The Effects of Exchange Rate Volatility on Dumping

The case of India

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Preface

This thesis presents the results of my research on the relationship between the exchange rate and antidumping filings. I would first like to thank my thesis supervisor Jean-Marie Viaene for his guidance and useful comments while working on this master thesis. I was initially challenged to build a model and realized how much time and thought it takes in developing a model. This thesis has given me new knowledge and insights in the creation of a model and empirically testing it. The reason for choosing this topic was based on my interest on how a developing country deals with new faced challenges when integrating with the global economy. After a while I realized that it was of great benefit that I have attended a seminar on exchange rates as it has helped me gained insight in the field of exchange rates. Another time consuming challenge was the creation of the dataset for the empirical part in Excel and using a statistical program (Stata) which I was not familiar with. Lastly I would like to thank my family and friends for their interest in this master thesis.

Abstract

This master thesis examines the relationship between antidumping filings and macroeconomic factors, with in particular the exchange rate and exchange rate volatility. Exchange rate volatility is a relatively unexplored feature in relation to antidumping filings. An augmented Brander and Krugman dumping model is build to understand the relationship between the exchange rate and dumping. Examining the bilateral filing pattern of India it is found that volatility has a negative relationship with antidumping filings which is consistent with theory and that a 1% increase in quarterly lagged volatility reduces quarterly case filings by 0.98% to 1.12%. A two quarter lag in exchange rate volatility reduces quarterly filings by 0.19% to 0.22%. The results for the level effect are not consistent with theory but are however with existing empirical literature. It is found that a 1% depreciation of the exchange rate reduces filings by 1.4% to 1.6% quarterly.

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1. Introduction

Import tariffs have been gradually reduced since the formation of the GATT agreement and the WTO. Nevertheless many countries, and in particular developed countries, have relied on non-tariff barriers as a substitute for tariff protection. Antidumping (AD) policies have emerged most prominently as newer forms of impediments to trade. Ample research has been conducted on the determinants of the dumping activity. The impact of macroeconomic factors and more specifically the exchange rate has become a focal point. However most of these studies focus either on antidumping filings initiated by the US or the EU. There are however several emerging economies that have also used antidumping actions in the last decades as a trade policy to protect their domestic markets. This master thesis contributes to the literature by theoretically examining the relationship of the exchange rate and exchange rate volatility on dumping. Additionally the theoretical predictions are empirically tested with a case study of India. Understanding the causes of emerging economies use of antidumping actions is important for a number of reasons. First, many of these countries are increasingly taking on WTO commitments that limit their ability to use other trade-restricting policies. The pattern of antidumping actions may thus be an important indicator for their overall level of protectionism. The increase in antidumping use by emerging economies raises the concern that much of the trade liberalization commitments they carried out may be offset by this newer form of protectionism. For example, India has since 2001 overtaken the U.S. in terms of initiations of new antidumping filings and is the top user of antidumping filings during the period 1995-2009 with 572 initiations, the U.S. is the second largest user with 452 initiations (Global Antidumping Database World Bank, 2010).

The WTO antidumping statute requires three criteria to be met in order to impose duties on foreign suppliers named in antidumping cases. First, domestic and export goods must be ‘like’ products. That is a product that is like, or in the absence of like, most similar in characteristics and uses with, the article subject to an investigation. Second, there must be evidence that the domestic industry has suffered ‘material injury’ as a result of dumped imports (causation). Third, foreign suppliers must be found to be pricing at ’less than normal value’. This latter criterion can be determined in either of two ways: the first is used in this master thesis and the method by showing that the price charged in the domestic market by the foreign suppliers is below the price charged for the same product in other markets, usually the home market (the ‘price-based’ method). The other way is by showing that the price charged

in the domestic market is below an estimate of cost plus a normal return ('constructed-value' method) (Bloningen and Prusa, 2003).

The focus of this master thesis is to analyze if and how macroeconomic factors in general, and movements in exchange rates in particular, can affect the determination of each of these criteria. The goal is not to explain antidumping filings, as case specific and microeconomic factors obviously play a more determining role than macroeconomic factors. As will be explained, a foreign firm's response to a exchange rate change increases the likelihood that at least one of the AD criteria will be satisfied. From a theoretical perspective it is entirely possible that exchange rate movements can either increase or decrease filings, depending on which criterion is most responsive to exchange rate changes. Empirically which effect is more important is also an open question. There appears to be a belief within the business community that a strong domestic currency encourages filings (Knetter and Prusa, 2003). An early study by Feinberg (1989) finds that a U.S. dollar depreciation relative to a foreign currency has a positive effect on filing in the U.S. On the other hand most studies, such as Stallings for the U.S. (1993), Leidy for the U.S. (1997), Knetter and Prusa for the U.S., E.U., Australia and Canada (2003), Irwin for the U.S. (2004), Niels for Mexico (2004), Feinberg for the U.S. (2005) and Sadni Jallab et al. for the U.S. and E.U. (2006) find that a domestic currency appreciation stimulates filings.

A macroeconomic factor that might influence AD filings which has not been explored so far in the existing literature is exchange rate volatility. In the model presented it will be shown that exchange rate volatility will tend to decrease the likelihood of dumping by the foreign firm in the domestic market. Thus one would expect that exchange rate volatility is negatively related to AD filings. The model shows furthermore that exchange rate volatility will increase the likelihood of dumping by the domestic firm in the foreign market. These predictions are also found after extending the model developed by Moraga-González and Viaene (2004a).

Fluctuations in economic activity, both in the importing and the exporting country, might also affect AD filings. A slump in economic activity in the importing country makes it more likely that domestic firms perform poorly which might facilitate a finding of material injury. Furthermore if the domestic country experiences a recession it is naturally for demand to decrease. In this case a foreign firm exporting to the domestic country would likely lower its price in the domestic market to retain market share. This could increase the likelihood of dumping. Thus one expects that the growth rate of the filing country will be negatively related to AD filings. It is however less clear how the growth rate of the defendant country is related

to AD filings. It is for instance possible that a weak foreign economy increases the likelihood that foreign firms will cut prices to maintain overall levels of output. Such behaviour might cause injury to the domestic firms but is it is not clear that it will lead to pricing below "normal value" as foreign firms would presumably be lowering prices to all market.

The nature of the research is as follows. First a theoretical model will be presented in section 2 on the relationship between the exchange rate and dumping. The relationships that will be explored can be divided in two effects, a level effect and a volatility effect. The level effect is the movement in the exchange rate. The level effect will be theoretically explored by looking at the effects it has on prices, dumping and the injury criterion. The volatility effect will be theoretically explored by looking at the effect it has on prices and the dumping condition. The related literature will be discussed in section 3. The theoretical findings will be empirically tested with a case study on India. Data and variables used in the empirical analysis are discussed in section 4. The empirical specification follows in section 5 and results in section 6. The master thesis is concluded in section 7.

The empirical findings for the level effect differs between the aggregate part and the bilateral part. The results for the aggregate filings show that a real depreciation of the filing country's currency will lead to an increase in AD filings which is consistent with theoretical predictions relating to the dumping condition. However the empirical findings for the bilateral filings show the reverse relationship which is consistent with existing empirical research and theoretical predictions relating to the material injury criterion. For instance it is found that a one percent depreciation of the exchange rate reduces AD filings by 1.4% to 1.6% quarterly. The results on exchange rate volatility are consistent with theoretical predictions. They show the expected sign and are statistically significant. The results in the bilateral analysis has shown that a 1% increase in quarterly lagged volatility reduces quarterly case filings by 0.98% to 1.12%, two quarter lagged exchange rate volatility reduces quarterly filings by 0.19% to 0.22%. It is also found that a one percent increase in domestic real GDP decreases AD filings by 0.11% to 0.12% per quarter. The results show further evidence in line with existing literature that antidumping law in India is not primarily used to address unfair trade. A significant role for the exchange rate and economic growth in explaining AD filings is unlikely to be associated with malevolent behaviour by foreign firms. The significant role of these macroeconomic factors seems contrary to the objective of antidumping rules in addressing unfairly traded products. The results suggest that the use of antidumping law in India is primarily used as protectionism.

2. The Model

This model augments the 'reciprocal dumping' model by Brander and Krugman (1983) by including the exchange rate together with a simple linear demand function. Assume there are two identical countries, one 'domestic' and one 'foreign', the later denoted by "$*$". Each country has one firm producing a commodity which is identical in both countries. There are transport costs incurred in exporting goods from one country to the other. The idea is that each firm regards each country as a separate market and therefore chooses the profit-maximizing quantity for each country separately. Firms employ a Cournot strategy. That is, each firm assumes that the other firm's output is fixed in each country.

The domestic firm produces output X_D for domestic consumption and output X_E for foreign consumption. Marginal cost is a constant, c, with $c > 0$ and transport cost are g, with $g \geq 0$. Marginal cost for producing a export product is then $c + g$ so that an amount of $1 + g$ leaves and 1 good eventually arrives in the export market. Similarly, the foreign firm produces output Y_D^* for foreign consumption and output Y_E^* for export to the domestic country. It faces the same cost structure as before, with its marginal costs expressed in local currency c^*. Marginal costs are assumed to be the same in both countries. To see the effects of the exchange rate in this model the forward exchange rate given to firms, e, is introduced. The exchange rate is defined as the domestic currency price of foreign currency. An increase in the exchange rate e reflects a depreciation of the domestic currency. Using p and p^* to denote domestic and foreign price, domestic profits can be written as:

$$\pi = X_D p + ep^* X_E - cX_D - (c+g)X_E, \tag{2.1}$$

where p^* is the price of the identical commodity in the foreign country which is multiplied by e to convert export receipts into domestic currency. Likewise, the foreign profits can be written as:

$$\pi^* = Y_D^* p^* + \frac{pY_E^*}{e} - c^* Y_D^* - (c^* + g)Y_E^*, \tag{2.2}$$

where p is the price of the identical commodity in the domestic country and by dividing by the exchange rate foreign export receipts are converted into foreign currency.

A simple linear demand function is introduced:

$$p = a - V, \qquad a > 0, \tag{2.3}$$

$$p^* = a - W, \qquad a > 0, \tag{2.4}$$

where $V = X_D + Y_E^*$, total consumption in the domestic country and $W = Y_D^* + X_E$, total consumption in the foreign country. It is assumed that a is greater than marginal cost so that each firm supplies at a positive level in any market.

Solving the pair of best-response functions in equilibrium outputs, equilibrium consumption and equilibrium price for the domestic market results in:

$$X_D = \frac{(a - 2c + e(c^* + g))}{3}, \tag{2.5}$$

$$Y_E^* = \frac{(a + c - 2e(c^* + g))}{3}, \tag{2.6}$$

$$V = \frac{(2a - c - e(c^* + g))}{3}, \tag{2.7}$$

$$p = \frac{(a + c + e(c^* + g))}{3}. \tag{2.8}$$

It is shown in appendix A that the second-order derivatives for an equilibrium in both countries are satisfied and that own marginal revenue declines when the other firm increases its output. This latter condition is equivalent to the reaction functions being downward sloping. They imply stability and uniqueness of the equilibrium (Brander and Krugman, 1983).

A closer examination to equation (2.6) shows that for Y_E^* to be positive one must have:

$$\frac{a + c - 2ec^*}{2c} > g.$$

Transport costs must be below a certain level before invasion in the domestic market takes place.

It is easy to check the following derivatives:

$$\frac{\partial X_D}{\partial g} > 0, \qquad \frac{\partial Y_E^*}{\partial g} < 0, \qquad \frac{\partial V}{\partial g} < 0,$$

and that $X_D > Y_E^*$ if:

$$e > \frac{c}{c^* + g}.$$

Thus as transport costs fall (g decreasing), goods produced in the foreign country make up a greater and greater share of domestic consumption. The share approaches ½ as g approaches zero and e approaches 1, as marginal costs are assumed to be the same in both countries. Furthermore total consumption rises as transport costs fall. If the condition holds for $X_D > Y_E^*$ then the foreign firm has a smaller market share in the domestic market than in the foreign market. In that case perceived marginal revenue is higher in the export market and foreign firms start to export to the domestic market. The effective marginal cost of delivering an exported unit is higher than for a unit of domestic sales, because of transport costs, but this is consistent with the higher marginal revenue (Brander, 1981).

Solving the pair of best-response functions in equilibrium outputs, equilibrium consumption and equilibrium price for the foreign market results in:

$$Y_D^* = \frac{(ea - 2ec^* + c + g)}{3e}, \tag{2.9}$$

$$X_E = \frac{(ea + ec^* - 2(c + g))}{3e}, \tag{2.10}$$

$$W = \frac{(2ea - ec^* - c - g)}{3e}, \tag{2.11}$$

$$p^* = \frac{(ea + ec^* + c + g)}{3e}. \tag{2.12}$$

The condition for X_E being positive is

$$\frac{ea + ec^* - 2c}{2} > g.$$

Transport costs must be below a certain level before invasion in the foreign market takes place. Again checking the following derivatives:

$$\frac{\partial Y_D^*}{\partial g} > 0, \qquad \frac{\partial X_E}{\partial g} < 0, \qquad \frac{\partial W}{\partial g} < 0,$$

and that $Y_D^* > X_E$ if,

$$\frac{c+g}{c^*} > e.$$

Similarly as in the domestic market if transport costs fall (g decreasing), goods produced domestically make up a greater and greater share of foreign consumption. The share approaches ½ as g approaches zero and e approaches 1, as marginal costs are assumed to be the same in both countries. Total consumption in the foreign market rises if transport costs fall. If the condition holds for $Y_D^* > X_E$ then the domestic firm has a smaller market share of its export market than of its share in the domestic market. In that case perceived marginal revenue is higher in the export market and domestic firms start to export to the foreign market.

2.1 Effects of the exchange rate

The following derivates show the effect of the exchange rate on output, price and equilibrium demand in the domestic market:

$$\frac{\partial X_D}{\partial e} > 0, \qquad \frac{\partial Y_E^*}{\partial e} < 0, \qquad \frac{\partial V}{\partial e} < 0, \qquad \frac{\partial p}{\partial e} > 0.$$

If the exchange rate increases (depreciation of the domestic currency) the output of the home firm in the domestic market increases and imports from the foreign firm decreases. This result follows from traditional exchange rate effects as a depreciation of the domestic currency makes imports more expensive relative to domestic production, which results in lower imports to the domestic country and increased demand for domestic production. The equilibrium price in the domestic market increases due to the increase in the price of imports and increased demand for domestic production. Total consumption decreases due to the increase of the domestic equilibrium price and due to the increase in the price of imports.

The effect of the exchange rate in the foreign market can be shown by the following derivatives:

$$\frac{\partial Y_D^*}{\partial e} < 0, \qquad \frac{\partial X_E}{\partial e} > 0, \qquad \frac{\partial W}{\partial e} > 0, \qquad \frac{\partial p^*}{\partial e} < 0.$$

If the exchange rate increases (depreciation of the domestic currency) the output of the foreign firm in the foreign market decreases and imports from the domestic firm to the foreign market increases. This result follows from traditional exchange rate effects as a depreciation of the domestic currency makes imports from the domestic firm cheaper relative to foreign production, which results in increased imports from the domestic firm and decreased demand for foreign production. The reduction in demand of foreign production and decrease in price of imports lead to a decrease in the foreign equilibrium price. The decrease in price of imports and decrease in the foreign equilibrium price leads to increased consumption.

2.2 Conditions for dumping

The WTO standard definition of dumping is when the export price to a particular country is less than the price the firm normally charges on its own market (price-based method).

2.2.1 Dumping in the domestic market by the foreign firm

Dumping by the foreign firm in the domestic market occurs if the freight on board (f.o.b.) price of exports is below the foreign price:

$$\frac{p}{e} - g < p^*,$$

substituting for p and p^* and rearranging terms leads to

$$a - ae < g(1 + 2e). \tag{2.13}$$

Proposition 1 *A depreciation of the domestic currency (increase in e) increases the likelihood of dumping by the foreign firm in the domestic market.*

Proof. An increase in e makes the LHS smaller (more negative if $e > 1$) and the RHS larger thus increasing the likelihood of dumping by the foreign firm in the domestic market.

2.2.2 Dumping in the foreign market by the domestic firm

Dumping by the domestic firm in the foreign market occurs if the f.o.b. price of exports is below the domestic price:

$$ep^* - g < p,$$

substituting for p and p^* and rearranging terms leads to

$$ae - a < ge + 2g. \tag{2.14}$$

Proposition 2 *A depreciation of the domestic currency (increase in e) decreases the likelihood of dumping by the domestic firm in the foreign market if:*

$$a > g,$$

if the inequality is reversed, a depreciation of the domestic currency increases the likelihood of dumping by the domestic firm in the foreign market.

Proof. The likelihood of dumping decreases if the LHS of the inequality increases more than the RHS with an increase in *e.* This happens if $ae > ge$ which leads to the condition $a > g$. This case is most likely in a Cournot setting with a large enough a (demand is large enough) and not too high transport costs.

2.2.3 Reciprocal dumping

Reciprocal dumping occurs if both firms dump their products in their export markets.

Proposition 3 *Reciprocal dumping arises if:*

$$a < g. \tag{2.15}$$

Proof. Reciprocal dumping occurs if both equation 13 and 14 are satisfied.

Rearranging inequality 2.13 and 2.14,

$$(a - g) - (a + 2g)e < 0, \tag{2.13a}$$
$$(a - g)e - (a + 2g) < 0. \tag{2.14a}$$

It is now easily seen that both inequalities are satisfied if $a<g$. As a result reciprocal dumping occurs only in the unlikely case when demand is lower than transport costs.

The results from propositions 1 and 2 show that exchange rate movements affect the dumping criterion in opposite directions. A depreciation of the domestic currency (increase in *e)* increases, ceteris paribus, the difference between the foreign currency price of exports (*p/e–g)* and the local price in the foreign country (*p**). This increases the likelihood of dumping by the foreign firm in the domestic market. On the other hand a depreciation of the domestic currency decreases, ceteris paribus, the difference between the domestic currency price of export (*ep*-g*) and the local price in the domestic country (*p*). This decreases the likelihood of dumping by the domestic firm in the foreign market.

2.3 Effect of exchange rate volatility on prices

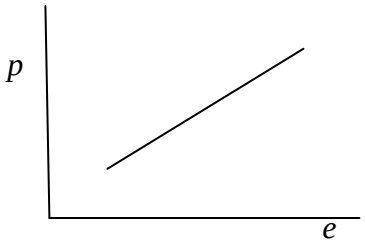
In this part the effect of exchange rate volatility on prices will be examined in both the domestic and foreign market.

