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Real Exchange Rate Volatility and Employment: Role of External Sector Exposure

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Abstract

This paper studies the impact of real exchange rate volatility on firm level employment using a difference-in-difference model applied on a panel of 900 manufacturing firms. Trade exposure as measured by the difference between the shares of exports and imports in a firm's total revenues and input costs respectively, emerges as an important determinant of firm's response to higher exchange rate volatility. Firms with a positive trade exposure are found to experience a larger increase, or a smaller decrease, in employment growth than similar "non-exposed" firms in response to an increase in real exchange rate volatility. The impact of exchange rate volatility on employment is found to be non-linear in trade exposure. Finally, domestically owned firms respond differently to exchange rate shocks as compared to the foreign owned firms. Similarly, exporters respond differently to higher exchange rate volatility than the non-exporters.

JEL Classification: F1, F4

Key Words: Real Exchange Rate Volatility, Trade Exposure,

Introduction

Development economics has long been concerned with the effects of exchange rate movements on the real economy. The topic continues to attract theoretical as well as empirical researchers alike. Exchange rate movements can affect economic performance through a number of channels, such as the cost of imported inputs relative to other factors of production, price of exports relative to foreign competitors or the cost of external borrowing. One particular aspect of exchange rate movements that has been a cause of concern for policy makers and academics alike is the volatility of these movements. Exchange rate volatility has adverse effects on the volume of international trade since risk-averse importers and exporters are faced with greater risk and uncertainty about profits from their overseas activities and, consequently, reduce their demand for and supply of traded goods (see Bahmani-Oskooee and Hegerty, 2007). This, in turn, is likely to have adverse impact on trade, employment and investment growth. The gold standard of the 19th and early 20th centuries and the ensuing Bretton Woods system are credited with fostering a period of sustained growth in trade and investment across the world by providing a system of stable exchange rates. However, more nuanced analysts qualify the simple causal relationship between exchange rate stability and high growth and regard Gold standard and Bretton Woods as historically specific institutions instead that were sustained by specific circumstances that resulted in high growth and stable exchange rates. An important problem with the study of relationship between growth and exchange rate volatility is endogeneity of growth and exchange rate shocks. Greater trade openness can increase the vulnerability of a firm to exchange rate volatility (e.g. Klein et al., 2003) but at the same time higher exchange rate volatility can have an impact on firm's decision to export and import (e.g. Ethier, 1973; Rose, 2000; Engel and Rose, 2000 and Frankel and Rose, 2002). Similarly, financing constraints, that

can increase the fluctuations in employment (Sharpe, 1994), inventories (Kashyap, Lamont, & Stein, 1994), and investment (Fazzari, Hubbard, & Petersen, 1998), are likely to become more binding with increased exchange rate volatility (e.g Bernanke & Gertler, 1990).

This paper uses a situation similar to a natural experiment and applies a difference in difference methodology to a well-documented firm level panel dataset in order to identify the impact of higher exchange rate volatility on employment growth. The key contributions of this paper are threefold: a) use of firm level trade exposure in order to identify the effect of exchange rate volatility on employment growth b) highlighting the impact of access to domestic and foreign equity finance on firm's response to exchange rate volatility c) taking in to account heterogeneity in firm and industry level characteristics affecting the response to exchange rate volatility. The paper is organized as follows: section 2 gives a brief review of literature while section 3 presents a small theoretical model to motivate the empirical analysis. Section 4 describes the dataset and methodology used in the empirical analysis and section 5 presents the results. Section 6 concludes.

Literature Review:

The macro and microeconomic effects of exchange rate volatility have long been a major concern in economics. Exchange rate volatility can affect investment and growth through multiple channels. In theory, the sign of the relationship is ambiguous depending on the underlying assumptions (Aiginger, 1987; Caballero and Pindyck, 1996; Dixit and Pindyck, 1994; and the collection of articles in Aizenman and Pinto, 2005). In contrast, a rich body of empirical research points out an unambiguously negative effect of uncertainty on investment, employment, and growth (Aghion et al., 2009; Aizenman and Marion, 1999; Chong and Gradstein, 2009;

Federer, 1993; Pindyck and Solimano, 1993; Rosenberg, 2004; Serven, 2003). The previous studies show that exchange rate volatility works its effects through: a) changing the relative costs of production (Burgess and Knetter, 1998; Gourinchas, 1999; Klein et al., 2003); b) reducing the degree of credit availability from the banking system (Bernanke and Gertler, 1990) with contractionary effects on employment (Nickell and Nicolitsas, 1999; Sharpe, 1994) and investment (Fazzari et al., 1988); c) decreasing aggregate growth and productivity growth especially in countries where financial development is low (Aghion et al., 2009; Ramey and Ramey, 1995); d) increasing inflation uncertainty, which is found to reduce employment (Seyfried and Ewing, 2001), and growth (Grier and Grier, 2006); e) raising interest rates (UNCTAD, 2006)with negative growth effects (Nickell and Nicolitsas, 1999); f) damaging firm balance sheets and net worth (Bernanke and Gertler, 1990; Braun and Larrain, 2005); and g) discouraging international trade by raising transaction risk (Baum and Caglayan, 2010).

