"STABILIZATION, VOLATILITY AND THE EQUILIBRIUM REAL EXCHANGE RATE"

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Stabilization, Volatility, and the Equilibrium Real Exchange Rate

by

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Abstract
In a general equilibrium model, we show that the value of the equilibrium real exchange rate is affected by its own volatility. Risk averse exporters, that make their exporting decision before observing the realization of the real exchange rate, choose to export less the more volatile is the real exchange rate. Therefore the trade balance and the variance of the real exchange rate are negatively related. An increase in the volatility of the real exchange rate, for instance, deteriorates the trade balance, and to restore equilibrium a real exchange rate depreciation has to take place. In the empirical part of the paper, we use the traditional (unconditional) standard deviation of RER changes as our measure of RER volatility. We describe the behavior of the RER volatility for Brazil, Argentina and Mexico. Monthly data for the three countries are used, and also daily data for Brazil. Interesting patterns of volatility could be associated to the nature of the several stabilization plans adopted in those countries, and to changes in the exchange rate regimes.

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1. Introduction

There is a large theoretical and empirical literature on the effects of real exchange rate volatility on international trade (see Côté (1994) for a recent survey of the literature). Traditional models consider risk averse exporters for whom the real exchange rate is the source of uncertainty. Two assumptions are crucial for the volatility of the real exchange rate to affect the exporting decision. One is that there is no perfect hedging - access to exchange rate forward market reduces the effect. The other is that exporters have to be very risk averse. As Caballero and Corbo (1989) point out, profit is a convex function of prices; hence increased variability of prices increases profits. To capture the behavior of a risk averse agent facing risk, exporters are assumed to maximize a concave function of profits. because a concave function has the property of decreasing with the variability of its argument. Hence, exporters maximize a concave function (a utility function) of a convex function (the profit function) of prices. They will ultimately be maximizing a concave function of prices if the utility function is sufficiently concave, that is, if he is sufficiently risk averse.

One common feature of all models that relate the volatility of the real exchange rate to trade is that they use a partial-equilibrium approach. They focus on the export sector, and study the effect of an exogenously given volatility of the real exchange rate on the quantity of exports. This paper tries to make a step into using a general equilibrium model. Substitution across sectors is considered, and the model allows the study of the effect of volatility on the equilibrium real exchange rate, that is, on the value of the real exchange rate that yields equilibrium in all markets of the economy. The volatility of the real exchange rate is derived endogenously. Its original source in the model is a demand shock.
This paper intends to make two points. The first one is that the value of the equilibrium real exchange rate is affected by its own volatility. Risk averse exporters, that make their exporting decision before observing the realization of the real exchange rate, choose to export less the more volatile is the real exchange rate. Therefore the trade balance and the variance of the real exchange rate are negatively related. An increase in the volatility of the real exchange rate, for instance, deteriorates the trade balance, and to restore equilibrium a real exchange rate depreciation has to take place.

The other point this paper intends to stress is that price stabilization plans may affect the variability of the real exchange rate. The effect on volatility is clear when the price stabilization plan embodies a change in the exchange rate regime. If the exchange rate was flexible before the plan, and is fixed after the plan, for instance, then a lower volatility of the real exchange rate should be expected. However, even if the exchange rate regime remains unchanged, as in our model, price stabilization may affect the variance of the real exchange rate. Price stabilization means that the inflation rate moves to a lower level, and that may affect its variability. The different volatility of the inflation rate would then affect the variability of the real exchange rate. The message this paper wants to convey is that the variability of the real exchange rate may affect its equilibrium level, and price stabilization may affect that variability.

If our theoretical results are correct, empirical studies should include the real exchange rate volatility as one of the explanatory variables of the real exchange rate itself.