2.3.1 Effect of exchange rate volatility on prices in the domestic market

The effect of exchange rate volatility on prices can be examined by taking the first and second order derivative of the equilibrium price in the domestic market w.r.t. the exchange rate:

$$\frac{\partial p}{\partial e} > 0 \qquad \frac{\partial^2 p}{\partial e^2} = 0$$

Figure 2.3.1 Effect of exchange rate volatility on the domestic equilibrium price



In this case there is no effect of exchange rate volatility on the equilibrium price in the domestic market as the exchange rate is just a linear increasing function of the domestic price.

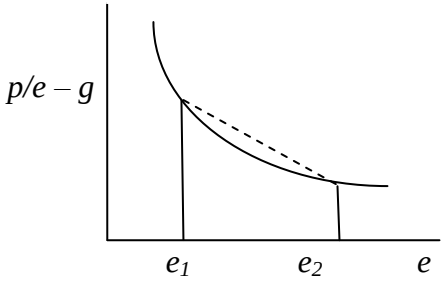
Nevertheless, exchange rate volatility can be analysed in the domestic market by examining the foreign currency export price. The foreign currency export price depends on the domestic price, the exchange rate and transport costs. The f.o.b price of exports from the foreign firm to the domestic market is:

$$\frac{p}{e} - g = \frac{a + c + ec^* - 2eg}{3e}.$$

The first and second order derivative of the foreign currency export price w.r.t. the exchange rate results in:

$$\frac{\partial(\frac{p}{e}-g)}{\partial e}<0, \qquad \frac{\partial^2(\frac{p}{e}-g)}{\partial e^2}>0.$$

Figure 2.3.2 Effect of exchange rate volatility on foreign currency export price



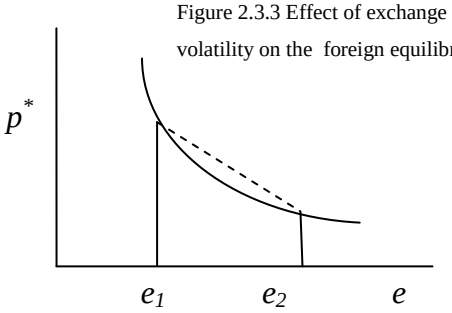
In this case the relationship is decreasing convex which implies that if the exchange rate increases the foreign currency export price decreases at a increasing rate. In terms of exchange rate volatility this implies that the foreign currency export price will be higher than if there is not any exchange rate volatility. If for example the exchange rate fluctuates between e_1 and e_2 then the export price will not be set on the decreasing convex line but rather on the dotted line (between the intersection points of e_1 and e_2 with the decreasing convex line) which is higher than the case if there is not any exchange rate volatility.

2.3.2 Effect of exchange rate volatility on prices in the foreign market

In the foreign market the effect of exchange rate volatility is somewhat different. Taking the first and second order derivative of the equilibrium price in the foreign market w.r.t. the exchange rate results in:

$$\frac{\partial p^*}{\partial e}<0, \qquad \frac{\partial^2 p^*}{\partial e^2}>0.$$

Figure 2.3.3 Effect of exchange rate volatility on the foreign equilibrium price



In this case the relationship is decreasing convex which implies that if the exchange rate increases the equilibrium price in the foreign market decreases at a increasing rate. In terms of exchange rate volatility this implies that the equilibrium price in the foreign market will be higher when there is exchange rate volatility.

Exchange rate volatility can also be analysed in the foreign market by examining the domestic currency export price. The domestic currency price of exports depends on the

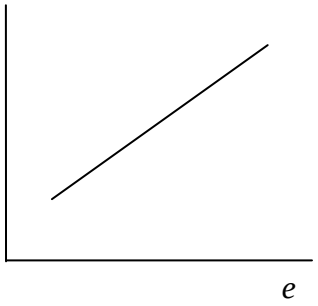
foreign market price, the exchange rate and transport costs. The f.o.b price of exports from the domestic firm to the foreign market is:

$$ep^* - g = \frac{ae + ec^* + c - 2g}{3}.$$

The first and second order derivative of the domestic currency export price w.r.t. the exchange rate results in:

$$\frac{\partial(ep^* - g)}{\partial e} > 0 \qquad \frac{\partial^2(ep^* - g)}{\partial e^2} = 0$$

Figure 2.3.4 Effect of exchange rate volatility on domestic currency export price



In this case there is no effect of exchange rate volatility on the domestic currency export price as the exchange rate is just a linear increasing function of the domestic currency export price.

2.4 Dumping and exchange rate volatility

In this part the effect of exchange rate volatility on dumping will be examined in both the domestic and the foreign market.

2.4.1 Dumping and exchange rate volatility in the domestic market

Dumping by the foreign firm in the domestic market occurs if the f.o.b. price of exports is below the foreign price:

$$\frac{p}{e} - g < p^* \Leftrightarrow p^* - \frac{p}{e} + g,$$

substituting for p and p^*:

$$\frac{a + c + ec^* - 2eg}{3e} < \frac{ea + ec^* + c + g}{3e},$$

rearranging leads to:

$$\frac{ea + g + 2eg - a}{3e} > 0.$$

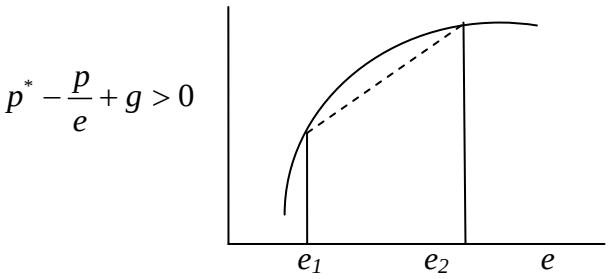
The first derivative w.r.t. the exchange rate results in:

$$\frac{3a-3g}{(3e)^2} > 0, \; with \; a > g,$$

the second derivative w.r.t. the exchange rate results in:

$$\frac{54ge-54ae}{(3e)^4} <, \; with \; a > g.$$

Figure 2.3.5 Effect of exchange rate volatility on dumping in the domestic market



The relationship is increasing concave. If the exchange rate increases the likelihood of dumping by the foreign firm in the domestic market increases, which is consistent with proposition 1. The effect of exchange rate volatility in this setting implies that the likelihood of dumping decreases if there is exchange rate volatility.

Proposition 4 *Exchange rate volatility decreases the likelihood of dumping by the foreign firm in the domestic market.*

2.4.2 Dumping and exchange rate volatility in the foreign market

Dumping by the domestic firm in the foreign market occurs if the f.o.b. price of exports is below the domestic price:

$$ep^* - g < p \Leftrightarrow p - ep^* + g > 0 \Leftrightarrow \frac{p}{e} + \frac{g}{e} - p^* > 0,$$

substituting for p and p^* and rearranging leads to:

$$\frac{a + eg + 2g - ea}{3e} > 0.$$

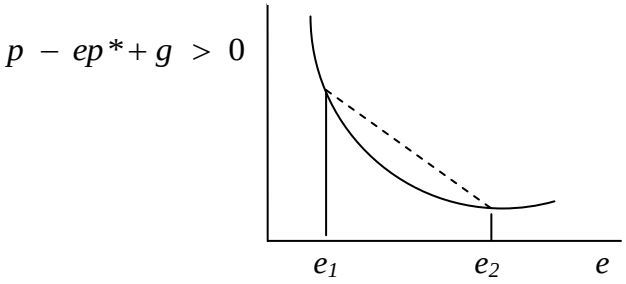
The first derivative w.r.t. the exchange rate results in:

$$\frac{-3a-6g}{(3e)^2} < 0,$$

the second derivative w.r.t. the exchange results in:

$$\frac{54ae+108eg}{(3e)^4} > 0.$$

Figure 2.3.6 Effect of exchange rate volatility on dumping in the foreign market



The relationship is decreasing convex. If the exchange rate increases the likelihood of dumping by the domestic firm in the foreign market decreases, which is consistent with proposition 2. The effect of exchange rate volatility in this setting implies that the likelihood of dumping increases if there is exchange rate volatility.

Proposition 5 *Exchange rate volatility increases the likelihood of dumping by the domestic firm in the foreign market.*

2.5 Material injury criterion

As already explained a AD filing depends on three criteria one of them is to show evidence that the domestic industry has suffered ‘material injury’ as a result of dumped imports. A method to proof material injury is if a firm loses market share. This method is examined by looking at the changes in market shares due to exchange rate movements.

2.5.1 Material injury in the domestic market

The share of the domestic firm in the domestic market can be expressed as follows:

$$Z = \frac{X_D}{X_D + Y_E^*},$$

substituting for X_D and Y_E^* results in:

$$Z = \frac{a - 2c + e(c^* + g)}{2a - c - e(c^* + g)}.$$

the derivative of Z w.r.t. the exchange rate is:

$$\frac{\partial Z}{\partial e} = \frac{3c^*(a-c) + 3g(a-c)}{(2a - c - e(c^* + g))^2} > 0, \text{ with } a > c.$$

The share of the foreign firm in the domestic market can be expressed as follows:

$$R = \frac{Y_E^*}{X_D + Y_E^*},$$

substituting for X_D and Y_E^* results in:

$$R = \frac{a + c - 2e(c^* + g)}{2a - c - e(c^* + g)}.$$

the derivative of R w.r.t. the exchange rate is:

$$\frac{\partial R}{\partial e} = \frac{3c^*(c-a) + 3g(c-a)}{(2a - c - e(c^* + g))^2} < 0, \text{ with } a > c.$$

Proposition 6 *A depreciation of the domestic currency (increase in e) increases the domestic share in the domestic market and decreases the foreign share in the domestic market. This will make it less likely that the domestic firm will initiate a AD filing.*

2.5.2 Material injury in the foreign market

The share of the domestic firm in the foreign market can be expressed as follows:

$$E = \frac{X_E}{X_E + Y_D^*},$$

substituting for X_E and Y_D^* results in:

$$E = \frac{ea + ec^* - 2(c + g)}{2ea - ec^* - (c + g)}.$$

The derivative of E w.r.t. the exchange rate is:

$$\frac{\partial E}{\partial e} = \frac{3a(c+g) - 3c^*(c+g)}{(2ea - ec^* - (c+g))^2} > 0, \text{ with } a > c^*.$$

The share of the foreign firm in the foreign market can be expressed as follows:

$$F = \frac{Y_D^*}{X_E + Y_D^*},$$

substituting for X_D and Y_E^* results in:

$$F = \frac{ea - 2ec^* + (c+g)}{2ea - ec^* - (c+g)}.$$

The derivative of F w.r.t. the exchange rate is:

$$\frac{\partial F}{\partial e} = \frac{3c^*(c+g) - 3a(c+g)}{(2ea - ec^* - (c+g))^2} < 0, \text{ with } a > c^*.$$

Proposition 7 *A depreciation of the domestic currency (increase in e) increases the domestic share in the foreign market and decreases the foreign share in the foreign market. This will make it more likely that the foreign firm will initiate a AD filing.*

3. Related literature

It is important to understand that a antidumping investigation arises from legal concepts. The meaning of 'less than normal value', causation, and 'material injury' are examined from a legal perspective. Given its legal basis it is not surprising that the economic motivation for antidumping laws is far from clear. A possible economic motivation is to address predatory pricing. Predatory pricing occurs when foreign firms are pricing low to induce exit by domestic firms, in order to attain monopoly prices in future periods. Most economists generally agree that predatory pricing leads to a welfare loss for a country, but are unconvinced about how often such a strategy is realistic or successful. Even more importantly, antidumping laws and practices do not apply the same rigid standard used by antitrust agencies to determine if pricing is predatory. Instead, depending on the typical definitions of 'normal' or 'fair' value used by agencies, simple price discrimination across markets or pricing below a level that would return a significant profit to the foreign firm will easily lead to accusations of dumping (Bloningen and Prusa, 2003). As a consequence economists generally believe that there is little connection between antidumping protection to address unfair trade and welfare considerations (Stiglitz, 1997). Instead most economists find evidence that antidumping filings are motivated by the same political-economy considerations that lead to other forms of trade protection. It has for instance it been found that industries

with production facilities in politically important districts fare better (Bloningen and Prusa, 2003).

3.1 Dumping criterion

The augmented Brander and Krugman model presented above is based on a duopoly in a horizontal product market with intra-industry trade. The model has explored the level effect of the exchange rate and the relation it has with the dumping criterion. It is shown that with a domestic currency depreciation the likelihood of dumping by the foreign firm in the domestic market increases. Furthermore a domestic currency depreciation decreases the likelihood of dumping by the domestic firm abroad.

A similar result is shown by Moraga-González and Viaene (2004a) based on a model with oligopolistic firms in a vertical product market with quality differentials between developed and developing countries. The main result of their model is that dumping is a natural strategy of firms and that it always takes place. Unilateral or reciprocal dumping arises as a consequence of cross-country difference in incomes. The explanation for dumping by foreign firms in the domestic market is that an increase in the exchange rate (depreciation of domestic currency) increases the gap between the international foreign currency price of the high quality product (produced and exported by the developed country) and the local price abroad. This increases the likelihood of dumping in the domestic market. On the other hand the increase in the exchange rate decreases the difference between the domestic currency price of low quality exports and the domestic price, which reduces the likelihood of dumping in the foreign market.

Knetter and Prusa (2003) have developed a two period duopoly model and found similar propositions on the dumping criterion. They have developed a model to show how AD law complicates the foreign firm pricing decision. In their model with typical pricing-to-market behaviour (pricing based on the exchange rate) a depreciation of the domestic currency will make it more likely that the foreign firm is guilty of dumping. The foreign firm will raise its export price by less than the change in the exchange rate. With partial pass-through this means that an affirmative dumping determination is more likely. However they have also shown that in this scenario a depreciation of the domestic currency decreases the chance of injury making the foreign firm less guilty of dumping behaviour.

3.2 Material injury criterion

As already explained a AD filing depends on three criteria, one of them is to show evidence that the domestic industry has suffered 'material injury' as a result of foreign imports. Thus potential domestic petitioners know they also must show injury caused by dumping. The weaker the industry's general condition, the stronger are their chances of convincing that they have been harmed by dumping. This implies that an appreciation of the domestic currency, which inevitably will lead to lower import prices and increased import competition, will increase the likelihood of receiving a positive material injury determination. Knetter and Prusa (2003) have also shown this formally in their model that with pricing-to-market behaviour an appreciation of the domestic currency will increase the chance of material injury. Similarly in the model presented above it is shown that the share of the domestic firm in the domestic market decreases and the share of the foreign firm in the domestic market increases as a result of an appreciation of the domestic currency (proposition 6). In such a case it will be easier for the domestic firm to proof material injury. Assuming that the incentive to file an AD case is positively related to the likelihood of affirmative decisions on the injury and dumping criteria then in theory it is entirely possible that either exchange rate appreciations or deprecations can increase AD filings.

3.3 Exchange rate volatility

In the model presented above it is shown that exchange rate volatility will decrease dumping in the domestic market and increase dumping in the foreign market. A similar result can be found by examining the model developed by Moraga-González and Viaene (2004a). In their model dumping by the foreign firm in the domestic market arises if:

$$\frac{p_h^*(1-t)}{e} < p^*,$$

where p_h^* is the price charged in the domestic market by the foreign firm, p^* is the international price in the foreign market, t a tariff rate and e the exchange rate expressed as the domestic currency price of foreign currency. Substituting for p_h^* and p^* results in the condition for dumping:

$$\frac{(1-t)}{e} < \lambda^*,$$

where λ^* is a measure of income differences across countries. To examine exchange rate volatility in their model one needs to look at the first and second derivative of the above condition w.r.t. the exchange rate.

Rearranging the above condition results in:

$$\lambda^* - \frac{(1-t)}{e} > 0.$$

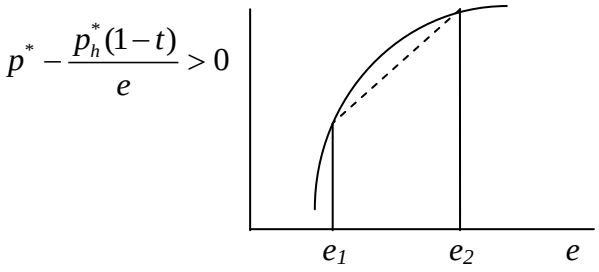
The first derivative w.r.t. the exchange rate results in:

$$\frac{(1-t)}{e^2} > 0, \ with\ t < 1,$$

the second derivative w.r.t. the exchange rate results in:

$$\frac{2e(t-1)}{e^4} < 0, \ with\ t < 1.$$

Figure 3.3.1 Effect of exchange rate volatility on dumping in the domestic market



The same increasing concave relationship, as found in the model above in part 2.4.1, is found here as well. When the exchange rate increases the likelihood of dumping by the foreign firm in the domestic market increases, which is consistent with corollary 1 in Moraga-González and Viaene (2004a). The effect of exchange rate volatility is the same as in the model above, it decreases the likelihood of dumping by the foreign firm in the domestic market.

Dumping by the domestic firm in the foreign market arises if:

$$ep_l\left(1-t^*\right) < p,$$

where p_l is the price charged by the domestic firm in the foreign market, *p is* domestic price, t^* is the tariff rate charged in the foreign market and *e* is the exchange rate. Substituting for p_l and *p* results in the condition for dumping:

$$\lambda^* < \frac{1}{(1-t^*)e},$$

rearranging the above condition results in:

$$\frac{1}{(1-t^*)e} - \lambda^* > 0.$$

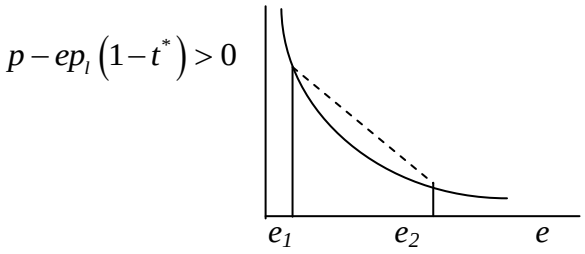
The first derivative w.r.t. the exchange rate results in:

$$\frac{(t^*-1)}{[(1-t^*)e]^2} < 0, \ with\ t^* < 1,$$

the second derivative w.r.t. the exchange rate results in:

$$\frac{2e(t^*-1)^2}{[(1-t^*)e]^4} > 0, \ with\ t^* < 1.$$

Figure 3.3.2 Effect of exchange rate volatility on dumping in the foreign market



The same decreasing convex relationship, as found in the model above in part 2.4.2, is found here as well. When the exchange rate increases the likelihood of dumping by the domestic firm in the foreign market decreases, which is consistent with their corollary 1 in Moraga-González and Viaene (2004a). The effect of exchange rate volatility is the same as in the model above, it increases the likelihood of dumping by the domestic firm in the foreign market.

3.4 Summary of theoretical predictions

The theoretical predictions based on the model presented above and the related literature is summarized in table 3.1.

