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Impact of Exchange Rate Movements on Exports: An Analysis of Indian Non-Financial Sector Firms

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ABSTRACT

We explore the real effective exchange rate (REER) effects on the share of exports of Indian non-financial sector firms for the period 2000 to 2010. Our empirical analysis reveals that, on average, there has been a strong and significant negative impact of currency appreciation as well as currency volatility on Indian firms' export shares. While the firm-level accounting information and other macro variables have limited implications, there is evidence that these Indian firms respond asymmetrically to exchange rates. For instance, the REER change effect is likely to be driven by a negative appreciation effect but not so much a depreciation effect. Also, the Indian firms that have smaller export shares tend to have a stronger response to both REER change and volatility. Compared with those exporting goods, the firms that export services are more affected by exchange rate fluctuations. The findings, especially those on asymmetric responses, have important policy implications.

JEL Classifications: F1, F4

Keywords: *Exchange rate fluctuations, Firm-level export shares, Asymmetric effects, Services exports*

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1. Introduction

The share of global trade in total world output has grown quite substantially and has almost tripled the level since the Second World War. In the last two decades or so, the global economy witnessed not just a rapid expansion in international trade but also growing prominence of dynamic emerging economies in the global trade landscape. Indeed over the past couple of decades, emerging markets have steadily become systematically important trading centers thanks to the growing role of global supply chains and high-technology exports.

Despite the steady growth in global trade, there are some recurrent concerns about the impact of exchange rate movements on trade in general and on a country's export and import activities. For instance, the collapse of the Bretton Woods system in the early 1970s triggered a heavy wave of debates on whether exchange rate variability is a deterrent of global trade. More recently, the discussions on exchange rate effects on trade were rekindled after the 1997 Asian financial crisis and the 2008 global financial crisis.

The overall trade activity of a country is an aggregation of decisions of individual firms. Hence in order to understand the effects of exchange rate changes on trade balance, it is important to analyze how exchange rate fluctuations affect the decisions of a wide range of individual firms. Such analysis provides insights into heterogeneous responses across firms to exchange rate movements and the related policy implications of the central bank's effort in managing and stabilizing foreign exchange variations.

India is an interesting case study to explore the issue of impact of exchange rate fluctuations on exports. During the 1960s and 1970s, India was one of the least open economies of the world. Indeed, before the 1990s, India's exchange rate was more or less fixed. However, since 1991, India has launched its policy reform agenda and implemented a host of liberalization reforms, primarily targeting the foreign exchange market and the tradable sectors. The year 1991 marked the beginning of an extensive regime shift so to speak. By 1992-93 India shifted to a more market oriented exchange rate system through devaluations and deregulations. Since then the exchange rate has mostly been under a managed floating regime with the Reserve Bank of India intervening from time to time to stabilize the nominal exchange rate.¹

¹ It is perceived that the Reserve Bank of India adopts an asymmetric intervention policy that stems a currency appreciation whereas allows a reasonable amount of depreciation (Sen Gupta and Sengupta, 2012).

At the same time the annual growth rate of India's exports of goods and services increased from 16% in 1999-2000 to around 33% in 2010-2011. The share of exports in GDP has gone up significantly from 6% in 1990 to 12% in 2000, and to 23% in 2010. Simultaneously, India's overall share in total world trade (which includes trade in both merchandise and services sector) has increased from 0.5% in 1990 to about 1.4% in 2010. As a result, India has moved up seven places between 1999 and 2009, to secure its rank as the fourteenth largest trading center worldwide.

During the period of 2000 to 2010, the growth of exports of commercial services has been faster than that of merchandise exports; the former registered an average growth rate of about 23% whereas the latter grew at a rate of about 18%. It is striking to note that the high export growth occurred despite the Indian real effective exchange rate (REER) appreciating by about 1.4% during the same period.

The Indian REER has been mostly in an appreciating phase from 1994-95 onwards. Anecdotal evidence suggests that while until 1993-94, the relationship between REER and total exports is exactly what the textbook prescribes; that is, exchange rate depreciation having a positive effect on exports, but starting from 1993-94 onwards, the expected relationship seems to have been reversed. However, as pointed out by Veeramani (2008), the observation that Indian exports grew rapidly since 2000 despite the REER appreciation need not imply that the latter had no adverse impact on the former – the actual growth of exports could have been larger had the REER not appreciated.

Against this background, it would be interesting to study how the fluctuations in the exchange rate have affected Indian firms' exporting decisions and to investigate whether the data shows any indication of a weakening of the link between REER and exports. Owing to data restrictions we focus on export behavior in the 2000s.

While there are a few studies including Veeramani (2008) and Srinivasan and Wallack (2003) in the Indian context that have looked into the impact of exchange rate changes on overall exports, no study so far has used micro-evidence to explore this issue. Accordingly, our objective in this paper is to use detailed firm-level data from a sample of Indian non-financial sector firms to empirically investigate the exchange rate effect on firms' export behavior, controlling for other possible determinants. Beside exchange rate changes, we investigate the implication of exchange rate volatility for trade as well. The trade effect of exchange rate volatility has been an intensely

debated issue since the breakdown of the Bretton-Woods system. Interestingly, both the theoretical and empirical studies do not offer a firm conclusion on the effect of exchange rate volatility on international flows (Côté, 2004 and Cheung, 2005).