In the empirical part of the paper, we use the traditional (unconditional) standard deviation of RER changes over some period as our measure of RER volatility, which is still the most widely used measure of volatility. Some recent empirical attempts have
estimated conditional variances using a GARCH model.\(^1\) One of the reasons to stick with the traditional method is the presence of structural breaks associated with changes in the exchange rate indexed regime that occurred in these countries over the period studied here. These structural breaks probably altered the autoregressive coefficients of the GARCH approach in a way hard to be detected in the data, since there are not too many observations in each regime. As the effects of these structural breaks are our main object of study in this paper, we decided not to use conditional variances at this time.

The empirical section consists of a description of the behavior of the RER volatility for Brazil, Argentina and Mexico. We used monthly data for the three countries, and also daily data for Brazil. Interesting patterns of volatility could be associated to the nature of the several stabilization plans adopted in those countries, and to changes in the exchange rate regimes.

This paper is organized as follows. The next section presents the model. Section 3 contains the empirical results. Section 4 concludes and points directions for future research.

\(^{1}\) Some authors argue that a conditional variance measure is preferred because it captures better the notion of uncertainty in the theoretical model, since a variable can be very volatile but in a known (thus, certain) fashion. See, for example, Caporale and Doroodian (1994).
2. The Model

In a simple general equilibrium framework, the model presented here tries to capture the effect of the volatility of the real exchange rate on its equilibrium level. The effect arises from the assumption that firms are risk averse and the decision on how much to export is made before the real exchange rate is observed. When the export activity is riskier relative to the others, less resources will be allocated to it. To maintain external balance, the real exchange rate has to be more depreciated. Therefore, there is a negative relation between the equilibrium real exchange rate and its volatility.

Production

A small open economy is considered, which produces three goods: a non-tradable good (\(Q_n\)), an importable good (\(Q_M\)) and an exported good (\(Q_x\)). The importable good is a substitute of the country's imports. The exported good is that good produced exclusively for export, and is not consumed locally. It can be thought as a good that is produced to attend foreign specifications. It is assumed that at the beginning of the period, before observing the realization of the real exchange rate, firms have to make a binding contract specifying the amount to be produced of the exported good. Assuming that the producer is risk averse, he will maximize the expected value of a concave function, which will be called utility function, of his profit. The problem of a representative firm at the beginning of the period is represented by:

\[
\text{Max } E[U(\tilde{p}_x Q_x(L_x) + \tilde{p}_M Q_M(L_M) + Q_x(\bar{L} - L_x - L_M))]
\]  

(1)

For simplicity, only one mobile factor of production exists, \(L\), presenting decreasing returns, and the firm's endowment of this factor is \(\bar{L}\). \(Q_x(L_x)\), \(Q_M(L_M)\), and \(Q_x(\bar{L} - L_x - L_M)\) represent the production functions of the exported, importable and
non-tradable goods, respectively. The relative prices of the exported and importable goods in terms of the non-tradable good, \( \tilde{p}_x \) and \( \tilde{p}_m \), are uncertain. The price of the exported good is equal to its international price, \( \tilde{p}_x \), exogenous and assumed constant, multiplied by the ratio between the nominal exchange rate and the price of the non-tradable good. This ratio, represented by \( \tilde{R} \), is uncertain, and the cause of this uncertainty will be discussed later. The price of the importable good is equal to its international price, \( \tilde{p}_m^* \), multiplied by the sum of the uncertain ratio \( \tilde{R} \) and the import tariff \( \tau \).

\[
\tilde{p}_x = \tilde{R} p_x^* \quad \text{and} \\
\tilde{p}_m = (\tilde{R} + \tau) p_M^*.
\]

By solving the maximization problem above, the producer chooses how much labor to allocate for the production of the exported good\(^2\). The two first order conditions that define \( L_x \) and \( L_m \) are:

\[
\frac{E[U^* \tilde{p}_x]}{E[U^*]} = \frac{Q_x^*}{Q_x^*}, \quad \text{and} \\
\frac{E[U^* \tilde{p}_m]}{E[U^*]} = \frac{Q_M^*}{Q_M^*}. \tag{3.a, b}
\]

where \( U^* \) is the derivative of the utility function with respect to profits, and \( Q_j^* \) is the marginal product of labor in the production of good \( j \), for \( j = X, M, N \).