That said, the idea that minimizing exchange rate volatility is an essential part of the growth recipe is disputed. The evidence linking exchange rate volatility to exports and investment is less than definitive. The implications of volatility for financial stability and growth will depend on the presence or absence of the relevant hedging markets—and on the depth and development of the financial sector generally (see Aghion et.al., 2009). There is some evidence that these markets develop faster when the currency is allowed to fluctuate and that banks and firms are more likely to take precautions, hedging themselves against volatility, than when the authorities seek to minimize volatility (e.g. Shah and Patnaik (2010)). There is evidence, for example, of faster development of these markets and instruments following the Asian crisis (see Hohensee and Lee (2004)). More generally, Duttagupta, Fernandez and Karasadag (2004) show that countries with more variable exchange rates tend to have more liquid foreign exchange markets,

since their banks and firms have an incentive to participate. To be sure, there are limits to this argument that price variability is conducive to the development of hedging markets and instruments: high levels of volatility will be subversive to financial development, including even the development of hedging markets and instruments, insofar as it induces capital flight and leads the authorities to resort to policies of financial repression.

Illustrating the ambiguity in the empirical evidence further, some studies of currency crises conclude that these cause only temporary and transient disruptions to growth (See e.g. Calvo, Izquierdo and Talvi (2006)). Ghosh et al. (1997) found no relationship between observed exchange rate variability and economic growth for a sample of 136 countries over the period 1960–89, Bailliu et al. (2001) reported a positive association between the degree of exchange rate flexibility and economic growth. That this association is positive rather than negative leads one to suspect that this result reflects the influence of other factors correlated with both exchange rate flexibility and growth: political stability, institutional strength, and financial market development, for example. A further problem with much of this literature is that it focuses on the nominal rather than the real exchange rate. Dollar (1992) does report evidence of a negative OLS relationship between real exchange rate variability and growth in a sample of 95 developing countries covering the period 1976–85. Using different measures and country samples, Bosworth et al. (1995) and Hausmann et al. (1995) report similar results. Belke and Kaas (2004) find the same thing focusing on employment growth, the Central and Eastern European transition economies, and a subsequent period. But two other studies exploring the relationship between real exchange rate variability and growth in different developing country samples (Ghura and Grennes 1993 and Bleaney and Greenaway 2001) find little evidence of a relationship. Potential explanations include different country samples, different periods, different controls, different

ways of measuring the real exchange rate, and different degrees of omitted-variables and simultaneity bias.

Some recent studies have tried to use firm level data to untangle the relationship between growth and exchange rate volatility (e.g. Demir, 2009, 2013). However, these studies suffer from the problem of endogeneity bias. A careful analysis of the relationship between exchange rate volatility and growth taking in to account firm heterogeneity, industry structure and role of institutional finance is therefore much called for. This paper fills this important gap.

Theoretical Model

In this section we present a simple model of the labor market that allows us to illustrate the mechanisms through which exchange rate swings can induce equilibrium wage adjustment. Following Campa and Goldberg (1999; 2001) and Nucci and Pizzolo (2001; 2010), we consider the optimal conditions for profit maximization of a firm operating in an imperfectly competitive market. The firm's problem is defined as:

$$\max_{q,q^*,z,z^*,l} \pi(q,q^*,z,z^*,l,e) = E\left[p_{i,t} \times q_{i,t} + p^*_{i,t} \times q^*_{i,t} \times e_t - z_{i,t} \times s_{i,t} - z^*_{i,t} \times s^*_{i,t} \times e_t - w_{i,t} \times l_{i,t}\right] \qquad (1)$$

Subject to the technology constraint: $q_{i,t} + q^*_{i,t} = F\left(z_{i,t}, z^*_{i,t}, l_{i,t}\right)$ (2)

where q and $q*$ are the volumes of production for the domestic and the foreign markets, respectively, and the inverse demand functions $p(q,e)$ and $p*(q^*,e)$, have been substituted into the profit function; l is employment and z and $z*$ are the levels of domestically produced and imported non-labor inputs, respectively; w is the wage and s and $s*$ are the prices of the domestically produced and the imported inputs, respectively; e is the exchange rate, quoted as

the number of domestic currency units per foreign currency unit (i.e., an increase of e is therefore a currency depreciation).

The first order conditions with respect to q and $q*$ for the solution of the constrained maximization problem (1) are:

$$\frac{\partial p_{i,t}}{\partial q_{i,t}} \times q_{i,t} + p_{i,t} = \lambda_{i,t} \quad (3)$$

$$\frac{\partial p^*_{i,t}}{\partial q^*_{i,t}} \times q^*_{i,t} \times e_t + p^*_{i,t} \times e_t = \lambda_{i,t} \quad (4)$$

where λ is the Lagrange multiplier. Similarly, the first order conditions for profit maximization with respect to z, $z*$ and l are:

$$-s_{i,t} + \lambda_{i,t} \times \frac{\partial F\left(z_{i,t}, z^*_{i,t}, l_{i,t}\right)}{\partial z_{i,t}} = 0 \qquad (5)$$

$$-s^*_{i,t} \times e_t + \lambda_{i,t} \times \frac{\partial F\left(z_{i,t}, z^*_{i,t}, l_{i,t}\right)}{\partial z^*_{i,t}} = 0 \qquad (6)$$

$$-w_{i,t} + \lambda_{i,t} \times \frac{\partial F\left(z_{i,t}, z^*_{i,t}, l_{i,t}\right)}{\partial l_{i,t}} = 0 \qquad (7)$$

Assuming a constant return to scale production technology, the Euler's theorem can be used to express total output as follows:

$$q_{i,t} + q^*_{i,t} = \frac{\partial F\left(z_{i,t}, z^*_{i,t}, l_{i,t}\right)}{\partial l_{i,t}} \times l_{i,t} + \frac{\partial F\left(z_{i,t}, z^*_{i,t}, l_{i,t}\right)}{\partial z_{i,t}} \times z_{i,t} + \frac{\partial F\left(z_{i,t}, z^*_{i,t}, l_{i,t}\right)}{\partial z^*_{i,t}} \times z^*_{i,t} \qquad (8)$$

