WPS4896

POLICY RESEARCH WORKING PAPER 4896

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The World Bank
Latin America and Caribbean Region
Office of the Chief Economist
April 2009

Policy Research Working Paper 4896

Abstract

The "New Open Economy Macroeconomics" argues that: (a) non-monetary factors have gained importance in explaining exchange rate volatility, and (b) trade and financial openness may have a potential role of mitigating and/or amplifying real and nominal shocks to real exchange rates. The goal of the present paper is to examine the ability of trade and financial openness to exacerbate or mitigate real exchange rate volatility. The authors collected information on the real effective exchange rate, its fundamentals, and (outcome and policy measures of) trade and financial openness for a sample of industrial and developing countries for the period 1975-2005. Using instrumental variables techniques, the analysis finds that: (a) High real exchange rate volatility is the result of highly volatile productivity shocks, and sharp oscillations in monetary and fiscal policy shocks. (b) Countries more integrated with international markets of goods and services tend to display more stable real exchange rate fluctuations. (c) Financial openness seems to amplify the fluctuations in real exchange rates. (d) The composition of trade and capital flows plays a role in explaining the smoothing properties of trade and financial openness. Although the former is mainly driven by manufacturing trade, the latter depends on the share of debt (and equity) in total foreign liabilities. (e) Financial openness would attenuate (magnify) real exchange rate volatility, the greater the share of equity (debt) in foreign liabilities. (f) The composition of flows also matters for explaining the smoothing properties of trade and financial openness in periods of currency crisis.

This paper—a product of the Office of the Chief Economist, Latin America and Caribbean Region—is part of a larger effort in the region to Latin American Region. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at ccalderon@worldbank.org.

Does Higher Openness Cause More Real Exchange Rate Volatility?*

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First Version: March 2007
This Version: March 2008

JEL Classification: F31, F41, C23

Key Words: Real Exchange Rate Volatility, Openness, Panel Data

* We are grateful to Eduardo Cavallo, Menzie Chinn, Maurizio Habib, Miguel Leon-Ledesma, Gian-Maria Milesi-Ferretti, Peter N. Smith and Michael Wickens as well as participants in the Second Open Macroeconomy and Development Conference at the Université de la Mediteranée and the 2008 Royal Economic Society Annual Conference for their comments and suggestions. This paper initially circulated with the title "Are real exchange rate fluctuations more volatile in more open economies?" The usual disclaimer applies. The views expressed in this paper are those of the author, and do not necessarily reflect those of the World Bank or its Boards of Directors.

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1. Introduction

After the collapse of the gold standard in 1971, industrial economies were forced to switch from fixed exchange rates to floating systems. This switch brought a larger volatility for both the nominal and the real exchange rate (RER) (Stockman, 1983; Mussa, 1986). During the 1970s, the monetary authorities were blamed for the greater RER volatility as Dornbusch (1976) showed that *unanticipated* monetary policy shocks were able to generate disproportionately large fluctuations in the exchange rates (*overshooting* effect).[1] 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 converged to the 1 to 2 percent range in the U.S., Japan, and Europe; whereas 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 in spite of the successful efforts to bring inflation down, allows us to think that the role of monetary factors implied by Dornbusch (1976) was overstated. Furthermore, 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: First, non-monetary factors have gained importance in explaining exchange rate volatility. That is, in addition to monetary shocks, we should include productivity shocks, goods demand shocks (say, government spending shifts), and labor supply shocks, among others. Second, openness to world markets of goods and assets may play a role in either smoothing out or amplifying the impact of shocks to real effective exchange rates. The literature shows that, by allowing greater flexibility in aggregate price adjustment, trade openness limits the impact of either nominal or real shocks on the volatility of real exchange fluctuations (Obstfeld and Rogoff, 1995, 1996; Hau, 2000, 2002). On the other hand, financial openness (through the reduction of frictions in the flow of capital across countries) tends to amplify the volatility of RER in the presence of nominal shocks and mitigate the oscillations in real exchange rates in the event of real shocks (Sutherland, 1996).

[1] According to Dornbusch, the lower speed of adjustment in the goods markets (relative to financial markets) was the mechanism through which the exchange rate disproportionately absorbed the unanticipated monetary shock in the short run.