Table 3.1 Theoretical propositions of movements in the exchange rate[1]

	Augmented model of Brander and Krugman			*Extension of Moraga-González and Viaene*[2]		
	Depreciation	**Appreciation**	**Volatility**	**Depreciation**	**Appreciation**	**Volatility**[3]
Dumping condition						
Dumping in the domestic market by the foreign firm	+	-	-	+	-	-
Dumping in the foreign market by the domestic firm[4]	-	+	+	-	+	+
Injury condition						
Domestic share in domestic market	+	-				
Foreign share in domestic market	-	+				
Domestic share in foreign market	+	-				
Foreign share in foreign market	-	+				

Note: (1) The exchange rate is defined as the domestic currency per unit of foreign currency so that an increase in the exchange rate reflects a depreciation of the domestic country's currency. (2) These results are reported in Proposition 2 and the corresponding corollary of Moraga-González and Viaene (2004a). (3) This result is derived in part 3.3 of this thesis based on the findings of Moraga-González and Viaene (2004a). (4) The condition for this is that a>g, demand is larger than the transport costs. (5) (+) Means an increase in the likelihood of dumping whereas (-) a decrease.

The model presented above as well as the model by Moraga-González and Viaene (2004a) show the same theoretical predictions for the level and volatility effect in relation to the dumping condition. The model by Moraga-González and Viaene is based on vertical product differentiation with intra-industry trade. On the other hand the model presented above is an extension of the horizontal product differentiation model with intra-industry trade by Brander and Krugman. This implies that with both type of market structures the same relationships with movements in the exchange rate are expected. The first reason for this is that the dumping conditions are similar in both models as they both follow from the standard definition of dumping by the WTO (see part 2.2). Second, in both models, movements in the exchange rate affect international prices in a similar fashion. A depreciation of the domestic currency (increase in *e)* increases, ceteris paribus, the difference between the foreign currency

price of exports and the local price in the foreign country. This increases the likelihood of dumping by foreign firms in the domestic market. On the other hand a depreciation of the domestic currency decreases, ceteris paribus, the difference between the domestic currency price of export and the local price in the domestic country. This decreases the likelihood of dumping by domestic firms in the foreign market. These similar relationships also lead to the similar result for the effects of exchange rate volatility on dumping. Knetter and Prusa (2003) also show the same results for the level effect of the exchange rate based on a two period duopoly model. The reason for this is that the dumping condition is the same in all models depending on the definition of the exchange rate[1]. However, the argumentation developed by Knetter and Prusa (2003) as well as Feinberg (2005) is somewhat different. In the absence of dumping the relationship would be $p/e = p^*$. A depreciation of the exchange rate (increase in *e)* would increase the likelihood of dumping if foreign exporters refrain from passing on the full increase in price dictated by the exchange rate change, taking lower profit margins on export sales to avoid losing market share.[2]

Considering the theoretical predictions for both the dumping condition as well the material injury condition it is entirely possible that either exchange rate appreciations or depreciations can lead to increased antidumping filings. It is an empirical matter to find out which criterion has the most impact on AD filings. To investigate these theoretical predictions an empirical research will be conducted on AD filing behaviour in ***India*** over the time period 1995-2009.

4. Data

To investigate the relationships between the exchange rate and antidumping filings, data is collected from several different sources. The variables used in the empirical analysis are discussed below. A more detailed description of the variables can be found in appendix B.

AD filings per quarter

Filings per quarter are calculated based on the *Global Antidumping Database (*Bown, World Bank, 2010). This database reports filing data for each country specifically and contains, (amongst others) the filing country, the defendant and the date of the initiation of the investigation.

[1] In this analysis it is assumed that the exchange rate *e* is defined as domestic currency per unit of foreign currency. Knetter and Prusa (2004) as well as Feinberg (2005) define the exchange rate as foreign currency per unit of domestic currency. The theoretical predictions however remain the same despite the different definitions.
[2] The incomplete exchange rate pass-through assumed here is thought to be the norm according to a survey by Goldberg and Knetter (1997).

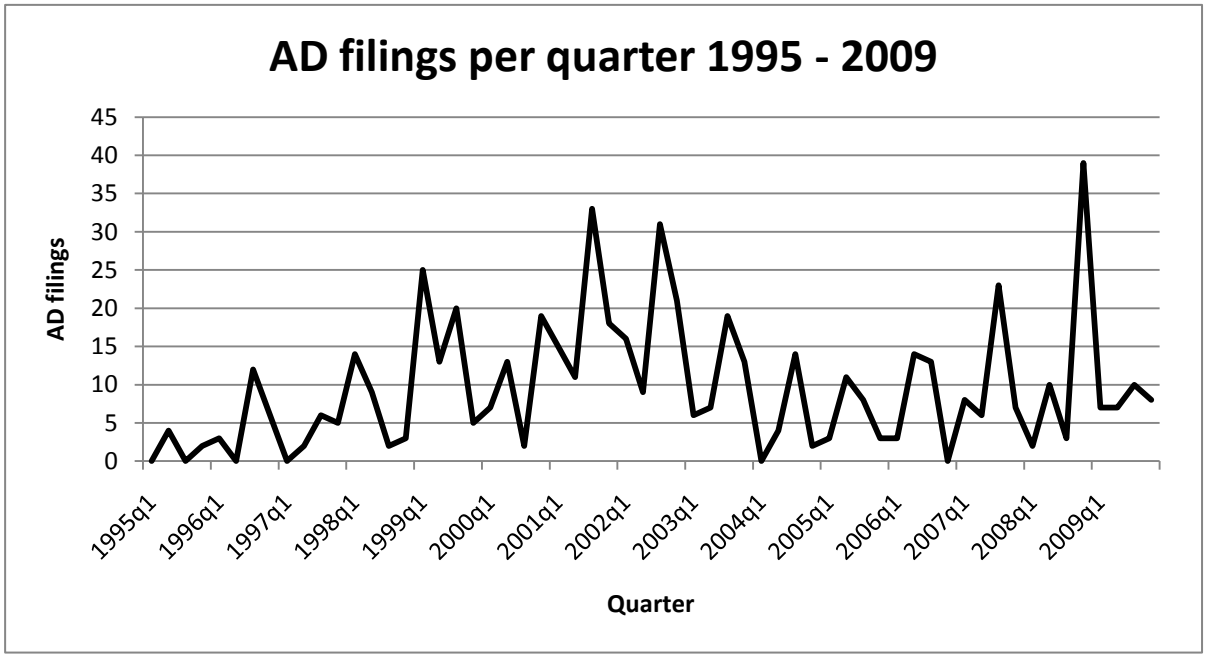
Table 4.1 Mean, standard deviation and variance of quarterly filings of India by source country, 1995-2009

	Total	Avg. filings per quarter	Std.Dev	Var.
China	126	2.100	1.953	3.812
South Korea	44	0.733	0.950	0.903
Taiwan	42	0.700	0.940	0.884
EU[1]	38	0.633	1.075	1.156
Thailand	32	0.533	0.911	0.829
Japan	30	0.500	0.813	0.661
USA	27	0.450	0.747	0.558
Indonesia	23	0.383	0.555	0.308
Singapore	23	0.383	0.846	0.715
Malaysia	19	0.317	0.537	0.288
Russia	18	0.300	0.613	0.376
Total sample	576	9.6	8.553	73.159

Note: (1) For the European Union only data from 2000-2009 is used.

Some basic statistics of the filings used in the analysis are summarized in table 4.1. There is substantial variation in filing across countries. It is clear that India can be considered as a heavy user of AD filings. The most targeted country in the sample is China. Remarkably the most countries targeted are situated in Asia. For the aggregate analysis the whole sample is used. For the bilateral analysis the eleven top targeted countries in table 4.2 are used with a total of 422 cases which accounts for 73% of the total sample. Figure 4.1 displays the number of quarterly filings by India in the time period 1995-2009. The figure shows that there is considerable variation in the number of filings from quarter-to-quarter.

Figure 4.1 AD filings per quarter in India 1995-2009



Exchange rates

For the aggregate filing behaviour, the real exchange rate used is the one based on Special Drawing Rights (SDR) as reported by the IMF. In the examination of filings against individual foreign countries (bilateral filings), bilateral real exchange rates are collected from the Economic Research Service of the U.S. Department of Agriculture as they report exchange rates in a consistent fashion for virtually all countries in the world. The exchange rate is defined as domestic currency per unit of foreign currency so that an increase in the exchange rate reflects a depreciation of the domestic country's currency. The exchange rate is, normalized, before taking the natural logarithm by dividing each exchange rate series by its sample mean so as to offset the scale effect from one exchange rate to the other. According to the theoretical predictions relating to the dumping condition the expected sign on the exchange rate coefficient should be positive. However a negative sign is also possible as in this case the injury criterion can be considered to be the main reason to initiate a AD filing.

Average real GDP growth

The International Monetary Fund *International Financial Statistics* provided real GDP growth rates for both the filing and defendant countries. The expected sign for the coefficient for the growth rate of India is negative, since if India is experiencing an expansion of its economy it will be hard to prove that is has suffered from material injury.

Real GDP per capita

The International Monetary Fund *International Financial Statistics* provided GDP per capita data for both the filing and defendant countries. GDP per capita is used in the empirical analysis as a measure of income differences across countries, λ^*. It is only used in the bilateral part. Moraga-González and Viaene (2004b) show that unilateral and reciprocal dumping depends on certain levels of λ^*. The data for this variable is constructed in two ways; one is the ratio of foreign GDP per capita to Indian GDP per capita (similarly as in figure 2 of Moraga-González and Viaene (2004b)). The other way is simply Indian GDP per capita minus foreign GDP per capita. The sign for this coefficient is expected to be positive since the bigger the difference in incomes the more likely unilateral dumping by the foreign firm in the domestic market will be according to Moraga-González and Viaene (2004b). There was no GDP per capita data available for Taiwan and therefore Taiwan is excluded for the empirical tests which use GDP per capita.

Exchange rate volatility

The sign for exchange rate volatility is expected to be negative based on theoretical predictions. The exchange rate volatility which is used in the empirical part is measured as follows, with the example of the bilateral exchange rate between India and the U.S.:

Let e_t = quarterly Indian Rupee/U.S. Dollar exchange rate

e_t^* = ln e_t

$de_t^* = e_t^* - e_{t-x}^*$ = change in the exchange rate

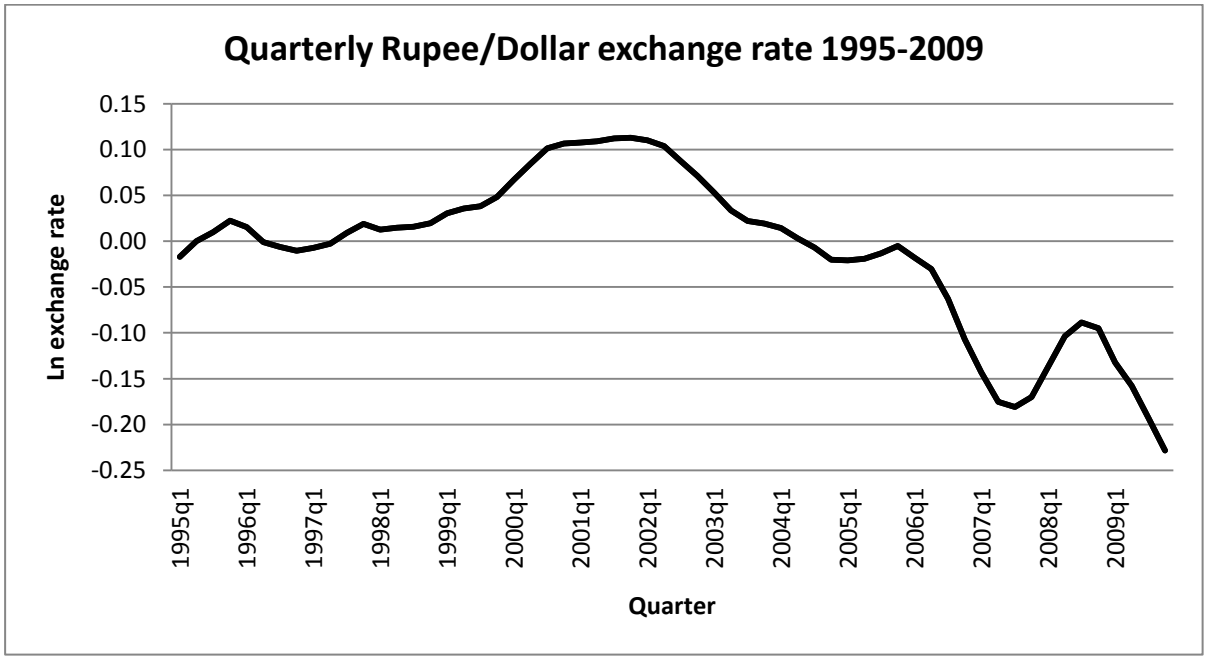
$d\bar{e}_t^*$ = mean of de_t^*

$X_t = de_t^* - d\bar{e}_t^*$ = deviation from the mean

X_t^2 = measure of volatility,

where x in e_{t-x}^* stands for different time periods considered. Thus X_t is the mean-adjusted change in the exchange rate. X_t^2 can now be used as a measure of volatility (Gujarati, 2003). Since it is a squared quantity its value will be large in periods when there are big changes in the exchange rate and its value will be comparatively small when there are modest changes in the exchange rate. To understand this volatility measure consider figure 4.2 which displays the natural logarithm of the quarterly Indian Rupee/U.S. Dollar exchange rate (e_t^*) for the period 1995-2009.

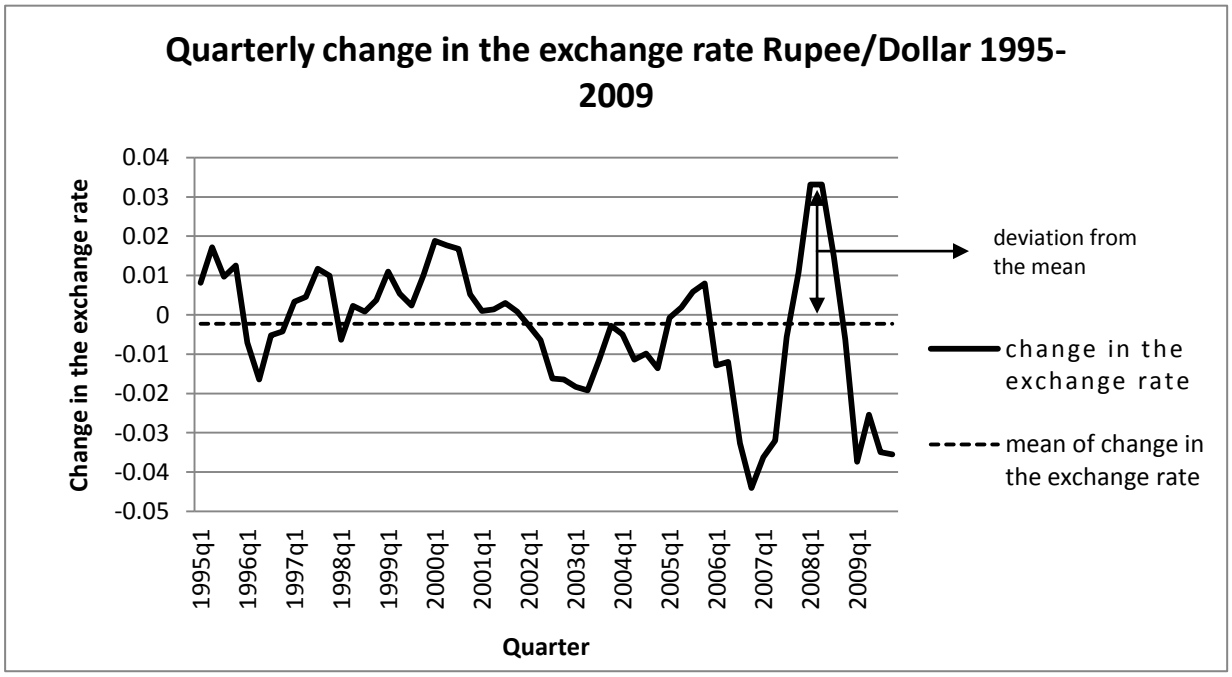
Figure 4.2 Ln of quarterly Indian Rupee/U.S. Dollar exchange rate 1995-2009



Note: Quarterly exchange rates have been calculated by taking the quarterly average of the monthly exchange rate.

As can be seen in figure 4.2 there are considerable ups and downs in the exchange rate over the sample period. To see this more vividly consider figure 4.3 where the changes in the natural logarithm of the quarterly exchange rate (de_t^*) and the mean of these quarterly changes ($d\bar{e}_t^*$) are plotted.

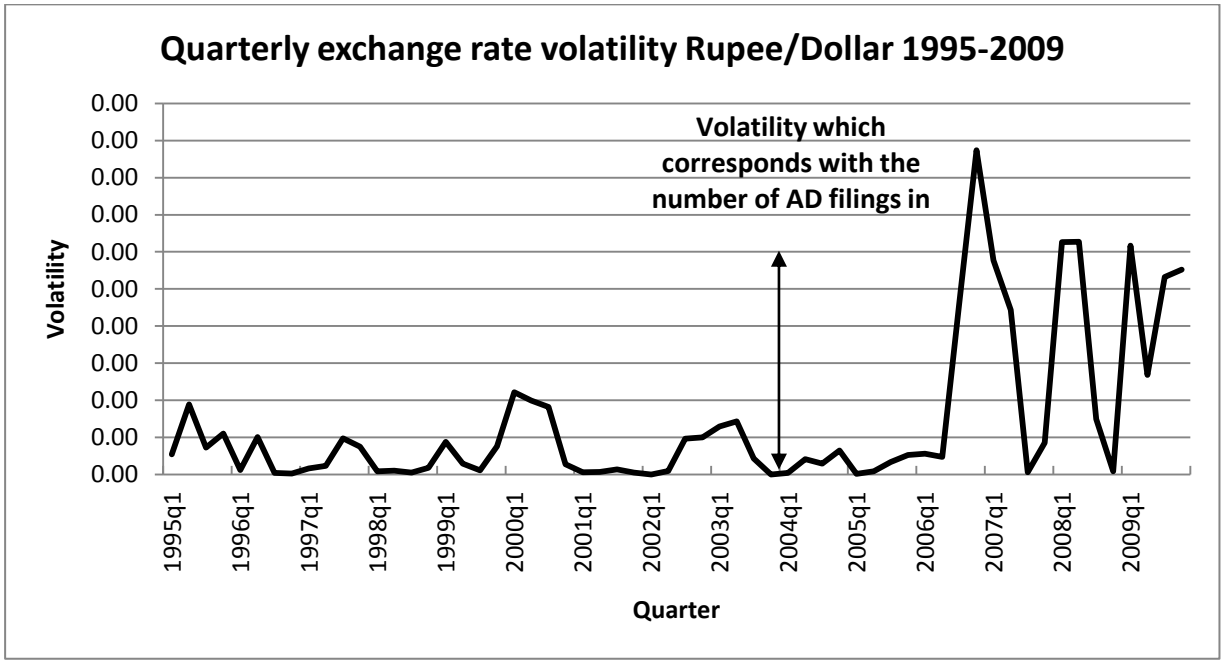
Figure 4.3 Quarterly changes in the exchange rate Rupee/Dollar and the mean of these quarterly changes in 1995-2009



Notes: Quarterly changes are plotted which implies that the period considered is a one quarter lag. If multiplied by a 100 these changes will give percentage changes. Mean of the change in the exchange rate is -0.00227.