Numerous studies in the empirical trade literature explore the aggregate relationships between exchange rate and international trade at the country level. However, studies using aggregate data are subject to problems such as aggregation bias (Dekle *et al.*, 2007), simultaneity (Adolfson, 2001), and measurement error in constructing aggregate indices. There is relatively little empirical work on the responses of exports at the level of firms or individual producers. Exceptions include Fitzgerald and Haller (2010), Berman, Martin and Meyer (2009), Greenaway, Kneller and Zhang (2007), Campa (2004), Bernard and Jensen (2004a, b), Bugamelli and Infante (2003), and Forbes (2002).

Most of the empirical studies using micro-evidence however are devoted to developed countries. The micro data evidence on the impact of exchange rate movements on individual producers' decision to export is ambiguous. It is common that these studies find quantitatively small effects of exchange rate movements on entry and exit and changes in exports due to exchange rate movements come mainly from existing exporters adjusting production (intensive margin) as opposed to the new entrants (extensive margin).

Our study focuses on exchange rate movements and exports for a large panel of Indian firms. Arguably, it is the first extensive firm-level study on India's firm exporting behavior. In doing so, our paper contributes to the growing literature on individual firms' responses to exchange rate variation in particular, and on trade behavior of developing countries in general. The use of a rich firm-level Indian data set enables us to exploit the heterogeneity across firms in a large developing economy and alleviate biases due to, say, aggregation. Given the reported weak extensive margin effect, we investigate mainly the intensive margin effect.²

More precisely, the questions we are primarily interested in are: (i) what is the impact of exchange rate depreciation (appreciation) on exports of Indian manufacturing firms? (ii) Does the textbook prediction that exchange rate devaluation (appreciation) boosts (deters) exports hold for Indian firms or is there no significant association at all? (iii) What are the firm-specific features that influence their export responses to exchange rate changes? And finally (iv) what are

² Our future research agenda includes analyses of the extensive margin and the impact of exchange rate changes on Indian firms' entry into and exit from the exports market.

the macro features of the economy as a whole that impact firm level export response to exchange rate movements?

To anticipate results, our baseline empirical analysis reveals that, with the generic exports equation that has exchange rate and income as explanatory variables, a one percentage point increase in the appreciation of the REER causes a 6.3 percent reduction in the change of the share of exports in Indian firms' total sales. In the presence of some control variables, the exchange rate effect could exceed 10 percent. The result is largely in line with studies including Virmani (1991), Joshi and Little (1994), Srinivasan (1998), Srinivasan and Wallack (2003) and Veermani (2007, 2008) that use aggregate data to demonstrate the negative REER appreciation effect on India's aggregate merchandise exports. Our empirical findings in general are suggestive of a negative volatility effect on firm's export shares. A one standard deviation decline in REER volatility would on average increase an Indian firm's export share by as much as 13 percent. Both these results are in line with the predictions of the standard theory.

In addition to the baseline formulation, we consider some alternative specifications to evaluate the exchange rate effects. Some findings are a) for Indian firms, the firm-specific accounting information does not affect the exchange rate and trade interaction, b) compared with depreciation, appreciation is associated with a stronger exchange rate change and a stronger volatility effect on trade, c) exchange rate effects are different between firms with large and small export shares, d) exchange rate changes have a stronger impact on services exports, especially on exports of information technology services. The negative exchange rate change effect is found in most of these additional analyses.

In the next section, we describe the data set used for our analysis. The baseline regression is reported in Section 3. The analyses based on alternative specifications are reported Sections 4 to 6. Some concluding remarks are offered in Section 7.

2. Data

The firm-level data were drawn from the Prowess database of the Center for Monitoring Indian Economy (CMIE). The database provides annual information on publicly traded non-financial firms (both consolidated and stand alone). For our paper we focus on exporting firms between 2000 and 2010, the period for which we had access to the data.

Tables 1 to 3 present some descriptive statistics of these firm level data. These are only for firms with positive exports; that is, firms that exported at least one time during the entire sample period. The numbers of firms in each of the sampled years, after dropping out outliers, are listed in Table 1.³ The size of our firm sample grows monotonically from 3214 firms in 2000 to 4289 firm in 2008. Following the 2008 global finance crisis, it drops to 4068 and then further to 3702 in 2010. Approximately 18% of the firms are present for all eleven years, close to 13% firms are present in the sample for at least 8 years, 56% are observed for at least 3 years and only 8% for only one year.

Some summary statistics for the firm-specific and macro variables are given in Tables 2 and 3. Table 2 covers the whole sample period and the firm-specific summary statistics are based on the full firm sample. Table 3, for comparison purposes, shows the summary statistics for three selected years – 2000, 2005 and 2010.