Using the first order conditions (3-8) along with the Euler equation (5) and defining $\frac{1}{\mu} = \left(1 + \frac{1}{\eta}\right)$ and $\frac{1}{\mu*} = \left(1 + \frac{1}{\eta*}\right)$ as the reciprocals of the mark-up ratios set, respectively, in the domestic and foreign product markets, we get the following equilibrium equation:

$$w_{i,t} \times l_{i,t} = E\left[\frac{p_{i,t} \times q_{i,t}}{\mu_{i,t}} - z_{i,t} \times s_{i,t} + \frac{p^*_{i,t} \times q^*_{i,t} \times e_t}{\mu^*_{i,t}} - z^*_{i,t} \times s^*_{i,t} \times e_t \right] \qquad (9)$$

Taking log of both sides we get:

$$\ln(l_{i,t}) = \ln\left(E\left[\frac{p_{i,t} \times q_{i,t}}{\mu_{i,t}} - z_{i,t} \times s_{i,t} + \frac{p^*_{i,t} \times q^*_{i,t} \times e_t}{\mu^*_{i,t}} - z^*_{i,t} \times s^*_{i,t} \times e_t \right] \right) - \ln(w_{i,t}) \qquad (10)$$

Equation 10 gives us the demand curve for labor.

Assume a standard supply curve for labor given by:

$$\ln(l_{i,t}) = a_0 + a_1 \times \ln(w_{i,t}) + a_2 \times \ln(y_{i,t}) \qquad (11)$$

where $\ln(y)$ is a measure of aggregate demand.

Using equation 11 to substitute for $\ln(w)$ in equation 10 we can get the following equation for equilibrium amount of labor:

$$\ln(l_{i,t}) = b_0 + b_1 \times \ln\left(\frac{p_{i,t} \times q_{i,t}}{\mu_{i,t}} - z_{i,t} \times s_{i,t} + E\left[\frac{p^*_{i,t} \times q^*_{i,t} \times e_t}{\mu^*_{i,t}} - z^*_{i,t} \times s^*_{i,t} \times e_t \mid \Omega_{t-1} \right] \right) + b_3 \times \ln(y_{i,t}) \qquad (12)$$

To keep the model analytically tractable, assume that the only source of uncertainty is the exchange rate. Further assume that the exchange rate follows a log-normal distribution with mean ν and variance σ_t^2, both of which are in the information set Ω_{t-1}. We can rewrite expression (12) as

$$\ln(l_{i,t}) = b_0 + b_1 \times \ln\left(\frac{p_{i,t} \times q_{i,t}}{\mu_{i,t}} - z_{i,t} \times s_{i,t} + \left(\frac{p^*_{i,t} \times q^*_{i,t}}{\mu^*_{i,t}} - z^*_{i,t} \times s^*_{i,t} \right) \times \exp\left(\nu + \frac{\sigma_t^2}{2} \right) \right) + b_3 \times \ln(y_{i,t}) \qquad (13)$$

Equation 13 shows how the exchange rate volatility can affect employment. As we can see, the effect of exchange rate volatility depends positively upon the difference between export earnings and import costs. Further, the impact is inversely related to the cost-price mark-up of the firm.

Equation 13 is non-linear in the variables of interest. In order to simplify the interpretation of the coefficients and to obtain an equation that can be used as the basis for empirical specification, equation 13 is linearized using a first-order Taylor approximation. Assuming that the mark-ups in domestic and foreign markets are same and linearizing equation 13 around the steady state gives us the following equation:

$$l_{i,t} = \varphi_0 + \varphi_1 \times \Lambda_{i,t}\left(\sigma_t^2 - \bar{\sigma}^2\right) + \varphi_3 \times \left(y_{i,t} - \bar{y}_i\right) \qquad (14)$$

where Λ_t is the trade exposure of the firm defined as the difference between share of exports in total revenues and share of imports in total costs. Eq. (14) is the key expression driving our empirical methodology below.

Data and Methodology

India presents an interesting case for empirical investigation of the role of exchange rate shocks both because of its dynamic growth experience over the last two decades and also because of its unique approach to financial integration in the face of rapid globalization and trade openness. India's overall management of capital flows can be characterized by its calibrated and gradualist approach towards capital account liberalization. In line with that, the RBI has followed a managed floating exchange rate regime to balance the competing objectives of exchange rate stability, low inflation and domestic growth. The section below gives a brief background of the recent Indian experience with exchange rates and capital flows.

Exchange Rate Volatility: The Indian Experience

"*With an open economy and large capital inflows, management of the exchange rate becomes an independent concern. The domestic currency can begin to appreciate (because of nominal appreciation) even with domestic price*

stability, if there are large capital inflows….Studies suggest that exchange rates are more volatile than can be explained by the macroeconomic fundamentals and moreover this excess volatility has in some cases inhibited international trade" - Rangarajan and Prasad (2008)

India's exchange rate policy has evolved over time in line with the gradual opening up of the economy as part of the broader strategy of macroeconomic reforms and liberalization since the early 1990s. In the post-independence period, India's exchange rate policy has seen a shift from a par value system to a basket-peg and further to a managed float exchange rate system. With the breakdown of the Bretton Woods System in 1971, the rupee was linked with pound sterling. In order to overcome the weaknesses associated with a single currency peg and to ensure stability of the exchange rate, the rupee, with effect from September 1975, was pegged to a basket of currencies till the early 1990s.

