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César Calderón

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Agustinas 1180
Teléfono: (56-2) 6702475; Fax: (56-2) 6702231

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TRADE OPENNESS AND REAL EXCHANGE RATE VOLATILITY: PANEL DATA EVIDENCE

César Calderón
Economista Senior
Gerencia de Investigación Económica
Banco Central de Chile

Resumen

De acuerdo a la "Nueva Macroeconomía de la Economía Abierta", factores no-monetarios han cobrado importancia en la explicación de la volatilidad cambiaria. En este sentido, se sugiere la inclusión de la volatilidad de factores como choques de productividad, términos de intercambio y fiscales, entre otros, en éste análisis. El objetivo del presente artículo es explicar la volatilidad del tipo de cambio real (TCR) mediante la formulación de una ecuación estructural que relaciona dicha volatilidad con sus determinantes. Para llevar a cabo este objetivo, juntamos información sobre tipos de cambio, producto, términos de intercambio, gasto de gobierno, agregados monetarios, regímenes cambiarios, así como apertura real y financiera para una muestra de países industriales y en desarrollo para el periodo 1974-2003. Utilizaremos el método generalizado de momentos con variables instrumentales en datos de panel para contrastar las siguientes hipótesis: (a) mientras más integrada está la economía a mercados mundiales de bienes y financieros, menor es la volatilidad de su TCR. (b) La mayor apertura comercial permite atenuar el impacto de choques volátiles a fundamentales sobre la volatilidad del TCR.

Abstract

A recent strand of the literature, the so-called "New Open Economy Macroeconomics", argues that nonmonetary factors have gained importance in explaining exchange rate volatility. In this context, it has been suggested the inclusion of shocks to productivity, terms of trade, and government spending, among others. The goal of the present paper is to explain the real exchange rate volatility by positing a structural relationship between volatility and its determinants. To perform our task we collected information on exchange rates, output, terms of trade, government spending, monetary aggregates, exchange rate regimes, trade and financial openness for a sample of industrial and developing countries for the 1974-2003 period. We will use GMM-IV methods for panel data to test the following hypotheses: (a) real exchange rate (RER) fluctuations are less volatile in more open countries, and (b) trade openness helps attenuate the impact of highly volatile shocks to fundamentals on the volatility of RER fluctuations.

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E-mail: ccaldero@bcentral.cl.

1. Introduction

The collapse of Bretton Woods in 1971 forced industrial economies to switch from a fixed exchange rate to a floating system. This switch brought a larger volatility for both the nominal and the real exchange rate (Stockman, 1983; Mussa, 1986). The monetary authorities were blamed for the greater volatility of real exchange rates during the 1970s. Theoretically, Dornbusch (1976) showed that unanticipated monetary policy shocks might generate disproportionately large fluctuations in the exchange rates (*overshooting* effect). The lower speed of adjustment in the goods markets (relative to financial markets) was the mechanism — according to this model— through which the exchange rate disproportionately absorbed the unanticipated monetary shock in the short run.

However, the hypothesis that monetary stability was the sole culprit of exchange rate instability lost ground as most industrial economies have stabilized inflation at annual rates below 3 percent. For example, inflation rates have converge to the 1 to 2 percent rage in the U.S., Japan, and Europe; wheras the exchange rates across the US dollar, the euro, and the yen are still significantly volatile (Rogoff, 1999). The fact that exchange rate volatility among the major currencies has not declined even though the serious and successful efforts to bring inflation down, allows us to think that the role of monetary factors implied by Dornbusch (1976) was overstated. In addition, the inability of monetary models to replicate and forecast exchange rate fluctuations (Meese and Rogoff, 1983) implies that monetary instability is only one of the several factors driving exchange rate volatility.

A recent strand of the literature, the so-called *"New Open Economy Macroeconomics"*, argues that non-monetary factors have gained importance in explaining exchange rate volatility. That is, in addition to money, we should include productivity shocks, terms of trade shocks, and government spending, among others. The goal of the present paper is twofold: First, posit a structural relationship between real exchange rate (RER) volatility and the volatility of RER fundamentals. Second, test the following hypotheses: (i) RER fluctuations are less volatile in more open economies, and (ii) trade openness helps attenuate the impact of volatile shocks to fundamentals on RER fluctuations. These theoretical predictions have been recently demostranted by Obstfeld and Rogoff (1996, 2000) and Hau (2000).

In order to perform our task we will gather information on exchange rates, productivity of the traded and non-traded sector, terms of trade, government spending, monetary aggregates, exchange rate regimes, as well as trade and financial openness for a sample of 79 countries (of which 22 are industrial countries) for the 1973-2001 period. We will use the GMM-IV techniques for panel data models —which will allow us to exploit both the time dimension and cross-sectional dimension of our database. Our testable hypotheses will be derived from a dynamic general equilibrium model in the spirit of Obstfeld and Rogoff (1995, 1996).

The present paper complements existing evidence already presented by Devereux and Lane (2003), where higher trade and financial linkages between debtor and creditor countries would render a lower volatility of the bilateral exchange rate of the debtor country vis-a-vis its creditor. It also complements evidence that shows the trade openness attenuating the impact of trade-related shocks (that is, terms of trade shocks and the growth of the main trading partners) on growth and volatility (Calderón, Loayza and Schmidt-Hebbel, 2004). In addition, this paper improves upon the evidence presented by Hau (2002) in three dimensions: First, it presents evidence for a larger sample of countries (79) and sample period (1974-2003).[1] Second, we present panel data evidence (instead of cross-section). We work with 5-year period observations on the volatility of RER and fundamentals.[2] Third, we directly test the hypothesis that trade openness helps attenuate the impact of volatile shocks to fundamentals on the volatility of RER fluctuations. Unlike Hau (2002), we include an interaction term between openness and the volatility of the RER fundamental that allows us to test the hypothesis mentioned above.

Finally, the paper will consist of the following sections: Section 2 presents our main testable implications —which are derived from the model with nominal rigidities and imperfect competitition a la Obstfeld-Rogoff (1996). Section 3 discusses the data and method of estimation. Section 4 presents the regression analysis of the real exchange rate volatility and it directly tests whether real exchange rate fluctuations are less volatile in countries more integrated to the world markets. Finally, section 5 concludes.

2. Some theoretical insights

In this section we present some theoretical foundations on the relationship among the volatility of RER fluctuations, the volatility of RER fundamentals, and trade openness. The testable hypothesis presented in this section will be derived from the Obstfeld-Rogoff (1995, 1996) model of exchange rate determination. See Appendix I for a detailed explanation of the basic set up and steady state analysis.

2.1 Introducing some notation

We first define the degree of trade openness in this model. Given a two-sector model (i.e. traded and non-traded sectors), we use equation (I.15) to define trade openness as:

$$\phi = \frac{P_T C_T}{P_T C_T + \bar{P}_N C_N} \tag{1}$$

[1] Hau (2002) gathered data for 48 countries (of which 23 were OECD countries) over the 1980.01-1998.12 period.

[2] We use 10- and 15-year windows for the calculation of volatilities and our results remained invariant.

Once we calculate the steady state (see section I.2 of the Appendix I), we analyze the dynamics of the model. To perform that task, we take a log-linear approximation around the benchmark steady state.

We denote $\tilde{X} = \left(\frac{X_1 - \overline{X}_0}{\overline{X}_0} \right)$ as the short-run percentage deviation from the benchmark steady-state, and $\hat{X} = \left(\frac{\overline{X} - \overline{X}_0}{\overline{X}_0} \right)$ as the long-run deviations from the same steady state.

2.2 Testable Implications

In the present sub-section we will present the relationship among volatility of RER fluctuations, volatility of RER fundamentals, and trade openness derived from the stylized Obstfeld-Rogoff redux model.

Productivity Shocks. Assume that the non-traded sector faces an unanticipated permanent technology shock —that is, $\hat{A}_N = \hat{A}_N^*$. By log-linearizing (I.10), we have:

$$-\tilde{P}_T - \tilde{C}_T = -\hat{A}_N + \tilde{y}_N \tag{2}$$

and since we assume constant endowments of traded goods, $\overline{y}_T$, a constant net foreign asset position, and the consumption-smoothing motive, we have $\tilde{C}_T = 0$. If we log-linearize (I.9), $\tilde{C}_N = \tilde{P}_T$, given that $\tilde{P}_N = 0$. Market-clearing conditions for non-tradables, $\tilde{C}_N = \tilde{y}_N$, then determines the fluctuations in the prices of traded goods, $\tilde{P}_T = -\frac{1}{2}\hat{A}_N$. Since the law of one price for tradables holds, we find that real exchange rate fluctuations are

$$\tilde{q} = \tilde{E} - \tilde{P} = \tilde{E} - \phi\tilde{P}_T = (1-\phi)\tilde{P}_T = -\left(\frac{1-\phi}{2}\right)\hat{A}_N \tag{3}$$

From (3) we find that the volatility of real exchange rate changes is:

$$\operatorname{var}(\tilde{q}) = \frac{(1-\phi)^2}{4}\operatorname{var}(\hat{A}_N) = h_A(\phi)\cdot\operatorname{var}(\hat{A}_N) \tag{4}$$

where the greater the degree of openness —that is, the larger is the value of ϕ— the smaller is the impact of the volatility of productivity shocks on the volatility of real exchange rate fluctuations.

Monetary Shocks. Now we assume that the economy only faces unanticipated permanent monetary shocks —that is, $\hat{M} = \tilde{M}$. We first log-linearize the money demand —equation (I.11)— around the steady state:

$$\varepsilon(\tilde{m} - \tilde{p}) = (\tilde{p}_T - \tilde{p}) + \frac{\beta}{1-\beta}(\tilde{p}_T - \hat{p}_T) \tag{5}$$

and, since the prices of nontradables are fixed in the short-run, $\widetilde{P}_N = 0$, and the non-neutrality of money holds, $\widetilde{P}_T = \hat{M} = \widetilde{M}$, we have:[3]

$$\widetilde{P}_T = \frac{\beta + (1-\beta)\varepsilon}{\beta + (1-\beta)(1-\phi+\phi\varepsilon)}\hat{M} \tag{6}$$

Since the law of one price holds for traded goods, these prices change in proportion to exchange rate fluctuations, i.e. $\widetilde{P}_T = \widetilde{E}$. In addition, changes in the real exchange rate are defined as,

$$\widetilde{q} = \widetilde{E} - \widetilde{P} = \widetilde{E} - \phi\widetilde{P}_T = (1-\phi)\widetilde{P}_T \tag{7}$$

Using (6) and (7), the volatility of real exchange rate changes is:

$$\text{var}(\widetilde{q}) = h_M(\phi)\,\text{var}(\hat{M}) \tag{8}$$

where $h_M(\phi)$ is the function that relates the volatility of real exchange rate fluctuations and the degree of openness. We can show that this relationship is negative.

Fiscal Shocks. Now we assume that the economy only faces unanticipated permanent fiscal shocks —that is, $\hat{G} = \widetilde{G}$. If we log-linearize equation (I.18) and combine with the other dynamic equations in the model, we have:

$$\widetilde{P}_T = \frac{1}{(1-\beta)+\theta(1+\beta)}\hat{G} \tag{9}$$

and, changes in the real exchange rate are defined as:

$$\widetilde{q} = \frac{1-\phi}{(1-\beta)+\theta(1+\beta)}\hat{G} \tag{10}$$

Hence, the volatility of real exchange rates is:

$$\text{var}(\widetilde{q}) = h_G(\phi)\,\text{var}(\hat{G}) \tag{11}$$

where $h_G(\phi)$ is the function that relates the volatility of real exchange rate fluctuations and the degree of openness. Also, it is straightforward to show that this relationship is negative.

3. Data and Methodology

In the present section we describe the data used for our empirical evaluation of real exchange rate volatility and we present a detailed outline of the econometric technique used.

3.1 The Data

In order to perform our regression analysis, we have gathered annual data on real exchange rates and fundamentals such as real output, money, terms of trade and government spending for

[3] Note that if ϕ=1, $\widetilde{P}_T = \hat{M}$.

a sample of 79 countries over the 1974-2003 period (see list of countries in Table A1).[4] Following Levy-Yeyati and Sturzenegger (2001) we ignore the Bretton Wood period for two reasons: (a) the predominance of fixed exchange rate regimes implemented for political reasons, and (b) to focus on the recent period of increasing integration to the world markets of goods and assets.

Our dependent variable, the *volatility of real effective exchange rate fluctuations,* is the standard deviation of changes in the real effective exchange rate over a 5-year window. Here, we construct the real effective exchange rate index for country k at period t, q_{kt}, as the nominal exchange rate index multiplied by the relative price of the rest of the world (expressed in US dollars) to the domestic price index,

$$q_{kt} = \frac{\left(\dfrac{s_{kt}}{s_{k0}}\right)}{\left(\dfrac{P_{kt}}{P_{k0}}\right)} \cdot \prod_{i=1}^{n} \left(\frac{P_{it}^{*}}{P_{i0}^{*}} \frac{s_{i0}}{s_{it}} \right)^{\omega_i}$$

where s_{kt} is the nominal exchange rate for country k observed in period t, P_{kt} is the consumer price level of country k in period t, s_{it} is the nominal exchange rate of the *i-th* trading partner in period t in units of local currency *vis-a-vis* the US dollar, and P_{it}^{*} is the consumer price level of country k's *i-th* trading partners in period t.[5] Price levels at time 0 represents the base period of our index numbers.