On average a firm exports around 28% of its sales. This percentage goes up from 26% to almost 29% between 2000 and 2005 but comes down to 27% in 2010, the post-crisis period. The exports of goods and services display different patterns. While share of exports of goods in total sales does not exhibit much fluctuation across years and is 25% on average, services exports on the other hand registers an increase from 25% to 31% between 2000 and 2005 and does not decline much by 2010. Across all the firms, the exports/sales ratio appears quite variable and has a standard deviation of around 32%. Further, the exports/sales ratio has a larger degree of dispersion for exports of services than for exports of goods. The variability allows us to discriminate the different behaviors between firms.

Some other firm-level characteristics such as capacity utilization and share of foreign currency borrowings seem to follow the pattern of exports/sales ratio – the 2005 values are higher than 2000 and 2010 values. The average firm size is increasing over time while the collateral (do we call the fixed asset/total asset “collateral”?) is declining over time.

The main explanatory variable of interest, REER exhibits a steady appreciation from 91 to 100 between 2000 and 2010 registering an appreciation of close to 12% in 2010.⁴ Compared

³ Extensive checks were conducted for preparing the sample. We drop all firm/year observations if the accounting data are not self-consistent. In particular, we drop observations if firm-level accounting variables do not accord with sign conventions (for example if sales or total assets or exports are negative or if exports exceed 100% of sales or if foreign currency borrowing exceeds total liabilities and so on). Firms with zero sales were also excluded.

⁴ Several studies used destination specific bilateral real or nominal exchange rates (RER, NER). Unfortunately destination specific information is not available for Indian firms. Given our data structure and limitations, aggregate

with data for 2000 and 2005, Both REER volatility and wages registered large values in 2010. Despite the commonly perceived adverse effect on trade volume, the world exports/GDP ratio in 2010 is than the levels at 2000 and 2005. Details on the macroeconomic variables used in the analysis are provided in the Data Appendix.

3. Baseline Regression

Our baseline specification for studying exchange rate effects, and is given by:

$$\Delta X_{it} = \beta_0 + \beta_1 \Delta REER_t + \beta_2 (REER_vol)_t + \beta_3 \Delta I_t^* + \chi \mu_i + \phi \eta_t + \varepsilon_{it}, \quad (1)$$

where X_{it} represents firm level export shares defined as the exports to sales ratio of firm i at time t ; $\Delta REER_t$ is the change in real effective exchange rate (REER) with an increase indicating an Indian rupee appreciation; ΔI_t^* is change in the level of foreign income (measured by trade-share weighted average of incomes of India's top five trading partners) that represents the general growth in overseas markets and $(REER_vol)_t$ is the volatility of real effective exchange rate measured using standard deviation of monthly REER indices of the year. Equation (1), thus, assesses the average of changes in firms' export shares to exchange rate change and variability. The exchange rate variables and income variable are the explanatory factors in a canonical exports demand equation.

A crucial problem in firm-level studies is the classical omitted variable problem caused by unobserved firm characteristics. One solution to this is to control for as many firm-level variables as possible but there is an obvious limitation imposed by the data set. The fixed-effects variable, μ_i , is included to capture firm's specific attributes that are (approximately) time-invariant and have implications for exporting behavior. These attributes may include managerial characteristics, foreign experience, and product quality.⁵ In the next subsection, we introduce an augmented specification that incorporates time-varying firm-specific explanatory variables.

The term η_t is an annual time effect reflecting temporal variations in export shares that are common to all firms in the sample. These year fixed effects control for common nation-level

REER and NEER were the only options available to us. We also do not have data on export volumes and hence have to work with exports/sales ratio based on data on values instead. In Section 6, we consider WPI and CPI based real exports data.

⁵ We also incorporated sector specific or industry dummy variables to capture characteristics that are specific to a firm's main sector. The results below were found to be robust to the presence of these dummy variables and, thus, not reported for brevity but are available upon request.

or macro shocks such as changes in the business cycle, trade liberalization across all firms, general technology advancements, etc., as well as global business cycle effects. Finally, ε_{it} is the regression error term.

The results of estimating Equation (1) are reported in Table 4. For brevity, the time and fixed effects variables (η_t and μ_i) included in the regression are not reported. Columns I and II present the individual effects of REER change and volatility on the export share. The joint effects are given under Column III.

Controlling for fixed effects, both exchange rate movements and volatility have a statistically significant negative impacts on export shares. More precisely, a one percentage point appreciation of the REER reduces an average firm's export share by 6.3% whereas a one standard-deviation rise in REER volatility (or 0.69 as per Table 2) dampens exports by as much as 26% (0.69×0.379).

The significant exchange rate effect is in accordance with the standard economic result – a higher price level deters exports. It also echoes, for example, Srinivasan and Wallack (2003), and Veeramani (2008) who reported a negative relationship between the real exchange rate and merchandise aggregate exports in India.⁶ The negative volatility effect lends support to the reasoning that a high level of uncertainty represented by a high level of volatility has an adverse effect on trade.⁷ The results under Column III suggests the overlap between the two exchange rate effects on exports is rather limited – the two coefficient estimates under Column III are quite comparable to their corresponding ones under Columns I and II.

