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**Working Paper**

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

CESifo Working Paper, No. 4214

**Provided in Cooperation with:**

Ifo Institute – Leibniz Institute for Economic Research at the University of Munich

*Suggested Citation:* Cheung, Yin-Wong; Sengupta, Rajeswari (2013) : Impact of Exchange Rate Movements on Exports: An Analysis of Indian Non-Financial Sector Firms, CESifo Working Paper, No. 4214, Center for Economic Studies and ifo Institute (CESifo), Munich

This Version is available at:

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CESIFO WORKING PAPER NO. 4214  
CATEGORY 7: MONETARY POLICY AND INTERNATIONAL FINANCE  
APRIL 2013

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

## 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. The labor costs are found to intensify the exchange rate effects on trade. Further, 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, 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-Code: F100, F400.

Keywords: exchange rate fluctuations, firm-level export shares, asymmetric effects, services exports.

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This Version: March 2013

We thank Joshua Aizenman, Joshua Felman, Reuven Glick, Ajay Shah and participants of the NIPFP-DEA-JIMF Conference, 2012 for their comments and suggestions on earlier drafts of the paper.

## 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.<sup>1</sup>

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<sup>1</sup> 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).

The current study focuses on India's exports. Compared with other firms, exporting firms are usually associated with a higher level of productivity and profitability. A strong export sector could generate considerable spillovers to other sectors thereby promoting overall economic growth. In the last decade or so, India witnessed strong economic performance coupled with a strong export sector. Thus, it may be conceived that a policy that promotes exports is conducive to economic growth.

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 went 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) increased from 0.5% in 1990 to about 1.4% in 2010. As a result, India 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 with the former registering an average annual growth rate of about 23% whereas the latter growing 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 rate 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' exporting 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, neither the theoretical nor the empirical studies offer a firm conclusion on the effect of exchange rate volatility on international trade 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.<sup>2</sup>

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<sup>2</sup> 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.

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 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 also 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 seem to affect the exchange rate and trade interaction, b) either real or nominal wage increase has a negative effect on exports, c) compared with depreciation, appreciation is associated with a stronger exchange rate change and a stronger volatility effect on trade, d) exchange rate effects are different between firms with large and small export shares, e) exchange rate changes have a stronger impact on services exports as compared to merchandise exports. 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 in 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.

Table 1: Number of exporting firms by year

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

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 once during the entire sample period. The numbers of firms in each of the sample years, after dropping out outliers, are listed in Table 1.<sup>3</sup> 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.

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<sup>3</sup> 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.



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

<b>Variables (In %)</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>Min</b>	<b>Max</b>
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
Real per capita GDP Growth rate	5.54	2.37	2.23	8.22
World Exports/World GDP	26.30	2.03	24.02	29.57

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 between different behavioral patterns across firms.

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
Real per capita GDP Growth rate	2.23	0	7.65	0	8.04	0
World Exports/World GDP	24.70	0	26.77	0	27.97	0

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 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.<sup>4</sup> Compared

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<sup>4</sup> Several studies used destination specific bilateral real or nominal exchange rates. Unfortunately destination specific information is not available for Indian firms. Given our data structure and limitations, aggregate REER and

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 slightly higher than the levels in 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 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;  $\Delta I_t^*$  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. Both contemporaneous  $\Delta REER_t$  and  $(REER\_vol)_t$  are used as it is unlikely that a firm's exporting behavior will have an effect on either REER change or REER volatility.<sup>5</sup> Equation (1), thus, assesses the average responses in 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,  $\mu_i$ , is included to capture firm's specific attributes that are (approximately) time-invariant and have implications for exporting behavior. These attributes may include managerial

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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. In Section 6, as a part of robustness checks, we consider WPI and CPI based real exports data.

<sup>5</sup> In fact, the inclusion of the lagged REER change and lagged REER volatility in the canonical regression does not change the significant negative exchange rate results reported below while the lagged REER change is insignificant. These results are available upon request.

characteristics, foreign experience, and product quality.<sup>6</sup> In the next section, we introduce an augmented specification that incorporates time-varying firm-specific explanatory variables.

The term  $\eta_t$  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 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,  $\varepsilon_{it}$  is the regression error term.

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

Note: 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.