Volatility of Fundamentals. Here we describe the sources of the data on the fundamentals of the real exchange rate used in the paper. First, we measured the volatility of output growth as the standard deviation of real GDP growth. In turn, real output is the real GDP as constructed by Loayza, Fajnzylber and Calderón (2004) using Summers and Heston (1991) output figures as well as the World Bank (2004). Second, volatility of money growth is the standard deviation of the growth rate in the monetary base. The monetary data was taken from the IMF's International Financial Statistics and from national sources whenever the data was unavailable from the IMF. Third, we compute the terms of trade volatility as the standard deviation of the changes in the

[4] Calderon (2003) evaluated the determinants of real exchange rate volatility for 21 industrial countries using quarterly data and finds that trade openness attenuates the RER volatility effects of volatiles shocks to output and money.

[5] Data on exchange rates are drawn from the line ***rf*** of the IMF's International Financial Statistics, which represents the average nominal exchange rate for the period. To approximate domestic prices, we use the consumer price index (CPI) because of the timeliness of publication and the availability of the data on a monthly and quarterly basis. Finally, there is a consensus among economists that the index of foreign prices should include mainly prices of tradable goods, whereas the domestic price level should comprise prices of both tradable and non-tradable goods. For this reason, economists have increasingly used foreign wholesale price indices in the construction of p*. The weights are computed using bilateral trade flows between the countries involved in our analysis.

terms of trade index. The data on this index was taken from the World Bank's World Development Indicators (WDI). Finally, we compute the volatility of government spending as the standard deviation of changes in the ratio of general government consumption expenditure to GDP. Data on government expenditure was also obtained from the World Bank's WDI. [6]

Openness. We consider here measures of trade and financial openness, and within each variable we construct outcome and policy measures of (both trade and financial) openness. Regarding *trade openness*, we consider the ratio of real exports and imports to real GDP (both expressed in local currency at constant prices) as our *outcome* measure of openness to international trade of goods and services. On the other hand, our *policy* measure of trade openness is based on an updated version of the Sachs and Warner (1995) binary variable of trade liberalization (Wacziarg and Welch 2003). This dummy variable takes the value of 1 whenever the trade regime is consider open and 0 otherwise.[7] Our policy measure is the share of years in the period that the country enjoys an open trade policy in the 5-year period.

We also construct measures of *financial openness* —openness to international trade of assets— for our sample of countries. Our *outcome* measure is an equity-based measure of financial integration, $EQIFI_{it}$, (Lane and Milesi-Ferreti, 2003):

$$EQIFI_{it} = \frac{PEQL_{it} + FDIL_{it}}{GDP_{it}}$$

where PEQL and FDIL are the stocks of portfolio equity and FDI liabilities.[8] Here we update the figures from Lane and Milesi-Ferreti (2001) for our sample of countries using data from the IMF's Balance of Payments Statistics. On the other hand, our *policy* measure of financial openness is based on the IMF binary variable of capital account restrictions. Our variable takes the value of 1 in the years when there are no restrictions on capital account transactions, and 0 otherwise. Then, we take averages corresponding to our 5-year periods. The source of the data is Prasad *et al.* (2003).[9]

Exchange Rate Regimes. In order to determine the exchange rate regime adopted by a country we use the classification of Reinhart and Rogoff (2004). Here, we consider four (4) binary variables. A dummy for *hard pegs* takes the value of 1 if the country has no separate legal tender (full dollarization) or a currency board. The dummy for *fixed regimes* takes the value of 1 if the country has either a hard peg or de facto pegs. On the other hand, the dummy

[6] Note that all standard deviation measures were taken for annual changes during 5-year periods.
[7] According to Sachs and Warner (1995, p. 22), we consider a country to have a *closed* trade policy if one of the following features hold: (i) More than 40% of its trade is convered by non-tariff barriers, (ii) It has average tariff barriers higher than or equal to 40%, (iii) Its black market exchange rate depreciates at a rate that is more than 20% relative to the official exchyange rate (during the 1970s and 1980s), (iv) It has a socialist economic system, and (v) a state monopoly on major exports.
[8] We also used the ratio of the stocks of portfolio equity and FDI assets and liabilities to GDP —see equation (2) in Lane and Milesi-Ferreti (2003)— and the results remained qualitatively invariant. Note that this variable indicates the level of equity (portfolio and FDI cross-holdings).
[9] Data on capital account restrictions can be downloaded from: http://www.nber.org/~wei/data.html

for *intermediate regimes* takes the value of 1 if the country has a de facto crawling peg or band. Finally, countries with managed or freely floating will be considered to take the value of 1 in the *flexible regime* dummy.

Finally, a more detailed description of the sources of the data for all the variables involved in our analysis is presented in Table A2.

3.2 Estimation Technique[10]

The proposed panel data regression poses some challenges for estimation. The first is the presence of unobserved period- and country-specific effects. While the inclusion of period-specific dummy variables can account for the time effects, the common methods to deal with country-specific effects ("within" or "difference" estimators) are inappropriate given the dynamic nature of the regression. The second challenge is that most explanatory variables are likely to be jointly endogenous with economic growth, and, thus, we need to control for the biases resulting from simultaneous or reverse causation. In the following paragraphs we outline the econometric methodology we use to control for country-specific effects and joint endogeneity in a dynamic model of panel data.

We use the Generalized-Method-of-Moments (GMM) estimators developed for dynamic models of panel data that were introduced by Holtz-Eakin, Newey, and Rosen (1988), Arellano and Bond (1991), and Arellano and Bover (1995). Taking advantage of the data's panel nature, these estimators are based on, first, differencing regressions and/or instruments to control for unobserved effects, and, second, using previous observations of explanatory and lagged-dependent variables as instruments (which are called "internal" instruments).

After accounting for time-specific effects and including the output gap in the set of explanatory variables X, we can rewrite equation (1) as follows,

$$y_{it} = \alpha\, y_{i,t-1} + \beta' X_{it} + \eta_i + \varepsilon_{it} \tag{2}$$

In order to eliminate the country-specific effect, we take first-differences of equation (2),

$$y_{i,t} - y_{i,t-1} = \alpha\left(y_{i,t-1} - y_{i,t-2}\right) + \beta'\left(X_{i,t} - X_{i,t-1}\right) + \left(\varepsilon_{i,t} - \varepsilon_{i,t-1}\right) \tag{3}$$

The use of instruments is required to deal with, first, the likely endogeneity of the explanatory variables, and, second, the problem that, by construction, the new error term, $\varepsilon_{i,t} - \varepsilon_{i,t-1}$, is correlated with the lagged dependent variable, $y_{i,t-1} - y_{i,t-2}$. Taking advantage of the panel nature of the data set, the instruments consist of previous observations of the explanatory and lagged dependent variables. Given that it relies on past values as instruments, this method only allows current and future values of the explanatory variables to be affected by the error term. Therefore, while relaxing the common assumption of strict

[10] The present sub-section draws heavily from Loayza, Fajnzylber and Calderón (2004).

exogeneity, our instrumental-variable method does not allow the *X* variables to be fully endogenous.

Under the assumptions that (a) the error term, ε, is not serially correlated, and (b) the explanatory variables, *X*, are weakly exogenous (i.e., the explanatory variables are assumed to be uncorrelated with future realizations of the error term), the GMM dynamic panel estimator uses the following moment conditions.

$$E\left[y_{i,t-s} \cdot \left(\varepsilon_{i,t} - \varepsilon_{i,t-1}\right)\right] = 0 \quad for\ s \geq 2; t = 3,\ldots,T \tag{4}$$

$$E\left[X_{i,t-s} \cdot \left(\varepsilon_{i,t} - \varepsilon_{i,t-1}\right)\right] = 0 \quad for\ s \geq 2; t = 3,\ldots,T \tag{5}$$

The GMM estimator based on these conditions is known as the *difference* estimator. Notwithstanding its advantages with respect to simpler panel data estimators, there are important statistical shortcomings with the difference estimator. Alonso-Borrego and Arellano (1999) and Blundell and Bond (1998) show that when the explanatory variables are persistent over time, lagged levels of these variables are weak instruments for the regression equation in differences. Instrument weakness influences the asymptotic and small-sample performance of the difference estimator. Asymptotically, the variance of the coefficients rises. In small samples, Monte Carlo experiments show that the weakness of the instruments can produce biased coefficients.[11]

To reduce the potential biases and imprecision associated with the usual difference estimator, we use a new estimator that combines in a *system* the regression in differences with the regression in levels (developed in Arellano and Bover, 1995, and Blundell and Bond, 1998). The instruments for the regression in differences are the same as above. The instruments for the regression in levels are the lagged *differences* of the corresponding variables. These are appropriate instruments under the following additional assumption: although there may be correlation between the levels of the right-hand side variables and the country-specific effect in equation (2), there is no correlation between the *differences* of these variables and the country-specific effect. This assumption results from the following stationarity property,

$$\begin{aligned} &E[y_{i,t+p} \cdot \eta_i] = E[y_{i,t+q} \cdot \eta_i] \quad and \\ &E[X_{i,t+p} \cdot \eta_i] = E[X_{i,t+q} \cdot \eta_i] \quad for\ all\ p\ and\ q \end{aligned} \tag{6}$$

The additional moment conditions for the second part of the system (the regression in levels) are:[12]

[11] An additional problem with the simple *difference* estimator relates to measurement error: differencing may exacerbate the bias due to errors in variables by decreasing the signal-to-noise ratio (see Griliches and Hausman, 1986).

[12] Given that lagged levels are used as instruments in the differences specification, only the most recent difference is used as instrument in the levels specification. Using other lagged differences would result in redundant moment conditions (see Arellano and Bover, 1995).

$$E[(y_{i,t-1} - y_{i,t-2}) \cdot (\eta_i + \varepsilon_{i,t})] = 0 \tag{7}$$

$$E[(X_{i,t-1} - X_{i,t-2}) \cdot (\eta_i + \varepsilon_{i,t})] = 0 \tag{8}$$

Thus, we use the moment conditions presented in equations (4), (5), (7), and (8) and employ a GMM procedure to generate consistent and efficient parameter estimates.

Using the moment conditions presented in equations (4), (5), (7) and (8), we employ a Generalized Method of Moments (GMM) procedure to generate consistent estimates of the parameters of interest and their asymptotic variance-covariance (Arellano and Bond, 1991; Arellano and Bover, 1995). These are given by the following formulas:

$$\hat{\theta} = (\overline{X}' Z \hat{\Omega}^{-1} Z' \overline{X})^{-1} \overline{X}' Z \hat{\Omega}^{-1} Z' \overline{y} \tag{9}$$

$$AVAR(\hat{\theta}) = (\overline{X}' Z \hat{\Omega}^{-1} Z' \overline{X})^{-1} \tag{10}$$

where θ is the vector of parameters of interest (α, β), $\overline{y}$ is the dependent variable stacked first in differences and then in levels, $\overline{X}$ is the explanatory-variable matrix including the lagged dependent variable (y_{t-1}, X) stacked first in differences and then in levels, Z is the matrix of instruments derived from the moment conditions, and $\hat{\Omega}$ is a consistent estimate of the variance-covariance matrix of the moment conditions. [13]

The consistency of the GMM estimators depends on whether lagged values of the explanatory variables are valid instruments in the growth regression. We address this issue by considering two specification tests suggested by Arellano and Bond (1991) and Arellano and Bover (1995). The first is a Sargan test of over-identifying restrictions, which tests the overall validity of the instruments by analyzing the sample analog of the moment conditions used in the estimation process. Failure to reject the null hypothesis gives support to the model. The second test examines the null hypothesis that the error term $\varepsilon_{i,t}$ is not serially correlated. As in the case of the Sargan test, the model specification is supported when the null hypothesis is not rejected. In the *system* specification we test whether the differenced error term (that is, the residual of the regression in differences) is second-order serially correlated. First-order serial correlation of the differenced error term is expected even if the original error term (in levels) is uncorrelated, unless the latter follows a random walk. Second-order serial correlation of the differenced residual indicates that the original error term is serially correlated and follows a moving average

[13] In practice, Arellano and Bond (1991) suggest the following two-step procedure to obtain consistent and efficient GMM estimates. First, assume that the residuals, $\varepsilon_{i,t}$, are independent and homoskedastic both across countries and over time. This assumption corresponds to a specific weighting matrix that is used to produce first-step coefficient estimates. Then, construct a consistent estimate of the variance-covariance matrix of the moment conditions with the residuals obtained in the first step, and use this matrix to re-estimate the parameters of interest (i.e. second-step estimates). Asymptotically, the second-step estimates are superior to the first-step ones in so far as efficiency is concerned.

process at least of order one. This would reject the appropriateness of the proposed instruments (and would call for higher-order lags to be used as instruments).