The margin effect of foreign income on export shares is illustrated under Columns IV and V. The positive and significant income effect is in line with standard textbook predictions and the results in also consistent with Srinivasan and Wallack (2003), Bugamelli and Infante (2003) and Veeramani (2008). It is noted that, in the specification that includes the time effect variables, the REER effect is strengthened to 7.1% from, say, 6.3%.

In sum, the exchange rate effects based on India's firm level data are largely in line with the standard trade theory. Our results are also consistent with the findings of a few studies on the same topic that are based on micro-data from developed economies; including Berman, Martin

⁶ Negative exchange rate effects based on developed country firm-level data are reported in, for example, Greenaway, Kneller and Zhang (2007), Forbes (2002) and Bernard and Jensen (2004b).

⁷ See Clark (1973), Baron (1976), Hooper and Kohlhagen (1978) among some of the earlier evidence of the negative impact of exchange rate volatility on trade and Côte (1994) for an extensive literature review on this effect.

and Meyer (2009), Bernard and Jensen (2004b), Campa (2004), Fitzgerald and Haller (2010), Forbes (2002), and Greenaway, Kneller and Zhang (2007).

4. Firm-Specific Effects

To control for effects of firm-specific variables, we consider the regression specification

$$\Delta X_{it} = \beta_0 + \beta_1 \Delta REER_t + \beta_2 (REER_vol)_t + \beta_3 \Delta I_t^* + \beta_4 Y_{it-1} + \chi u_i + \phi \eta_t + \varepsilon_{it}, \quad (2)$$

where Y_{it-1} is a vector of observable characteristics of firm i at time $t-1$, that could affect a firm's export decision. The time-varying firm-level explanatory variables are all lagged by one year to avoid any simultaneity effect. We had also included the firm-specific variables in their first differences. The results were found to be qualitatively the same and, hence, were not reported for brevity.

The firm-specific variables included are: (i) firm size measured by the log of total assets and often interpreted as a proxy for a firm's success or ability to cope with financial constraints, (ii) firm's efficiency in capital utilization measured by ratio of sales to total assets, the underlying hypothesis being that more efficient firms are more likely to handle unfavorable exchange rate movements, (iii) firm's ability to borrow externally captured by a measure of collateral such as ratio of net fixed assets to total assets, and (iv) firm's foreign currency borrowing measured by the ratio of secured and unsecured foreign currency borrowings to total liabilities. While currency depreciation increases the local currency burden of foreign currency debt thereby adversely affecting a firm's balance sheet, exporters have a natural hedge against currency depreciation by virtue of their export revenues that are denominated in foreign currency. Thus, the extent of foreign currency borrowing may have an overall ambiguous implication for exchange rate effects on exports. These firm characteristics have been used in exploring factors determining firms' exports in studies including Roberts and Tybout (1997), Campa (2004), Greenaway, Guariglia and Kneller (2005), and Bernard and Jensen (2004b).

The results of estimating Equation (2) are reported in Table 5. We sequentially introduce the firm-level determinants to the baseline regression. It is kind of unexpected to find that none of these firm-level variables has a significant effect on firms' export shares. The insignificant result is quite different from those studies based on data from developed countries (Greenaway, Kneller and Zhang, 2007; Bugamelli and Infante, 2003 and Forbes, 2002).

In passing, we note that some efforts were made to ensure that the adopted specification

is not the main reason driving the insignificant results, including the one pertaining to the firm size. Specifically, we considered a specification that includes the contemporaneous, instead of lagged, firm-level variables. On the firm size variable, we used the log of total number of employees to define firm size – an alternative measure of firm size employed by some studies. We also interacted the REER change and volatility variables with the firm size measure. Results derived from these modifications are qualitatively the same as those in Table 5 and thus, are not reported here for brevity.

The inclusion of these firm-specific variables in general has limited impacts on the exchange rate and income variables. The REER volatility variable becomes marginally insignificant at the 10% level in the presence of firm size and collateral variables. However, the results from other specifications do not confirm the insignificance of the volatility variables. Indeed, the inclusion of insignificant firm-level variables could have impaired the regression efficiency and reduce the level of significance of other variables.

5. Macro Effects

The effect of India's macro conditions on its firm's export decision is examined using

$$\Delta X_{it} = \beta_0 + \beta_1 \Delta REER_t + \beta_2 (REER_vol)_t + \beta_3 \Delta I_t^* + \beta_4 Y_{it-1} + \beta_5 Z_t + \chi \mu_i + \phi \eta_t, \quad (3)$$

where the term Z_t includes (i) percentage change in nominal wage index, (ii) percentage change in nominal GDP, and (iii) percentage change in real wage index. While the wage variable is included to capture operation costs, the GDP change reflects aggregate domestic demand.

From the point of view of an average firm, it is unlikely that its exporting behavior will have a noticeable impact on either REER change or REER volatility or any of the other macro control variables. So we incorporate the contemporaneous and not lagged values of the macro variables, which represent common shocks to all firms. All these macro variables have been examined in other empirical trade studies including Bernard and Jensen (2004a), Greenaway *et al.* (2007), Bugamelli and Infante (2003).

