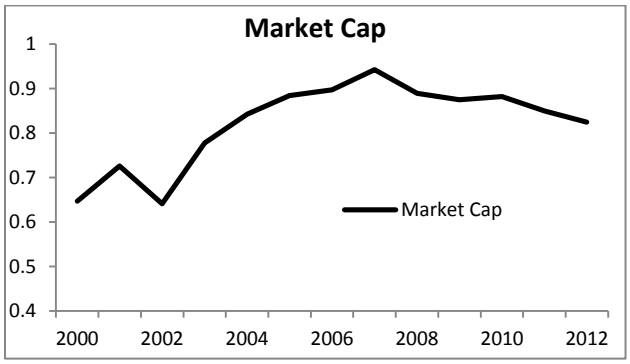


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Figure 6: Aggregate and Industry Specific REER

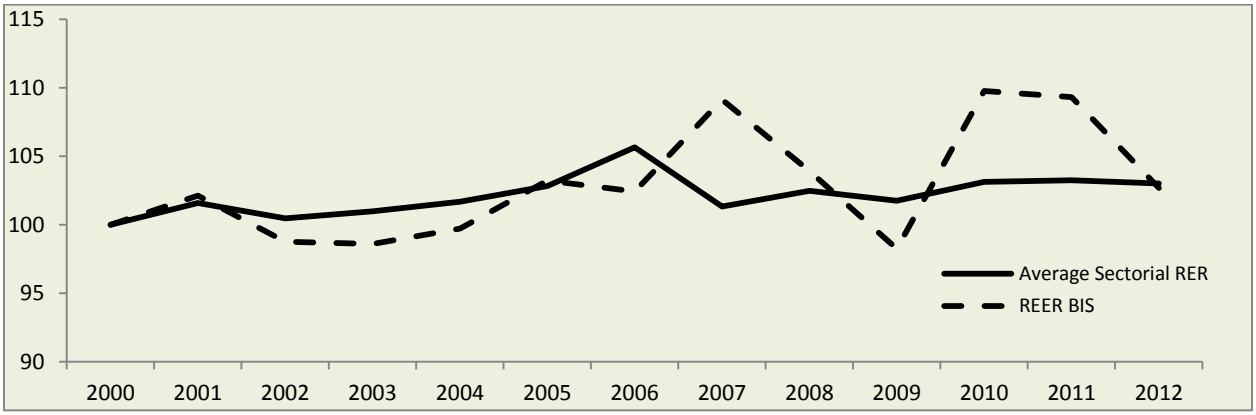

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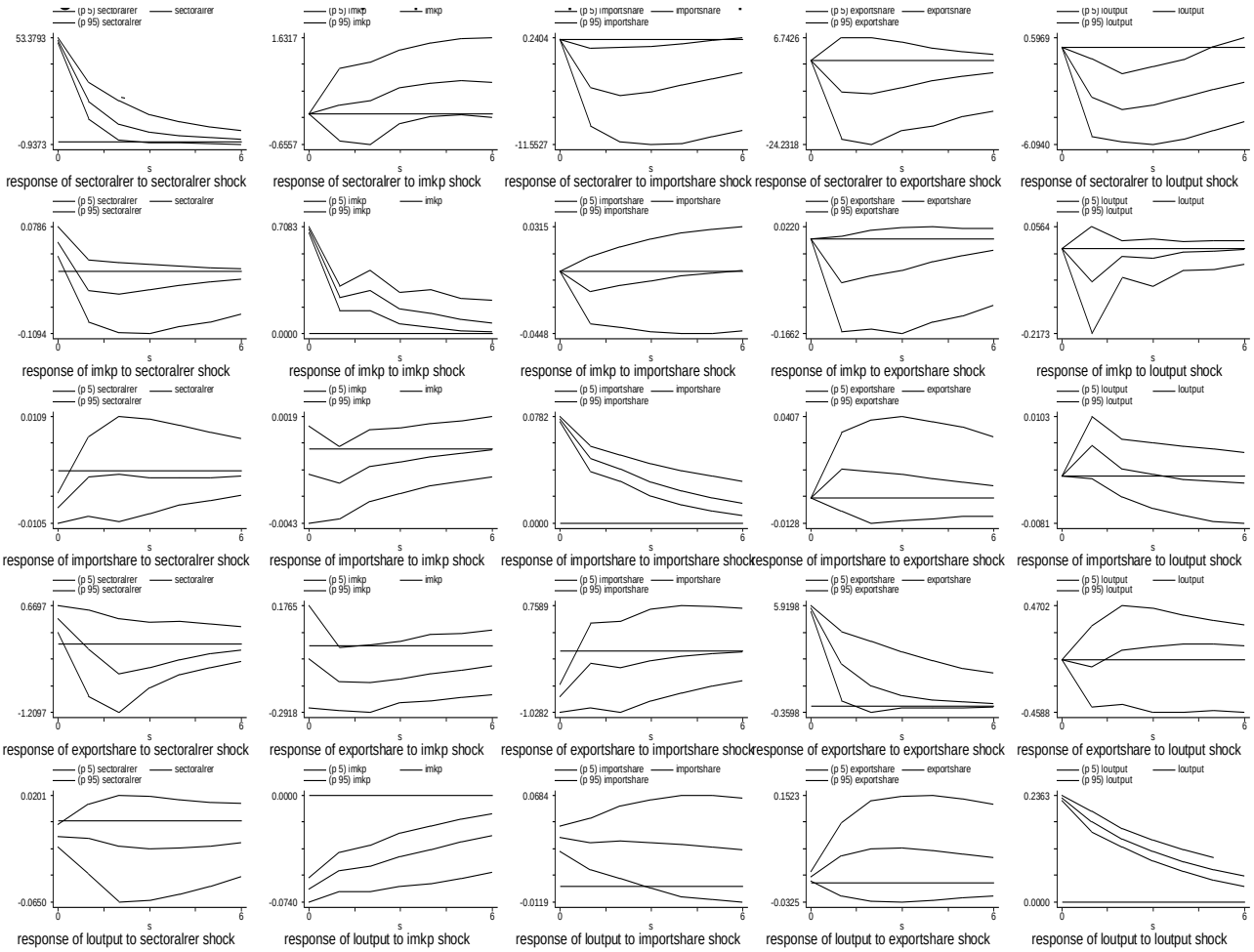
Figure 7 Impulse responses with actual real exchange rate