The results of estimating Equation (1) are reported in Table 4. For brevity, the time and fixed effects variables ( $\eta_t$  and  $\mu_i$ ) 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.

<sup>6</sup> 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.

Controlling for fixed effects, both exchange rate movements and volatility have a statistically significant negative impact 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% ( $0.69 \times 0.379$ ).

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.<sup>7</sup> 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.<sup>8</sup> 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 marginal 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 are 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 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

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

where  $Y_{it-1}$  is a vector of observable characteristics of firm  $i$  at time  $t-1$ , that could affect a firm's

<sup>7</sup> 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).

<sup>8</sup> 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.

export decision. The time-varying firm-level explanatory variables are all lagged by one year to avoid any simultaneity effect. We also included the firm-specific variables in their first differences. The results were found to be qualitatively the same and, hence, are 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.

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

Note: 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.

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 variable. Indeed, the inclusion of insignificant firm-level variables could have impaired the regression efficiency and reduced 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

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

where the term  $Z_t$  includes (i) percentage change in nominal (or real) wage index, (ii) percentage change in the world exports to GDP ratio, and (iii) real per capita GDP growth rate. The wage variables are included to capture operation costs, the world exports to GDP ratio to assess the global trade effect, and the GDP change reflects aggregate domestic demand.<sup>9</sup>

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).<sup>10</sup>

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 reported and discussed here for brevity. Indeed, adding or dropping these firm specific account variables does not qualitatively affect the macro variable effects.

Nominal wages have a negative effect on firms' export share (Column I). The result is quite intuitive because a rise in wages increases operation costs that in turn reduce a firm's competitiveness in the global market. A similar negative effect is also obtained when real wages were used instead (Column II). This is consistent with other related studies such as Bugamelli and Infante (2003) who find that for their sample of Italian firms, the probability of exporting decreases with average wages – the latter acting as a proxy for cost competitiveness.

Apparently, the Indian firms' exports co-move with the world exports. The world exports to GDP ratio has a significantly positive coefficient estimate (Column III). In addition to the general trend in global trade, the world exports to GDP ratio measures the effect of the sharp contraction of world trade during the crisis period. Our results suggest that the global trade pattern points to the general behavior of Indian exporting firms – however, it does not overshadow the exchange rate effect. In fact, the exchange rate effect coefficient estimate is the largest under Column III.

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<sup>10</sup> However as mentioned earlier, our baseline results are in general robust to the inclusion of lagged REER change and lagged REER volatility variables.



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

Variables	I	II	III	IV
REER Change	-0.100*** (0.023)	-0.103*** (0.024)	-0.172*** (0.039)	-0.108*** (0.043)
REER Volatility	-0.938*** (0.335)	-0.959*** (0.345)	-0.700*** (0.280)	-0.663*** (0.285)
I* Change	0.066*** (0.019)	0.067*** (0.004)		
Change in Nominal Wages	-0.006* (0.003)		-0.004 (0.003)	-0.001 (0.003)
Change in Real Wages		-0.007*** (0.004)		
Change in World Exports to GDP Ratio			0.107*** (0.032)	0.069** (0.033)
Real per capita GDP Growth Rate				-0.131*** (0.053)
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
Observations	33132	33132	33132	33132

Note: 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. *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. *Real per capita GDP growth rate* is the annual percentage change in per capita GDP (constant local currency units) with data from the WDI database.

The coefficient estimate of real per capita GDP growth is negative, indicating the tendency that export activity declines with an increase in domestic demand that is proxied by GDP growth (Column III). The negative effect of domestic demand is similar to the one found for Italian firms in Bugamelli and Infante (2003).

It is interesting to observe that the inclusion of these macro variables renders the wage effect insignificant and, at the same time, strengthens the exchange rate effect. Comparing the

corresponding coefficient estimates in Table 4 and Table 6, the effects of REER Change and REER Volatility appear stronger in the latter table than in the former. The income variable also displays a substantial increase in its impact on export shares in Table 6. Thus, developments in the domestic and global markets could affect the response of trade to exchange rate and foreign income.

## **6. Additional Analyses**

To further deepen our investigation, we conduct a few additional analyses as well. First, we consider asymmetric exchange rate change effects. We construct dummy variables for appreciation and depreciation and interact 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 is found to hurt export activity.