The initiation of economic reforms saw, among other measures, a two-step downward exchange rate adjustment by 9 per cent and 11 per cent between July 1 and 3, 1991 to counter the massive draw down in the foreign exchange reserves, to install confidence in the investors and to improve domestic competitiveness. The Liberalized Exchange Rate Management System (LERMS) was put in place in March 1992 involving the dual exchange rate system in the interim period. The dual exchange rate system was replaced by a unified exchange rate system in March 1993.

Trading volumes in the Indian foreign exchange market grew significantly in line with these developments. The daily average turnover saw almost a ten-fold rise during the 10 year period from 1997-98 to 2007-08 from US $ 5 billion to US $ 48 billion. The pickup was particularly sharp from 2003-04 onwards since when there was a massive surge in capital inflows. It is noteworthy that the increase in foreign exchange market turnover in India between April 2004 and April 2007 was the highest amongst the 54 countries covered in the Triennial Central Bank

Survey of Foreign Exchange and Derivatives Market Activity[1i] conducted by the Bank for International Settlements (BIS). The ratio of gross capital flows to GDP increased to a peak of 62.4 percent in 2007-08 before declining to 46.2 percent in 2009-10.

Initially, in order to prevent rupee from appreciating in response to the rise in capital inflows, RBI intervened in the foreign exchange market but at the same time tried to sterilize most of the intervention by depleting its stock of net domestic assets. In the face of large capital flows coupled with declining stock of government securities, the Reserve Bank of India introduced a new instrument of sterilization, viz., the Market Stabilization Scheme (MSS) in April 2004 to sustain open market operations. The RBI sold these MSS bonds on the behalf of the government to sterilize the impact of capital inflows. By August 2005, the amount of outstanding MSS bonds increased to Rs. 0.71 trillion. Overall result of this policy was that the real exchange rate of the Indian Rupee was kept stable during this period even though the fiscal cost of sterilization kept mounting.

In 2006-07 and 2007-08, the surge in capital inflow accelerated and the capital account registered a surplus of $46 billion and $107 billion, respectively. The RBI opted for an intermediate regime to manage the impossible trinity of stable exchange rate, free capital flows and independent monetary policy. It introduced several measures to limit capital inflows. These included imposing restrictions on ECBs curbing the use of Participatory Notes (PNs) and introducing measures to limit loans to both foreign and domestically held mutual funds operating in India. The RBI again resorted to heavy intervention and purchased over $95.4 billion (Rs.4.0 trillion) during this period. While, despite a growing fiscal cost, fresh MSS bonds worth Rs. 1.5 trillion were issued between April 2006 and November 2007 to sterilize the purchases, it was not

[1] Source: Dua and Ranjan (2012)

enough to completely sterilize the foreign inflows. The outbreak of the sub-prime crisis in the United States in late 2007 led to a "flight to safety" of foreign capital from emerging markets resulting in a drop in the net capital inflows to $7.2 billion. The RBI responded to the drop in capital inflows and declining exports by allowing the Rupee to depreciate sharply. The decline in capital inflows and rise in flexibility of the Rupee allowed the authorities to pursue a more independent monetary policy during this period. Overall impact of these changes was a rise in the volatility of real exchange rate of INR between 2006 and 2008.

Figure 1

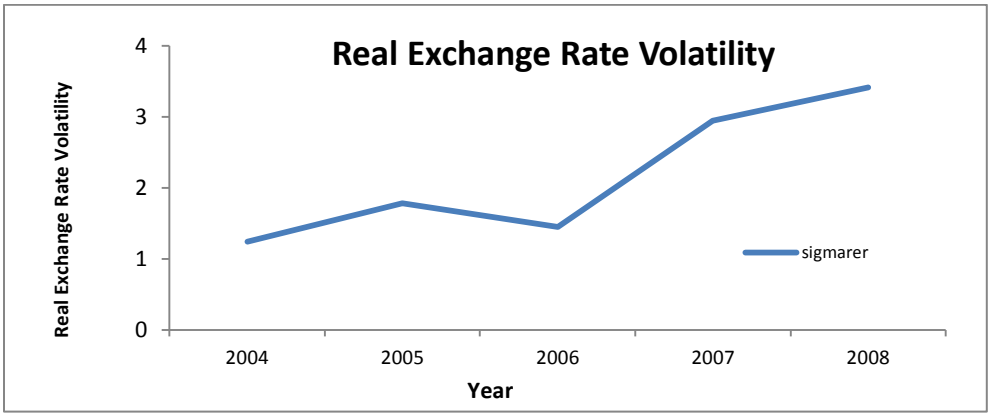


Figure 1 shows the movement in RER volatility of the Indian Rupee between 2004 and 2008. Volatility is measured as the standard deviation of the monthly real effective exchange rate calculated by the *BIS*. As we can see, volatility of real exchange rate, after remaining stable between 2004 and 2006, increased sharply between 2006 and 2007. This situation presents us with a kind of natural experiment to study the role of exchange rate volatility.

Table 1 presents a similar picture. Average volatility of real exchange rate doubled between 2004-06 and 2006-07 while reserve accumulation and net sales of foreign exchange by the RBI

halved during the same period. Average RER (in logs) did not change much between these two periods.

Table 1

Period	Volatility of Real Exchange Rate	Reserve Accumulation[2]	Net Sales of Foreign Exchange by RBI[3]	Average RER
2004-2006	1.5	0.96	1	4.61
2006-2008	2.6	0.55	0.5	4.62

Overall it shows the move towards greater exchange rate flexibility in the face of increasingly volatile capital flows and growing costs of monetary sterilization in the second period. In combination with our theoretical model above this leads us to our empirical strategy.