Given the properties of the production functions, the production of the exported good is positively related to \( E[U^* \tilde{p}_x] \) - which can be interpreted as the marginal utility for the producer of producing one extra unit of the exported good - and is negatively related to \( E(U^*) \) - which can be interpreted as the marginal utility for the producer of

\(^2\) The solution also yields the amount planned to be allocated to the importable and to the non-tradable goods. However, the decision of how much labor is allocated between them is made after the realization of the real exchange rate.
producing one extra unit of the non-tradable good. The amount of exported good to be produced can then be represented by:

$$Q_x = q_x(E(U^\prime \hat{p}_x), E(U^\prime \hat{p}_m), E(U^\prime)).$$

The derivative of the offer curve with respect to the first argument is positive, and with respect to the other two it is negative.

After the realization of the real exchange rate, the firm decides how much to produce of the importable and non-tradable goods with the labor net of the amount used in the production of the exported good. The offer function of the two goods are represented as the functions:

$$Q_I = q_I(p_m, E(U^\prime \hat{p}_x), E(U^\prime \hat{p}_m), E(U^\prime)) \text{ and }$$

$$Q_N = q_N(p_m, E(U^\prime \hat{p}_x), E(U^\prime \hat{p}_m), E(U^\prime)).$$

where $p_m$ is the realization of the variable $\hat{p}_m$. The derivatives of the two functions have the following signs:

$$\frac{\partial q_m}{\partial p_m} > 0, \quad \frac{\partial q_m}{\partial E[U^\prime \hat{p}_m]} > 0, \quad \frac{\partial q_m}{\partial E[U^\prime]} < 0, \quad \frac{\partial q_n}{\partial p_m} < 0, \quad \frac{\partial q_n}{\partial E[U^\prime \hat{p}_m]} < 0, \quad \frac{\partial q_n}{\partial E[U^\prime]} > 0.$$

$$\frac{\partial q_n}{\partial E[U^\prime]} > 0, \quad \text{and} \quad \frac{\partial q_n}{\partial E[U^\prime \hat{p}_x]} < 0 \text{ for } j = M, N.$$

Consumption

Now that the production side of the economy is defined, let's turn to the consumption decisions. The consumer in this model economy consumes two types of goods: importables and non-tradables. They maximize their utility from consumption subject to their budget constraint. It is also assumed that their demand for goods depends positively on the amount of money they hold. Two possible ways to model this assumption are either by using a cash-in-advance constraint, or by placing money in the utility function. The role of introducing money is this model is to create a demand shock. Hence, money should be viewed here solely as a source of demand shocks. An alternative way to accomplish this could be made by introducing government expenditures.
instance, that would have a positive effect on the demand of both goods. The demand for each type of good may be represented by:

\[ C_M = c_M(p_M, m) \quad \text{and} \quad C_N = c_N(p_N, m). \]

where \( m \) is the real amount of money in terms of the price of the non-tradable good, and \( \frac{\partial c_M}{\partial p_M} < 0, \frac{\partial c_N}{\partial p_M} > 0, \) and \( \frac{\partial c_j}{\partial m} > 0 \) for \( j = M, N. \)

**Equilibrium Conditions**

There are two equilibrium conditions in this economy. The first one is that the total production of the non-tradable good must equal its total consumption. The condition is represented by the following equation:

\[ c_N(p_M, m) = q_N(p_M, E(U^* p_X), E(U^* p_M), E(U^*)). \]

(7)

The second condition is that the country's trade balance constraint must also be satisfied. Assuming that there are no transactions with the rest of the world other than trade relations, this constraint translates into a balanced trade equation:

\[ p_M^*[c_M(p_M, m) - q_M(p_M, E(U^* p_X), E(U^* p_M), E(U^*))] = p_N^*E(U^* p_X)E(U^* p_M)E(U^*). \]