4. Empirical Evidence

In the present section we describe the main results of our empirical analysis of the determinants of real exchange rate volatility for our sample of 79 countries, using 5-year non-overlapping observations, over the 1974-2003 period. First, we describe the main statistics and present a basic correlation analysis. Then, we carry out the panel data regression analysis.

4.1 Basic Statistics

In Table 1 we present the basic statistics or real exchange rate volatility, openness and the volatility of the real exchange rate fundamentals. We report the averages of these variables for the full sample of countries and for sub-samples classified according to the level of development of the economy and the exchange rate regime put in place in the country.

First, we find that real exchange rate fluctuations and shifts in the fundamentals are more volatile in developing countries than in industrial countries. Real exchange rate fluctuations in developing countries are 4 times as volatile as in industrial economies. Output growth is twice as volatile while fluctuations in the terms of trade and government consumption in developing nations are 3-3.5 times than in developed nations. Finally, volatility in the growth rate of money in developing nations is more than 10 times larger than in developed countries.[14]

Second, we find that the more flexible is the exchange rate regime, the more volatile are the real exchange rate fluctuations. Among industrial countries, real exchange rates among countries with flexible regimes are twice as volatile than among countries with either hard pegs or fixed regimes. On the other hand, real exchange rates among developing countries with flexible regimes are more than three times as volatile as those in developing countries with either hard pegs or fixed regimes. This result is consistent with evidence presented by Stockman (1983, 1988), Mussa (1986) and Lothian and McCarthy (2002).

Third, the differences in the volatility patterns of output growth (as well as other real variables such as terms of trade fluctuations and changes in government consumption) seem to be small. For example, output volatility for countries with flexible regimes is 0.029, while the volatility of output for countries with intermediate and fixed regimes is 0.028 and 0.032.[15] As we observe, the differences in output volatility are also negligible if we compare across

[14] This could be attributed to the high inflation episodes that were experienced by most Latin American countries in the 1980s.
[15] Ghosh et al. (2002) finds that output volatility is slightly lower among countries with flexible exchange rate regimes than among countries with pegged rates. Levy-Yeyaty and Sturzenegger (2003) found that the finding of higher output volatility for countries with fixed regimes is driven by non-industrial countries.

exchange rate regimes within the group of industrial and developing countries. For instance, output volatility for industrial countries with fixed regimes is slightly lower than the one displayed by industrial countries with flexible regimes (0.017 vs. 0.015), while output volatility is similar for developing countries with fixed and flexible exchange rate regimes (and equal to 0.038). This result is consistent with the findings of Baxter and Stockman (1989).[16]

Fourth, fluctuation in the monetary base are more (than 10 times as) volatile among developing countries than among industrial economies. In addition, volatility in the growth rate of money is higher when the exchange rate regime is less flexible for the full sample of countries. We observe that this result is mainly driven by developing countries, since the volatility pattern is reversed for industrial countries.

Finally, we find that although developing countries are more open than industrial countries to international trade in goods and services (outcome measure), their trade liberalization regimes are younger than the ones taking place in industrial economies. Regarding the international trade of assets, industrial countries display a higher degree of financial openness than developing countries regardless of the indicator used.

4.2 Correlation Analysis

In Table 2 we report the panel correlation analysis —as well as its probability values— for the real exchange rate (RER) volatility, openness and the volatility of RER fundamentals. We report the correlation for the full sample of countries as well as sub-samples according to level of development and exchange rate regimes.

Correlation between RER and Fundamental Volatility. We first find that RER volatility is positively correlated with the volatility of the RER fundamentals (say, output, money, terms of trade, and government consumption) for the full sample of countries as well as for the sub-samples of industrial and developing countries. This correlation is higher among industrial than among developing countries (0.14 vs. 0.06, respectively). We also observe that the association between RER volatility and output volatility is the weakest among countries with flexible regimes (and in some cases, it is even negative).

Second, the correlation between RER volatility and money volatility is positive and significant (at the 5% level) for the full sample of countries as well as for the sub-samples of industrial and developing countries, with the correlation being stronger for the latter group. We also find that the correlation between RER and money volatility is stronger among countries

[16] Using a dynamic general equilibrium model with sticky prices, Dedola and Leduc (2001) show that and local-currency-pricing strategies help account for the non-variability of macroeconomic quantities across exchange rate regimes. In addition, Duarte (2003) adds incomplete asset markets in a two country model to show that although the volatility of real exchange rates increases sharply when switching from fixed to flexible regimes, a similar pattern across exchange rate regimes cannot be replicated for the volatilities of output, consumption or trade flows.

with fixed regimes than among countries with flexible regimes, result that is driven by non-industrial countries.

Third, the volatility of terms of trade shocks is positively and significantly associated with RER volatility for the full sample of countries as well as for sub-samples classified according to income level. For the full sample of countries, the correlation between RER and terms of trade volatility is stronger among countries with flexible exchange rate regimes. This result is driven mainly by the behavior of this correlation among developing countries.

Finally, the correlation between RER and government consumption volatility is the lowest for the full sample of countries. We also find that there is no specific pattern of correlation between these variables across exchange rate regimes.

Correlation between RER Volatility and Openness. We find that RER volatility and trade openness (either proxied by the outcome or policy measure) are negatively correlated for the sample of all countries as well as for the samples of industrial and developing countries (see figures 1a and 2a). This implies that the higher the degree of openness to international trade in goods and services (and the longer the existence of an open trade regime in a country), the lower the volatility of the real exchange rate fluctuations.

On the other hand, RER volatility is negatively associated with (outcome and policy measures of) financial openness in most cases, although it is only significant for the full sample of countries using the policy measure (see scatterplots in figures 1b and 2b). Roughly speaking, we can say that there is a weak negative correlation between financial openness and RER volatility.

Some Naive Partial Correlation Analysis. In Table 3 we proceed to run some naive regressions in order to have a first look at partial correlations beween REER volatility, trade and financial openness, and exchange rate regimes. We run some pooled OLS regressions to explain the partial association between REER volatility and structural determinants such as openness to international trade in goods and assets, as well as the monetary arrangement that takes place in the country.

We find a negative partial association between REER volatility and trade openness that is significant only when we use outcome measures (except for the sample of developing countries). Also, we find that —except for the sample of industrial countries— REER volatility and financial openness are negatively associated, although this relationship seems to be non-significant. Finally, we find that the dummy variables for fixed and intermediate exchange rate regimes enter with a negative and significant coefficient in our regressions. This implies that countries with less flexible exchange rate arrangements tend to display less volatile fluctuations in their REERs.

4.3 Panel Regression Analysis

In the present section, we present evidence on the determinants of real exchange rate volatility for a sample of 77 industrial countries over the 1974-2003 period. As we stated in the previous sections, our dependent variable is the volatility of exchange rate fluctuations measured by the standard deviation of changes in the real effective exchange rate.

4.3.1 Baseline Regression Model

In Table 4 we present the estimation results of the baseline regression model using the GMM-IV system estimator described in section 3. Here we regress the REER volatility on the volatility of the fundamentals (output growth, money growth, terms of trade, and government spending volatility), openness (trade and financial), the exchange rate regime, and the level of output per capita. Regarding openness, we report regression with outcome measures and policy measures of openness.

Our baseline regression equation is:

$$y_{it} = \mu_i + X_{it}\beta + T_{it}\gamma + Zit\delta + \varepsilon_{it}$$

where y_{it} represents the RER volatility, X_{it} is the vector of fundamental volatility —which comprises the standard deviation of shocks to output, money, terms of trade and government consumption—, T_{it} is the measure of trade openness (either outcome or policy), while Z_{it} represents the matrix of control variables such as output per capita (in logs), dummys for the fixed and intermediate exchange rate regimes, and (outcome and/or policy measures of) financial openness.

First, we find that the higher the volatility of output growth, money growth and terms of trade fluctuations, the higher is the volatility of real exchange rate fluctuations. The estimated coefficientes for the volatility in output growth, money growth and terms of trade shocks are positive and statistically significant. However, the volatility of changes in government spending enters with the wrong sign.

According to our estimates in column 1 of Table 1, we find that if output volatility decline from the average levels of developing countries to the one of industrial countries —that is, from 0.036 to 0.018— the RER would decline by 0.4%. On the other hand, an analogous decline in money volatility —from an average of 0.742 for developing countries to an average of 0.064 for industrial countries— would reduce RER volatility by 9%. Finally, if the volatility of terms of trade fluctuations is reduced from 0.118 (average for developing nations) to 0.034 (average for industrial economies), the volatility of RER fluctuations will approximately decrease by 13%.

Second, trade openness and financial openness have a negative relationship with the volatility of real exchange rates regardless of the indicator of openness used. Whether we use the outcome or the policy measure, we find that the more open the economy is to international trade in goods and assets, the lower is the REER volatility. According to our estimates in Table 4, an increase in the volume of exports and imports as a percentage of real GDP from the levels observed by the 25% percentile of the world distribution of trade openness (Egypt and Indonesia with an average coefficient of trade openness of approximately 50% of GDP for the 1999-2003 period) to the levels displayed by the 90% percentile (Thailand with a coefficient of 100%), the RER volatility would decrease by 1.1%. On the other hand, if countries in the 50% and 75% percentiles (Mexico and Denmark, with real exports and imports representing approximately 70 and 85% of GDP, respectively) were to reach the openness of countries in the 90% percentile, their RER fluctuations would be less volatile —with the decline in volatility being approximately equal to 0.7 and 0.4%. On the other hand, if our policy measure of trade openness (the age of the liberal trade regime) were to increase by 0.2 (that is, 1 year), RER volatility may decline by almost 7%.

Third, the coefficient of financial openness is negative and significant regardless the measure of financial integration used (*i.e.* it is significant at the 10% for the outcome measure, and at 5% for the policy measure). Hence, if the country is more integrated to the international financial, fluctuations in the RER will be less volatile. According to our estimates, an increase in the equity-related measure of financial integration from the 25% percentile of the world distribution of financial integration for the 1999-03 period (that is, Morocco and Guatemala with FDI and portfolio-equity liabilities of over 20% of GDP) to the levels exhibited by the 90% percentile (Panama and Austria with equity-related foreign liabilities of more than 90% of GDP), RER fluctuations will be 0.6% less volatile. In addition, if countries in the 50% and 75% percentiles (Colombia and Germany, with FDI and portfolio-equity liabilities representing approximately 45 and 70% of GDP, respectively) were to reach the financial openness of countries in the 90% percentile, their RER fluctuations would be less volatile —with the decline in volatility being approximately equal to 0.4 and 0.2%.

Finally, we also find that real exchange rate volatility is lower in less flexible exchange rate regimes. Compared to flexible regimes, RER volatility in fixed exchange rate regimes is lower by 7.1 percentage points, while the one for intermediate regimes display is lower by 2.4 percentage points (see Table 4, column 1).

4.3.2 Trade Openness and Fundamental Volatility: Outcome Measures

In the present section we explicitly test the main implications of the theoretical model. That is, trade openness helps attenuate the effects of the volatility of fundamentals (say, volatility in output growth, money growth, terms of trade shocks or changes in government consumption) on the RER volatility. Here we add to our baseline model the interaction between trade openness and the standard deviation of a RER fundamental,

$$y_{it} = \mu_i + X_{it}\beta + T_{it}\gamma + X_{it} \cdot T_{it}\phi + Zit\delta + \varepsilon_{it}$$

In each column of Table 4 we show the interaction of outcome trade openness with each of the four REER fundamentals considered in the model. Before we discuss the results of our variables of interest we should note that the additional controls have the expected signs: REER volatility is lower for fixed and intermediate regimes (relative to more flexible arrangements) and in countries with a higher degree of financial openness. We also need to point out that our regressions are validated by the specification tests reported (i.e. Sargan test of overidentifying restrictions and serial correlation tests).

In column [1] we evaluate the interaction between trade openness and output volatility. As shown in the theoretical model, the impact of productivity shocks on real exchange rate fluctuations is smaller if the economy is more outward-oriented. Therefore, in our regression analysis we include output volatility and the interaction term between output volatility and openness. We expect these variables to have a positive and negative coefficient, respectively.

We find that higher output volatility is associated with higher real exchange rate volatility with the coefficient being significant at the 5 percent level. We also find that there is a turning point for the degree of openness in which the impact of output volatility turns negative. This threshold level for the degree of openness (trade as a ratio to GDP) is approximately 0.50 (Note that the average degree of openness for the sample of industrial countries is 0.47, and for G-7 countries is 0.32). According to our estimates, a 1% increase in the volatility of output would increase RER volatility by 0.6% for countries with a degree of trade openness of 10% of GDP. The increase in RER volatility would be equal to 0.5 and 0.3% for countries with exports and imports of 20 and 30% of GDP. Finally, for countries with a degree of openness more than or equal to 50% of GDP, the impact of higher output volatility on RER volatility would be negligible or negative (see figure 3a).