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

Relatively speaking, the adverse exchange rate effect seems to be stronger on firms with a small export share than with a large one. The estimated 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 with above the median level export share. Firms that export relatively less are apparently more adversely affected by appreciation.

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

Note: 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.

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 supported by, say, models based on risk aversion, a positive volatility is a possibility with models that are based on transaction costs considerations and that view exporting activity as an option exercised under favorable conditions.<sup>11</sup> 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 could have the incentive and, possibly, the means to benefit from exchange rate volatility via, say, hedging and re-directing their exports to alternative destinations.

Third, in recognizing the growing importance of services trade, we split our firm sample into those that export goods and those that export services and investigate whether exchange rate has differential impacts on these different export activities. 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 further 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 appear less sensitive to the negative exchange rate effect. The coefficient estimates indicate that the effect of the REER change on services exports is about 50% stronger than on goods exports.<sup>12</sup> Interestingly, while the exports of IT services yield a large (in magnitude) REER change coefficient estimate, the estimate is statistically insignificant. Instead, non-IT services are the only type of services exports that seem to be significantly impacted by exchange rate change. Thus, exchange rate management could have different implications for different types 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.

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<sup>11</sup> Clark (1973) is an early paper on the negative volatility effect and Franke (1991) offers an example of the positive volatility effect.

<sup>12</sup> This result is consistent with Eichengreen and Gupta (2012) who find that at the macro level the effect of the real exchange rate is stronger for exports of services than exports of merchandise.

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	-0.062*** (0.017)	-0.105** (0.049)	-0.195 (0.177)	-0.068*** (0.021)
REER Volatility	-0.198 (0.210)	-0.343 (0.360)	-0.539* (0.315)	-0.425 (0.423)
I* Change	0.042*** (0.012)	0.029 (0.018)	-0.031 (0.040)	0.048*** (0.022)
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
Observations	27073	9247	2456	6928

Note: 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.

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, as well as 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 wholesale or consumer price indices. Normalization using either wholesale or consumer price indices does not change the estimation results. Both the exchange rate and foreign income effects are qualitatively similar to those reported for export shares in our baseline model in Table 4. Indeed, the magnitudes of the exchange rate change, volatility and foreign income effects on firms' real exports are found to be larger than those on firms' export shares. Thus, measuring exporting behavior using either export share or real exports yields similar average exchange rate and foreign income effects across firms.

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

Note: 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).

The two nominal exchange rate variables are constructed following the same methodology 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 may be 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 not 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 on trade.

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

Note: 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.

In addition to these results, we conduct a few other analyses to assess the robustness of the real exchange rate effect. To conserve space, we briefly discuss the results of these additional exercises below, and the details are available upon request.

We excluded firms with less than three years of data and re-estimated Equation (3) with firm-level control variables and macro economic factors. We found that results for the sample in which firms are present for a sufficient time period are qualitatively similar to those reported in previous sections.

Next, as an alternative way to assess the implications of the global financial crisis, we re-estimated the canonical trade equation using two non-overlapping samples of 2000 to 2007 and 2008 to 2010. In both sub-samples, the REER Change effect is found to be statistically negative. The effect is stronger between 2000 and 2007 (coefficient estimate = -.15) than during the crisis

period (coefficient estimate =  $-.04$ ). The strong negative exchange rate effect in the pre-2008 period is also recorded for other specifications such as those that allow for asymmetric responses reported in Table 7. The small estimated exchange rate effect is possibly due to both the relatively short sample period and the high volatility experienced during the crisis period.

Finally, we assessed the possible roles of a few other macro variables that may affect exporting behavior. Specifically, we considered the effects of a terms of trade variable, a crude oil price measure, and the VIX index that represents overall market volatility. The encouraging finding is that, in the presence of these variables, the real exchange effect maintains its significance and, usually, is stronger than the one reported in, say, Table 4.