Data

The firm level dataset consists of information on 900 manufacturing firms regarding the number of workers employed, sales, total assets, exports and imports. The data is obtained from the CMIE - PROWESS database and cover the five year period from 2004 to 2008. The data covers eighteen manufacturing industries classified according to the three digit NIC code[4]. The trend employment growth amongst the firms in our sample was about 2.3 percent during the entire period while trend growth in sales was 8.7 percent. Average size of asset holdings of the firms in our sample was INR 9100 million while average workforce was 2300 during this period. Further, they had an average share of exports in total sales was about 0.20 and the average share of imports in total inputs 0.28 over the same time. Of the 900 firms in the sample roughly ten

[2] A as percentage of overall Balance of Payments
[3] As a share of total turnover in the foreign exchange market
[4] Appendix gives the details of industrial classification

percent were non-exporters while four percent had no imported inputs during the period under consideration.

As discussed above, exports and imports can be an important means of providing a natural hedge to firms against exchange rate movements. Market power and ownership structure are other important determinants of firm's response to exchange rate changes. Firms with higher market power are likely to face changes in exchange rates better compared to those with lower market power. Similarly, level of export orientation, leverage, import dependence, size, productivity, and profitability also determine the nature of firm response to exchange rate shocks (Klein et al., 2003). Finally, in the presence of financing constraints firms that have access to domestic and/or foreign capital markets can deal with unexpected exchange rate shocks better than others.

Table 2 presents the behavior of employment growth over the pre and post "shock" period across different sub-group of firms to capture some of these aspects. The first column gives the trade exposure of the firms. Defining Λ = export share – import share, the firm is classified as having a positive trade exposure if $\Lambda > 0$. It is classified as having a negative trade exposure if the opposite is true. The second column gives the ownership status of the firm. A firm is defined as having foreign ownership if more than ten percent of its outstanding shares are held by foreign firms. The next three columns give the number of firms and average growth of employment in the pre and post 'shock' period. Let dy_{i0} = (ln (y_{i2006})-ln (y_{i2004}))/3 and dy_{i1} = (ln (y_{i2008})-ln (y_{i2006}))/3 be the average growth in employment for firm *i* in the two periods. Then dY_0 and dY_1 are the averages of dy_{i0} and dy_{i1} across firms.

Table 2 Firm Characteristics and Employment Growth

Exposure	Foreign Ownership	No. of Firms	dY_0	dY_1	dY_1-dY_0
Positive	Yes	41	-4.4	8.5	12.9
Positive	No	385	-4.4	8.2	12.6
Negative	Yes	77	16.9	5.9	-11.0
Negative	No	399	-3.4	0.9	4.3

As we can see, firms with a positive trade exposure saw an increase in employment growth between the 'pre' and 'post' shock period irrespective of their ownership structure. Firms with a negative trade exposure, on the other hand, saw a decline in their employment growth over the same period (or a smaller increase in employment as compared to the firms with a positive trade exposure e.g. in the case of domestic firms). This is in line with the predictions of the theoretical model above. This finding motivates the empirical analysis in the next section.

Empirical Model

Based on the expression in equation (14) in Section 3 the following econometric specification is proposed for the empirical analysis:

$$\Delta l_{i,t} = \varphi_i + \theta_t + \tau_{i,t} + \varphi_1 \times \Lambda_{i,0} \times \Delta\sigma_t^2 + \varphi_3 \times (\Delta y_{i,t}) + \varphi_4 \times \lambda_{i,t} + \varepsilon_{i,t} \qquad (14`)$$

where $\Delta y_{i,t} = (y_{i,t} - y_{i,t-2})/3$ for $t = 2004, 2008$. $\Delta\sigma_t^2$ and $\Delta l_{i,t}$ are defined similarly. The effect of the exchange rate volatility is assumed to be determined by the interaction term $\Lambda_{i,0} \times \sigma_t^2$ where, $\Lambda_{i,0}$ is the net currency exposure in the base year (2004) and σ_t^2 is the volatility of exchange rate. The model allows for time-invariant heterogeneity in growth rates across firms (the φ_i). However, there may also be variation in growth rates which coincides with our measure of net exposure. For example, it may be that some industries experience worsening worldwide business

conditions, and that these conditions are correlated with exposure. θ_t is the time-specific effect capturing economy-wide business cycle conditions. To control for idiosyncratic industry shocks – applying worldwide – we use industry specific time trends in our model $\tau_{i,t}$. These industry specific trends will help control for underlying worldwide changes in supply and demand, changes in pricing-to market behavior, changes in the degree of competition from low cost countries such as China, and other time-varying industry characteristics.

Differencing equation 14` across periods yields our baseline difference-in-difference firm-level specification:

$$\Delta l_{i,1} - \Delta l_{i,0} = \theta + \varphi_1 \times \Lambda_{i,0} \times \left(\Delta\sigma_1^2 - \Delta\sigma_0^2\right) + \varphi_3 \times \left(\Delta y_{i,1} - \Delta y_{i,0}\right) + \xi \times x_{i,0} + \varphi_4 \times \tau_i + \nu_i \qquad (15)$$

where $\theta = \theta_1 - \theta_0$; $\nu_i = \varepsilon_{i,1} - \varepsilon_{i,0}$; $\tau_i = \tau_{i,1} - \tau_{i,0}$ and the firm fixed effect φ_0 is differenced out. The variable $\left(\Delta\sigma_1^2 - \Delta\sigma_0^2\right)$ is defined as the difference in the economy-wide change in the real exchange rate volatility between the pre-shock and the shock period and will just be a positive constant across all firms. However, variation in $\Lambda_{i,0}$ will enable us to make inferences about φ_1. A positive φ_1 implies that the increase in exchange rate volatility had a positive impact on employment with exposed firms (i.e. firms with $\Lambda_{i,0} > 0$) experiencing a larger increase, or smaller decrease in employment growth than similar non-exposed firms (i.e. firms with $\Lambda_{i,0} \leq 0$). Estimating equation 15 does not suffer from serial correlation in the errors, since the averaging over periods ignores time-series information.