In column [2] we perform a similar exercise but for monetary volatility. We also find that higher volatility in money growth would lead to higher volatility in REER fluctuations. However, the impact of volatile monetary shocks on the volatility of real exchange rate fluctuations does not decrease if the economy has a higher degree of openness to international trade. On the contrary, we find that the interaction coefficient is positive and significant (see figure 3b).

In column [3] we evaluate the impact of the volatility of terms of trade shocks on REER volatility. Here, we find a result that is analogous to the one for output volatility. That is, higher volatility in terms of trade fluctuations leads to higher volatility of REER changes. However, the impact of highly volatile terms of trade shocks on REER fluctuations would declines if the degree of trade openness in the economy is larger. In this case, we find that a one-percent-increase in the volatility of terms of trade fluctuations would lead to an increase in the RER volatility of 1.7% for countries with a degree of trade openness of 20% of GDP. The increase in RER volatility would be 1.5% —to an analogous simulation— for countries with trade volumes of 50% of GDP. Finally, a response of 1.3% for RER volatility is expected for countries with a degree of trade openness of 100% of GDP (see figure 3c).

Finally, we find that volatility of government spending has a surprising negative coefficient that is significant across all specifications in Table 5, while the interaction term is positive and significant. Surprisingly, we find that the coefficients associated to the volatility of fluctuations in government spending do not present the expected signs.

4.3.3 Trade Openness and Fundamental Volatility: Policy Measures

In order to check the robustness of our results, we present a similar analysis to the one presented in subsection 4.3.2. Here we use policy measures of trade and financial openness instead of their corresponding outcome measures. Our results are reported in Table 6.

Before we discuss the relationship between REER volatility, fundamental volatility and trade openness, we discuss some of the results from the control variables. We find that the dummy variables for fixed and intermediate exchange rate regimes have a negative and significant coefficient regardless of the specification used. This implies that REER fluctuations are less volatile in less flexible exchange rate arrangements. We should also note that exchange rate fluctuations are the least volatile when fixed exchange rate regimes are in place. In addition, both policy measures of openness (trade and financial) have a negative and significant coefficient regardless of the regression. Hence, REER fluctuations are less volatility in countries more open to international trade in goods and assets.

We first find that higher output volatility leads to more volatile REER fluctuations, and that the REER volatility effects of higher output volatility are buffered by a more open stance in trade policy (see figure 4a). According to our estimates, a one-percent increase in output volatility would raise RER volatility by 2.9% for countries that have remained close throughout the period. For countries that liberalized since the end of the 80s and beginning of the 90s, an analogous increase in output volatility will increase RER volatility by 1.7%. Finally, RER volatility will increase approximately 0.4% for countries that have liberal trade regimes throughout the sample period. As we observe, the impact of output volatility on RER volatility is lower in more mature liberal trade regimes.

Second, we find that —unlike the results in Table 5 using the outcome measures— monetary shocks increase the volatility of REER fluctuations, although the impact of volatile money fluctuations declines if the country puts in place more open trade policies (see figure 4b). Here we find that a 10-percent increase in the volatility of money growth will raise the volatility of RER fluctuations by 2.4% for countries with closed trade regimes throughout the period. The response of RER volatility would be 0.7% for countries with liberal trade regimes since the end of the 80s.

Third, countries facing more volatile terms of trade fluctuations would have a higher REER volatility. However, the more open is the trade policy in a country, the smaller impact of these volatility terms of trade shocks on REER fluctuations is (see column [3] of Table 6 and figure 4c). A one-percent surge in the volatility of terms of trade shocks would generate an increase in the volatility of RER of 2% for countries with a 10% share of years with liberal trade regimes. For countries with a 30% share of years with liberal trade regimes, the response of RER volatility to a one percent increase in terms of trade volatility is an increase of 0.8%. Finally for countries with more than 50% share of years, the response will be negligible or negative.

Finally, we are unable to find results for the government spending that are consistent with the predictions of the model. This result is qualitatively similar to the one found in subsection 4.3.2.

4.3.3 About the impact of trade openness on volatility

In Table 4 we find that countries with higher trade openness —either proxied by outcome or policy measures— display less volatile RER fluctuations. In addition, we find in Tables 5 and 6 that (outcome and/or policy) trade openness dampens the impact of volatile fluctuations in fundamentals on the RER volatility —especially for output and terms of trade. In this subsection we analyze whether the dampening effect of trade openness depend on whether the fundamental shocks are highly volatile or not.

In figure 5 we present the coefficient of outcome trade openness as a function of the volatility of changes in RER fundamentals. We observe that the coefficient of outcome trade openness is negative for both high and low volatile shocks to output and terms of trade (see figures 5a and 5b). The higher is the volatility of either output shocks or terms of trade shocks, the larger (in absolute value) is the impact of outcome trade openness on REER volatility. According to our estimates, if the degree of trade openness were to increase by 10 percentage points of GDP, the volatility of RER fluctuations would decrease by 0.5% for countries with low output volatility (that is, up to 3% of output volatility). On the other hand, the decline in RER fluctuations would be larger —that is, 1.6%— if countries have larger output volatility (of approximately 10%). In the case of terms of trade shocks, an increase in the trade volume of 10 percentage points of GDP would render a decline in the volatility of RER fluctuations of 0.2% if the volatility of terms of trade shocks is 10%. If that volatility increases to 30%, the volatility of RER fluctuations would decrease 1.1% in the event of higher trade openness. Finally, we should mention that our result for the interaction of trade openness with the volatility of money fluctuations is not consistent with the theory (see figure 5b).

In figure 6 we report also the coefficient estimate of policy trade openness, as a function of the volatility of changes in fundamentals. We find that the coefficient of policy trade openness is more negative the larger the volatility of changes in output, money and terms of trade fluctuations. Although the impact of policy trade openness is negative for both low and high volatile shocks to output and terms of trade, it is negative only for medium to highly volatile monetary shocks.

5. Conclusions

Using a model in the spirit of the *"New Open Economy Macroeconomics"*, we find that the explanation power of the volatility of shocks to fundamentals increases if we include the degree of trade openness of the economy. Specifically, we find that the impact of volatile shocks to output, money and terms of trade fluctuations on the volatility of RER fluctuatios is smaller if the economy is more open to international trade.

To perform our task we gathered information on exchange rates, output, and money indicators, as well as some structural macroeconomic variables (e.g. exchange rate regimes, trade and financial openness, output per capita, among others) for a sample of 79 countries (of which 22 are industrial countries) for the 1974-2003 period. In general, we find that:

First, real exchange rate volatility is higher if the monetary arrangement is more flexible. According to our regressions in Table 5, real exchange rate fluctuations under fixed regimes are between 4 and 7.5% less volatile than under floating regimes, while RER fluctuations under intermediate regimes are between 1 and 4% less volatile than under floats. In addition, we find evidence that —in most cases— exchange rate volatility is lower in countries with higher output per capita. This implies that a one-standard-deviation increase in output per capita (in logs) would decrease the RER volatility by 1-2.5%.

Second, we find that higher volatility of shocks to output, money and terms of trade generate more volatile RER fluctuations; however, we can not find the predicted result for volatility in government consumption.

Third, we find a robust negative relationship between the volatility of real exchange rate fluctuations and the degree of openness —regardless of using an outcome or a policy measure. This result is consistent with the implications of the Obstfeld-Rogoff model and with the findings of Hau (2002). Specifically, we find that if the outcome measure of trade openness increases by one standard deviation, RER volatility will decline 0.9%. In addition, we laso find a negative relationship between RER volatility and (both outcome and policy) measures of financial openness. Here, we find that a one-standard deviation increase in outcome financial openness would lead to a decline of RER volatility of 0.3%.

Fourth, we find a robust negative relationship between trade openness and the volatility of either output shocks or terms of trade shocks —regardless of the measure of openness used.

Joint with the positive coefficient for the volatility of these fundamental shocks, this result implies that trade openness attenuates the impact of highly volatile shocks to fundamentals on the volatility real exchange rate fluctuations. This result holds for monetary shocks only when we use the policy measure of trade openness. Finally, for fiscal shocks the results are inconsistent with the theory.

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Appendix I: The Model

We use the textbook model of Obstfeld and Rogoff (1996) as a general framework to extract inferences on the volatility of real exchange rate fluctuations. We consider a small country model with the non-traded sector being the locus of the monopoly and sticky price problems, and where the traded sector has a single homogeneous output that is priced in competitive world markets. Each representative agent of the Home country is endowed with a constant quantity of the traded good each period, $\bar{y}_T$, and has a monopoly power over one of the non-tradables goods z $\in$ [0,1]. We assume that all agents have similar preferences throughout the world over a real consumption index and work effort. Given the symmetry in preferences and budget constraints across agents, we solve the optimization problem for the representative national consumer-producer.

I.1 Set up

The intertemporal utility function of the typical Home agent *j* is given by:

$$U_t^j = \sum_{s=t}^{\infty} \beta^{s-t} \left[\phi \ln C_{T,s}^j + (1-\phi) \ln C_{N,s}^j + \frac{\chi}{1-\varepsilon} \left(\frac{M_s^j}{P_s} \right)^{1-\varepsilon} - \frac{\kappa}{2} y_{N,s}^2 \right] \tag{I.1}$$

where $\beta \in (0,1)$, and $\sigma,\kappa > 0$.[17] On the other hand, C_T represents the consumption of traded goods, and C_N is the composite consumption of non-traded goods:

$$C_N = \left[\int_0^1 c_N(z)^{\frac{\theta-1}{\theta}} dz \right]^{\frac{\theta}{\theta-1}} \tag{I.2}$$

In addition, *P* is the consumption-based price index (defined as the minimum cost of purchasing an additional unit of real consumption $C_T^{\gamma} C_N^{1-\gamma}$),

$$P_N = \left[\int_0^1 p_N(z)^{1-\theta} dz \right]^{\frac{1}{1-\theta}} \tag{I.3}$$

where $p_N(z)$ is the price of non-traded good z. Bonds are denominated in tradables, with r denoting the constant world net interest rate in tradables and $\beta(1+r) = 1$. The typical household j's period nominal budget constraint is:

$$P_{T,t} F_{t+1}^j + M_t^j = P_{T,t}(1+r) F_t^j + M_{t-1}^j + p_{Nt}(j) y_{Nt}(j) + p_{T,t} \bar{y}_{T,t} - P_{N,t} C_{N,t}^j - P_{T,t} C_{T,t}^j - P_{T,t} \tau_t \tag{I.4}$$

[17] Disutility in producing more output is captured by the term $-(\kappa/2) y_{N,s}^2$. Assuming that disutility from effort ℓ_N is given by $-\psi \ell_N$ and that $y_N = A \ell_N^{\alpha}$ (α<1), then $\kappa = 2\psi / A^{1/\alpha}$. The output term in equation (I.1) is

where F_t denotes real bonds (in units of the tradable good) that pay off a real return r, and τ_t represents taxes per capita in terms of the tradable goods. Abstracting from government spending, we assume that the government balances its budget each period (in units of tradables),

$$\frac{M_t - M_{t-1}}{P_t} + \tau_t = 0 \tag{I.5}$$

Finally, the producer of non-traded goods face the following demand curve:

$$y_{N,t}^d = \left[\frac{p_{N,t}(j)}{P_{N,t}}\right]^{-\theta} C_N^A \tag{I.6}$$

where C_N^A represents Home's aggregate consumption of non-traded goods.

To solve the agent's optimization problem, we maximize equation (I.1) subject to equations (I.4) and (I.6). The solution for the paths of consumption (tradable and non-tradable), money and work effort might meet the following first-order conditions:

$$C_{T,t+1} = C_{T,t} \tag{I.7}$$

$$\frac{\phi}{P_{T,t}C_{T,t}} = \chi \frac{P_{T,t}}{P_t}\left(\frac{M_t}{P_t}\right)^{-\varepsilon} + \beta \frac{P_{T,t}}{P_{T,t+1}}\left(\frac{\phi}{C_{T,t+1}}\right) \tag{I.8}$$

$$\frac{C_{N,t}}{C_{T,t}} = \frac{1-\phi}{\phi}\left(\frac{P_{N,t}}{P_{T,t}}\right)^{-1} \tag{I.9}$$

$$y_{N,t}^{\frac{\theta+1}{\theta}} = \left[\frac{(\theta-1)(1-\phi)}{\theta\kappa}\right] C_{N,t}^{-1}\left(C_{N,t}^A\right)^{1/\theta} \tag{I.10}$$

Equation (I.7) reflects the Euler equation for optimal intertemporal consumption smoothing for traded goods. Note that the assumption $\beta(1+r) = 1$ was instrumental in obtaining a traded version of Hall's result. Equation (I.8) depicts the utility maximizing trade-off between spending on tradables in period t and a combination of one-period money holding and consumption spending in period t+1. Equation (I.9) states the marginal rate of substitution between traded and non-traded goods must be constant over time. Note that according to this condition, we can define the degree of openness as $\frac{P_T C_T}{P_T C_T + P_T C_N} = \phi$. Finally, the

obtained when α =0.5. A rise in productivity A is here captured by a fall in κ (Obstfeld and Rogoff, 1996).

equilibrium supply of non-tradables is presented in equation (I.10). This relationship establishes the condition for price-setting strategy for monopolistically competitive firms in the optimum.[18]

We obtain the demand for real balances by replacing (I.7) into (I.8),

$$\frac{M_t}{P_t} = \frac{\chi}{\gamma} \frac{C_{T,t} \frac{P_{T,t}}{P_t}}{\left(1 - \beta \frac{P_{T,t}}{P_{T,t+1}}\right)} \tag{I.11}$$

with the demand depending upon the consumption of tradables, changes in the price of tradables and changes in the real price of tradables.