The deviation from the mean squared can then be used as a measure of volatility. This measure is plotted in figure 4.4. The mean of the change in the exchange rate is negative which implies that over the sample period considered the exchange rate between the Rupee and the Dollar has been on a appreciating trend.

Figure 4.4 Quarterly exchange rate volatility of the Rupee/Dollar 1995-2009



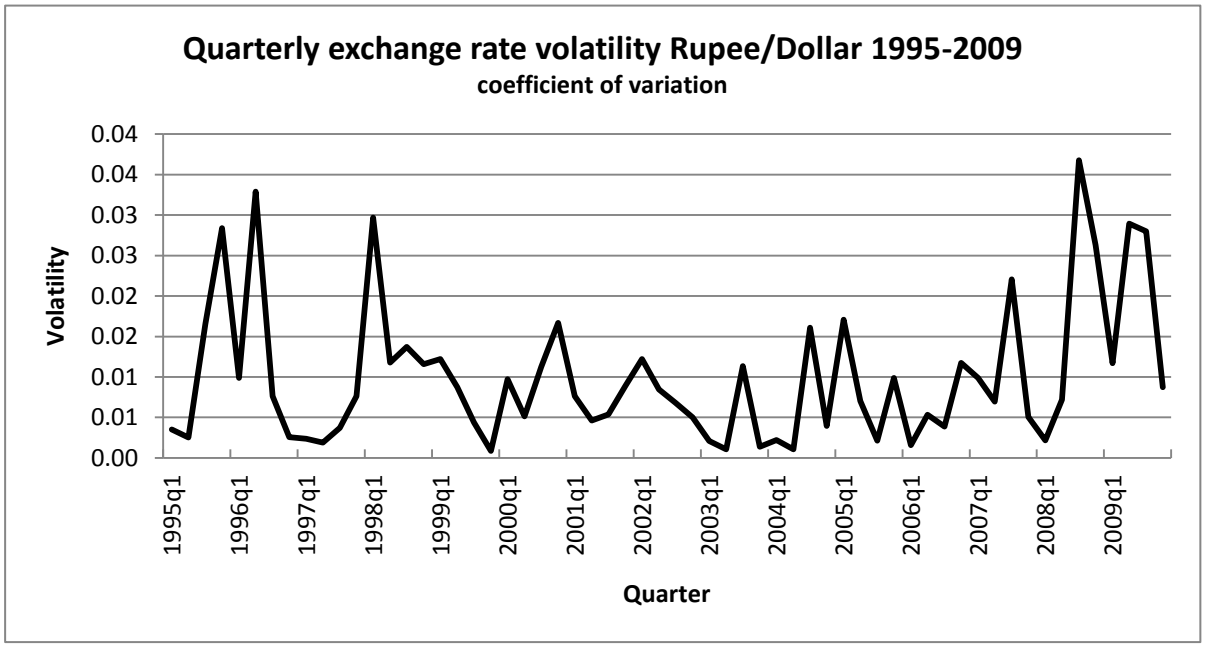
The exchange rate volatility which then corresponds to the number of AD filings in a particular quarter is just the exchange rate volatility as plotted in figure 4.4.

Empirical test were also conducted with a different volatility parameter namely; the coefficient of variation, these results are only reported in the appendix. Exchange rate volatility in this case is measured as the ratio of the standard deviation to the mean:

$$\text{Coefficient of Variation} = \frac{\text{Standard deviation}_{t-x}}{\text{Mean}_{t-x}}$$

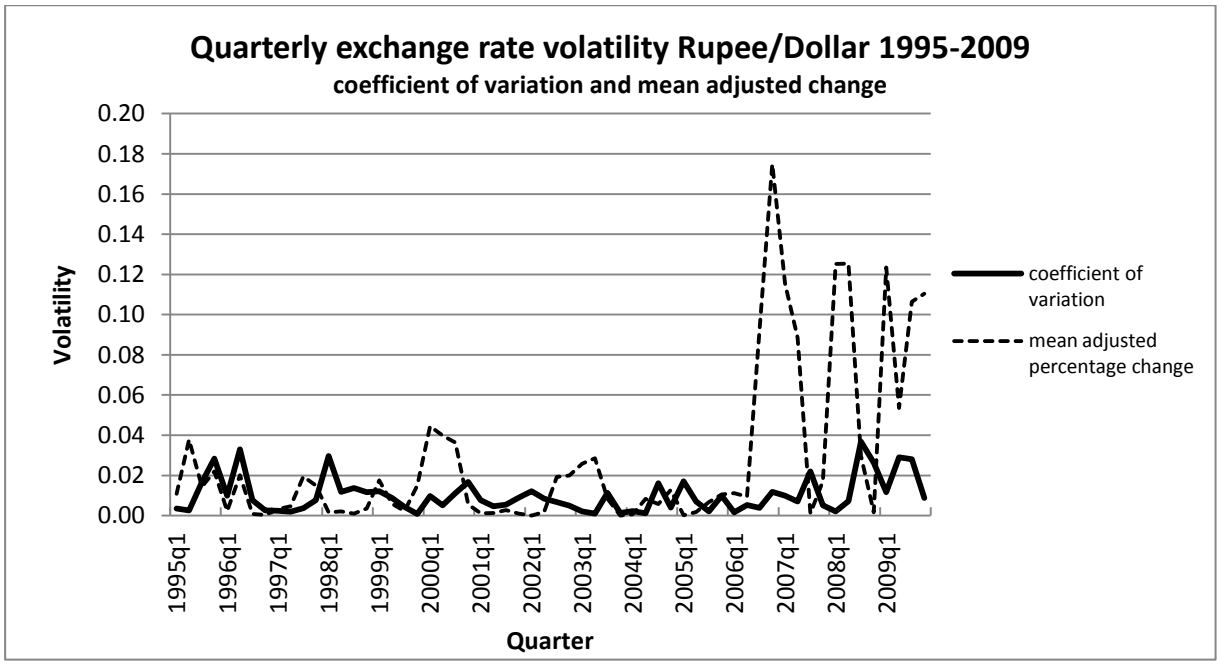
where the *x* stands for different time periods considered. The standard deviation as well as the mean are calculated by looking at a one or two quarter period and a yearly period. Exchange rate volatility in each quarter is then based on a rolling standard deviation and a rolling mean. To compare the volatility measures the coefficient of variation is depicted in figure 4.5.

Figure 4.5 Quarterly exchange rate volatility Rupee/Dollar 1995-2009 using the coefficient of variation



At first sight comparing the two figures it looks like exchange rate volatility using the coefficient of variation is much more volatile. Including both measures in figure 4.6 one can see that the volatility measures do differ in the period 1997-2003. Nevertheless both volatility measures show that exchange rate volatility was high in the period 1995-1996 and from 2006 onwards. For the period from 2006 onwards, however the mean adjusted change measure shows considerably higher exchange rate volatility then the coefficient of variation.

Figure 4.6 Comparing volatility measures



Note: Volatility based on the mean adjusted change is multiplied by 100 for comparison.

5. Empirical specification

The dependent variable in this econometric research will be the number of filings per quarter. Since the number of filings is a non-negative count variable the natural way to estimate the relationship between the number of filings and macroeconomic factors is using a count model such as the Poisson model. However previous studies in this field have estimated the relationship with a negative binomial regression (Knetter and Prusa, 2003; Feinberg, 2005). The negative binomial regression is essentially a Poisson model which allows for overdispersion. One feature of the Poisson model which is likely to be violated with this kind data is the equivalence of the expected value and variance of a Poisson random variable (Wooldridge, 2006). Count data often exhibit overdispersion with respect to the Poisson model. Overdispersion means that the variance of the observed counts exceeds their mean. In such a case the alternative is to assume that the data are generated by a negative binomial random variable which, in contrast to the Poisson model, allows for a variance that is greater than the expected value of the distribution (Knetter and Prusa, 2003). It can be seen in table 4.2 that the variance exceeds its mean in most of its respective series. In appendix C results of statistical tests are presented that show that for this data set the negative binomial regression is preferred over the Poisson model in both the aggregate as well as the bilateral data set.

All the regressions in the bilateral analysis, except the first, in table 6.2.4 use random country effects instead of fixed country effects. The difference between a fixed effects model and a random effects model is the assumption whether there is any correlation between the cross-section specific error component and the independent variables. If it is assumed that the error component and the independent variables are uncorrelated the random effects model is appropriate. Whereas if the error component and the independent variables are correlated the fixed effect model is appropriate (Johnston and DiNardo, 1997). According to Baltagi (2005) the intuitive explanation between the two models is that fixed effects is more appropriate if the focus is on a specific set of countries and that inference of the results is restricted to the behaviour of these countries alone. On the other hand, the random effects model is a more appropriate specification if one draws a set from a larger population. In this case the individual effect is characterized as random and inference pertains to the population from which this sample was drawn. In this setting it would imply that if fixed effects are used the assumption would be that India only files AD cases to a set of fixed countries and that inference of the results is restricted to the behaviour these countries. This is however not the case as India has many trading partners and not all of them dump their products in the Indian

market. There are only several countries which are accused of dumping and these countries can therefore be considered as random. The random effects model is then an appropriate specification if the defendant countries are drawn from a larger population (Baltagi, 2005). This is the case in this analysis as the eleven countries used in the analysis are drawn from a larger set of countries that trade with India. A specification test proposed by Hausman (1978) is conducted to make the choice for the random effects model more formal. The results and explanation of the test can be found in appendix D.

Another important specification issue is the lag structure of the independent variables. The legal framework used in testing for the criteria offers some guidance here. However not specified under WTO rules, most countries generally analyze pricing behaviour over the year preceding the filing of the case in order to assess pricing at less than 'normal value' (Knetter and Prusa, 2003). Material injury, on the other hand, is evaluated over a longer time horizon. In general injury is determined over the three years preceding the filing. Here the results are reported with a one year lag on the exchange rate, three year lags on real GDP growth and three year lags on real GDP per capita differences. For exchange rate volatility results are reported with a one quarter lag and with a two quarter lag based on the square of the mean-adjusted relative change. Results for a one year period lag can be found in appendix E. Exchange rate volatility has also been measured with the coefficient of variation and with the standard deviation, however with these measures no statistically significant results were found. The results based on these measures can also be found in appendix E.

Furthermore in all the regression outputs, statistical tests are reported that test for significance of the models. Amongst these tests reported is the Log Likelihood which is used in the Likelihood Ratio Chi-Square test of whether all independent variables in the model are simultaneously zero (Wooldridge, 2006). The Likelihood Ratio (LR) Chi-Square test will also be reported and abbreviated as LR chi2. This test is analogous to an F-test in a linear regression. The probability of getting a LR statistic as reported by the Chi-square test is also reported under Prob > chi2 (p-value). In the regression outputs for the bilateral data set a Wald Chi-Square test (Wald chi2) will be reported instead of the Likelihood Ratio Chi-Square test. This Wald test is similar as the LR Chi-Square test and tests whether all of the regression coefficients in the model are equal to zero.

5.1 Hypotheses

The hypotheses which will be tested empirically based on the theoretical predictions are the following:

1. H_0: *A depreciation of the domestic currency (increase in e) increases the likelihood of dumping by the foreign firm in the domestic market.*

The above hypothesis relates to the level effect of the exchange rate and will be tested in both the aggregate part as well as the bilateral part of the analysis. This hypothesis is based on the theoretical prediction derived from the augmented Brander and Krugman model developed in part 2.2.1.

2. H_0: *Exchange rate volatility will tend to decrease the likelihood of dumping by the foreign firm in the domestic market.*

The second hypothesis relates to the volatility effect of the exchange rate and is based on the theoretical predictions derived from the augmented Brander and Krugman model in part 2.4.1 as well as the extension of the model by Moraga-González and Viaene developed above in part 3.3.

6. Results

6.1 Quarterly data on aggregate filings

The first set of results are based on aggregate quarterly number filings by India over the time period 1995-2009. The estimation is the number of filings as a function of the real exchange rate, domestic real GDP growth and exchange rate volatility using the negative binomial regression. The real exchange rate variable is lagged one year and normalized by dividing each exchange rate series by its sample mean before taking the natural logarithm. The real GDP growth variable is the three year growth rate from *t-3* to *t*. Exchange rate volatility is measured as the squared mean adjusted change in the exchange rate. The results are reported in table 6.1.1. All the regressions have at least one independent variable which is significantly different from zero at the 95% level. This can be seen by looking at the Prob>chi2 term which reports p-values for the Likelihood Ratio Chi-Square test that at least one of the independent coefficients is not equal to zero in the model.

In all of the models the exchange rate has as a statistically significant impact. The aggregate filing data unambiguously indicate that AD filings increase when the Indian Rupee

depreciates w.r.t. the SDR, which is consistent with the first hypothesis but contradicts with existing empirical research. The coefficients indicate that with a 1% depreciation AD filings per quarter will increase by 2.1% to 3.1%.

Table 6.1.1 Negative binomial estimation of aggregate filings per quarter India 1995-2009

	(1)	(2)	(3)	(4)	(5)	(6)
ln rxr(-1y)	2.387**	2.270**	2.135**	3.061***	2.752***	2.702**
	(2.10)	(2.12)	(1.98)	(2.74)	(2.45)	(2.37)
avggr(-3y)				-0.187**	-0.126	-0.134
				(-2.03)	(-1.20)	(-1.30)
vol(-1q)		-902.031**			-594.225	
		(-2.12)			(-1.20)	
vol(-2q)			-227.034**			-144.990
			(-2.01)			(-1.13)
Constant	2.165***	2.340***	2.322***	3.376***	3.095***	3.133***
	(17.70)	(15.74)	(15.94)	(5.49)	(4.74)	(4.84)
Observations	60	60	60	60	60	60
LR chi2	4.18	8.17	7.74	8.18	9.57	9.40
Prob > chi2	0.0410	0.0168	0.0208	0.0167	0.0226	0.0244
Log likelihood	-195.900	-193.901	-194.115	-193.896	-193.201	-193.288

Notes: ln rxr(-1y) is the natural logarithm of the SDR exchange rate lagged one year. avggr(-3y) is average growth in real GDP of India over the prior three years, vol(-1q) is exchange rate volatility lagged one quarter and vol(-2q) is exchange rate volatility lagged two quarters. Z-statitistics for a test of no effect on filings are in parentheses *** Significant at 1% level, ** 5% level and * 10% level, based on p-values.

The exchange rate volatility coefficients in columns (2) and (3) are statistically significant in explaining AD filings. Both the exchange rate volatility lagged one quarter and two quarter lagged show the expected negative sign. The coefficients look to have a large impact but it must be taken into account that the measure for exchange rate volatility is in terms of percentage changes. The coefficients reported have to be divided by a hundred to see elasticity effects. The exchange rate volatility coefficients thus indicate that a 1% increase in quarterly exchange rate volatility reduces quarterly case filings by 9%. Considering a two quarter lag, exchange rate volatility is expected to reduce quarterly AD filings by 2%. Average real GDP growth in India reported in column (4) is statistically significant and negatively related to quarterly AD filings, which is consistent with expectations. However in columns (5) and (6) average real GDP growth and exchange rate volatility become both insignificant when included with the exchange rate. In appendix E.1 results are reported for exchange rate volatility with a one year lag in table E.1.1 and the regressions with the coefficient of variation and the standard deviation as volatility measures are reported, respectively, in tables E.1.2 and E.1.3.

6.2 Quarterly data on bilateral filings

The estimation in the bilateral cases is similar as in the aggregate case. The number of AD filings by India against an defendant country are estimated in each quarter as a function of the bilateral exchange rate, India's real GDP growth, bilateral exchange rate volatility, foreign country real GDP growth and GDP per capita differences. The advantage of this dataset is that the exchange rate is more precisely targeted to match the country named in the filings. The main results are presented in table 6.2.1. Appendix E.2 reports the complete results of all the additional regressions in table E.2.1, the regressions with the coefficient of variation in table E.2.2 and the standard deviation as volatility measure in table E.2.3.

All the regressions have at least one independent variable which is significantly different from zero at the 99% level. This can be seen by looking at the Prob>chi2 term which reports p-values for the Wald Chi-Square test that at least one of the independent coefficients is not equal to zero in the model.

Table 6.2.1 Negative binomial estimation of bilateral filings per quarter India 1995-2009

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ln rxr(-1y)	-1.508***	-1.457***	-1.622***	-1.514***	-1.520***	-1.571***	-1.663***	-1.679***	-1.616***	-1.545***
	(-3.74)	(-3.66)	(-3.96)	(-3.63)	(-3.64)	(-3.68)	(-3.89)	(-3.91)	(-3.72)	(-3.51)
avggr(-3y)			-0.127***			-0.123***	-0.113***	-0.119***		
			(-2.75)			(-2.61)	(-2.45)	(-2.57)		
vol(-1q)				-113.467**			-98.556**			
				(-2.27)			(-2.09)			
vol(-2q)					-22.150*			-19.654*		
					(-1.94)			(-1.82)		
foreign avggr(-3y)						-0.010				
						(-0.44)				
gdp(-3y)									0.0000161	
									(1.44)	
ratio gdp(-3y)										-0.009
										(-0.40)
Constant	0.7777***	0.746***	1.637***	0.868***	0.835***	1.689***	1.641***	1.653***	0.923***	0.803
	(2.78)	(2.72)	(3.96)	(3.02)	(2.94)	(3.91)	(3.94)	(3.98)	(2.99)	(2.60)
Observations	640	640	640	640	640	640	640	640	580	580
Wald chi2	13.95	13.43	20.66	16.76	15.56	20.82	22.94	22.13	15.28	13.38
Prob > chi2	0.0002	0.0002	0.0000	0.0002	0.0004	0.0001	0.0000	0.0001	0.0005	0.0012
Log likelihood	-620.342	-668.544	-664.689	-663.881	-665.353	-664.592	-660.846	-661.989	-598.134	-599.074
Specification	FE	RE	RE	RE	RE	RE	RE	RE	RE	RE

Notes: ln rxr(-1y) is the natural logarithm of the bilateral exchange rate lagged one year, avggr(-3y) is average growth in real GDP of India over the prior three years, vol(-1q) is exchange rate volatility lagged one quarter and vol(-2q) is exchange rate volatility lagged two quarters, foreign avggr is the average growth in real GDP of the defendant country over the prior three years, gdp(-3y) is the average difference in real GDP per capita between India and the foreign country over the prior three years and ratio gdp(-3y) is the average ratio of the foreign country real GDP per capita to Indian real GDP per capita over the prior three years. FE stands for fixed effects, RE stands for random effects. Z-statitistics for a test of no effect on filings are in parentheses. *** Significant at 1% level, ** 5% level and * 10% level, based on p-values.