Equation 15 represents a difference-in-difference model with 2004-06 as the "pre-shock" period (or period with low RER volatility) and 2006-08 as the "shock" period (or period with high RER

volatility). If there were just two groups of firms, exposed and non-exposed, then equation 15 would amount to a triple-differences strategy: φ_1 would reflect the difference in change in average growth rates between the exposed and non-exposed firms. Following Trefler (2004), and Ekholm et al (2011) a vector of control variables $x_{i,0}$ from the base year 2004 is also added to the benchmark model. The firm level controls include size of the firm as measured by the natural logarithm of its total assets, the number of workers employed in logs, capital efficiency measured by the ratio of sales to net fixed assets, the ratio of foreign borrowing to firm's total borrowing and dummy variables indicating whether the firm is an exporter and/or importer .

According to equation 13 the effect of exchange rate volatility on employment also depends upon the firm's mark up. The model therefore includes the firm level mark-up[5] along with its interaction with the exposure term $\Lambda_{i,0}$. Table 3 presents the results from the benchmark model. In line with our theoretical model we find a positive coefficient on the trade exposure term $\Lambda_{i,0}$ and its interaction with the firm level mark-up (though only the latter appears to be statistically significant). A positive coefficient on $\Lambda_{i,0}$ indicates that higher real exchange rate volatility had a positive impact on employment growth, with exposed firms experiencing a larger increase, or a smaller decrease, in employment growth than similar non-exposed firms. Further, employment in firms with a higher level of price-cost margin appears to be less sensitive to changes in exchange rate. Amongst the other variables only the dummies for exporter and importer status appear to have a significant impact on firm level employment.

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

Table 3: Results Benchmark OLS Estimates[6]

Dependent Variable: Employment Growth	**Coefficient**
$\Lambda_{i,0}$ *mark-up^{-1}	0.0002*** [0.00]
$\Lambda_{i,0}$	0.01 [0.04]
Sales Growth	-0.00 [0.00]
Mark-up	-0.00 [0.00]
Size	0.01 [0.01]
Efficiency	0.001 [0.00]
Number of workers	-0.02 [0.02]
Foreign debt	0.00 [0.05]
Export dummy	0.04** [0.02]
Import dummy	-0.1** [0.04]
Industry Dummies	Yes
Number of firms	288

Selection Bias

The econometric strategy used above precludes using data on firms entering or exiting the sample, so firms which failed during the sample period are dropped. But balancing the panel is not a random process. Firms staying in business may respond differently to shocks than those who are driven out of business, and this could potentially bias the results. To deal with this selection problem, the two-step Heckman (1979) procedure is used. This involves estimating a reduced form probit model of the probability of a firm being in the continuous sample in the first

[6] Figures inside the square brackets are standard errors adjusted for cross-cluster heterogeneity.
Dependent variable is $\Delta l_{i,1} - \Delta l_{i,0}$ [6]. All explanatory variables are from the base year 2004. Value of sales growth in the base year is used as an instrument to ensures that the covariates are pre-determined, which should minimize concerns about reverse causality
*** implies significant at 0.01 level ;** *implies* significant at 0.05 level

step. In the second step, a variable is constructed using the inverse Mills ratio from the probit model and used as an additional regressor in the estimation of equation 15 to correct for selection bias.

The dependent variable in the first stage is a dummy variable taking the value 1 if the firm is present from the beginning to the end of the sample. The dependent variable is set to 0 if the firm was present in the base year but exited in 2008 or earlier. The probability of surviving will generally depend on the same firm and industry characteristics that affect the RER response**.**

A different set of variables is used in the first stage to ensure proper identification. Following Ekholm et al. (2011) it is assumed that operating profits in the base year (2004) enter the exit decision, but are excluded from the main estimating equation. All variables in the selection equation refer to values in the base year.

Table 4 presents the results from our model after controlling for the selection bias. In line with our benchmark results we find that the trade exposure term is positive and significant once again indicating that higher real exchange rate volatility had a positive impact on employment growth, , with exposed firms experiencing a larger increase, or smaller decrease, in employment growth than similar non-exposed firms.

The results point to a clear link between real exchange rate volatility and growth in employment. Based on the benchmark specification, a one percent increase in exchange rate volatility caused employment growth to increase by 5 percent for a firm with a net exposure of 1 and an initial markup of 1. With an average exposure of -0.11 in the base year and an average mark-up of 8.2, the near doubling of real exchange rate volatility resulted in a reduction in employment growth of roughly 0.7 percentage points.