I.2. Approximate Solution

Here we describe the steady state solution of this economy under the assumption that all prices are fully flexible and all our exogenous variables are constant. We first assume that the economy has zero initial net foreign assets. Given that the production of tradables is constant in this model at $\overline{y}_T$, and the first-order condition of consumption smoothing in tradables, equation (I.7), we find that $C_{T,t} = \overline{y}_T$, for all t. Analogously, a symmetric equilibrium for the market of non-tradables implies that $C_{N,t} = y_{N,t}(z) = C_{N,t}^A$, for all z non-traded goods.

Combining equations (I.9) and (I.10), we obtain the steady state level for the consumption and production of non-traded goods:

$$Y_N = C_N = \left(\frac{(\theta - 1)(1 - \phi)}{\theta\kappa}\right)^{\frac{1}{2}} \tag{I.12}$$

In this model, steady state prices for traded goods determine the aggregate price level:

$$P = \frac{\phi}{\chi}(1 - \beta)\left(\frac{M}{C_T}\right) \tag{I.13}$$

whereas the steady state nominal exchange rate is:

$$E = \frac{\phi}{\chi}(1 - \beta)\left(\frac{M}{C_T}\right)\frac{1}{P*} \tag{I.14}$$

According to the model, prices in the competitive tradable sector are fully flexible, whereas prices in the monopolistic non-traded goods sector are set a period in advance (and they adjust only in period 2). Since there are no current account effects, money is neutral in the long run, and only nominal variables change across the steady state.

[18] Hau (2002) interprets this condition as the marginal utility of an additional unit of non-traded consumption being equal to the marginal disutility of the production of an extra unit. According to this strategy, a mark-up of θ/(θ-1) is added by monopolistically competitive firms.

In the short run, prices on non-traded goods are fixed at $\overline{p}_{N,0}$ and the output of non-traded goods is determined by demand. By symmetry across several domestic producers, we have that $\overline{p}_{N,0} = \overline{P}_{N,0}$. The short run demand is given by $y_N^d = C_N$.

If we combine equation (I.9), with the equilibrium in tradables, and the short-run demand for non-tradables, we find that the output and consumption of non-tradables can be expressed as a function of the tradable prices,

$$y_N = C_N = \left(\frac{1-\phi}{\phi}\right)\left(\frac{P_T}{\overline{P}_N}\right)\overline{y}_T \tag{I.15}$$

I.3. Government in the Redux Model[19]

In the present section we include the government in the Obstfeld-Rogoff (1995, 1996) exchange rate redux model. Following Caselli (2001) we make the following assumptions about government consumption, G_t: (a) It is dissipative and it does not affect productivity, and (b) it is financed by non-distortionary taxes and seignorage. Hence, the government budget constraint is:

$$G_t = \frac{M_t - M_{t-1}}{P_t} + \tau_t \tag{I.16}$$

We also assume that the government only demands the non-traded product. Now, the producer of non-traded goods face the following demand curve:

$$y_{N,t}^d = \left[\frac{p_{N,t}(j)}{P_{N,t}}\right]^{-\theta}\left(C_N^A + G_N^A\right) \tag{I.17}$$

where C_N^A and G_N^A represent the Home country's private and public demand for non-traded goods. If we solve the optimization problem augmented by the government, only the first-order condition in (I.10) changes,

$$y_{N,t}^{\frac{\theta+1}{\theta}} = \left[\frac{(\theta-1)(1-\phi)}{\theta\kappa}\right]C_{N,t}^{-1}\left(C_{N,t}^A + G_{N,t}^A\right) \tag{I.18}$$

Note that, in equilibrium, total consumption —both private and public— must be equal to total output of non-traded goods.

[19] Alternative ways of modelling fiscal shocks are presented by Annicchiarico (2003), Balvers and Bergstrand (2002) and Sercu and Uppal (2000)

Table 1
Real Exchange Rate Volatility and Openness: Basic Statistics
Sample of 82 countries, 1974-2003 (5-year period observations)

	Full Sample	Sample of Countries with Regimes			
		Hard Pegs	Fixed	Intermediate	Flexible
I. All Countries					
Volatility					
- Real Exchange Rate	0.143	0.082	0.072	0.080	0.204
- Output	0.031	0.038	0.032	0.028	0.029
- Money	0.556	0.330	0.252	0.164	0.103
- Terms of Trade	0.095	0.103	0.081	0.075	0.096
- Government Consumption	0.014	0.015	0.013	0.010	0.011
Trade Openness					
- Outcome Measure	0.631	0.661	0.681	0.681	0.557
- Policy Measure	0.652	0.426	0.590	0.747	0.775
Financial Openness					
- Outcome Measure	0.229	0.326	0.322	0.191	0.223
- Policy Measure	0.308	0.338	0.379	0.291	0.422
II. Industrial Countries					
Volatility					
- Real Exchange Rate	0.048	0.033	0.031	0.046	0.062
- Output	0.018	0.017	0.015	0.020	0.017
- Money	0.064	0.036	0.039	0.077	0.061
- Terms of Trade	0.034	0.022	0.016	0.039	0.040
- Government Consumption	0.006	0.004	0.005	0.006	0.005
Trade Openness					
- Outcome Measure	0.573	0.914	0.828	0.527	0.428
- Policy Measure	0.982	1.000	1.000	0.966	0.990
Financial Openness					
- Outcome Measure	0.348	1.223	0.701	0.199	0.294
- Policy Measure	0.556	0.867	0.681	0.334	0.805
III. Developing Countries					
Volatility					
- Real Exchange Rate	0.178	0.090	0.087	0.095	0.300
- Output	0.036	0.041	0.038	0.031	0.038
- Money	0.742	0.379	0.332	0.204	0.132
- Terms of Trade	0.118	0.116	0.106	0.091	0.133
- Government Consumption	0.016	0.017	0.017	0.012	0.016
Trade Openness					
- Outcome Measure	0.653	0.618	0.625	0.749	0.645
- Policy Measure	0.504	0.305	0.403	0.642	0.554
Financial Openness					
- Outcome Measure	0.182	0.163	0.169	0.187	0.174
- Policy Measure	0.217	0.250	0.266	0.272	0.163

Table 2
Real Exchange Rate Volatility and Openness: Panel Correlation Analysis
Sample of 82 countries, 1974-2003 (5-year period observations)
Correlation between real exchange rate volatility and determinants

	Full Sample		Sample of Countries according to Exchange Rate Regimes:							
			Hard Pegs		Fixed		Intermediate		Flexible	
	P.Corr.	P-value	P.Corr.	P-value	P.Corr.	P-value	P.Corr.	P-value	P.Corr.	P-value
I. All Countries										
Fundamental Volatility										
- Output	0.084	(0.06)	0.267	(0.02)	0.308	(0.00)	0.194	(0.01)	0.064	(0.53)
- Money	0.584	(0.00)	0.365	(0.00)	0.362	(0.00)	0.105	(0.16)	-0.010	(0.92)
- Terms of Trade	0.215	(0.00)	0.124	(0.26)	0.194	(0.04)	0.075	(0.31)	0.282	(0.01)
- Government Consumption	0.077	(0.09)	0.315	(0.00)	0.278	(0.00)	0.394	(0.00)	0.186	(0.07)
Trade Openness										
- Outcome Measure	-0.056	(0.21)	-0.266	(0.02)	-0.272	(0.00)	-0.015	(0.83)	-0.097	(0.33)
- Policy Measure	-0.113	(0.02)	0.128	(0.29)	-0.003	(0.97)	-0.184	(0.02)	-0.391	(0.00)
Financial Openness										
- Outcome Measure	-0.059	(0.21)	-0.061	(0.59)	-0.060	(0.53)	-0.059	(0.43)	-0.099	(0.33)
- Policy Measure	-0.078	(0.08)	-0.161	(0.14)	-0.156	(0.09)	0.011	(0.88)	-0.172	(0.09)
II. Industrial Countries										
Fundamental Volatility										
- Output	0.142	(0.11)	0.092	(0.75)	-0.181	(0.31)	0.234	(0.08)	-0.050	(0.75)
- Money	0.213	(0.02)	0.223	(0.45)	0.036	(0.84)	0.268	(0.05)	0.086	(0.59)
- Terms of Trade	0.240	(0.01)	-0.270	(0.37)	0.103	(0.56)	0.126	(0.34)	0.015	(0.92)
- Government Consumption	0.064	(0.46)	-0.209	(0.48)	-0.068	(0.70)	0.276	(0.04)	-0.266	(0.10)
Trade Openness										
- Outcome Measure	-0.331	(0.00)	0.184	(0.54)	0.097	(0.59)	-0.265	(0.05)	-0.312	(0.06)
- Policy Measure	-0.038	(0.66)	0.000	(1.00)	0.000	(1.00)	-0.033	(0.80)	-0.114	(0.47)
Financial Openness										
- Outcome Measure	-0.100	(0.25)	0.073	(0.81)	0.141	(0.43)	-0.023	(0.86)	0.036	(0.82)
- Policy Measure	-0.107	(0.22)	-0.442	(0.15)	-0.373	(0.04)	-0.006	(0.96)	-0.141	(0.38)
III. Developing Countries										
Fundamental Volatility										
- Output	0.056	(0.29)	0.213	(0.07)	0.216	(0.05)	0.148	(0.09)	-0.004	(0.97)
- Money	0.581	(0.00)	0.361	(0.00)	0.356	(0.00)	0.088	(0.33)	-0.127	(0.34)
- Terms of Trade	0.197	(0.00)	0.064	(0.59)	0.084	(0.44)	0.007	(0.94)	0.238	(0.07)
- Government Consumption	0.054	(0.31)	0.277	(0.02)	0.211	(0.05)	0.358	(0.00)	0.121	(0.36)
Trade Openness										
- Outcome Measure	-0.066	(0.21)	-0.252	(0.04)	-0.258	(0.02)	-0.051	(0.56)	-0.158	(0.23)
- Policy Measure	-0.084	(0.15)	0.287	(0.03)	0.200	(0.10)	-0.109	(0.24)	-0.213	(0.19)
Financial Openness										
- Outcome Measure	-0.070	(0.20)	0.203	(0.10)	0.194	(0.09)	-0.065	(0.46)	-0.084	(0.52)
- Policy Measure	-0.063	(0.23)	-0.085	(0.47)	-0.074	(0.50)	0.032	(0.72)	-0.108	(0.41)

Table 3
Real Exchange Rate Volatility and Openness: Partial Correlation Analysis
Sample of 82 countries, 1974-2003 (5-year period observations)
Partial Correlation between real exchange rate volatility and determinants

	Using Outcome Measures of Openness			Using Policy Measures of Openness		
	All	Industrial	Developing	All	Industrial	Developing
Constant	0.640 **	0.083	0.170	0.413 **	0.126	0.315 *
	(0.18)	(0.08)	(0.19)	(0.13)	(0.09)	(0.18)
Output per capita	-0.039 **	-0.001	0.031	-0.012 *	-0.006	0.004
(in logs)	(0.01)	(0.01)	(0.03)	(0.01)	(0.01)	(0.01)
Trade Openness	-0.036 *	-0.021 **	-0.034	-0.102	-0.008	-0.092
	(0.02)	(0.01)	(0.03)	(0.07)	(0.01)	(0.07)
Financial Openness	-0.037	0.008 *	-0.277	-0.035	0.005	-0.030
	(0.06)	(0.01)	(0.24)	(0.03)	(0.01)	(0.03)
Fixed Exchange Rates	-0.204 **	-0.030 **	-0.267 **	-0.171 *	-0.035 **	-0.228 *
Rates	(0.09)	(0.01)	(0.13)	(0.09)	(0.01)	(0.13)
Intermediate Exchange	-0.197 **	-0.017 **	-0.271 **	-0.151 *	-0.019 **	-0.204 *
Rates	(0.10)	(0.01)	(0.13)	(0.09)	(0.01)	(0.12)
R**2	0.073	0.265	0.084	0.068	0.242	0.025
Observations	465	132	333	426	132	294

*The numbers in parenthesis below the coefficient estimates are the robust standard errors. * (**) implies statistical significance at the 10 (5) % level.*

Table 4
Real Exchange Rate Volatility and Openness: Basic Regression Model
Sample of 82 countries, 1974-2003 (5-year period observations)
Estimation Method: GMM-IV System Estimator (Arellano and Bover, 1995)

	Outcome Measures	Policy Measures
Constant	0.143 **	-0.535 **
	(0.03)	(0.06)
Output Volatility	0.252 **	2.905 **
	(0.06)	(0.18)
Money Volatility	0.137 **	0.089 **
	(0.00)	(0.00)
Terms of Trade Volatility	1.564 **	0.989 **
	(0.02)	(0.08)
Government Spending	-7.428 **	-6.295 **
Volatility	(0.19)	(1.06)
Trade Openness	-0.020 **	-0.357 **
	(0.00)	(0.03)
Financial Openness	-0.008 *	-0.029 **
	(0.00)	(0.01)
Fixed Exchange Rates	-0.071 **	-0.086 **
	(0.00)	(0.01)
Intermediate Exchange Rates	-0.024 **	-0.025 *
	(0.00)	(0.02)
Output per capita (in logs)	-0.013 **	0.080 **
	(0.00)	(0.01)
Countries	77	71
Observations	380	353
R**2	0.407	0.456
Specification Tests (p-values)		
- Sargan Test	(0.19)	(0.37)
- 2nd. Order Correlation	(0.27)	(0.37)

See footnote in Table 3.