The results show that the real exchange rate is negatively related to AD filings and statistically significant at the 99% level in all models. When considering bilateral filings, the findings in the aggregate data set are now completely reversed. The results for the bilateral filings indicate that when India experiences a 1% depreciation of the Rupee, AD filings decrease by 1.4% to 1.6% per quarter. This contradicts with the theoretical proposition for the dumping condition but is however consistent with the theoretical prediction for the material injury criterion (proposition 6) and existing empirical research. The difference in using fixed effects and random effects are minimal looking at the first two models. The exchange rate has in both cases the expected negative relationship and the coefficients do not differ significantly.

It is also apparent that India's real GDP growth is negatively and statistically significantly related to the number of filings at the 99% level. Columns (3), (6), (7) and (8) show that a 1% increase in India's real GDP growth decreases AD filings quarterly by 0.11% to 0.12%. Adding real GDP growth of the defendant countries in column (6) does not affect this estimate and is statically insignificant. Defendant country real GDP growth appears to be unrelated to the number of AD filings. Only the changes in real GDP growth of India seem to affect AD filings.

The exchange rate volatility coefficients in the columns (4), (5), (7) and (8) are all statistically significant and show the same relationship as the one found in the aggregate filings. A 1% increase in exchange rate volatility lagged one quarter reduces quarterly case filings by 0.98% to 1.12%. A 1% increase in exchange rate volatility lagged two quarter reduces quarterly case filings by 0.19% to 0.22%. Looking at the lag structure one can see that the coefficients for the one quarter lag are much larger than the ones for the two quarter lag[3]. It seems that firms in India wait with the decision to initiate a AD filing in periods of high exchange rate volatility until the level effect is completely set.

Country difference in incomes is not statistically significant in explaining AD filings as can be seen in columns (9) and (10), this result is most likely due to the fact that GDP per capita of the defendant country is in all the cases larger than the GDP per capita in India. Despite the fact that GDP per capita has been increasing for India in the time period considered, the difference with GDP per capita levels of the target countries are still very large as can be seen in Table 6.2.2 According to Moraga-González and Viaene (2004b) this is the case of unilateral dumping by the foreign firm when income differences are sufficiently

[3] In appendix E.2 results are also reported for a one year lag in table E.2.1. Despite the fact that the coefficient is insignificant the coefficient is considerably smaller than the one and two quarter lagged coefficients.

large. Their theory applies in this case but it cannot explain AD filings as there are no defendant countries whose income level is below that of India.

Table 6.2.2 Annual GDP per capita levels 1992 - 2008, PPP (constant 2005 international $)

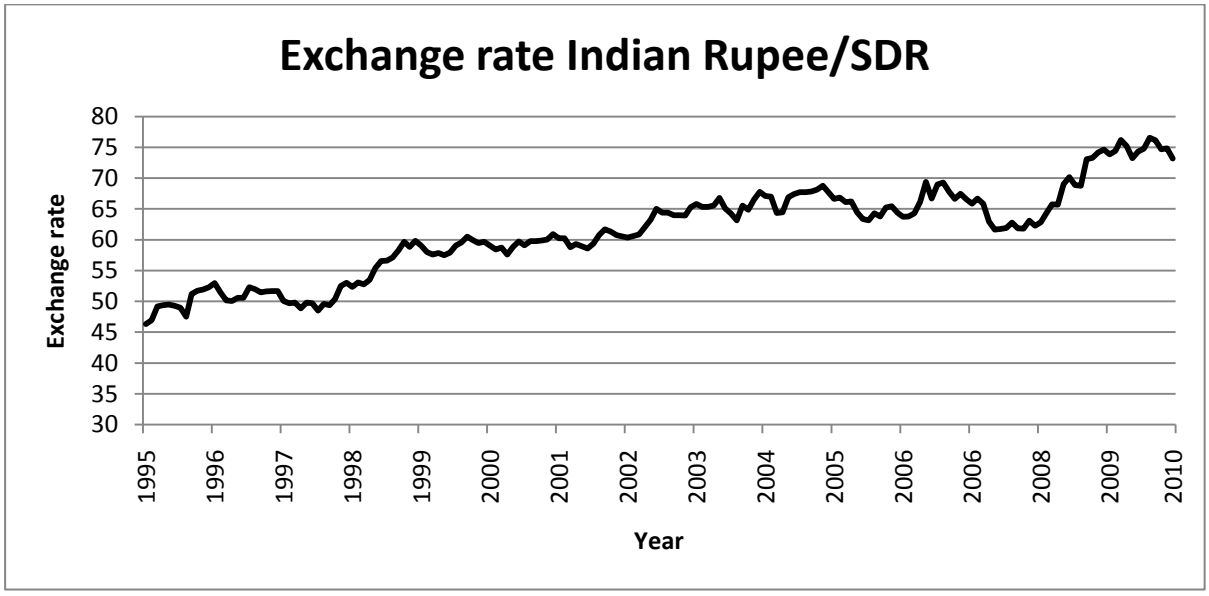
	India	China	South Korea	EU	Japan	Thailand	United States	Indonesia	Singapore	Malaysia	Russia
1992	1239	1336	12944	24071	26932	4527	32068	2361	25493	7518	10222
1993	1274	1505	13615	23790	26933	4840	32499	2494	27772	8055	9347
1994	1335	1684	14645	24305	27136	5217	33407	2643	30028	8578	8182
1995	1410	1847	15761	24857	27562	5645	33849	2823	31505	9185	7853
1996	1490	2010	16704	25198	28247	5930	34711	2996	32607	9850	7591
1997	1524	2175	17318	25806	28615	5810	35855	3093	34160	10306	7720
1998	1591	2322	16015	26496	27958	5168	36935	2650	32565	9312	7331
1999	1679	2477	17410	27209	27866	5361	38153	2634	34632	9650	7832
2000	1718	2664	18730	28170	28613	5568	39122	2727	37461	10271	8615
2001	1779	2864	19331	28604	28603	5631	39017	2788	35590	10108	9076
2002	1817	3104	20598	28730	28611	5861	39271	2875	36732	10442	9549
2003	1940	3393	21071	28794	28953	6203	39912	2973	38577	10839	10300
2004	2071	3714	21961	29244	29738	6520	40985	3082	41745	11363	11094
2005	2234	4076	22783	29595	30310	6751	41833	3217	43755	11755	11861
2006	2416	4524	23884	30304	30933	7038	42591	3352	45949	12213	12833
2007	2600	5085	25021	30946	31669	7333	43031	3519	47497	12763	13911
2008	2721	5515	25498	31018	31464	7469	42809	3689	45553	13129	14706

Both hypotheses cannot be rejected in the aggregate analysis. On the other hand in the more detailed analysis of the bilateral dataset the first hypothesis on the level effect of the exchange rate has to be rejected. All the regressions in the bilateral part showed that a exchange rate depreciation reduces the number of AD filings in a quarter. These empirical findings are in line with existing empirical research. Furthermore these findings suggest that AD filings are mainly driven by the material injury criterion. The hypothesis on exchange rate volatility cannot be rejected and is thus consistent with theoretical predictions.

6.3 Explaining the difference

As is evident the increased detail of the observations has a great impact on the role of the exchange rate. The aggregate data showed that a depreciation increases AD filings, whereas the more detailed bilateral dataset showed the reverse relationship. One way to explain this difference in findings is examining the movement of the exchange rate of India w.r.t. Special Drawing Rights in figure 6.3.1.

Figure 6.3.1 Exchange rate of India Rupee per one unit of SDR 1995-2009



Note: Figure based on monthly exchange rates.

Figure 6.3.1 shows that the exchange rate of the Indian Rupee w.r.t. SDR has been on a depreciating trend. Considering AD filings per quarter in figure 6.3.2 and per year in figure 6.3.3 it can be seen that India has become an extensive user of AD filings in the selected period. Despite the drop in AD filings from 2002 to 2004 the overall trend is positive, which explains the finding in the aggregate part that a depreciation of the Rupee increases filings.

Figure 6.3.2 AD filings India per quarter 1995-2009

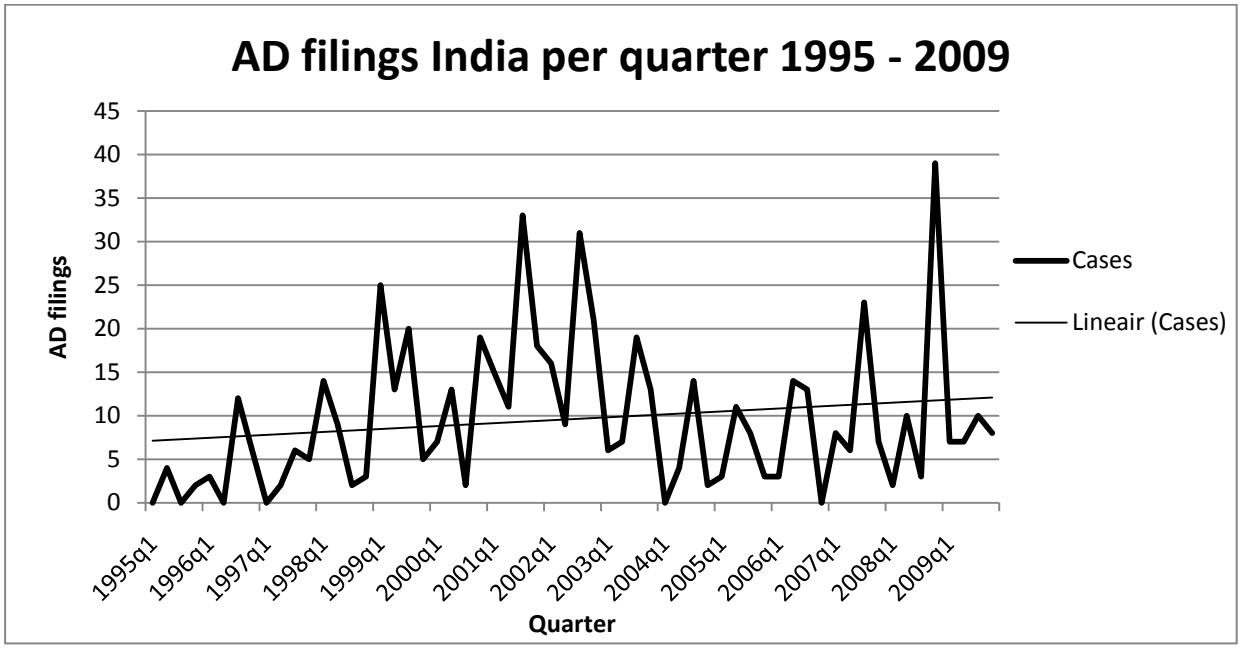
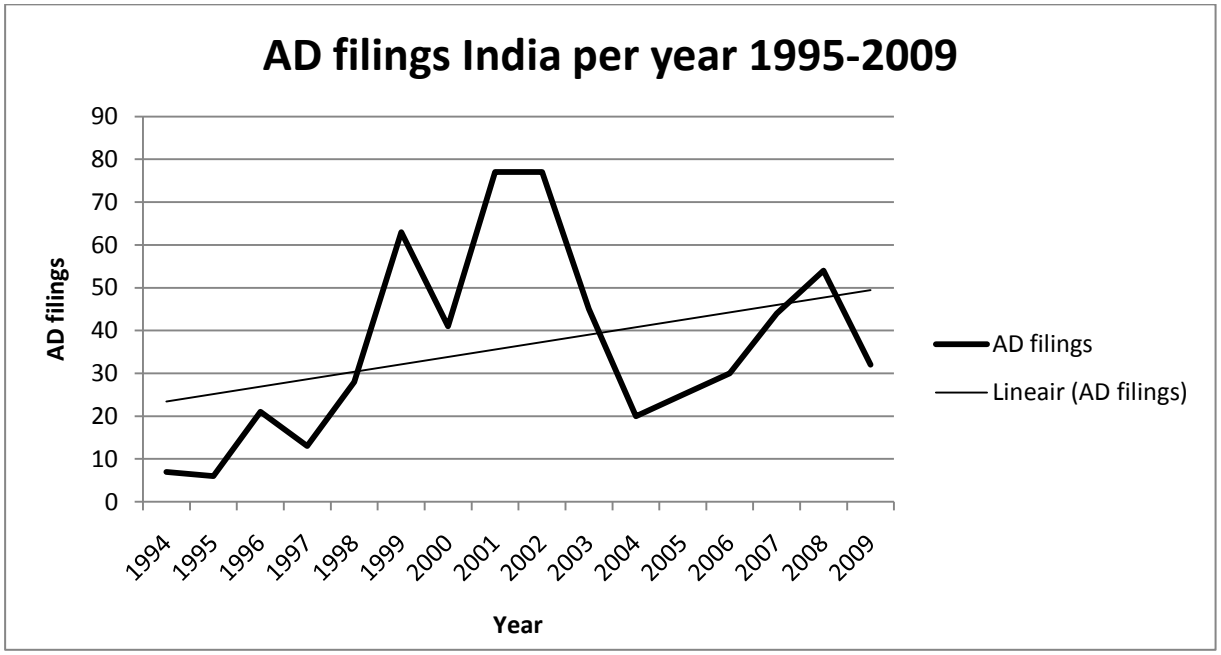


Figure 6.3.3 AD filings per year India 1995-2009



In the bilateral part however the result is reversed and it found that if the Indian rupee depreciates AD filings increase. A look at the bilateral exchange rate series in appendix F and exchange rate volatility in appendix G shows that these are much more volatile than the SDR exchange rate used in the aggregate filings. The different link between filings and the exchange rate in the bilateral data is no doubt attributable to the increased number of observations and the more volatile bilateral exchange rates. Furthermore the Wald Chi-Square tests in the bilateral part report higher values and better p-values than in the aggregate data set, which suggests that bilateral exchange rates explain AD filings better than just the Indian rupee w.r.t. SDR exchange rate. It appears that aggregation over the defendant countries and studying total filings in relation to a single exchange rate obscures some important information. Therefore more trust should be placed in the bilateral results.

7. Concluding remarks

This research has examined how the exchange rate, exchange rate volatility and macroeconomic factors in general can influence the probability of affirmative findings for the dumping criterion and the material injury criterion. This master thesis has contributed to the literature by theoretically examining the relationship of the exchange rate and exchange rate volatility on dumping. Exchange rate volatility is a factor which has not been explored so far in the existing literature. Additionally the theoretical predictions are empirically tested with a case study of India. The contribution in this sense is that India can be considered as an emerging/developing country while most studies in this field have focussed on developed countries such as the U.S. and E.U..

It is found in the aggregate analysis that a depreciation increases AD filings. This result is consistent with the first hypothesis on the level effect of the exchange rate but at odds with existing empirical research on this subject and can be explained if one looks at the depreciating trend of the Indian Rupee and the generally increased AD filing behaviour of India. The results are reversed if bilateral filings are considered and the first hypothesis has to be rejected in this case. These results show that a 1% depreciation of the exchange rate decreases AD filings by 1.4% to 1.6% per quarter. There is however empirical evidence found that supports the second hypothesis on exchange rate volatility. Exchange rate volatility has the expected sign based on theory and is statistically significant in explaining AD filings for India. The results in the bilateral analysis indicate that a 1% increase in quarterly lagged volatility reduces quarterly case filings by 0.98% to 1.12%, a two quarter lag reduces quarterly filings by 0.19% to 0.22%. It is also found that a 1% increase in real GDP growth for India decreases AD filings by 0.11% to 0.12% per quarter.

The results found in the empirical analysis indicate that antidumping filings in India are influenced by macroeconomic factors similarly as in previous studies for developed countries such as the U.S. and E.U. Exchange rate volatility however has been an unexplored factor in relation to AD filings. The empirical results are consistent with the theoretical predictions based on the augmented Brander and Krugman model as well as the extended model by Moraga-González and Viaene. It must be noted that the empirical results are not robust considering more familiar volatility measures such as the coefficient of variation and the standard deviation. Exchange rate volatility furthermore loses its impact after a longer time period which suggests that firms are not likely to initiate a AD filing if they are in a period of severe exchange rate volatility but rather wait for a short time period until the level

effect has set. In the long run, the impact of exchange rate volatility diminishes and the level effect of the exchange rate and economic growth are the only macroeconomic factors which influence AD filings.

The result for the link between the exchange rate and AD filings suggest that either foreign firms are being held responsible for factors outside of their control or that foreign firms behave in a "predatory" manner when conditions favour them most. This latter view asserts that domestic producers seem to seek protection against adverse market conditions and not against dumping (Knetter and Prusa, 2003). The results in the bilateral analysis are in line with both interpretations and suggest that the material injury criterion is more important in deciding to initiate a antidumping filing in India. The relationship of the exchange rate and antidumping filings found in the bilateral empirical analysis is consistent with theoretical predictions for the injury criterion (proposition 6). Furthermore the empirical results found for the growth rate of India are also consistent with this argumentation. Reductions in the growth rate lead to an increase in antidumping filings. It is easier to proof material injury when the economy is in a recession or when the domestic currency appreciates.

These findings suggest that firms use these macroeconomic conditions when deciding to initiate a AD filing. In a similar line of reasoning, Feinberg (2005) found that in the U.S. the steel industry has been very effective in learning about the role of macroeconomic indicators and acting on this learning by responding to exchange rate movements that are beneficial for them in terms of showing material injury. It is in fact asserted by both Feinberg (2005) and Knetter and Prusa (2003) that the focus is to persuade the International Trade Commission of the U.S. of material injury to the domestic industry. The reason for this is that over a time period of 20 years only 28 of 800 U.S. cases received a negative dumping determination. By contrast there have been over 300 negative injury determinations. This implies that more antidumping cases would be filed when macroeconomic factors improve the odds of an affirmative material injury decision in the U.S. That is when the domestic currency is appreciating (negative coefficient on the exchange rate) or when the domestic country is in a recession (negative coefficient on the growth rate). This scenario seems also to be the case in India as the empirical analysis has found similar results.