Errors are 5% on each side generated by Monte-Carlo with 500 reps

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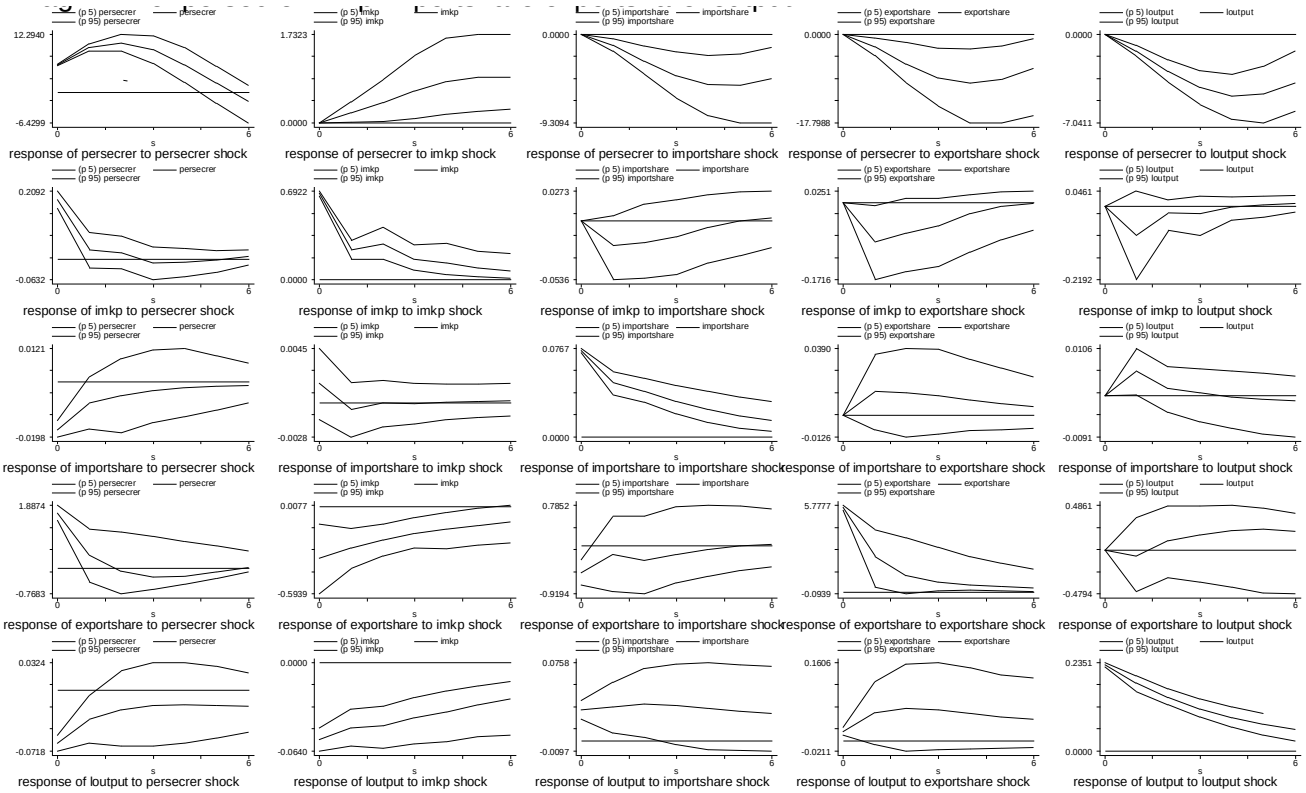
Figure 8 Impulse responses with permanent component of real exchange rate



Errors are 5% on each side generated by Monte-Carlo with 500 reps

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Appendix I

Table A

Year	Total Turnover In Foreign Exchange Market[25] (Billions of USD)	Balance of Payments Size (Billions of USD)	Foreign Currency Assets of RBI (Billions of USD)
1996	73.2	88.3	2.84
2002	130	133.5	30
2011	1175	1014	163.3

*Note: Data on Turnover in Foreign Exchange Market, Balance of Payments and Foreign Currency Assets of RBI are from RBI's *Handbook of Statistics* and *Database on Indian Economy*

[25] Total Turnover in the foreign exchange market is defined as the sum of total sales and purchase in the foreign exchange market

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