Table 5

Real Exchange Rate Volatility and Outcome "Trade" Openness: Panel Regression Model

Sample of 82 countries, 1974-2003 (5-year period observations)

Estimation Method: GMM-IV System Estimator (Arellano and Bover, 1995)

Using Outcome Trade and Financial Openness Indicators

	Interaction between Trade Openness and Volatility of:			
	Output	Money	Terms of Trade	Government
Constant	0.122 **	0.120 **	0.129 **	0.620 **
	(0.02)	(0.03)	(0.03)	(0.03)
Output Volatility	0.756 **	1.540 **	0.444 **	1.072 **
	(0.09)	(0.06)	(0.04)	(0.08)
Money Volatility	0.142 **	0.018 **	0.141 **	0.152 **
	(0.00)	(0.00)	(0.00)	(0.00)
Terms of Trade Volatility	1.523 **	1.566 **	1.747 **	1.630 **
	(0.02)	(0.02)	(0.03)	(0.04)
Government Spending	-7.316 **	-8.831 **	-7.422 **	-39.511 **
Volatility	(0.16)	(0.16)	(0.16)	(0.36)
Trade Openness	-0.008 **	-0.137 **	0.028 **	-0.559 **
	(0.00)	(0.00)	(0.00)	(0.01)
Financial Openness	-0.038 **	-0.008	-0.016 **	-0.031 *
	(0.01)	(0.01)	(0.01)	(0.02)
Trade Openness *	**-1.507 ****	**0.255 ****	**-0.454 ****	**34.286 ****
Fundamental Volatility	**(0.10)**	**(0.00)**	**(0.03)**	**(0.34)**
Fixed Exchange Rates	-0.066 **	-0.074 **	-0.075 **	-0.039 **
	(0.00)	(0.00)	(0.00)	(0.01)
Intermediate Exchange Rates	-0.016 **	-0.041 **	-0.024 **	-0.006 *
	(0.00)	(0.00)	(0.00)	(0.00)
Output per capita (in logs)	-0.010 **	-0.005 *	-0.014 **	-0.026 **
	(0.00)	(0.00)	(0.00)	(0.00)
Countries	77	77	77	77
Observations	380	380	380	380
R**2	0.396	0.490	0.405	0.355
Specification Tests (p-values)				
- Sargan Test	(0.28)	(0.14)	(0.19)	(0.35)
- 2nd. Order Correlation	(0.32)	(0.19)	(0.27)	(0.30)

See footnote in Table 3.

Table 6

Real Exchange Rate Volatility and "Policy" Trade Openness: Panel Regression Model

Sample of 82 countries, 1974-2003 (5-year period observations)

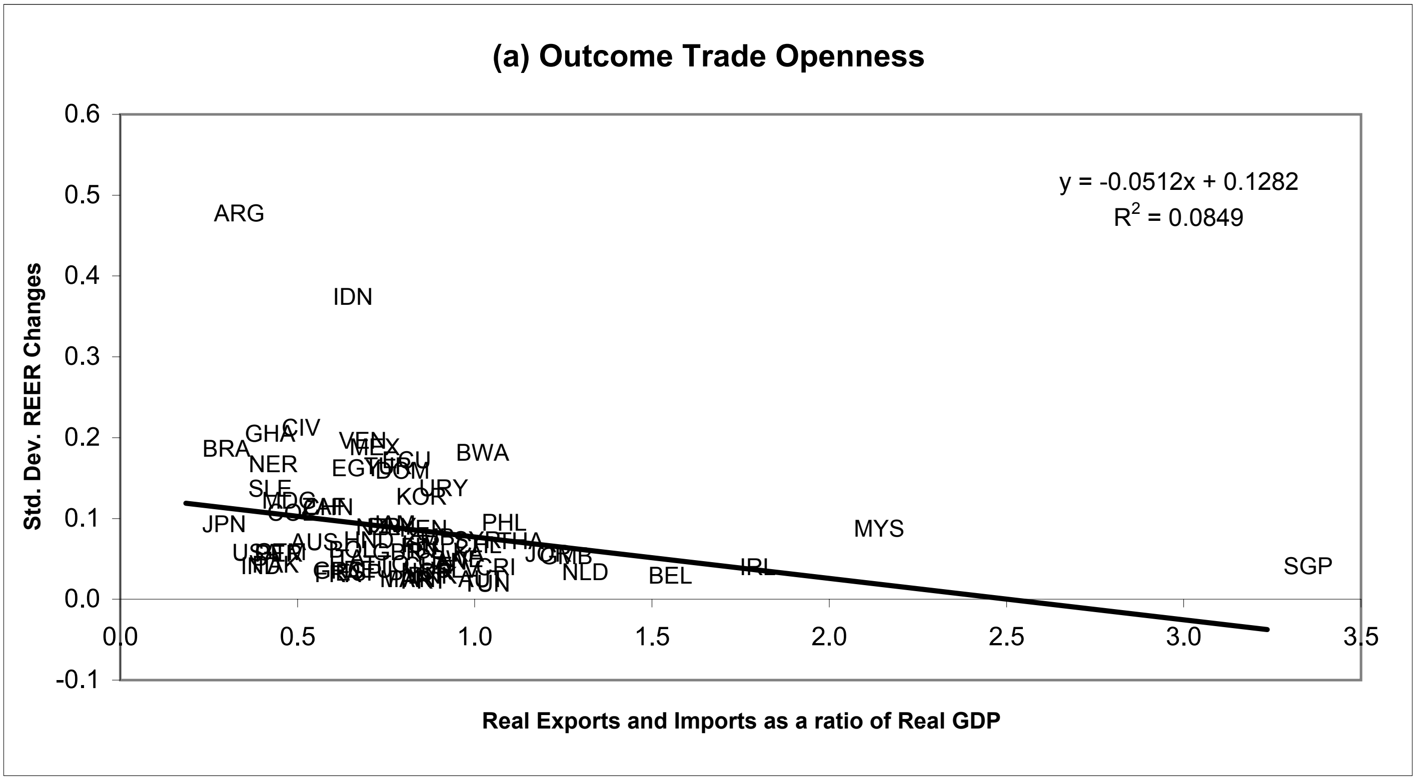
Estimation Method: GMM-IV System Estimator (Arellano and Bover, 1995)

Using Policy Trade and Financial Openness Indicators

	Interaction between Trade Openness and Volatility of:			
	Output	Money	Terms of Trade	Government
Constant	-0.378 **	0.281 **	0.485 **	-0.292 **
	(0.06)	(0.01)	(0.07)	(0.07)
Output Volatility	2.871 **	1.720 **	2.870 **	3.522 **
	(1.03)	(0.04)	(0.16)	(0.17)
Money Volatility	0.087 **	0.243 **	0.104 **	0.100 **
	(0.00)	(0.00)	(0.00)	(0.00)
Terms of Trade Volatility	0.678 **	0.087 **	2.620 **	1.105 **
	(0.13)	(0.01)	(0.15)	(0.08)
Government Spending Volatility	-5.153 **	-0.152 **	-7.759 **	-32.796 **
	(0.97)	(0.06)	(0.80)	(2.23)
Trade Openness	-0.380 **	0.111 **	0.322 **	-0.832 **
	(0.08)	(0.01)	(0.02)	(0.04)
Financial Openness	0.050 **	0.035 **	0.179 **	0.065 **
	(0.01)	(0.00)	(0.01)	(0.01)
Trade Openness * Fundamental Volatility	**-2.440 ***	**-0.354 ** **	**-6.047 ** **	**36.656 ** **
	(1.36)	**(0.00)**	**(0.19)**	**(2.14)**
Fixed Exchange Rates	-0.097 **	-0.043 **	-0.132 **	-0.104 **
	(0.01)	(0.00)	(0.01)	(0.01)
Intermediate Exchange Rates	-0.048 **	-0.005 *	-0.022 **	-0.013 **
	(0.01)	(0.00)	(0.01)	(0.01)
Output per capita (in logs)	0.056 **	-0.037 **	-0.079 **	0.089 **
	(0.01)	(0.00)	(0.01)	(0.01)
Countries	71	71	71	71
Observations	353	353	353	353
R**2	0.440	0.490	0.496	0.365
Specification Tests (p-values)				
- Sargan Test	(0.61)	(0.39)	(0.56)	(0.68)
- 2nd. Order Correlation	(0.29)	(0.12)	(0.30)	(0.77)

See footnote in Table 3.