(8)

Ex-post relative price of importables and real money supply must satisfy the two equilibrium equations above, given the distribution function of the random variables. The equilibrium is represented in figure 1. The vertical axis depicts the relative price of importables, and the horizontal axis represents the real money supply. The equilibrium occurs where the non-tradables market equilibrium curve (NT), that represents equation (7), crosses the trade balance curve (TB), that represents equation (8).
Figure 1

Uncertainty is introduced in the model through the money supply. All economic agents know the distribution for the possible realization of the money supply, and the government sets the nominal exchange rate without observing its realization. The rigidity of the nominal exchange rate is what makes the variability of the money supply to have real effects. Nominal exchange rate is set by the government targeting the equilibrium real exchange rate. However, prices are collected with a lag. Therefore, in an inflationary environment, prices may be different from expected, and the real exchange rate may result misaligned. The setting modeled here represents such a situation. Hence, the real exchange rate will be different from the equilibrium one when the rate of inflation, or, in the context of our static model, when the money supply is different from expected. This means that the variability of the real exchange rate will be larger the larger is the variability of the inflation rate, or the larger the variability of the money supply in our model.

Solving the Model

Equilibrium in the model is achieved as follows. The government sets the nominal exchange rate consistent with equilibrium, taking the money supply as equal to its
expected value, and zero import tariffs. In terms of figure 1, nominal exchange rate is set so that $p_y$ equals its equilibrium value, with zero tariffs. When the realization of the money supply is larger than expected, the demand for both goods is also larger than expected, and the economy is at a point to the right of the equilibrium point. To reestablish equilibrium in both markets, the price of non-tradables increases, and, at the same time, we assume that an import tariff is levied, so that real money supply returns to its (expected) equilibrium level, while the relative price of importables remains unchanged. On the other hand, when the realized nominal money supply is smaller than its expected value, the price of non-tradables decreases while an import subsidy is put in effect. Given that the value of the tariff will be greater than zero at realizations of the money supply larger than its mean, and it is symmetrically negative on the opposite case, then the expected value of tariffs is zero.

The relative price of importables will then be the same for any realization of the money supply. The same is not true for the relative price of the exported good. When the money supply is larger than expected, for instance, the relative price of the exported good is smaller than expected. Therefore, the variability of the relative price of the exported good is positively related to the variability of the money supply, which represents here the variability of the inflation rate.

The equations that determine the production decision for the exported good (2.a) and the plan for the production of other goods (2.b) can then be rewritten as:

\[ \text{Note that the role of the tariff in the model is just to maintain external balance when the realization of the random variable is different from expected. This could also be accomplished by allowing the country to run deficits or surpluses, using the international financial market. We want, however, to keep a static framework for simplicity.} \]
To assess the effect of changes in the variability of inflation on the equilibrium inflation rate, one has to determine the effect of that variability on the expected values above, and that, in turn, depends on the concavity of the functions $U' \hat{p}_x$ and $U'$ with respect to $\hat{p}_x$. Concavity of the first function and convexity of the second are sufficient conditions for the variability of $\hat{p}_x$ to affect negatively the production of the exported good and positively the production of importables. It is plausible to assume this sign for the derivatives, so that when the expected value of the marginal utility of one more unit of production of exported good ($E[U' \hat{p}_x]$) decreases due to a higher volatility of $\hat{p}_x$, for instance, the firm will lower the production of exported good, and will increase the production of importables and non-tradables.

Finally, the equilibrium conditions can now be rewritten as:

$$c_x(p_M,m) = q_x(p_M,E(U' \hat{p}_x),E(U'))$$

$$p_M[q_x(p_M,m) - q_x(p_M,E(U' \hat{p}_x),E(U'))] = p_xq_x(p_M,E(U' \hat{p}_x),E(U'))$$

Now we are ready to show that the variability of the real exchange rate, which will be shown to depend positively on the variability of the inflation rate, affects positively the equilibrium real exchange rate.