Table 6 shows the estimation results of incorporating macro-level factors. Since the firm specific accounting variables considered in Section 4 are again insignificant when included in the regression, they are not discussed in this section. Indeed, adding or drop these firm specific account variables does not qualitatively affect the macro variable effects.

Nominal wages have a negative effect on firms' export share, which does make intuitive

sense because a rise in wages increases operation costs that in turn reduces a firm's competitiveness in the global market. The negative effect is also obtained when real wages were used instead. The coefficient estimate of GDP change is negative; indicating the tendency that exports activity declines with domestic demand that is proxied by GDP change. The negative effect of domestic demand is similar to the one found for Italian firms in Bugamelli and Infante (2003). However, for Indian firm's exports share, the effect is not statistically significant. It is worth noting that even after controlling for both firm specific as well as country-level determinants, the negative effect of REER appreciation continues to hold.

6. Additional Analyses

To further deepen our investigation, we conduct a few additional analyses as well. First, we consider the asymmetric exchange rate change effect and the asymmetric exchange rate volatility effect.

On asymmetric exchange rate effects, we constructed dummy variables for appreciation and depreciation and interacted them with the REER change and volatility terms. The results allowing for exchange rate asymmetry are reported in Columns I and II of Table 7. Apparently, the exchange rate effects observed in previous sections are driven by exchange rate appreciation and not by depreciation.

The coefficient estimate of REER change interacted with the appreciation dummy is statistically significant with a negative sign implying that a large appreciation reduces exports as is expected. The magnitude of the estimate is larger in absolute value than the corresponding one in Table 4.

However, when interacted with the Depreciation dummy, the REER change variable is not significant. The REER volatility variable displays similar asymmetric effects. Under the appreciation phase, REER volatility has a strong and statistically significant negative effect on export share. Its effect is, on the other hand, insignificant when the REER is depreciating. All in all, it is appreciation that hurts export activity.

Next, we assess the dependence of response to exchange rates on a firm's export level. The small and large exports dummy variables are constructed based on whether the export shares are above or below the median level. Then, we interacted these dummy variables the REER change and volatility terms. Results are shown in Columns III and IV of Table 7.

Relatively speaking, the adverse exchange rate effect is stronger on firms with a small export share than with a large one. The estimate results indicate that a one percentage point REER appreciation reduces the export share by around 11% for firms with below the median export share, and by 5% for firms above the median level export share. Firms that export relatively less are more adversely affected by appreciation.

On the volatility side, once again firms with below median exports react negatively to REER volatility but curiously enough, firms with larger exports react positively to a rise in exchange rate volatility. As mentioned earlier, existing theoretical models and empirical results do not offer a definite verdict on the volatility effect on trade. Although the negative volatility effect appears intuitive and is support by, say, models based on risk aversion, a positive volatility is a possibility with models based on transaction costs considerations and view exporting activity an option that is exercised under favorable conditions.⁸ By splitting the sample according to firm's export shares, both positive and negative effects are revealed. Arguably, firms that have a large export share would have the incentive and, possibly, the means to benefit from exchange rate volatility via, say, hedging and re-directing its exports to alternative destinations.

Third, in recognizing the growing importance of services trade, we split to firm sample into those that exports goods and those that exports services and investigate whether exchange rate has differential impacts on these difference export activities. In fact, India's export sector has been dominated by commercial services over the last decade or so. For instance, in Table 3 it is shown that the share of services exports in firms' sales is on average around 30% whereas that of goods exports is only 23%. As exports of information technology (IT) services is a main component of India's commercial services exports (average export shares under the IT services category for our sample period is around 64%) we separate exports of non-IT services from IT services.

Results in Table 8 are suggestive of differential exchange rate effects across alternative type of exports. Compared with services exports, goods exports are less sensitive to the negative exchange rate effect. The coefficient estimates indicate that the effect of the REER change variable on service exports is about 50% stronger than on goods exports. Interestingly, while the exports of non-IT services yield a large (in magnitude) REER change coefficient estimate, the

⁸ Clark (1973) is an early paper on the negative volatility effect and Franke (1991) offers an example of the positive volatility effect.

estimate is statistically insignificant. Instead, non-IT services are the only type of exports that is significantly impacted by exchange rate volatility. That is, exchange rate management could have different implications for different type of exporting activities. The breakdown of firms into different categories reveals that the foreign income effect is only observed for exports of goods – exports of services are not significantly influenced by income.

Fourth, to investigate the sensitivity of results to our choices of the trade and exchange rate variables, we consider a) real exports as the dependent variable, and b) effects of the nominal effective exchange rate (NEER).

Table 9 reports the results of estimating equation (1) with the exports variable measured by a firm's exports normalized by the wholesales or consumer price indexes. Normalization using either wholesales or consumer price indexes does not change the estimation results. Both the exchange rate and foreign income effects are quality similar to those reported for export shares in Table 4. Indeed, the magnitude of the exchange rate change, volatility and foreign income effects on firm's real exports are larger than those on firm's export shares. Thus, measuring exporting behavior using either export share or real exports yield similar average exchange rate and foreign income effects across firms.