Figure 1
Real Exchange Rate Volatility and Outcome Measures of Openness



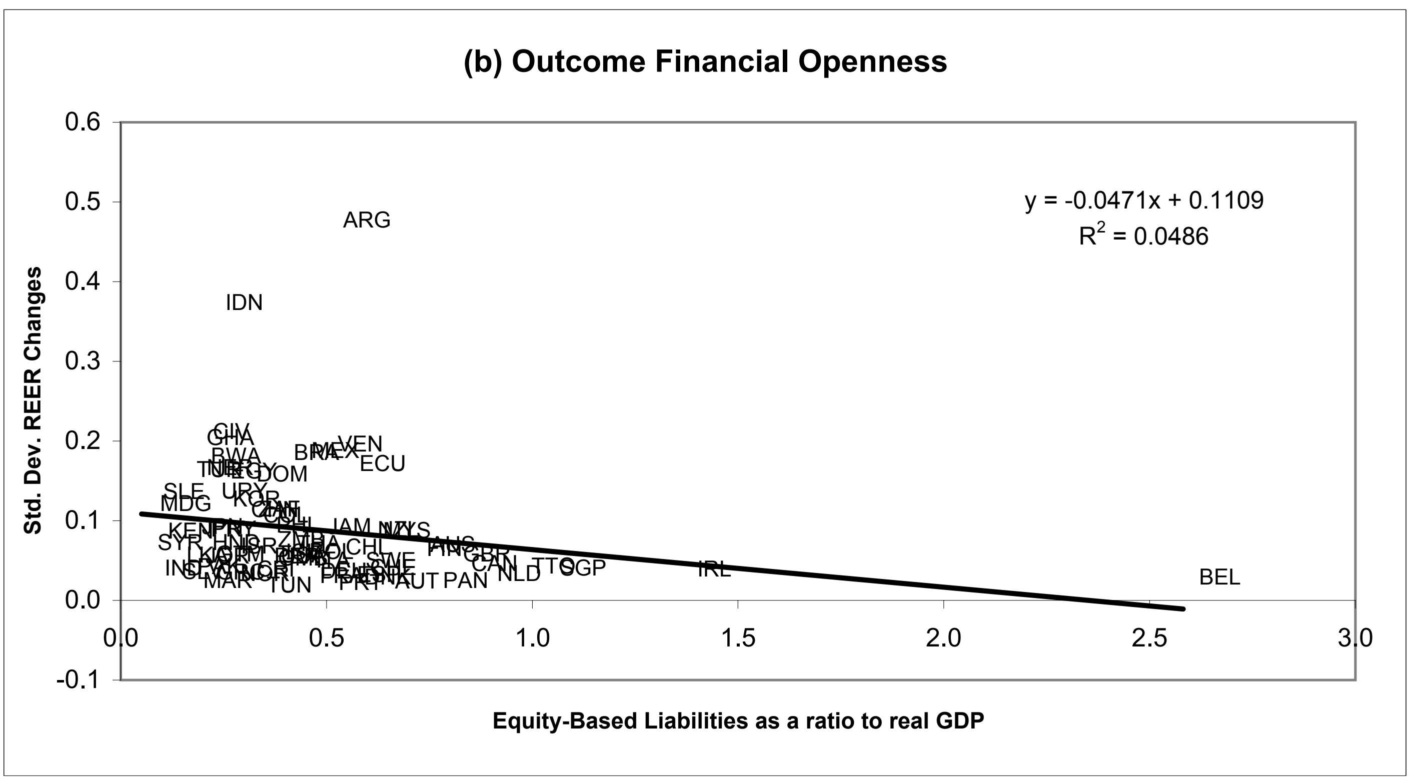


Figure 2
Real Exchange Rate Volatility and Policy Measures of Openness

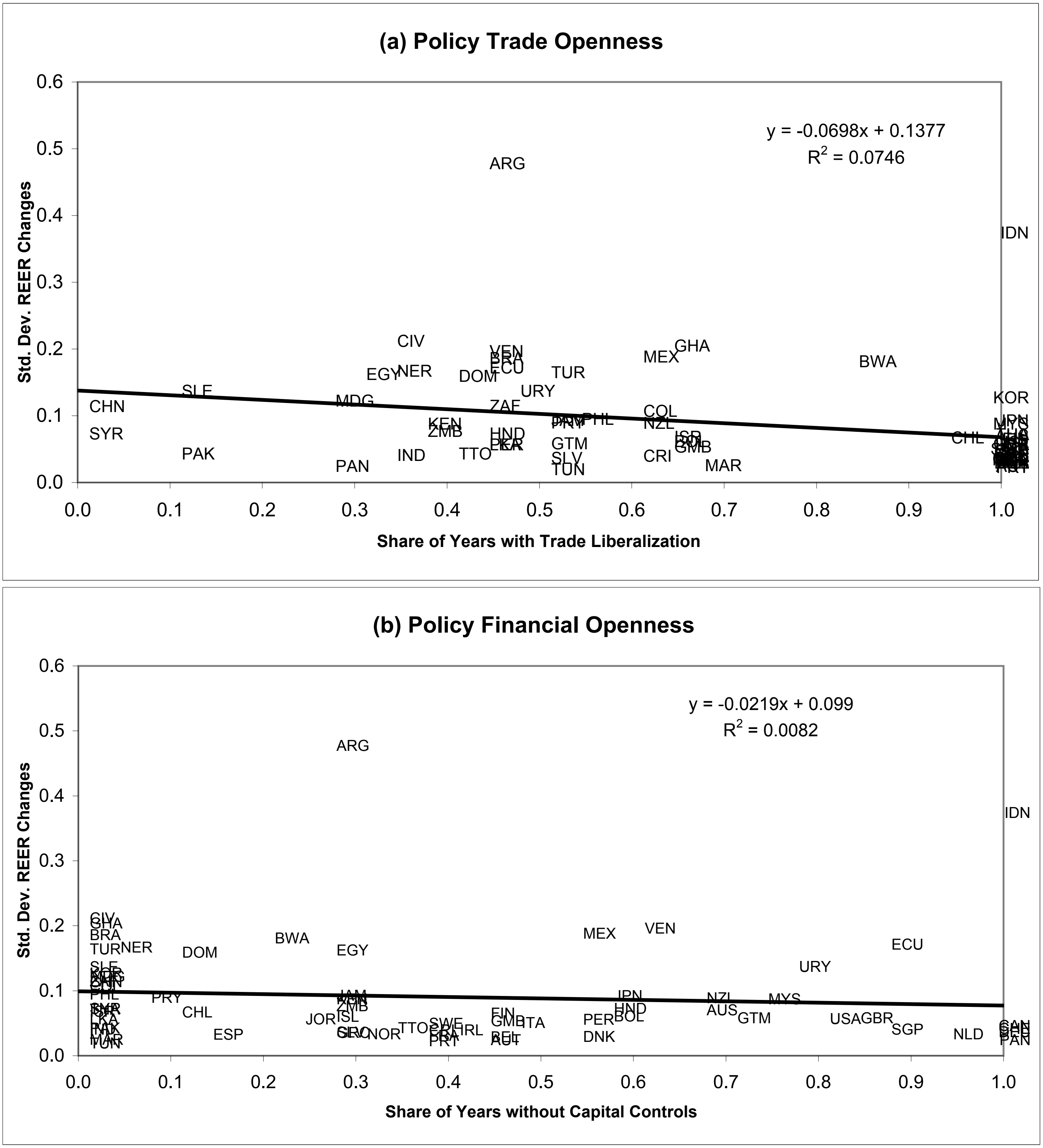


Figure 3
Impact of the Volatility of Fundamentals on Real Exchange Rate Volatility as a Funcion of Outcome Trade Openness

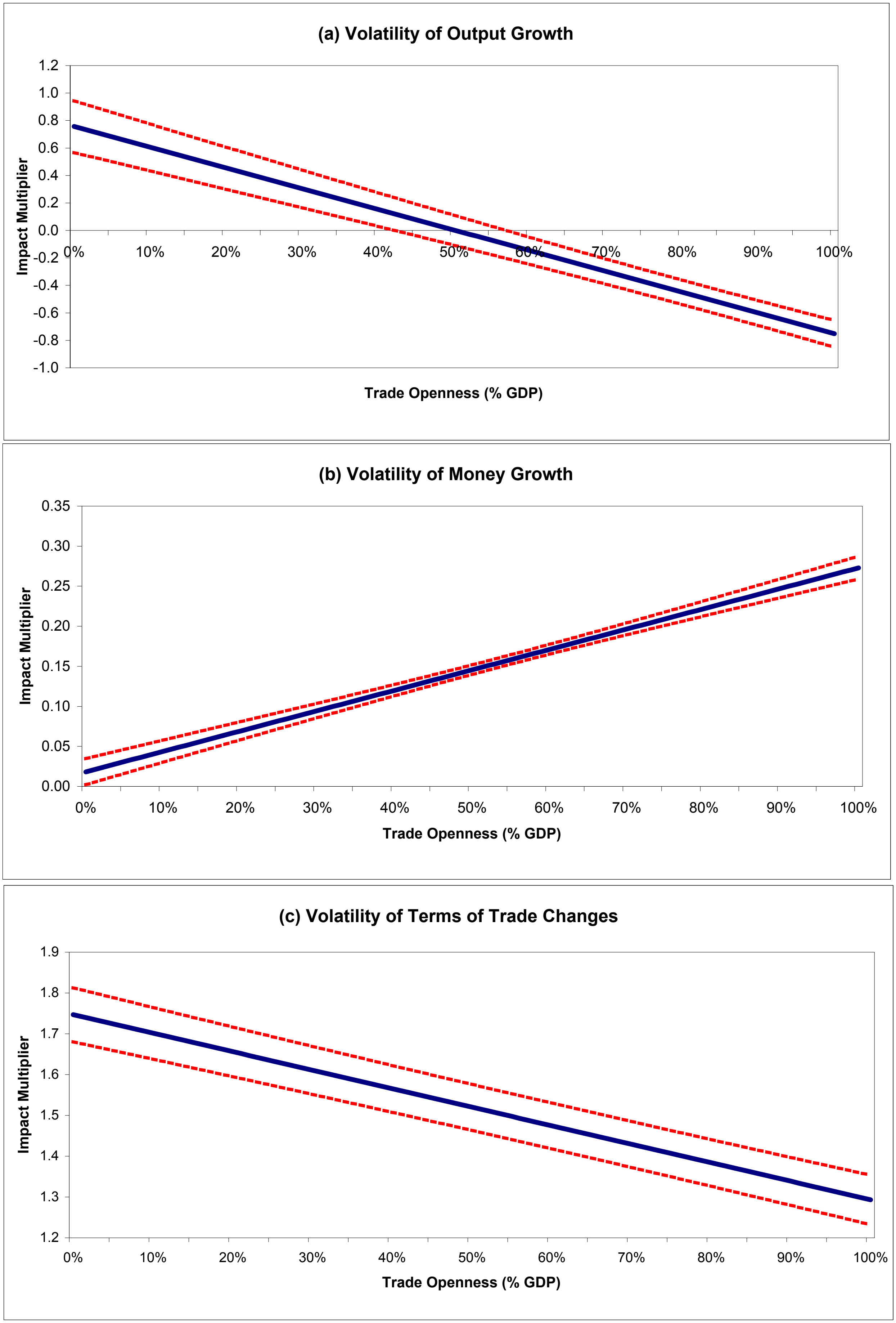


Figure 4
Impact of the Volatility of Fundamentals on Real Exchange Rate Volatility as a Funcion of Policy Trade Openness

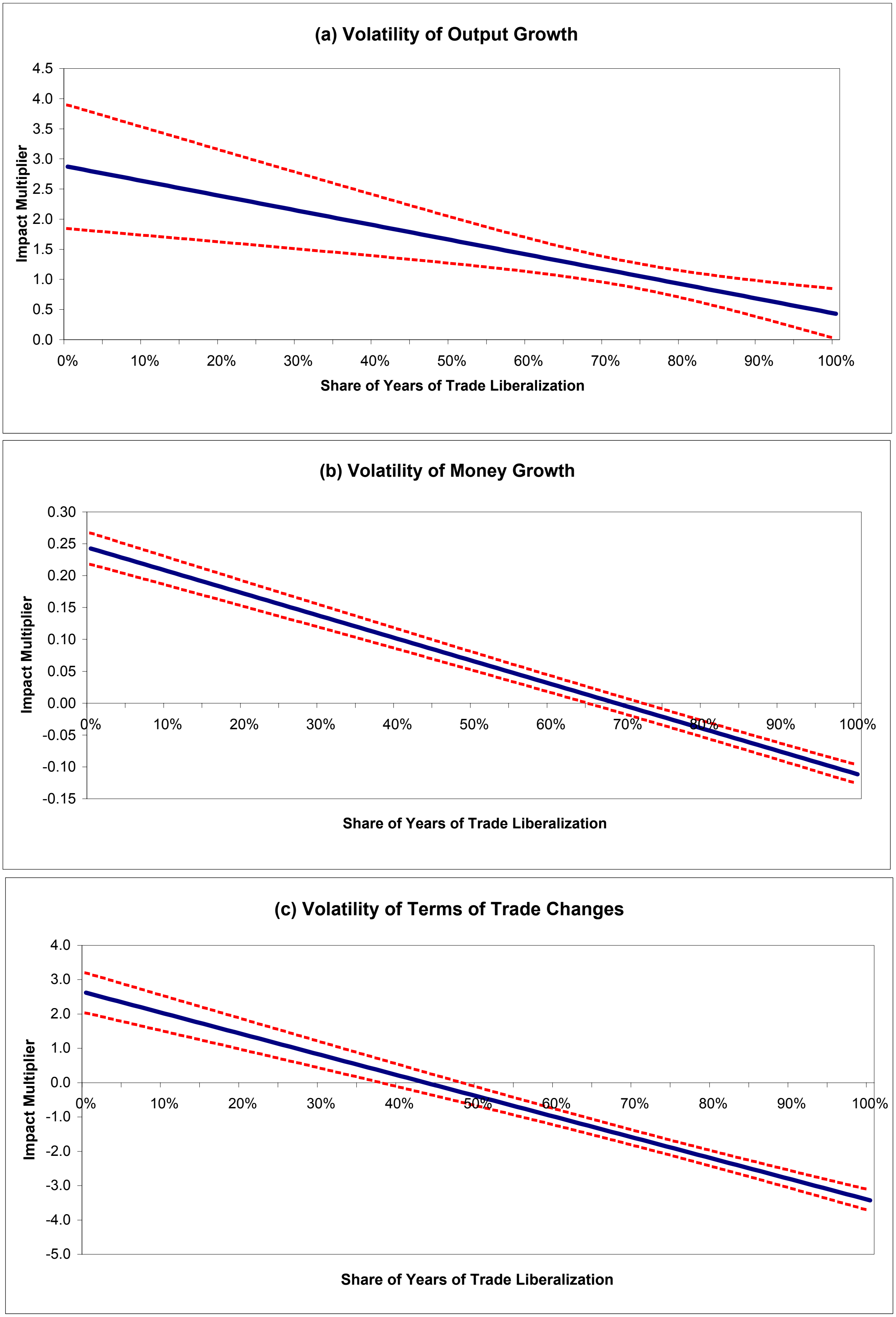


Figure 5
Impact of Outcome Trade Openness on Real Exchange Rate Volatility
as a Funcion of Volatility of Changes in Fundamentals