The real exchange rate is the ratio of the price of tradables and the price of non-tradables. In terms of the model presented here, the real exchange rate is:

$$RER = \Pi(\hat{p}_M, \hat{p}_x).$$

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4 The function $U' p_x$ can be concave and $U'$ convex in $p_x$ at the same time, because

$$\frac{\partial^2 U'}{\partial p_x^2} = U'' p_x (Q_x) + 2 U'' Q_x < U'''(Q_x) \frac{\hat{p}_x}{\hat{p}_x}.$$
where the derivative of the function $\Pi(.)$ is positive with respect to both arguments. First, it is clear that the variability of the real exchange rate depends positively on the variability of the relative prices of importable and exported goods, which variability, in turn, increases with the variability of inflation.

Remember that:

$$\tilde{p}_x = \tilde{R}p_x^*, \quad \text{and}$$

$$\tilde{p}_m = (\tilde{R} + \tau)p_m^*.$$  \hspace{1cm} (2)

Hence, to determine the effect of the variability on the equilibrium real exchange rate we must determine its effect on $\tau$ and $\tilde{R}$. The value of the tariff will always be such as to keep the relative price of importables unchanged. To determine the effect on $\tilde{R}$ we need to know the effect of real exchange rate variability on the equilibrium value $p_m^*$, and on the possible realizations of $\tilde{p}_x$.

Figure 2 represents the changes in the equilibrium conditions caused by an increase in the variability of $\tilde{p}_x$. From the assumptions in equations (2'), when the variability of $\tilde{p}_x$ increases, the production of non-tradables also increases. Thus, the curve NT in figure 2 shifts upward and to the right relative to its previous position.

The effect on the country's trade balance constraint is ambiguous. The increased variability of $\tilde{p}_x$ decreases production of exported good, but at the same time it increases production of importables. It is plausible to assume, however, that the first effect is larger than the second, so that the TB curve shifts upward and to the left.
Figure 2

It is clear from the picture that the new equilibrium value for the price of imports is larger than before, and therefore so is the expected value of $\bar{p}_n$. Consequently, the equilibrium real exchange rate is larger the larger its variability. The intuition for this result is that the increase in variability of the RER depresses exports, so that to maintain external balance an incentive in the form of a RER depreciation is necessary.

The model shows that the volatility of the inflation rate has a positive effect on the volatility of the RER, and the volatility of the RER, in turn, affects positively the equilibrium real exchange rate.

3. Real Exchange Rate Volatility

There is a vast empirical literature on the effects of (nominal and real) exchange rate variability on trade flows and trade prices. Most of the papers in this literature were based on partial equilibrium models of export determination. In general, the main sources

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of exchange rate volatility considered were associated to the end of the Bretton Woods system or issues related to the introduction of economic integration regions (Nafta, European Union, and Mercosul), like macroeconomic policy harmonization and currency unions.

The results regarding the effects of exchange rate volatility on trade flows are still inconclusive. While most papers found a negative significant effect, the magnitudes of the coefficients are in general relatively small. For evidence of a negative relationship between real exchange rate (RER) volatility and trade in developing countries, see Coes (1979), Paredes (1989), and Grobar (1993). For evidence of no relationship between the two variables in Colombia, see Steiner and Wullner (1994).

On the other hand, most authors tend to find an increase in exchange rate volatility after the collapse of the Bretton Woods regime, most notably in developing countries (see Edwards, 1989). Regional economic integration was also found to reduce the effect of exchange rate variability on trade (see, for example, Frankel and Wei, 1993).

In this paper, we depart from the previous empirical literature in two ways.