The two nominal exchange rate variables are constructed the same ways as the REER change and volatility variables, and their estimated effects are presented in Table 10. We note that the Reserve Bank of India manages the Indian rupee nominal exchange rate and most discussions on exchange rate effects in the media refer to nominal exchange rate policy. Thus, it is likely that the nominal rate rather than the real rate is what the firms follow.

The estimated coefficient of NEER change is negative and statistically significant across all specifications. With the exception of specification V, the NEER change effects have magnitudes comparable to those in Table 4. The NEER volatility effect, however, is quite different from the REER volatility effect. Specifically, the NEER volatility variable is only statistically significant under specification V and has a positive sign. The positive effect is opposite to the negative effect for REER volatility in Table 4. As noted earlier, the volatility effect on trade is no conclusive from either a theoretical or an empirical point of view. However, it will be of interest in further research to investigate the different real and nominal exchange rate volatility effects.

Fifth, we excluded firms with less than three years of data and re-estimated Equation (3)

with firm-level control variables and macro economic factors. It is found that the results for the sample in which firms are present for a sufficient time period are qualitatively similar to those reported in previous sections and, thus, are not reported for brevity but are available upon request.

7. Concluding Remarks

India is one of the famed BRIC countries. Since 1991, India has launched a series of reform initiatives and becoming more integrated with the global economy. Its international trade has expanded considerably – from 6% of GDP in 1990 to 23% in 2010. Undeniably, India's economy is increasingly linked to the rest of the world and has a reasonable amount of dependence on exports—starting from 7% of in 1990, exports in 2010 accounted for almost 23% of India's GDP.

Against this backdrop, we investigate the exchange rate effects on exports using Indian firm level data. Specifically, we use detailed data on a sample of Indian non-financial sector firms for the period 2000-2010 to analyze the effects of the REER change and volatility on a firms' export shares. During this period, exports registered a remarkable increase, while the REER exhibited a steady appreciation trend; barring the post-crisis period of 2009 when there was a sharp depreciation. Thus, it is of interest to find out whether such appreciation has an adverse impact on firms' exports as is predicted by standard textbook theory.

Our basic empirical analysis reveals that indeed over the sample period a currency appreciation had a strong and significant negative impact on Indian firms' export shares. REER volatility also tends to have a negative effect on a firm's export decision. In that sense, our results are in line with those reported by other studies using firm level data from developed countries as well as other Indian studies that use aggregate exports data.

While the firm-level accounting information and other macro variables have limited implications for the interaction between exchange rate and exports, there is evidence that these Indian firms respond asymmetrically to exchange rates. For instance, the REER change effect is likely to be driven by the negative appreciation effect but not the depreciation effect. Also, the Indian firms that have a smaller export shares tend to have a stronger response to both REER change and volatility. Compared with those exporting goods, the firms that export services are more affected by the exchange rate.

These results have some important policy implications. In view of the Indian economy's dependence on exports and the Reserve Bank of India's managed exchange rate policy, our empirical results indicate a currency appreciation and volatility, in general, have an adverse effect on Indian firms' exports, and the effect tend to be stronger for firms that have a smaller export share or export services. Thus, if policy makers wish to promote exports especially as Indian growth rate keeps faltering in recent times, they ought to focus their efforts on stemming steady appreciation of the exchange rate and reducing volatility. Apparently, the Reserve Bank of India has been pursuing the asymmetric policy of intervening to prevent appreciation over the last decade or so (Sen Gupta and Sengupta, 2012). It should be noted that the exchange rate policy could have a stronger effect on some firms than others, and alternative policies may be sought to offer a balanced effect across different types of firms.

In sum, a finer classification of firms and exchange rate movement suggests that the exchange rate effects are more complex than the simple textbook prescription. To shed additional insight to the exporting behavior of Indian firms, it is warranted in future research to examine the factors underlying the asymmetric responses. The availability of destination-specific and sector-specific firm level and price data could allow future studies to gauge a better picture of firm's exporting behavior.

Data Appendix

Macro Variables	Definitions/Descriptions	Data Sources
REER	Real Effective Exchange Rate-weighted averages of bilateral exchange rates adjusted by relative consumer prices. Weighting pattern is time varying, and the weights are based on trade in 2008-10. The base year of index is 2010.	Bank of International Settlements (BIS) database
REER Change	Annual percentage change in REER indices	BIS
REER Volatility	Annual standard deviation of monthly REER indices.	BIS
Change in Nominal Wages	Annual percentage change in hourly wages in local currency, over previous year	Yearbook of Labor statistics from the International Labor Organization (ILO)
Change in Real Wages	Annual percentage change in hourly wages in local currency adjusted for inflation, over previous year.	Derived from ILO labor statistics
GDP Change	Annual percentage change in nominal GDP	Penn World Tables (version 7.1)
Change in foreign income level	Change in trade-share weighted incomes of top 10 trading partners	GDP data of trade partners from World Development Indicators (WDI); Trade shares data from the Export-Import data bank maintained by the Department of Commerce in the Ministry of Commerce and Industry (Govt. of India)
Change in Share of World Exports	Percentage change in the ratio of world exports to world GDP	World Development Indicators (WDI) database.