## **7. Concluding Remarks**

India is one of the well-known BRIC countries. Since 1991, India has launched a series of globalization and liberalization reform initiatives. Undeniably, India's economy is now 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 REER change and volatility on firms' export shares. During the sample 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 explore whether such appreciation has an adverse impact on firms' exports as 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 was also found 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 has limited implications for the interaction between exchange rate and exports, the labor cost apparently could intensify the exchange rate effects on trade. Further, there is evidence that these Indian firms respond asymmetrically to



exchange rate movement. The REER change effect is likely to be driven by the negative appreciation effect but not so much by the depreciation effect. Also, Indian firms with smaller export shares were found to have a stronger response to both REER change and volatility. Compared with those exporting goods, firms that export services seem to be 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 that currency appreciation and currency volatility in general, have an adverse effect on Indian firms' exports. Based on this circumstantial evidence, it appears that if policy makers wish to promote exports, especially as the 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).

As noted earlier, exchange rate policy could have a stronger effect on some firms than others – for instance, our exercise indicates that the effect tends to be stronger for firms that have a smaller export share or that export services. Thus, a simple policy of managing the rate of appreciation to promote exports may have the unintended consequences of creating imbalances between different types of firms.

However, the policy of preventing appreciation may not survive the argument based on the so-called Penn effect. Briefly, the Penn effect suggests that appreciation goes hand in hand with growth. During the sample period, India's average per capita real economic growth was 5.54%. If we assume the income effect on real exchange rate is 0.25 (Cheung, Chinn, and Fujii, 2007), then the implied rate of appreciation is  $1.38\% = 0.25 \times 5.54\%$ . Since the actual average real exchange rate appreciation of 1.35% recorded during the sample is indeed smaller than the implied appreciation, one could argue that the observed exchange rate is undervalued. Thus, a policy of preventing appreciation may be counter-productive. Indeed, it is worth noting in this context that the 2001-02 crisis experienced by Argentina-another emerging market economy, was arguably a result of its attempt in the 1990s to rein in its currency appreciation at a time of high economic growth.

Of course, the numerical example discussed above is mainly for illustration. We know that the income effect on real exchange rate is estimated with considerable amount of uncertainty. The important point to note here is that, for a fast growing country, the trade effect of exchange rate is not that straightforward to pin down. A discussion too focused on exchange rates runs the risk of overlooking other factors that may hinder India's exports. For instance, our results are suggestive of some kind of cross-market interaction – higher labor costs could magnify the negative exchange rate effects. Thus, policymakers should not focus exclusively on an exchange rate policy to promote India's export activity. India's export performance could very well benefit from a host of other catalytic factors such as investments in infrastructure including highways and ports, liberalization of the labor market, and a concerted policy to promote manufacturing industries.

On the other hand, the negative REER volatility effect that is consistently found in most of our reported regressions may deserve a close scrutiny. Reducing REER volatility will probably enhance export performance. Besides better hedging instruments, policies could be devised to alleviate volatility. However, as noted by Aizenman, Edwards, and Riera-Crichton (2012), the exchange rate volatility reducing policies usually come with costs including those associated with accumulating a high level of international reserves.

To summarize, a finer classification of firms and exchange rate movements suggests that the exchange rate effects on firms' exports are more complex than the simple textbook prescription. In order to shed additional insights into the exporting behavior of Indian firms and especially to obtain clear policy implications from such an empirical analysis, future research may be warranted to further examine the factors underlying the asymmetric responses of exporting firms to exchange rate movements. The availability of destination-specific and sector-specific firm-level exports and price data as well as as extending the sample period forward and backward and considering alternative estimation techniques including robust methods could further enhance our understanding of Indian firms' exporting behavior.

## Data Appendix

Macro Variables	Definitions/Descriptions	Data Sources
<b>REER</b>	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
<b>REER Change</b>	Annual percentage change in REER indices	BIS
<b>REER Volatility</b>	Annual standard deviation of monthly REER indices.	BIS
<b>Change in Nominal Wages</b>	Annual percentage change in hourly wages in local currency, over previous year	Yearbook of Labor statistics from the International Labor Organization (ILO)
<b>Change in Real Wages</b>	Annual percentage change in hourly wages in local currency adjusted for inflation, over previous year.	Derived from ILO labor statistics
<b>Real per capita GDP growth rate</b>	Annual percentage change in real per capita GDP	World Development Indicators (WDI) database.
<b>Change in foreign income level</b>	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)
<b>Change in Share of World Exports</b>	Percentage change in the ratio of world exports to world GDP	World Development Indicators (WDI) database.

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