The first innovation is to investigate a different source of RER volatility: the effects of stabilization plans in high inflation countries. As our model suggests, for a given exchange rate indexation regime, inflation variability and RER variability are positively correlated. Changes in the indexation regime or changes from a fixed to a floating exchange rate system are also other potential sources of RER variability. By examining the behavior of volatility indexes over the last ten to fifteen years for Brazil, Argentina and Mexico, we try to identify the influence of stabilization plans on these variability measures.
The second innovation here is the use of daily data for Brazil. By assuming a constant exponential growth for prices within each month, we were able to obtain daily RERs since January 1st of 1980 for Brazil.  

Graphs 1 and 2 display daily Brazilian RER levels and changes, respectively, from the beginning of 1980 to the end of June 1995. Daily nominal exchange rates (E) were obtained from the Central Bank: sell quotation, dollar/domestic currency. As usual in small economy models, real exchange rates were proxied by RER = E/WPI*CPI, where WPI is the U.S. wholesale price index and CPI is the Brazilian consumer price index (INPC, also from IBGE).  

A very volatile RER picture emerges from the graphs. Large one-day swings were observed in the 30% maxi-devaluation episode of February 1983, and in several mid-devaluations that preceded most stabilization plans of the 1980s. Months of steep inflation acceleration/deceleration not only brought changes in the RER level but also caused an increase in (within-month) volatility, which is not perceived in monthly data.

We use the (moving) standard deviation of daily RER changes as our measure of volatility. We computed four versions of this measure: two using the standard deviation of the RER changes within each quarter (STD-Q), and two within each semester (STD-S). The difference between the members of each pair is that one of them is centered in the middle of each quarter (or semester), while in the other each standard deviation date corresponded to the last observation of each quarter (or semester). We use a C at the end of the names of the centered measures.

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6 The assumption of a constant exponential price growth within each month does not seem damaging to our results, since ex-ante RER expectations should be based on a hypothesis like this, as other distributions are unknown.

7 See Edwards (1989) for a comparison of several measures of RERs. The same definition of RER was applied to Argentina and Mexico.
Table 1 shows the means of the four measures of RER volatility, together with the daily inflation average. Remember that these averages are taken over weekdays only, excluding weekends, holidays, and bank holidays. The magnitudes were relatively high (around 0.7% a working day), about the same size as the daily rate of inflation. Table 1 also shows the correlation between our four measures and with inflation. Contrary to other studies for other countries, the four measures are not very highly correlated with each other. Moreover, all measures were found to be uncorrelated with the inflation rate. As our model suggests, it is the variability of inflation (not the level) that matters for explaining RER volatility. Changes in the exchange rate indexation regime are also important in this respect.

Graph 3 shows the behavior of our preferred volatility measure (STD-QC). Several comments emerge from that graph. First of all, most peaks in the volatility measure were related to large devaluations, that were made either to deal with the external debt crisis, as in February of 1983, or preceding stabilization plans.\(^8\) The remaining peaks reflected large appreciations that followed both the Collor and the Real plans.

Second, if we do not consider those peaks, at least six volatility patterns can be identified. The first one, observed in the period running from 1980 to February 1983, is characterized by a relatively high volatility (around 0.7% a day), which resulted from a loose crawling peg regime without a fixed-period indexation rule. The second period, observed from February-1983 to mid-1985, was one of a daily indexation. However, inflation acceleration (from 100% a year to 200% a year) compensated the indexation effect, resulting in a RER volatility of around 0.7% a month, similar to that observed in the first period. The third period, from mid-1985 to the end of 1988, was characterized