Table 4: Controlling for the *selection bias*[7]

Dependent Variable: Employment Growth	Coefficients
$\Lambda_{i,0}$ *mark-up^{-1}	0.001*** [0.00]
$\Lambda_{i,0}$	0.05 [0.03]
Mark-up	0.00 [0.00]
Sales Growth	-0.03 [0.05]
Size	-0.003 [0.004]
Efficiency	0.003 [0.003]
Number of workers	-0.01 [0.01]
Foreign debt	0.06 [0.06]
Export dummy	0.02 [0.03]
Import dummy	-0.10 [0.07]
Industry Dummies	Yes
Number of Firms	288

Non-linear Impact

Impact of exchange rate volatility on firm employment can be non-linear in the size of trade exposure. To explore this possibility the firms are divided into 5 mutually exclusive groups, based on their level of initial net exposure $\Lambda_{i,0}$. These groups are (Λ_1) firms with $\Lambda_{i,0} < -0.52$, (Λ_2) firms with $\Lambda_{i,0} > -0.52 \& \Lambda_{i,0} < -0.09$, (Λ_3) firms with $\Lambda_{i,0} > -0.09 \& \Lambda_{i,0} < 0$, (Λ_4)

[7]Dependent variable is $\Delta l_{i,1} - \Delta l_{i,0}$. All explanatory variables are from the base year 2004

*** implies significant at 0.01 level ;** implies significant at 0.05 level

firms with $\Lambda_{i,0} > 0 \& \Lambda_{i,0} < 0.16$ and (Λ_5) firms with $\Lambda_{i,0} > 0.16$. The thresholds roughly correspond to the 10, 30, 50 and 90 percentile of initial exposure. The following model is then estimated to capture non-linearity in the effect of exchange rate volatility. Table 5 presents the results of this exercise.

Table 5: Non-Linear Impact

Dependent Variable: Employment Growth	**Coefficient**
Λ_1	-0.06 [0.04]
Λ_2	-0.15*** [0.05]
Λ_3	-0.07 [0.04]
Λ_4	-0.04 0.05]
Firm Controls	Yes
Industry Dummies	Yes
Number of Firms	288

Dependent variable is $\Delta l_{i,1} - \Delta l_{i,0}$. All explanatory variables are from the base year 2004

*** implies significant at 0.01 level ;** implies significant at 0.05 level

As one can see, exchange rate volatility affects groups $\Lambda_1, \Lambda_2, \Lambda_3, \Lambda_4$ negatively relative to the baseline group Λ_5 though the impact is significant only for group Λ_2.

Foreign Ownership

Another important aspect of firm's response to exchange rate movements is their ownership structure. Foreign owned firms are likely to respond differently to exchange rate shocks when compared to domestic firms due to factors such as differences in their relative productivity levels and access to finance in the face of exchange rate volatility. To test this hypothesis firms are divided in to foreign and domestically owned firms based on the ownership structure of their

outstanding shares. A firm is classified as being foreign owned if at least 10 percent of its outstanding shares are owned by foreigners. Table 6 presents the results from estimating equation 15 on the two samples separately.

Table 6: Foreign versus domestically owned firms

Dependent Variable:		
Employment Growth	**Foreign Firms**	**Domestic Firms**
$\Lambda_{i,0}$ *mark-up^{-1}	0.26** [0.13]	0.0002*** [0.00]
$\Lambda_{i,0}$	0.08 [0.09]	0.003 [0.01]
Firm Controls	Yes	Yes
Industry Dummies	Yes	Yes

Dependent variable is $\Delta l_{i,1} - \Delta l_{i,0}$. All explanatory variables are from the base year 2004

*** implies significant at 0.01 level ;** implies significant at 0.05 level

It can be seen from the table that real exchange rate volatility has a significantly larger positive impact on employment in the foreign firms as compared to the domestically owned firms. In other words, foreign firms benefitted more from (or were less adversely affected by) the increase in real exchange rate volatility in the second period. This is possibly a reflection of higher productivity and/or better access to external sources of finance among foreign owned firms. The result is also in line with Dhasmana (2014a) that shows that foreign owned firms are less severely affected by movements in real exchange rates.

Trade Openness

Openness to trade can be another important determinant of the firm's response to exchange rate changes. The level of export orientation is an important factor, along with leverage, import

dependence, size, productivity, and profitability, affecting the nature of firm response to exchange rate shocks according to Klein et al. (2003). To check this assertion the sample of firms is divided in to two based on their export status in the base year. If a firm was exporting in the base year it was classified as an exporter and if not then it was classified as non-exporter. Benchmark model was then estimated separately on the two sub-samples. Table 7 shows the results from this exercise.

Table 7: Exporters versus Non-exporters[8]

Dependent Variable: Employment Growth	**Exporters**	**Non-exporters**
$\Lambda_{i,0}$ *mark-up^{-1}	0.0002*** [0.00]	-0.18*** [0.05]
$\Lambda_{i,0}$	0.03 [0.03]	-0.05 [0.14]
Firm Controls	Yes	Yes
Industry Dummies	Yes	Yes

Clearly there is a significant difference between the reaction of exporters and non-exporters to exchange rate volatility. Exporters see a positive correlation between the level of their trade exposure and employment response to higher exchange rate volatility. Opposite is true for non-exporters. Their trade exposure is negatively correlated with the change in employment due to higher exchange rate volatility.