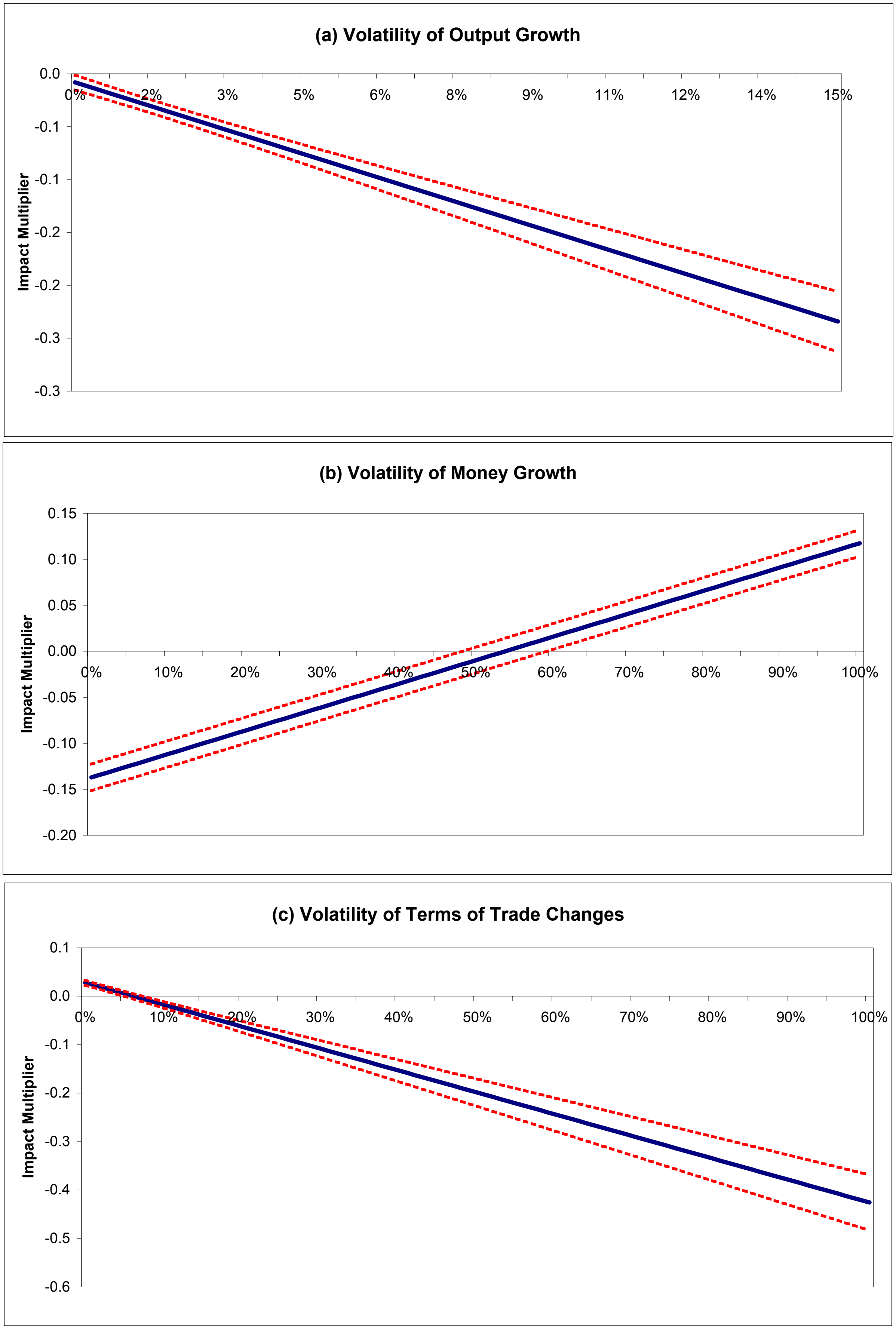


Figure 6
Impact of Policy Trade Openness on Real Exchange Rate Volatility as a Funcion of Volatility of Changes in Fundamentals

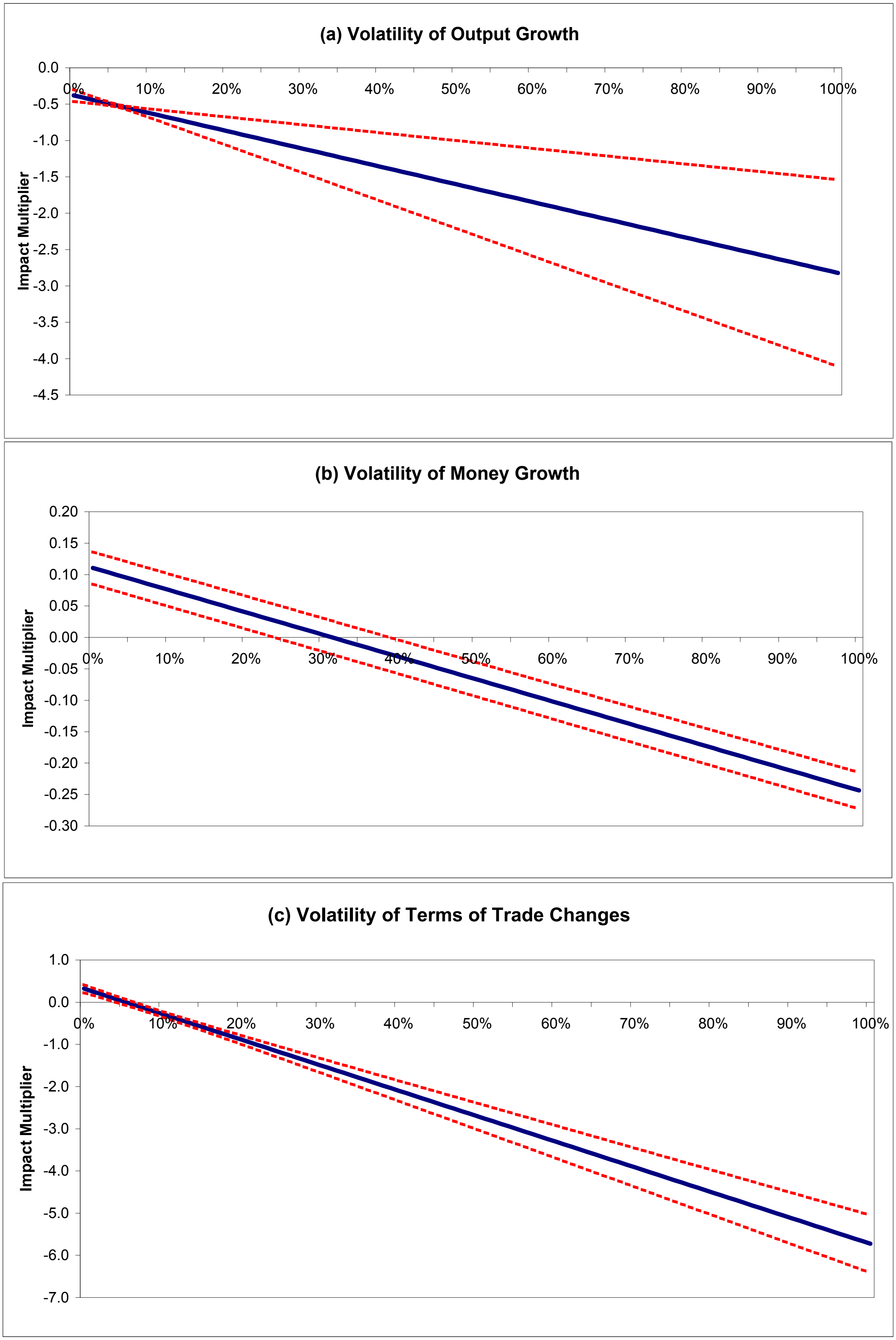


Table A.1
Sample of Countries

Code	Name	Region	Outcome	Policy
ARG	Argentina	AMER	X	X
AUS	Australia	IND	X	X
AUT	Austria	IND	X	X
BEL	Belgium-Luxembourg	IND	X	X
BFA	Burkina Faso	SSA		X
BGD	Bangladesh	SA		X
BOL	Bolivia	AMER	X	X
BRA	Brazil	AMER	X	X
BWA	Botswana	SSA	X	X
CAN	Canada	IND	X	X
CHE	Switzerland	IND	X	X
CHL	Chile	AMER	X	X
CHN	China	EAP	X	X
CIV	Cote d'Ivoire	SSA	X	X
COL	Colombia	AMER	X	X
CRI	Costa Rica	AMER	X	X
DEU	Germany	IND	X	X
DNK	Denmark	IND	X	X
DOM	Dominican Republic	AMER	X	X
ECU	Ecuador	AMER	X	X
EGY	Egypt, Arab Rep.	MENA	X	X
ESP	Spain	IND	X	X
FIN	Finland	IND	X	X
FRA	France	IND	X	X
GBR	United Kingdom	IND	X	X
GHA	Ghana	SSA	X	X
GMB	Gambia, The	SSA	X	X
GRC	Greece	IND	X	X
GTM	Guatemala	AMER	X	X
HND	Honduras	AMER	X	X
HTI	Haiti	AMER	X	
IDN	Indonesia	EAP7	X	X
IND	India	SA	X	X
IRL	Ireland	IND	X	X
IRN	Iran, Islamic Rep.	MENA	X	
ISL	Iceland	IND	X	X
ISR	Israel	MENA	X	X
ITA	Italy	IND	X	X
JAM	Jamaica	AMER	X	X
JOR	Jordan	MENA	X	X
JPN	Japan	IND	X	X
KEN	Kenya	SSA	X	X
KOR	Korea, Rep.	EAP7	X	X
LKA	Sri Lanka	SA	X	X
MAR	Morocco	MENA	X	X
MDG	Madagascar	SSA	X	X
MEX	Mexico	AMER	X	X
MWI	Malawi	SSA	X	
MYS	Malaysia	EAP7	X	X
NER	Niger	SSA	X	X
NGA	Nigeria	SSA	X	
NIC	Nicaragua	AMER	X	X
NLD	Netherlands	IND	X	X
NOR	Norway	IND	X	X
NZL	New Zealand	IND	X	X
PAK	Pakistan	SA	X	X
PAN	Panama	AMER	X	X
PER	Peru	AMER	X	X
PHL	Philippines	EAP	X	X
PNG	Papua New Guinea	EAP	X	
PRT	Portugal	IND	X	X
PRY	Paraguay	AMER	X	X
SEN	Senegal	SSA	X	
SGP	Singapore	EAP7	X	X
SLE	Sierra Leone	SSA	X	X
SLV	El Salvador	AMER	X	X
SWE	Sweden	IND	X	X
SYR	Syrian Arab Republic	MENA	X	X
TGO	Togo	SSA	X	
THA	Thailand	EAP7	X	X
TTO	Trinidad and Tobago	AMER	X	X
TUN	Tunisia	MENA	X	X
TUR	Turkey	MENA	X	X
URY	Uruguay	AMER	X	X
USA	United States	IND	X	X
VEN	Venezuela	AMER	X	X
ZAF	South Africa	SSA	X	X
ZMB	Zambia	SSA	X	X
ZWE	Zimbabwe	SSA	X	
No. Countries			**77**	**71**

Table A.2
Definitions and Sources of Variables Used in Regression Analysis

Variable	Definition and Construction	Source
GDP	Real Gross Domestic Producto. GDP is in 1985 PPP-adjusted US$.	Authors' construction using Summers and Heston (1991) and The World Bank (2002).
Growth Rate in GDP	Log differences of Real GDP.	Authors' construction using Summers and Heston (1991) and The World Bank (2002).
Volatility of Output Growth	Standard deviation of the log difference of real GDP.	Authors' construction using Summers and Heston (1991) and The World Bank (2002).
GDP per capita	Ratio of total GDP to total population. GDP is in 1985 PPP-adjusted US$.	Authors' construction using Summers and Heston (1991) and The World Bank (2002).
Trade Openness: Outcome Measure	Ratio of exports and imports (in 1995 US$) to GDP (in 1995 US$).	World Development Network (2002) and The World Bank (2002).
Trade Openness: Policy Measure	Average years of trade openness according to Sachs and Warner criteria.	Sachs and Warner (1995), Wacziarg and Welch (2003).
Financial Openness: Outcome Measure	Ratio of the Stock of Equity-based Foreign Liabilities to GDP (both expressed in 1995 US$).	Lane and Milesi-Ferreti (2001, 2003), IMF's Balance of Payments Statistics
Financial Openness: Policy Measure	Average years of absence of controls on capital account transactions during the corresponding 5-year period.	IMF's Exchange Arrangements and Exchange Restrictions (Various Issues), and Prasad, Rogoff, Wei and Kose (2003).
Dummy for Fixed Exchange Rates	Takes the value of 1 for arrangements such as full dollarization, currency boards, and de facto pegs.	Author's calculations with data from Reinhart and Rogoff (2004)
Dummy for Intermediate Exchange Rates	Takes the value of 1 for crawling pegs.	Author's calculations with data from Reinhart and Rogoff (2004)
Dummy for Flexible Exchange Rates	Takes the value of 1 for managed and free floating schemes.	Author's calculations with data from Reinhart and Rogoff (2004)
Money	M1 = Currency in Circulation plus Time Deposits.	International Monetary Fund (2003) and National Sources where available.
Volatility of Money Growth	Standard deviation of the log difference of money	Authors' construction using International Monetary Fund (2003).
Terms of Trade	Net barter terms of trade index (1995=100)	World Development Network (2002) and The World Bank (2002).
Terms of Trade Changes	Log differences of the terms of trade index	Authors' construction using The World Bank (2002).
Volatility of Terms of Trade Changes	Standard deviation of the log difference of the terms of trade.	Authors' construction using The World Bank (2002).
Government Spending	General Government Consumption Expenditure (as % of GDP)	World Development Network (2002) and The World Bank (2002).
Volatility of Changes in Government Spending	Standard deviation of the changes in the Government Spending to GDP ratio	Authors' construction using The World Bank (2002).
Period-specific Shifts	Time dummy variables.	Authors' construction.

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