Antidumping investigations have become an increasingly popular form of protection for firms engaged in international markets. Given the findings of other related literature in this field (Boltuck and Litan, 1991; Knetter and Prusa, 2003; Feinberg, 2005) it is natural to believe that in general foreign firms are being held responsible for factors outside their control which necessarily casts doubt on the fairness of AD law in terms of addressing unfair trade.

The fact that AD filings are significantly influenced by macroeconomic factors suggests that the problem with countries abusing antidumping rules is not simply a problem in developed countries. Rather, the results found indicate that WTO rules governing antidumping law allow abuses of the statute. Of course case-specific and microeconomic factors play an important role. Nevertheless, a significant role for the exchange rate and economic growth seems contrary to the spirit of antidumping rules aimed at addressing unfair trade, not global or domestic macroeconomic movements. Future WTO rounds must include antidumping reform on the agenda. Countries engaged in intra-industry trade should accept the responsibility by proposing an amendment to the Antidumping Agreement which would limit the influence of macroeconomic factors on case filings.

Future research should attempt to examine exchange rate volatility effects on dumping in other, developed and developing, countries. The possible influence of the import penetration rate is perhaps an additional measure which could be considered to see if a specific industry has indeed experienced a sharp increase in imports which is a necessary requirement to proof material injury. Furthermore future work should separate out the relative contributions to antidumping filings of case-specific and macroeconomic factors in order to examine the importance of each.

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Appendix

A. Conditions for a stable equilibrium

Each firm maximizes profit with respect to its own output, which yields the following first-order conditions:

For the domestic market,

$$\frac{\partial \pi}{\partial X_D} = a - 2X_D - Y_E^* - c = 0,$$
$$\frac{\partial \pi^*}{\partial Y_E^*} = \frac{a - X_D - 2Y_E^*}{e} - c^* - g = 0.$$

For the foreign market,

$$\frac{\partial \pi}{\partial X_E} = e(a - Y_D^* - 2X_E) - c - g = 0,$$
$$\frac{\partial \pi^*}{\partial Y_D^*} = a - 2Y_D^* - X_E - c^* = 0.$$

The solutions are an equilibrium if the second-order conditions are satisfied:

For the domestic market,

$$\frac{\partial^2 \pi}{\partial X_D{}^2} = -2 < 0,$$
$$\frac{\partial^2 \pi^*}{\partial Y_E^{*2}} = \frac{-2}{e} < 0.$$

For the foreign market,

$$\frac{\partial^2 \pi}{\partial X_E{}^2} = -2e < 0,$$
$$\frac{\partial^2 \pi^*}{\partial Y_D^{*2}} = -2 < 0.$$

Own marginal revenue declines when the other firm increases its output, i.e. reaction curves are downward sloping:

For the domestic market,

$$\frac{\partial \pi / \partial X_D}{\partial Y_E^*} = -1 < 0$$
$$\frac{\partial \pi^* / \partial Y_E^*}{\partial X_D} = \frac{-1}{e} < 0.$$

For the foreign market,

$$\frac{\partial \pi / \partial X_E}{\partial Y_D^*} = -e < 0$$
$$\frac{\partial \pi^* / \partial Y_D^*}{\partial X_E} = -1 < 0.$$

B. Description of the variables used in the empirical analysis

AD filings per quarter

Filings per quarter are calculated based on the *Global Antidumping Database (*Bown, World Bank, 2010). This database reports filing data for each country specifically and contains, (amongst others) the filing country, the defendant and the date of the initiation of investigation. This data is used to indicate in which quarter an AD filings is placed.

Aggregate exchange rate

The one period lagged real effective exchange rate for the aggregate data set is calculated based on the monthly exchange rate of the Indian Rupee w.r.t. SDR from data of the *IMF International Financial Statistic* online database. This database reports monthly exchange rates. The monthly real exchange rate were normalized by dividing each exchange rate series by its sample mean so as to offset the scale effect from one exchange rate to the other. After this transformation the natural logarithm is taken. The exchange rate used in a particular quarter is calculated in the following way; for example the exchange rate used for filings in the 1st quarter of 2000 is constructed by taking the average of the monthly exchange from January-1999 until December-1999 (12 months). The exchange rate used for filings in the 2nd quarter of 2000 is constructed by taking the average of the monthly exchange rate from April-1999 until March-2000 (12 months). The exchange rate used for filings in the 3rd quarter of 2000 is constructed by taking the average of the monthly exchange rate from July-1999 until June-2000 (12 months) and so forth.

Bilateral exchange rate

The one period lagged real effective bilateral exchange rate is calculated based on data from the Economic Research Service of the U.S. Department of Agriculture as they report exchange rates in a consistent fashion for virtually all countries in the world. In this data set the monthly real exchange rates are derived by multiplying the nominal exchange rate by the ratio of the U.S. to local currency Consumer Price Index. To calculate bilateral exchange rates for the countries used in this analysis, the exchange rate of the Indian Rupee per one dollar is divided by the exchange rate of 'X' currency per one dollar. The monthly real exchange rate were normalized by dividing each exchange rate series by its sample mean so as to offset the scale effect from one exchange rate to the other. After this transformation the natural logarithm is taken. The exchange rate used in a particular quarter is calculated in the exact same way as in the aggregate case.

Average real GDP growth

The three year lagged real average growth rate is calculated based on quarterly data from the *IMF International Financial Statistic* online database. Average real GDP growth lagged three years in a particular quarter is calculated in the following way; for example the average real GDP growth used for filings in the first quarter in 2000 is constructed by taking the average of the quarterly growth rates from the first quarter in 1997 until the last quarter in 1999. The average growth rate used for filings in the second quarter in 2000 is constructed by taking the average of the quarterly growth rates from the second quarter in 1997 until the first quarter in 2000. The average growth rate used for filings in the third quarter in 2000 is constructed by taking the average of the quarterly growth rates from the third quarter in 1997 until the second quarter in 2000 and so forth.

Real GDP per capita

The International Monetary Fund *International Financial Statistics* provided quarterly real GDP per capita data (PPP (constant 2005 international $)) for both the filing and defendant countries. Real GDP per capita is used in the empirical analysis as a measure of income differences across countries, λ^*. It is only used in the bilateral part. Real GDP per capita lagged three years in a particular quarter is calculated in the following way; for example real GDP per capita used for filings in the first quarter in 2000 is constructed by taking the average of quarterly real GDP per capita from the first quarter in 1997 until the last quarter in 1999. Real GDP per capita used for filings in the second quarter in 2000 is constructed by

taking the average of the quarterly real GDP per capita from the second quarter in 1997 until the first quarter in 2000. Real GDP per capita used for filings in the third quarter in 2000 is constructed by taking the average of the quarterly real GDP per capita from the third quarter in 1997 until the second quarter in 2000 and so forth.

Exchange rate volatility

The exchange rate volatility which is used in the empirical part is measured as follows, with the example of the bilateral exchange rate between India and the U.S.:

Let e_t = quarterly Indian Rupee/U.S. Dollar exchange rate
e_t^* = ln e_t
de_t^* = e_t^* - e_{t-x}^* = change in the exchange rate
$d\bar{e}_t^*$ = mean of de_t^*
X_t = de_t^* - $d\bar{e}_t^*$ = deviation from the mean
X_t^2 = measure of volatility,

where x in e_{t-x}^* stands for different time periods considered. Thus X_t is the mean-adjusted change in the exchange rate. X_t^2 can now be used as a measure of volatility (Gujarati, 2003). Since it is a squared quantity its value will be large in periods when there are big changes in the exchange rate and its value will be comparatively small when there are modest changes in the exchange rate. Empirical tests have also been conducted with the coefficient of variation and the standard deviation as measures of exchange rate volatility but these are only reported in appendix 5. Exchange rate volatility using the coefficient of variation is measured as the ratio of the standard deviation to the mean.

$$\text{Coefficient of Variation} = \frac{\text{Standard deviation}_{t-x}}{\text{Mean}_{t-x}},$$

where the x stands for different time periods considered. The standard deviation as well as the mean are calculated by looking at a one or two quarter period and a yearly period. Exchange rate volatility in each quarter is then based on a rolling standard deviation and a rolling mean.

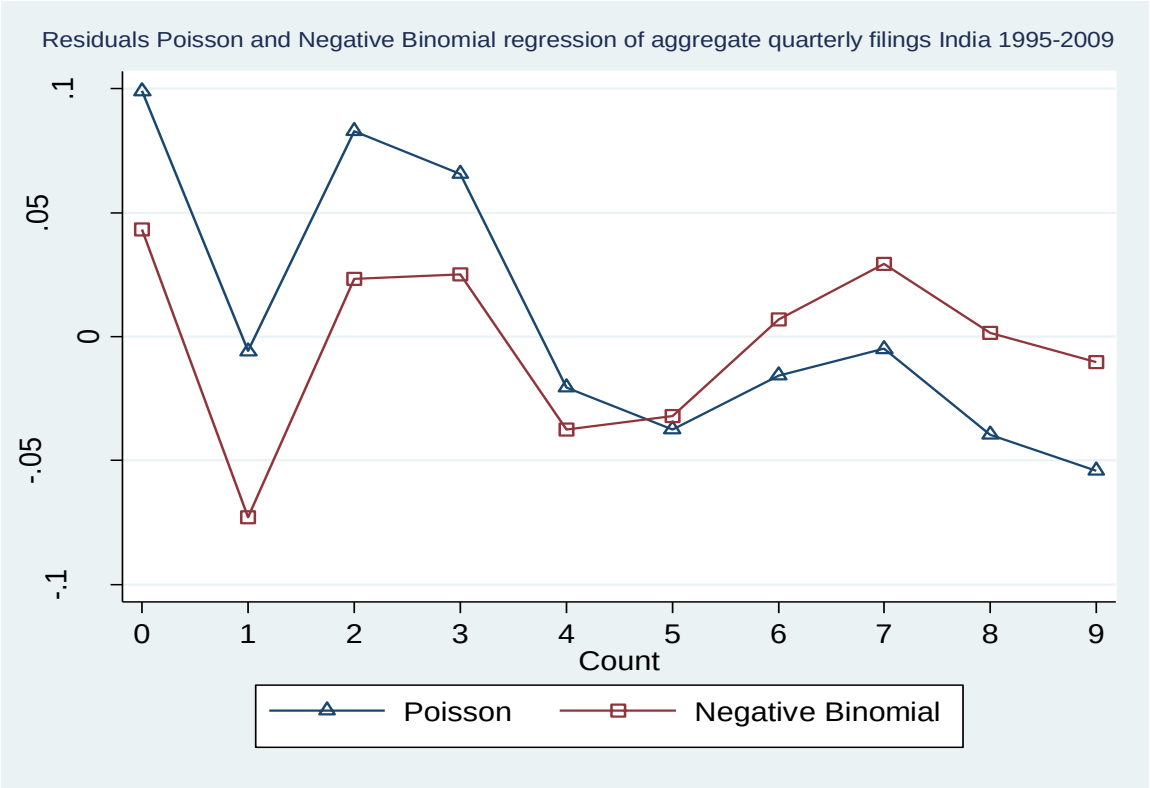
Exchange rate volatility measured by the standard deviation is calculated by looking at a one or two quarter period and a yearly period. Exchange rate volatility in each quarter in this case is based on a rolling standard deviation.

C. Statistical tests for determining the correct regression model

These test statistics are conducted with the statistical program Stata, option countfit.

C.1 Statistical tests for the aggregate data set

Figure C.1.1 Residuals of the Poisson and Negative binomial regression



Note: positive deviations show underpredictions.

The estimated relationship is AD filings as a function of the natural logarithm of the one year lagged exchange rate, the three year lagged average real GDP growth of India and exchange rate volatility lagged two quarters. The residual plot in Figure C.1.1 does not give a clear answer of which model to use. The essential part to look at are the last three columns of table C.1.1 below. These columns cleary indicate that the negative bionomial regression (NBRM) is preffered over the Poisson model (PRM).

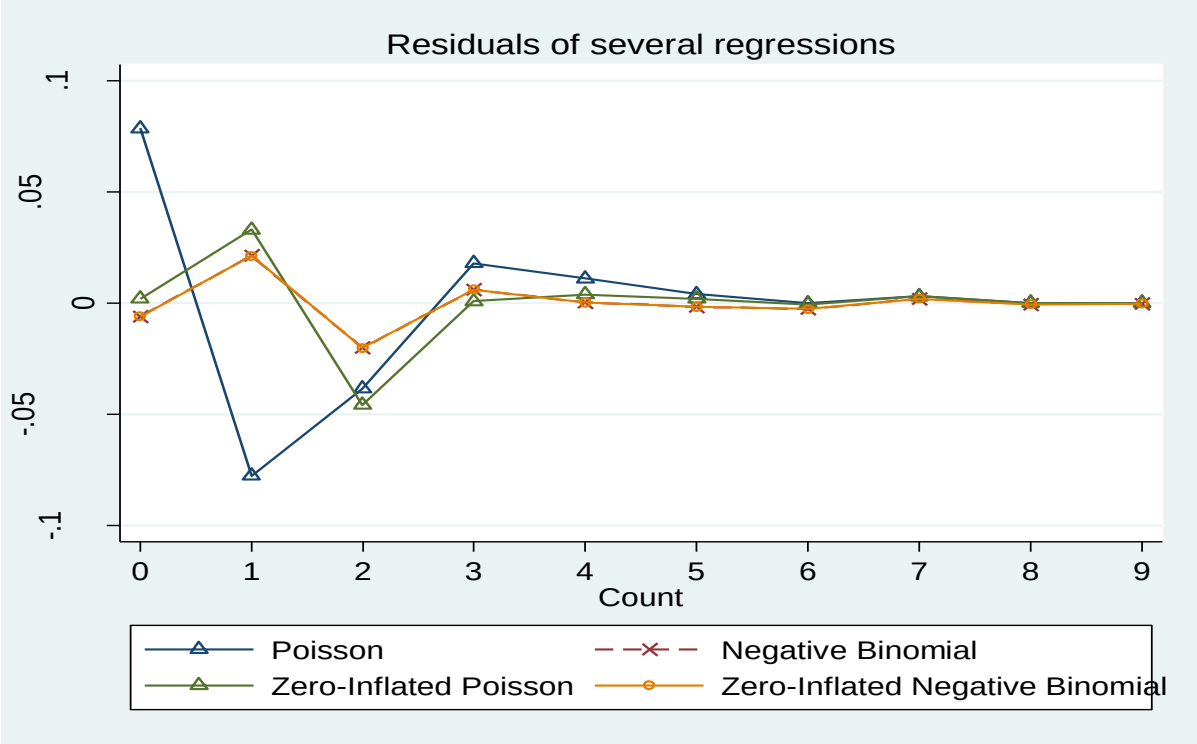
Table C.1.1 Tests and Fit Statistics Poisson vs. Negative Binomial

Tests and Fit Statistics

PRM	BIC=	350.926	AIC=	9.838	Prefer	Over	Evidence
vs **NBRM**	BIC=	156.706	dif=	194.220	**NBRM**	**PRM**	**Very strong**
	AIC=	6.566	dif=	3.272	**NBRM**	**PRM**	
	LRX2=	198.314	prob=	0.000	**NBRM**	**PRM**	**p=0.000**

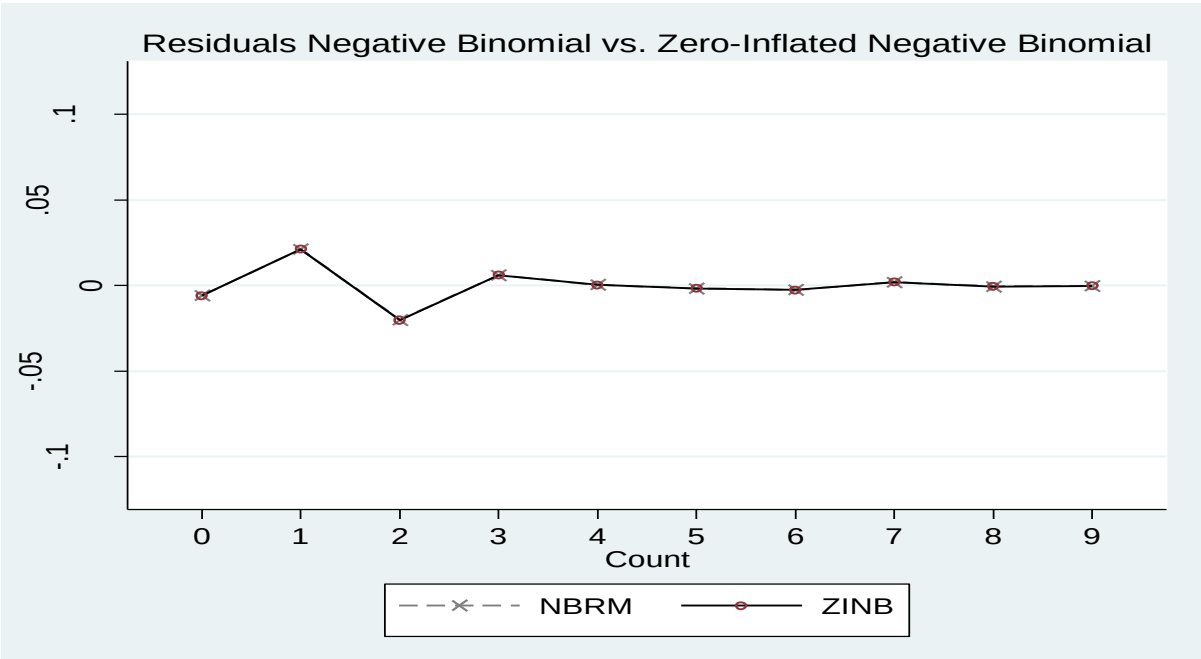
C.2 Statistical tests for the bilateral data set

Figure C.2.1 Residuals of several regressions



Note: positive deviations show underpredictions.

Figure C.2.2 Residuals of the Negative binomial and Zero-Inflated Negative binomial regression



Note: positive deviations show underpredictions.