Imported Capital Goods

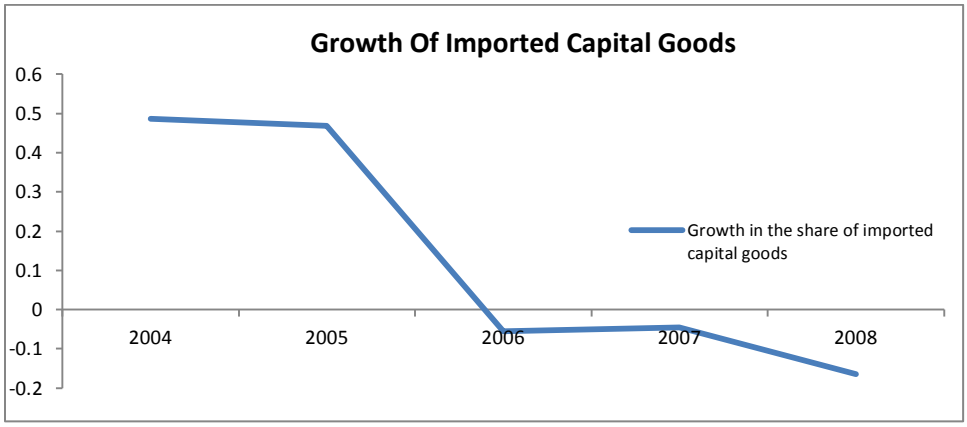
Firms with greater reliance on imported capital goods are likely to be more severely affected by exchange rate shocks (Eaton and Kortum , 2001). Though the theoretical model does not capture

[8] Dependent variable is $\Delta l_{i,1} - \Delta l_{i,0}$. All explanatory variables are from the base year 2004

*** implies significant at 0.01 level ;** implies significant at 0.05 level

this effect we can find some evidence of this in the data. Figure 2 shows the growth in the share of imported capital goods in total inputs.

Figure 2



It can be seen that the growth rate of imported capital goods fell dramatically between the "pre" and "post" shock period. To check whether firms with a greater reliance on imported capital goods were more severely affected by higher exchange rate volatility the benchmark model is estimated separately for firms importing capital goods in the base year and the rest. Table 8 presents the result from this exercise.

Table 8: Imported Capital Goods

Dependent Variable: Employment Growth	**Imported Capital Goods**	**No Imported Capital Goods**
$\Lambda_{i,0}$ *mark-up^{-1}	-0.09 [0.06]	0.0003*** [0.00]
$\Lambda_{i,0}$	0.08 [0.08]	0.16*** [0.01]
Firm Controls	Yes	Yes
Industry Dummies	Yes	Yes

Dependent variable is $\Delta l_{i,1} - \Delta l_{i,0}$. All explanatory variables are from the base year 2004

*** implies significant at 0.01 level ;** implies significant at 0.05 level

Reliance on imported capital goods adversely affects employment in manufacturing firms during episodes of increased exchange rate volatility. While firms with no imported capital goods see a significant increase in their employment with an increase in volatility (or a smaller decrease in case the firm has a negative trade exposure), same cannot be said about the firms relying on imported capital goods. Lower productivity of labor due to a decline in the import of capital goods could be a significant factor behind the employment response to exchange rate shocks. While the result seems intuitive, the significant difference in the size of the coefficients across the two groups highlights the importance of imported capital goods.

Robustness Checks

To check the robustness of these results several robustness tests are conducted. These include estimating the model without the set of firm level controls, incorporating the ratio of imported capital goods to the total input costs and using industry wide wage rate in to the model (obviously we do not include industry specific dummies in the last case). The main results remain unchanged despite these changes to the benchmark model. Results of these robustness checks are provided in the appendix.

Conclusion

This paper looks at the impact of an increase in the real exchange rate volatility on firm level employment as measured by the number of workers. It uses firm level data on 900 Indian manufacturing firms and a benchmark model derived from the profit maximization problem of

an imperfectly competitive firm to study the response of employment to higher exchange rate volatility. The key finding of the paper suggests that a firm's trade exposure as measured by the difference between their export and import shares significantly affects it response to changes in exchange rate volatility. This suggests the possibility of firms using their trade exposure as a hedge against exchange rate shocks (Dhasmana (2014) finds some evidence for it). In fact, if we look at the average trade exposure amongst the firms in our sample we find that the average trade exposure increased from a small and negative amount in the first period to positive 0.05 in the second period. An important question is thrown up by these findings. How and to what extent does the availability and use of financial hedging instruments alter the relationship between trade exposure and firms' response to exchange rate shocks? Unfortunately data on the use of exchange rate hedging instruments by the firms is currently unavailable. Further work in this direction would however be very fruitful.

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Appendix A

Data definitions

$\Delta l_{i,t} = \frac{\left(l_{i,t} - l_{t,t-2}\right)}{3}; t = 2006,2008$; Labor is measured as the number of workers employed.

$\Delta y_{i,t} = \frac{\left(y_{i,t} - y_{t,t-2}\right)}{3}; t = 2006,2008$; Sales growth is deflated by the wholesale price index to get a measure of real output.

$$\Lambda_{i,0} = \frac{\text{exports}_{\text{i,0}}}{\text{sales}_{i,0}} - \frac{\text{imports}_{\text{i,0}}}{\text{inputcost}_{i,0}}$$

$$\text{Efficiency} = \frac{\text{sales}_{i,t}}{\text{net fixed assets}_{\text{i,t}}}$$

$$\text{Size} = \ln\left(\text{total assets}_{\text{i,t}}\right)$$

$$\text{Foreign Debt} = \frac{\text{foreign borrowings}_{i,t}}{\text{total borrowings}_{\text{i,t}}}$$

Appendix B

Table I: Robustness Tests

Dependent Variable: dw_0 Employment Growth	**Coefficients**		
	No Firm Controls	**Industry Wage**	**Import of Capital Goods**
$\Lambda_{i,0}$ *mark-up^{-1}	0.0002*** [0.00]	0.0006*** [0.00]	0.0007*** [0.00]
$\Lambda_{i,0}$	0.045** [0.02]	0.05 [0.04]	0.05 [0.04]
Industry Dummies	Yes	No	Yes

[i] Dua and Ranjan, 2012, OUP catalogue.