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Table 1: Number of exporting firms by year

Year	2000	2001	2002	2003	2004	2005
Total Exporting Firms	3214	3251	3698	3348	4105	4154
Year	2006	2007	2008	2009	2010	
Total Exporting Firms	4167	4225	4289	4068	3702	

Table 2: Descriptive Statistics of some important variables: Full Sample

Variables (In %)	Mean	Std. Dev.	Min	Max
Exports/Sales	28.03	31.91	0	100.99
Exports/Sales (Goods)	25.07	29.60	0	100.99
Exports/Sales (Services)	26.19	35.51	0	100.98
Firm Size (log of Total assets)	6.64	1.83	0	14.86
Capacity Utilization	110.27	75.74	0	599.37
Collateral (Net fixed assets/Total assets)	32.30	20.84	0	100
Foreign Liability/Total Liability	1.66	6.08	0	99.46
REER	93.35	3.44	89.52	100
REER Change	1.35	4.88	-5.45	11.71
REER Volatility	1.90	0.69	1.22	3.54
Nominal Wage Index	219.04	127.46	87.40	418.1
GDP Change	9.96	3.33	4.33	14.33
World Exports/World GDP	26.30	2.03	24.02	29.57

Table 3: Descriptive Statistics of some important variables for three years

Variables (In %)	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
	2000		2005		2010	
Exports/Sales	26.18	31.27	28.89	32.31	27.04	31.22
Exports/Sales (Goods)	25.92	50.13	26.15	35.72	23.99	28.77
Exports/Sales (Services)	25.59	53.83	31.29	55.66	30.54	73.35
Firm Size (log of Total assets)	6.32	1.63	6.45	1.81	7.29	1.93
Capacity Utilization (Sales/Total assets)	103.81	72.56	114.38	75.43	106.88	72.44
Collateral (Net fixed assets/Total assets)	36.28	21.41	31.52	20.41	29.60	20.16
Foreign Liability/Total Liability	0.73	4.35	2.15	6.80	1.75	5.64
REER	91.34	0	94.10	0	100.001	0
REER Change	4.53	0	3.40	0	11.71	0
REER Volatility	1.91	0	1.74	0	2.19	0
Nominal Wage Index	103.76	0	100	0	418.1	0
GDP Change	4.33	0	13.53	0	11.39	0
World Exports/World GDP	24.70	0	26.77	0	27.97	0

Table 4: Baseline regression I: Dependent variable is Change in Exports/Sales

Variables	I	II	III	IV	V
REER Change	-0.063*** (0.017)		-0.062*** (0.017)	-0.063*** (0.017)	-0.071*** (0.019)
REER Volatility		-0.379*** (0.119)	-0.375*** (0.119)	-0.455*** (0.120)	-0.303* (0.174)
I* Change				0.027*** (0.009)	0.033*** (0.010)
Year Dummies	No	No	No	No	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	33132	33132	33132	33132	33132

Robust Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, Constant is not reported.

The Table presents results of estimating Equation (1) in the text. I^* is the level of foreign income (proxied by trade-share weighted average of incomes of India's principal trading partners) that represents growth in overseas markets.

Table 5: Estimating Equation 2 in Text: Adding Lagged Firm-Level Controls

Variables	I	II	III	IV
REER Change	-0.070*** (0.020)	-0.069*** (0.020)	-0.072*** (0.020)	-0.073*** (0.020)
REER Volatility	-0.293 (0.183)	-0.285 (0.183)	-0.312* (0.185)	-0.322* (0.184)
I* Change	0.033*** (0.011)	0.034*** (0.011)	0.037*** (0.011)	0.036*** (0.011)
Lagged Firm Size	-0.038 (0.209)	-0.042 (0.213)	0.090 (0.236)	0.127 (0.234)
Lagged Collateral		0.008 (0.010)	0.009 (0.010)	0.010 (0.010)
Lagged Capacity Utilization			0.002 (0.003)	0.002 (0.003)
Lagged Foreign Liability Share				-0.026 (0.017)
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
Observations	33132	33021	32930	32922

Robust Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1, Constant is not reported.

The Table presents results of estimating Equation (2) in the text. *Firm Size* is measured using logarithm of total assets. *Collateral* is defined as the ratio of net fixed assets to total assets, *capacity utilization* is measured by the ratio of sales to total assets, and *foreign liability share* is the ratio of foreign currency liabilities (secured and unsecured foreign currency borrowings) and total liabilities. All firm-level control variables are lagged by one year.