Table C.2.1 Tests and Fit Statistics Poisson, Negative Binomial, Zero-Inflated Poisson and Zero-Inflated Negative Binomial

Tests and Fit Statistics

PRM	BIC= **-2613.907**	AIC=	**2.356**	Prefer	Over	Evidence
vs **NBRM**	BIC= **-2692.585**	dif=	**78.677**	**NBRM**	**PRM**	**Very strong**
	AIC= **2.226**	dif=	**0.130**	**NBRM**	**PRM**	
	LRX2= **85.139**	prob=	**0.000**	**NBRM**	**PRM**	**p=0.000**
vs **ZIP**	BIC= **-2651.542**	dif=	**37.635**	**ZIP**	**PRM**	**Very strong**
	AIC= **2.284**	dif=	**0.073**	**ZIP**	**PRM**	
	Vuong= **2.589**	prob=	**0.005**	**ZIP**	**PRM**	**p=0.005**
vs **ZINB**	BIC= **-2679.662**	dif=	**65.754**	**ZINB**	**PRM**	**Very strong**
	AIC= **2.233**	dif=	**0.124**	**ZINB**	**PRM**	
NBRM	BIC= **-2692.585**	AIC=	**2.226**	Prefer	Over	Evidence
vs **ZIP**	BIC= **-2651.542**	dif=	**-41.042**	**NBRM**	**ZIP**	**Very strong**
	AIC= **2.284**	dif=	**-0.057**	**NBRM**	**ZIP**	
vs **ZINB**	BIC= **-2679.662**	dif=	**-12.923**	**NBRM**	**ZINB**	**Very strong**
	AIC= **2.233**	dif=	**-0.006**	**NBRM**	**ZINB**	
	Vuong= **-0.003**	prob=	**0.499**	**NBRM**	**ZINB**	**p=0.499**
ZIP	BIC= **-2651.542**	AIC=	**2.284**	Prefer	Over	Evidence
vs **ZINB**	BIC= **-2679.662**	dif=	**28.119**	**ZINB**	**ZIP**	**Very strong**
	AIC= **2.233**	dif=	**0.051**	**ZINB**	**ZIP**	
	LRX2= **34.581**	prob=	**0.000**	**ZINB**	**ZIP**	**p=0.000**

The estimated relationship is AD filings as a function of the natural logarithm of the one year lagged exchange rate, the three year average real GDP growth of India and exchange rate volatility lagged two quarters. The different regression methods are Poisson model (PRM), negative binomial model (NBRM), zero-inflated Poisson model (ZIP) and the zero-inflated negative binomial model (ZINB). The zero-inflated models are used to test if the zeros in the data sample have an influence on the estimitated coefficients. Looking at figure C.2.1 it can be seen that the Poisson and the zero-inflated Poisson model have the largest resisiduals and are thus not good predicters for this data set. Looking in more detail to the residuals of the negative binomial and zero-inflated negative binomial regression it can be seen in figure C.2.2 that the estimations of both models are identical. However the results for the test and fit statistics in Table C.2.1 indicate that the standard negative binomial regression (NBRM) is preffered over the zero-inflated negative binomial model (ZINB).

D. Hausman specification test

The generally accepted way of choosing between fixed and random effects is running a Hausman test (Baltagi, 2005). The idea is that one uses the random effects estimates unless the Hausman test rejects the assumption made in the random effects model that the unobserved individual error country effect (a_i) is uncorrelated with each independent variable (x_{itj}) that is,

$$Cov(x_{itj}, a_i) = 0,\ t=1,2,\ldots,T;\ j=1,2,\ldots.k.$$

Table D.1 Hausman specification test

```
. hausman fixed random

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
       lnrxr |  -1.750073    -1.678751       -.0713214        .0761896
       Iavggr |  -.1212411    -.1187207       -.0025205               .
    meanvol6m |  -19.06458    -19.65386        .5892849        1.569407
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtn_fe
            B = inconsistent under Ha, efficient under Ho; obtained from xtn_re

    Test:  Ho:  difference in coefficients not systematic

                  chi2(3) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =          1.22
                Prob>chi2 =        0.7486
```

The above test is conducted in Stata by estimating the relationship AD filings as a function of the natural logarithm of the one year lagged exchange rate, the three year average real GDP growth of India and exchange rate volatility lagged two quarters. The relationship is estimated with using fixed effects and random effects. The null hypothesis underlying the Hausman test is that the fixed effect estimators and the random effects estimators do not differ substantially (Baltagi, 2005). The test statistic has an asymptotic chi-square distribution. As can be seen in the above table D.1 the chi-square statistic of 1.22 which is not significant and therefore does not reject the null hypothesis. Hence the random effects estimator is consistent and efficient.

E. Empirical regressions

E.1 Negative binomial estimation of aggregate filings

Table E.1.1 Negative binomial estimation of aggregate filings per quarter India 1995-2009

	1	2
ln rxr(-1y)	2.444**	3.114***
	(2.20)	(2.76)
avggr(-3y)		-0.209*
		(-1.83)
vol(-1y)	-39.647	15.839
	(-0.97)	(0.32)
constant	2.246***	3.484***
	(15.04)	(4.97)
Observations	60	60
LR chi2	5.08	8.28
Prob > chi2	0.0789	0.0405
Log likelihood	-195.448	-193.846

Notes: ln rxr(-1y) is the natural logarithm of the SDR exchange rate lagged one year, avggr is average growth in real GDP of India over the prior three years, vol(-1y) is exchange rate volatility lagged one year. Z-statitistics for a test of no effect on filings are in parentheses. *** Significant at 1% level, ** 5% level and * 10% level, based on p-values.

Table E.1.2 Negative binomial estimation of aggregate filings per quarter India 1995-2009 with the coefficient of variation as volatility measure

Model	1	2	3
ln rxr(-1y)	2.389**	2.418**	2.363**
	(2.10)	(2.12)	(2.07)
vol(-1y)	-0.534		
	(-0.06)		
vol(-2q)		10.521	
		(0.81)	
vol(-1q)			3.363
			(0.26)
Constant	2.179***	1.965***	2.121***
	(8.09)	(7.27)	(10.30)
Observations	60	60	60
LR chi2	4.18	4.84	4.25
Prob > chi2	0.1238	0.0888	0.1197
Log likelihood	-195.898	-195.566	-195.865

Notes: ln rxr(-1y) is the natural logarithm of the SDR exchange rate lagged one year, vol(-1y) is exchange rate volatility lagged one year, vol(-2q) is exchange rate volatility lagged two quarters and vol(-1q) is exchange rate volatility lagged one quarter. Z-statitistics for a test of no effect on filings are in parentheses. *** Significant at 1% level, ** 5% level and * 10% level, based on p-values.

Table E.1.3 Negative binomial estimation of aggregate filings per quarter India 1995-2009 with the standard deviation as volatility measure

Model	1	2	3
ln rxr(-1y)	2.395**	2.201*	2.284*
	(2.04)	(1.90)	(1.95)
vol(-1y)	-0.258		
	(-0.03)		
vol(-2q)		9.994	
		(0.83)	
vol(-1q)			4.372
			(0.37)
Constant	2.171***	1.973***	2.106***
	(8.52)	(7.68)	(10.66)
Observations	60	60	60
LR chi2	4.18	4.88	4.32
Prob > chi2	0.1239	0.0873	0.1155
Log likelihood	-195.899	-195.549	-195.829

Notes: ln rxr(-1y) is the natural logarithm of the SDR exchange rate lagged one year, vol(-1y) is exchange rate volatility lagged one year, vol(-2q) is exchange rate volatility lagged two quarters and vol(-1q) is exchange rate volatility lagged one quarter. Z-statitistics for a test of no effect on filings are in parentheses. *** Significant at 1% level, ** 5% level and * 10% level, based on p-values.

E.2 Negative binomial estimation of bilateral filings

Table E.2.1 Negative binomial estimation of bilateral filings per quarter India 1995-2009

Model	1	2	3	4	5
ln rxr(-1y)	-1.588***	-1.603***			
	(-3.59)	(-3.61)			
avggr(-3y)	-0.107**	-0.112**			
	(-2.26)	(-2.37)			
vol(-1q)	-99.828**		-102.449**		
	(-2.13)		-2.18		
vol(-2q)		-20.289*		-19.532*	
		(-1.88)		(1.87)	
foreign avggr(-3y)	-0.017	-0.017			
	(-0.70)	(-0.72)			
vol(-1y)					-1.636
					(-0.85)
constant	1.728***	1.743***	0.861***	0.827***	0.768***
	(3.94)	(3.94)	(3.08)	(3.00)	(2.85)
Observations	640	640	640	640	640
Wald chi2	23.34	22.45	4.74	3.48	0.73
Prob > chi2	0.0001	0.0002	0.0294	0.0621	0.3927
Log likelihood	-660.602	-661.733	-670.614	-672.160	-674.903
Specification	RE	RE	RE	RE	RE

Notes: ln rxr(-1y) is the natural logarithm of the bilateral exchange rate, lagged one year; avggr(-3y) is average growth in real GDP of India over the prior three years, vol(-1q) is exchange rate volatility lagged one quarter and vol(-2q) is exchange rate volatility lagged two quarters, foreign avggr is the average growth in real GDP of the defendant country over the prior three years, vol(-1y) is exchange rate volatility lagged one year. RE stands for random effects. Z-statitistics for a test of no effect on filings are in parentheses. *** Significant at 1% level, ** 5% level and * 10% level, based on p-values.

Table E.2.2 Negative binomial estimation of bilateral filings per quarter India 1995-2009 with the coefficient of variation as volatility measure

Model	1	2	3
ln rxr(-1y)	-1.506***	-1.463***	-1.466***
	(-3.65)	(-3.63)	(-3.65)
vol(-1y)	-0.746		
	(-0.46)		
vol(-6m)		-0.173	
		(-0.08)	
vol(-3m)			-0.530
			(-0.18)
Constant	0.768***	0.750***	0.752***
	(2.77)	(2.70)	(2.73)
Observations	640	640	640
Wald chi2	13.54	13.42	13.43
Prob > chi2	0.0011	0.0012	0.0012
Log likelihood	-668.432	-668.541	-668.528
Specification	RE	RE	RE

Notes: ln rxr(-1y) is the natural logarithm of the bilateral exchange rate lagged one year, vol(-1y) is exchange rate volatility lagged one year, vol(-2q) is exchange rate volatility lagged two quarters and vol(-1q) is exchange rate volatility lagged one quarter. RE stands for random effects. Z-statitistics for a test of no effect on filings are in parentheses. *** Significant at 1% level, ** 5% level and * 10% level, based on p-values.

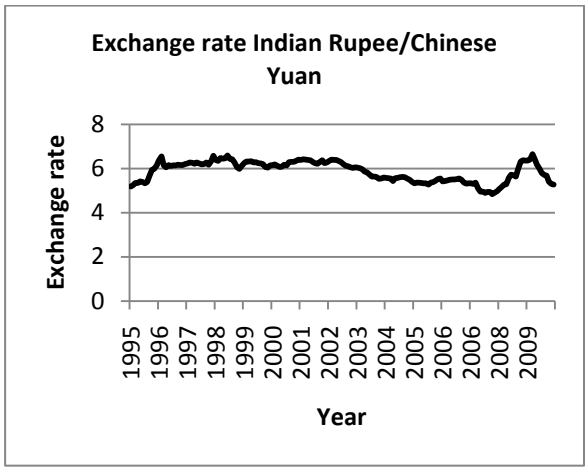
Table E.2.3 Negative binomial estimation of bilateral filings per quarter India 1995-2009 with the standard deviation as volatility measure

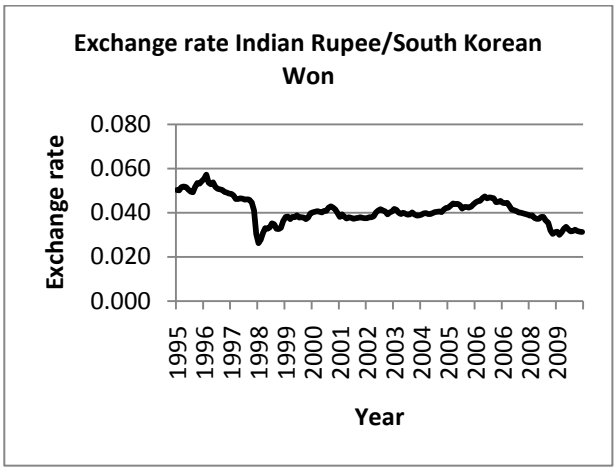
Model	1	2	3
ln rxr(-1y)	-1.466***	-1.578***	-1.461***
	(-3.67)	(-3.94)	(-3.67)
vol(-1y)	-0.796		
	(-0.44)		
vol(-2q)		0.136	
		(-0.06)	
vol(-1q)			0.488
			(-0.15)
constant	0.771***	0.823***	0.742***
	(2.76)	(2.80)	(2.68)
Observations	640	640	640
Wald chi2	13.54	15.49	13.48
Prob > chi2	0.0011	0.0004	0.0012
Log likelihood	-668.446	-663.304	-668.533
Specification	RE	RE	RE

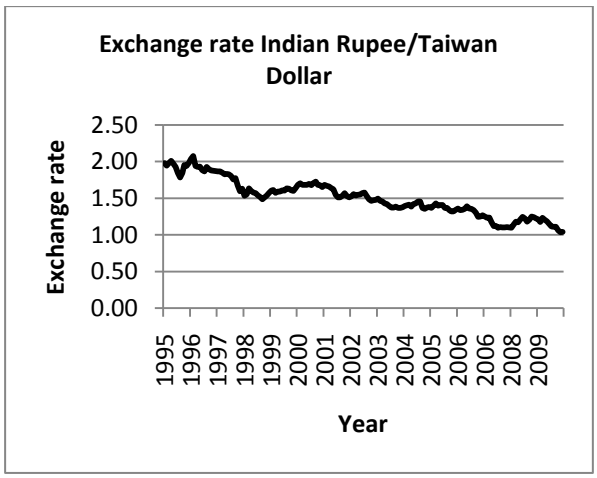
Notes: ln rxr(-1y) is the natural logarithm of the bilateral exchange rate lagged one year, vol(-1y) is exchange rate volatility lagged one year, vol(-2q) is exchange rate volatility lagged two quarters and vol(-1q) is exchange rate volatility lagged one quarter. RE stands for random effects. Z-statitistics for a test of no effect on filings are in parentheses. *** Significant at 1% level, ** 5% level and * 10% level, based on p-values.

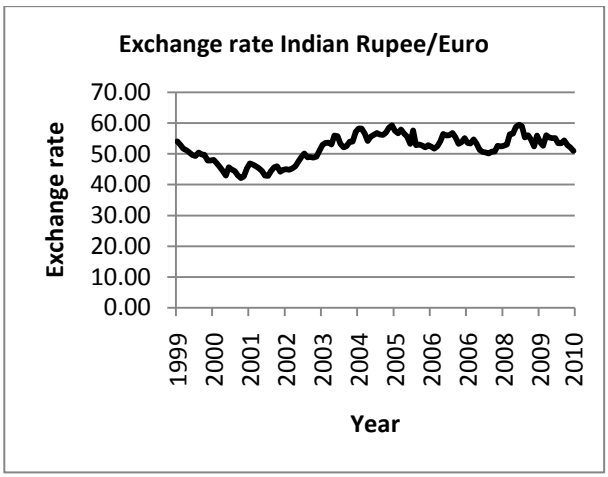
F. Bilateral exchange rates for each country used in the bilateral analysis 1995-2009

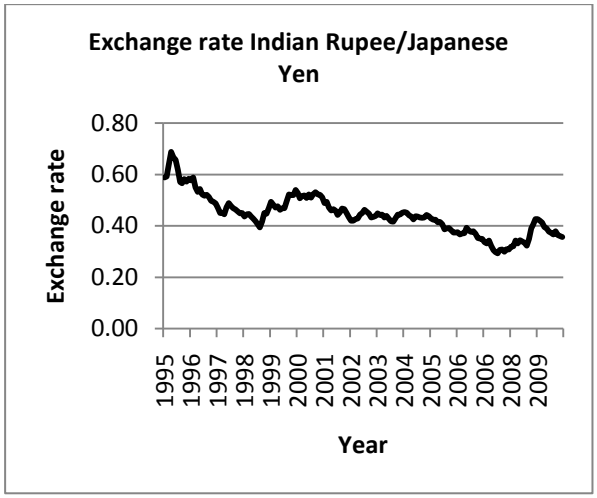
These figures are based on monthly exchange rates.