\(^8\)We stress the point that these peaks should be kept as part of the volatility index, since in all these periods, forward-looking agents were uncertain about the future levels of the RER, anticipating the possibility of large devaluations or price freezing.
by a low daily RER volatility (around 0.2% a day), which resulted from two price (and exchange rate) freezing attempts and a policy orientation of keeping the RER unchanged. despite the inflation acceleration at the end of the period. The fourth period runs from 1990 to the middle of 1991, period in which the Central Bank did not follow any indexation (parity) rule, letting the exchange rate float under unspecified thresholds, which characterized what is usually called a "dirty floating" regime. The result was a very high RER volatility (above 1% a day). A fifth period, from mid-1991 to mid-1994, illustrates the return to a daily indexation regime and was characterized by some attempts to point to a more devalued currency. Continuous inflation acceleration in that period, together with a lag on current price observation, resulted in a continuous increase in the volatility measure. The magnitudes, however, were not large, compared to other periods, averaging around 0.3% a day. The sixth pattern was the one introduced by the floating exchange regime that followed the Real Plan. After a brief period of a relatively high volatility, which was caused by the large appreciation of the Real, inflation stabilization at low levels, together with the introduction of exchange rate bands in March 1995 helped to decrease the RER variability. However, RER volatility is still larger than the one observed in the fourth period, period in which the average inflation rate was around 25% a month.

Graphs 4, 5 and 6 show RER monthly changes for Argentina, Mexico and Brazil, respectively. [Comments to come]

We computed three measures of volatility for each country's monthly data, all based on (moving) standard deviations of RER changes: one for changes within the last 12 months (STD-12); another for changes within the last 24 months (STD-24); and a third centered in the middle of each year (STD-12C). Table 2 shows the means of the three volatility measures for the three countries, respectively. It also gives the correlation matrix between the three measures and the inflation rate. Mexico experienced the lowest average level of inflation (3.5% a month) and the lowest RER volatility measures, in absolute terms. Argentina, on the other hand, experienced the highest average level of
inflation (3.5% a month) and the highest RER volatility measures, both in absolute terms and relative to the inflation rate. Note that Brazil's monthly volatility index is much lower than its daily counterpart analyzed above (3.2% a month compared to around 12%, the monthly equivalent of the daily measure).

Graph 7 displays the centered (moving) yearly standard deviation of the RER (STD-12C). We ignored the large 1989-1991 numbers for Argentina which were above 60% a month, so as to provide a better visual comparison between the three countries. Mexico experienced the lowest RER volatility among the three countries, specially after the events of late 1982. It remained below 2% a month throughout most of the period. Argentina's RER volatility was the highest of the group. After 1991, however, RER volatility remained below 0.5% a month, the lowest level reached by any of the three countries in the period.

[To be completed]

4. Future Research

As our theoretical model showed, RER volatility seems to affect positively the equilibrium real exchange rate level. We intend to test empirically this result by estimating the equilibrium RER. A traditional method of estimating equilibrium RER has been applied to other developing countries' data by Edwards (1995) and Elbadawi (1995), among others, usually using real variables such as terms of trade and fiscal and monetary variables as the long-run determinants of the RER. In a future paper, we intend to apply this method to Brazil, including RER volatility as one of the variables that cointegrate with the RER.

In future research, we also intend to estimate conditional variances. We will try to invest in techniques for detecting the problems associated with the presence of structural breaks mentioned in the introduction. Contrary to other applications, we will study the possibility of using a vector error correction model with the error correction given by the
equilibrium RER equation as mentioned above. Since most GARCH models are clearly inadequate for picking up effects such as expectations of large exchange rate devaluations following a balance of payments crisis, for example. In fact, most GARCH applications use ARIMA specifications for the RER equation, which obviously do not carry enough information to approximate the information set available to economic agents.
Bibliography


Coes (1979), ...


Paredes (1989). ...

### Table 1

**Brazil: Daily RER Volatility Measures**

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Real Exchange Rate - Brazil

Daily - Reais of 15/6/95

Dec-79 Apr-81 Sep-82 Jan-84 Jun-85 Oct-86 Feb-88 Jul-89 Nov-90 Apr-92 Aug-93 Jan-95
Real Exchange Rate - Brazil

Daily Variation (%)
Volatility: Daily RER Changes - Brazil

Std Deviation - Quarter, Centered (%)
Real Exchange Rate - Brazil

Monthly Changes (%)
Volatility: Monthly RER Changes

Std Deviation - 12 Months Centered (%)

ARGENT. — BRAZIL    MEXICO