Table 6: Estimating Equation 3 in Text: Adding Country-Level Controls

Variables	I	II	III
REER Change	-0.100*** (0.023)	-0.097*** (0.023)	-0.100*** (0.023)
REER Volatility	-0.938*** (0.335)	-0.912*** (0.264)	-0.936*** (0.269)
I* Change	0.066*** (0.019)	0.062*** (0.015)	0.064*** (0.015)
Change in Nominal Wages	-0.006* (0.003)	-0.006*** (0.002)	
GDP Change		-0.016 (0.066)	-0.013 (0.066)
Change in Real Wages			-0.006*** (0.002)
Firm Fixed Effects	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes
Observations	33132	33132	33132

Robust Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1, Constant is not reported.

The Table presents results of estimating Equation (3) in the text. *Change in Nominal Wages* denotes percentage change in hourly wages in local currency, over previous year, with data from the Yearbook of Labor statistics. *GDP Change* is the annual percentage change in GDP with data from the Penn World Tables. *Change in Real Wages* denotes percentage change in hourly wages in local currency adjusted for inflation, over previous year, with data from the Yearbook of Labor statistics.

Table 7: Additional Analysis I: Asymmetric Effects of REER Change & Volatility

Variables	I	II	III	IV
I* Change	0.013 (0.012)	0.018* (0.011)	0.025*** (0.010)	-0.042** (0.021)
REER Change*Appreciation Dummy	-0.163*** (0.053)			
REER Change* Depreciation Dummy	0.192 (0.126)			
REER Volatility*Appreciation Dummy		-0.644*** (0.214)		
REER Volatility*Depreciation Dummy		-0.154 (0.171)		
REER Change*Small Exports Dummy			-0.111*** (0.046)	
REER Change*Large Exports Dummy			-0.053*** (0.019)	
REER Volatility *Small Exports Dummy				-0.930** (0.412)
REER Volatility *Large Exports Dummy				1.263*** (0.413)
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
Observations	33132	33132	33132	33132

Robust Standard errors in parentheses;*** p<0.01, ** p<0.05, * p<0.1, Constant is not reported.

The Table presents results of estimating Equation (1) in the text. REER Change and REER Volatility are each interacted with an Appreciation dummy variable, which takes the value 1 if REER Change is positive and zero otherwise and with a Depreciation dummy variable which takes the value 1 if REER Change is negative and zero otherwise. REER Change and REER Volatility are each also interacted with a Small Exports dummy that is 1 if the value of exports is less than the median and 0 otherwise and a Large exports dummy that is 1 if the value of exports is greater than or equal to the median value and 0 otherwise.

Table 8: Additional Analysis II: Splitting sample according to Goods & Services Exports

Variables	Exports of Goods (I)	Exports of Services (II)	Exports of IT Services (IV)	Exports of Non-IT Services (V)
REER Change	-0.061*** (0.017)	-0.096** (0.050)	-0.195 (0.177)	-0.094*** (0.039)
REER Volatility	-0.207 (0.211)	-0.461 (0.326)	-0.539* (0.315)	0.194 (0.290)
I* Change	0.042*** (0.012)	0.028 (0.018)	-.031 (0.040)	.014 (0.022)
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
Observations	26952	9025	2456	5475

Robust Standard errors in parentheses;*** p<0.01, ** p<0.05, * p<0.1, Constant is not reported.

The dependent variable in Column I is change in the ratio of goods exports/sales whereas in Column II it is change in the ratio of services exports/sales. Column III estimates the effect of REER change and volatility on the change in services exports/sales ratio exclusively for the software services industry and Column IV for the non-IT services industries.

Table 9: Robustness Check I: Using Change in Real Exports as a dependent variable

Variables	Real Exports (WPI) I	Real Exports (CPI) II
REER Change	-0.085*** (0.020)	-0.082*** (0.019)
REER Volatility	-0.494*** (0.192)	-0.472*** (0.189)
I* Change	0.042*** (0.011)	0.045*** (0.011)
Year Dummies	Yes	Yes
Firm Fixed Effects	Yes	Yes
Observations	38175	38175

Robust Standard errors in parentheses;*** p<0.01, ** p<0.05, * p<0.1, Constant is not reported. The dependent variable in Column I is percentage change in total exports deflated by CPI [Consumer price index-Industrial Workers (Fiscal year 2001=100) in local currency, period average, obtained from the Labor Bureau of India] and in Column II it is percentage change in total exports deflated by WPI (Wholesale Price Index in local currency, period average).

Table 10: Robustness Check II: Effect of NEER change and volatility

Variables	I	II	III	IV	V
NEER Change	-0.063*** (0.019)		-0.067*** (0.019)	-0.071*** (0.019)	-0.030* (0.019)
NEER Volatility		0.063 (0.073)	-0.034 (0.076)	-0.147 (0.097)	0.216*** (0.075)
I* Change				0.025** (0.012)	-0.011 (0.012)
Year Dummies	No	No	No	No	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	33132	33132	33132	33132	33132

Robust Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1, Constant is not reported.

The Table presents results of estimating Equation (1) in the text. *I** is the level of foreign income (proxied by trade-share weighted average of incomes of India's principal trading partners) that represents growth in overseas markets.