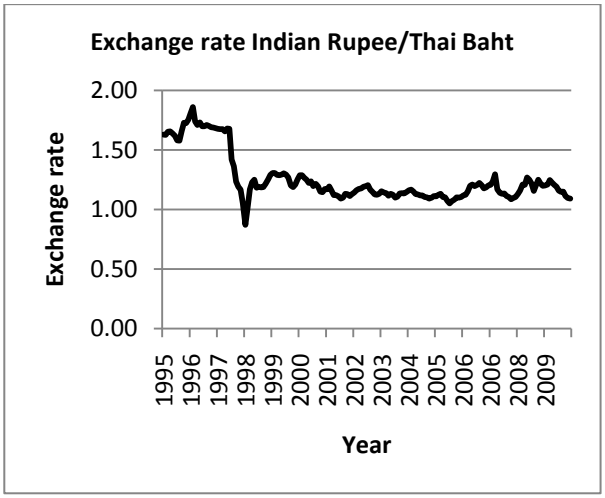


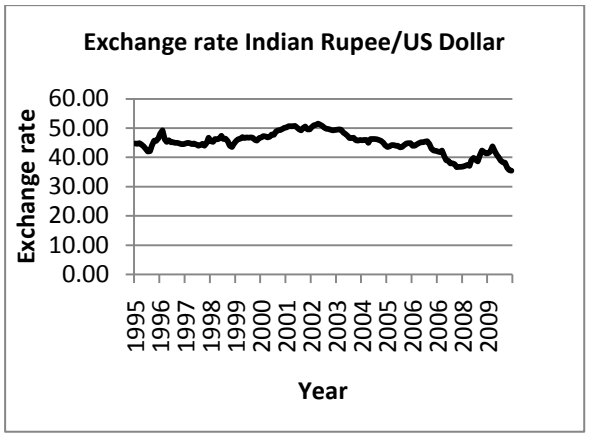


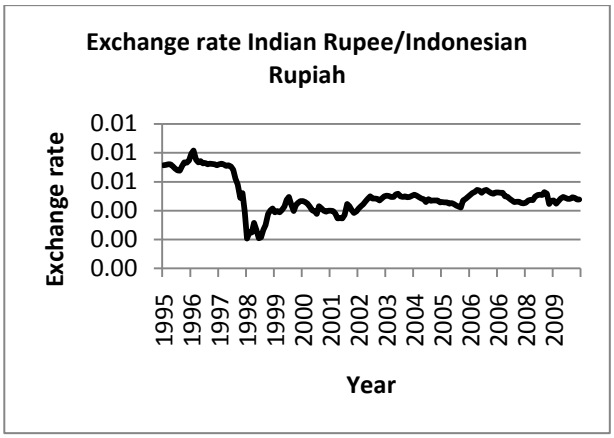


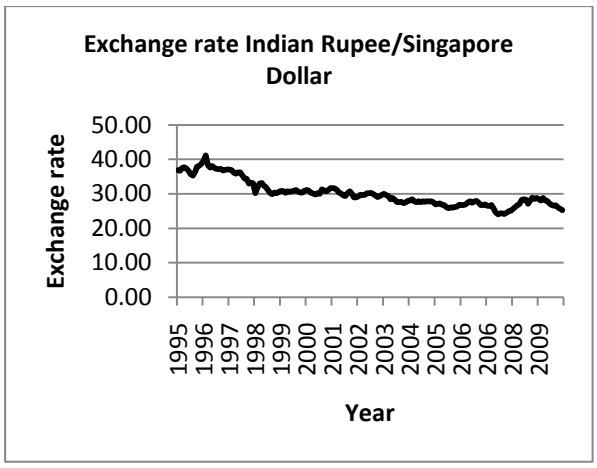


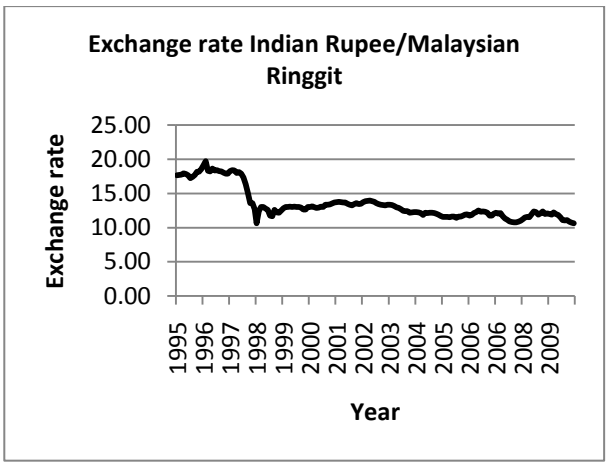


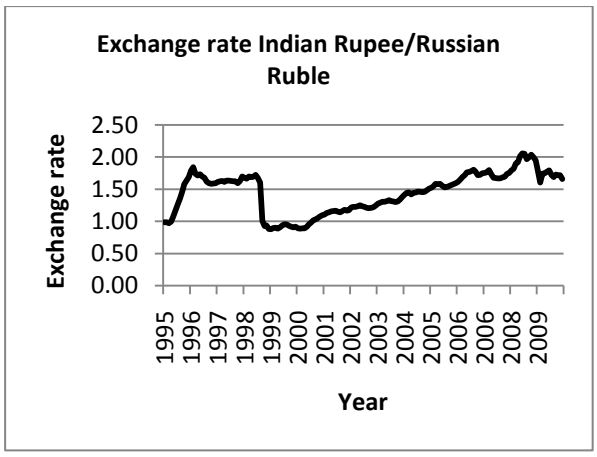


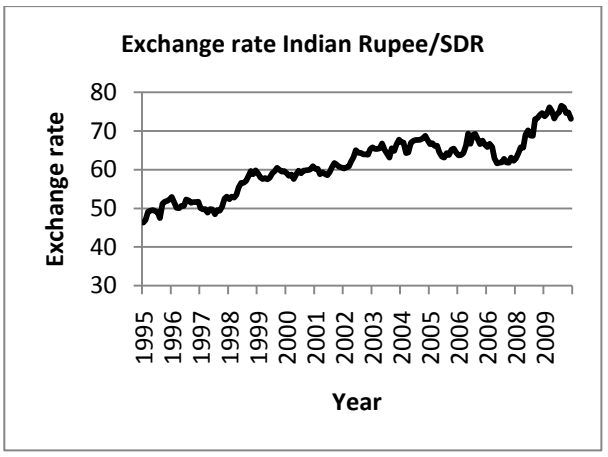

Exchange rate Indian Rupee/US Dollar
Exchange rate
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2006 2008 2009
Year


Exchange rate Indian Rupee/Indonesian Rupiah
Exchange rate
0.01
0.01
0.01
0.00
0.00
0.00
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2006 2008 2009
Year


Exchange rate Indian Rupee/Singapore Dollar
Exchange rate
50.00
40.00
30.00
20.00
10.00
0.00
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2006 2008 2009
Year

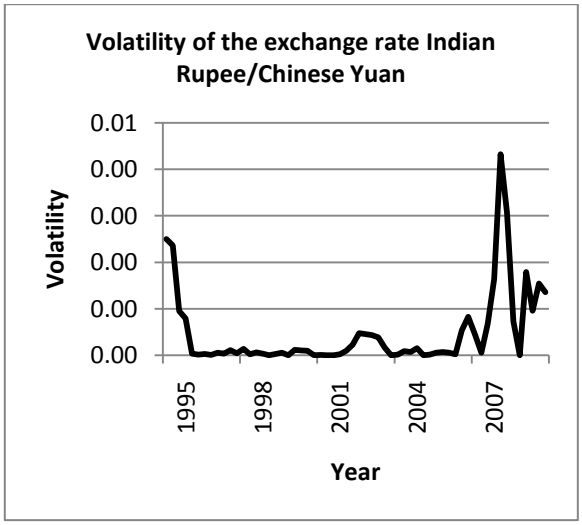

Exchange rate Indian Rupee/Malaysian Ringgit
Exchange rate
25.00
20.00
15.00
10.00
5.00
0.00
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2006 2008 2009
Year

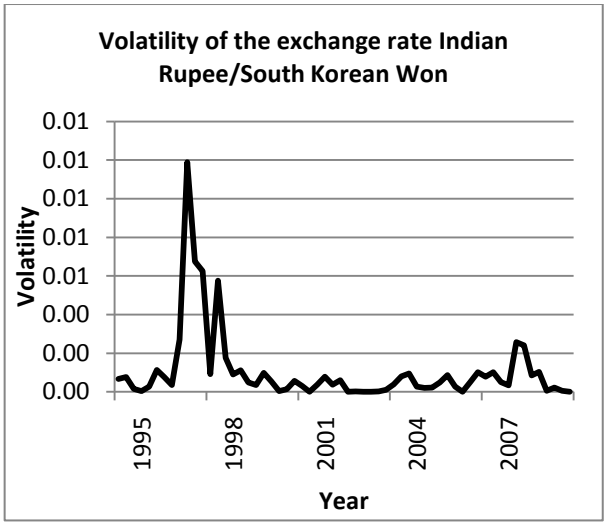

Exchange rate Indian Rupee/Russian Ruble
Exchange rate
2.50
2.00
1.50
1.00
0.50
0.00
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2006 2008 2009
Year

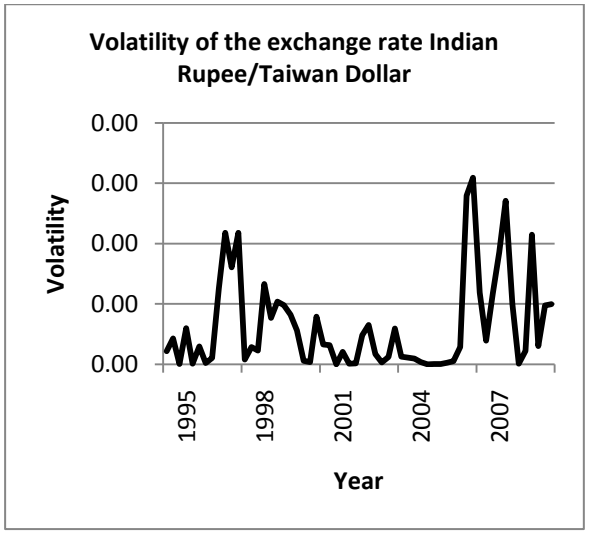

Exchange rate Indian Rupee/SDR
Exchange rate
80
70
60
50
40
30
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2006 2008 2009
Year

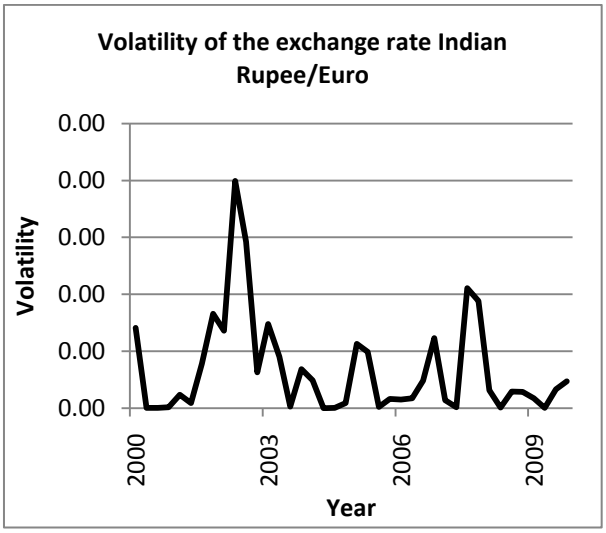
G. Volatility of the bilateral exchange rates for each country used in the bilateral analysis 1995-2009

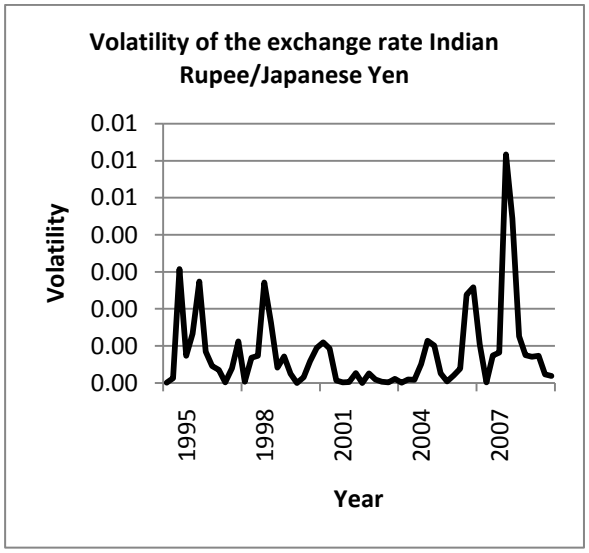
Exchange rate volatility in these figures is based on the square of the mean adjusted relative change in the exchange rate lagged one quarter.

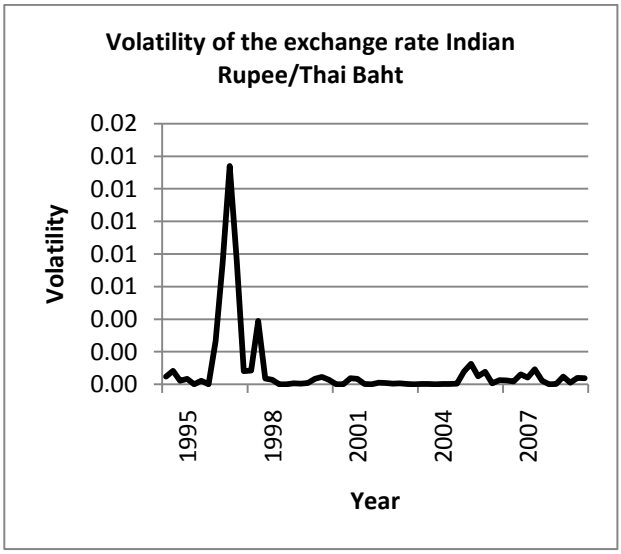


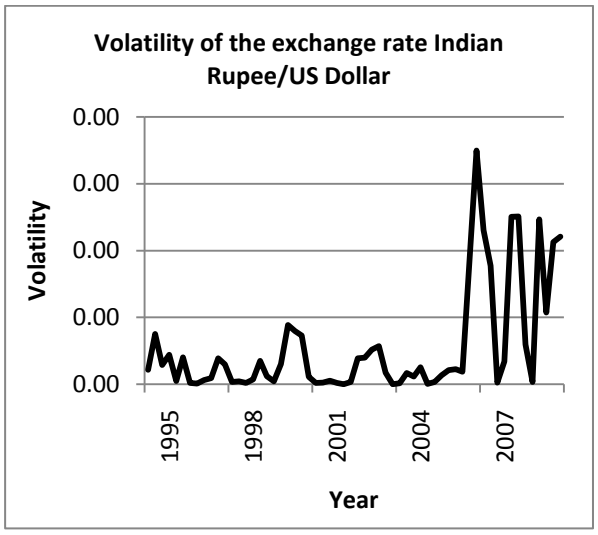


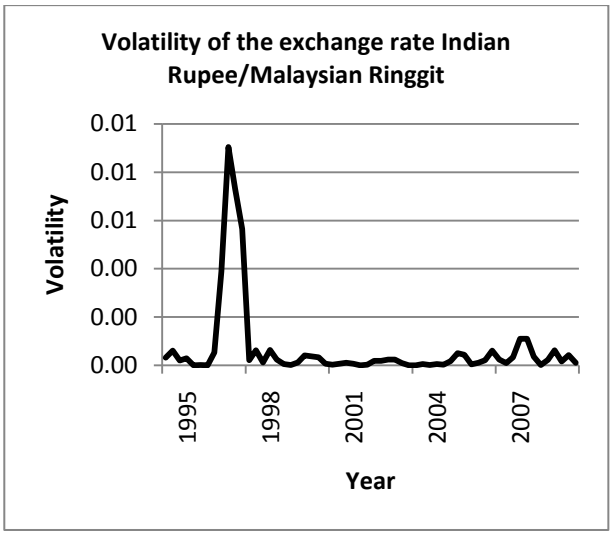


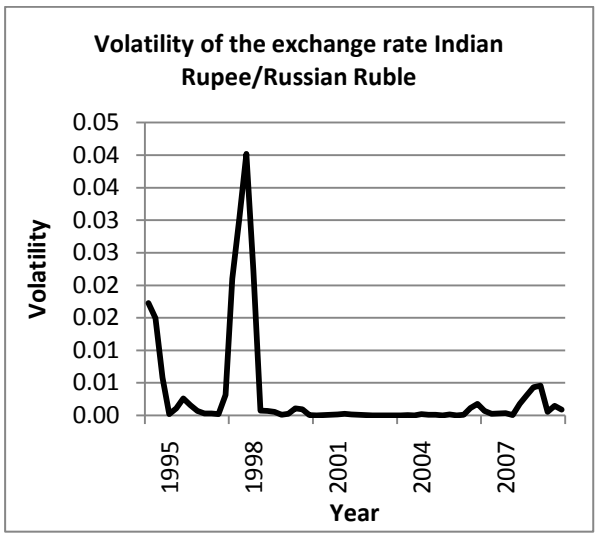


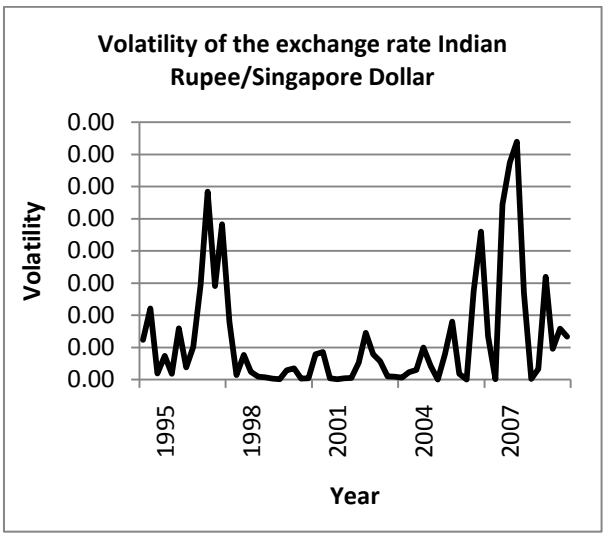


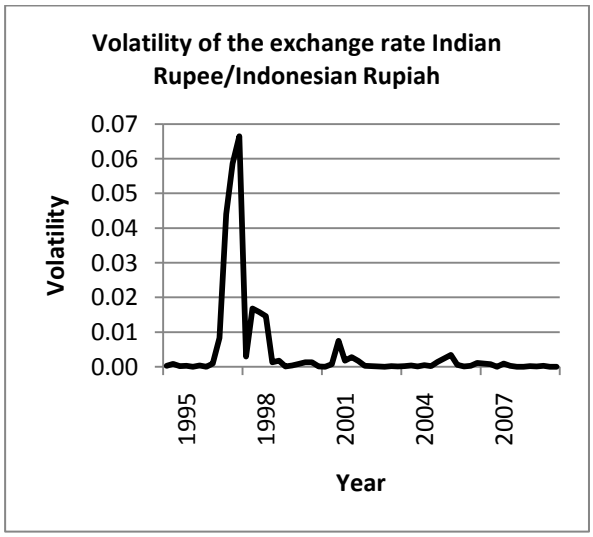


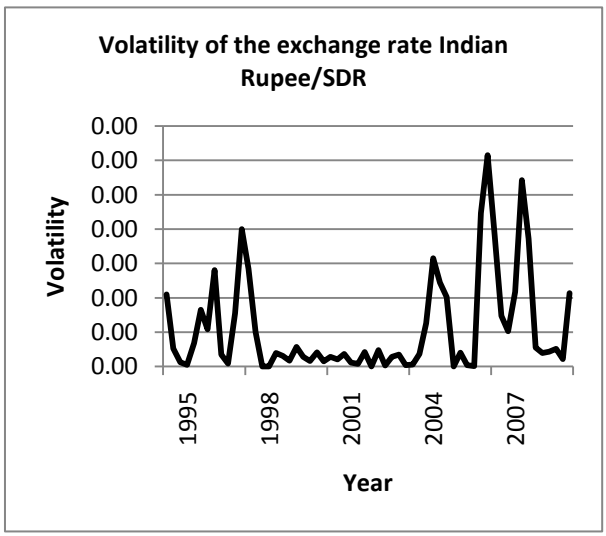

Volatility of the exchange rate Indian Rupee/US Dollar
Volatility
0.00
0.00
0.00
0.00
0.00
1995
1998
2001
2004
2007
Year


Volatility of the exchange rate Indian Rupee/Malaysian Ringgit
Volatility
0.01
0.01
0.01
0.00
0.00
0.00
1995
1998
2001
2004
2007
Year


Volatility of the exchange rate Indian Rupee/Russian Ruble
Volatility
0.05
0.04
0.04
0.03
0.03
0.02
0.02
0.01
0.01
0.00
1995
1998
2001
2004
2007
Year


Volatility of the exchange rate Indian Rupee/Singapore Dollar
Volatility
0.00
0.00
0.00
0.00
0.00
0.00
0.00
0.00
0.00
1995
1998
2001
2004
2007
Year


Volatility of the exchange rate Indian Rupee/Indonesian Rupiah
Volatility
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
1995
1998
2001
2004
2007
Year


Volatility of the exchange rate Indian Rupee/SDR
Volatility
0.00
0.00
0.00
0.00
0.00
0.00
0.00
0.00
0.00
1995
1998
2001
2004
2007
Year