In order to analyze our econometric results with some structural interpretation, we use a dynamic general equilibrium model of exchange rate dynamics as a theoretical background. This model follows in spirit the ones formulated by Obstfeld and Rogoff (1995, 1996) and Hau (2000, 2002). Spefically, we follow a modified version of the *redux* model that includes the government sector (Calderon, 2004). We should point out that we do not test the model directly, but we use econometric techniques to test some of the implications of the model.

The goal of this paper is two-fold. First, test the relationship between RER volatility and openness for a panel data of countries. We evaluate whether the data confirms the implications on the relationship between: (a) RER volatility and trade openness as implied by Obstfeld and Rogoff (1996), Hau (2002) and Calderon (2004); and, (b) RER volatility and financial openness as derived by Sutherland (1996). We simply assess whether RER volatility declines if the country is more integrated to international markets of goods and capital. Second, we test whether the composition of trade flows as well as capital flows may play a role in explaining the smoothing properties of trade and financial openness. Does trade openness help to smooth shocks to the RER in countries with concentrated output structures? Does financial openness help to smooth or to amplify shocks to the RER in countries with different structures of capital flows and external liabilities? Accounting for the composition of flows would be crucial, especially in the case of financial openness when the ability to mitigate or to magnify the volatility of RER depends on the nature of the shocks facing the economy. This conjecture is consistent with Sutherland (1996), who shows that financial openness would mitigate (magnify) the volatility of RER fluctuations in the presence of unanticipated real (nominal) shocks.

To perform this task, we collect information on exchange rates, labor productivity in the Home and Foreign country, terms of trade, government spending, monetary aggregates, exchange rate regimes, as well as trade and financial openness for a sample of 82 countries (of which 22 are industrial countries) for the period 1975-2005. We will use both least squares and instrumental methods for panel data model. To instrument for trade openness, we follow the strategy developed by Frankel and Romer (1999) of calculating the geographic component of trade openness from the gravity model of bilateral trade. On the other hand, we select the appropriate instrument for financial openness and the structure of external capital following Faria and Mauro (2004) and Faria, Mauro, Lane and Milesi-Ferretti (2006).

Understanding the factors determining RER volatility and the role of openness in either mitigating or amplifying the shocks to real exchange rates is crucial due to the effects of the variability of RERs on economic performance. Aghion *et al.* (2006) show theoretically and empirically that rising exchange rate volatility can hamper growth, especially in countries with shallow financial markets and macroeconomic volatility is mainly driven by financial shocks. The negative impact of the RER volatility on growth can be transmitted through declining investment (Servén, 1998; Bleany and Greenaway, 2001) and by lower foreign trade —particularly in differentiated products (Broda and Romalis, 2003). This paper also relates to the literature that investigates the role of RERs as shock absorbers. Although more flexible exchange arrangements have greater ability to mitigate the impact of real shocks (say, terms of trade shocks) on economic performance — especially, negative terms of trade shocks (Broda, 2004; Edwards and Levy-Yeyati, 2005), this line of research goes beyond our scope.

Our paper complements existing evidence that 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 (Dereveux and Lane, 2003). In general, deeper trade linkages between two countries would dampen their real exchange rate volatility and may encourage them to join a currency union (Broda and Romalis, 2003). It also complements evidence on the role of openness in mitigating or amplifying the impact of real shocks in the economy. For instance, Calderón, Loayza and Schmidt-Hebbel (2005) find that trade openness tend to amplify the impact of terms of trade shocks on output volatility while financial openness seem to attenuate the impact of trade and financial shocks. Di Giovanni and Levchenko (2006) use data at the industry level to show that trade leads to deeper specialization and increasing output volatility in more outward-oriented industries. Finally, Buch *et al.* (2006) use the firm-level data in Germany to show that rising trade openness affects the volatility of firm's output by modifying the exposure to shocks as well as the response of firms with the net effect being ambiguous.

In addition, our paper improves upon the evidence presented by Hau (2002) in the following dimensions: first, it presents evidence for a larger sample of countries (82) and sample period (1975-2005).[2] Second, we present panel data evidence (instead of cross-section). We work with 5-year period observations on the volatility of RER such as openness and fundamentals. Third, we instrument for trade and financial openness using external instruments recommended by recent existing literature. Fourth, unlike Hau (2002),

we directly test the hypothesis that trade openness helps attenuate the RER volatility after controlling for fundamental volatility. Fifth, we evaluate whether the composition of trade and capital flows may play a role in explaining the openness-RER volatility relationship. Finally, as opposed to periods of tranquility, we test whether the relationship between openness and RER volatility changes in times of currency crisis (i.e. *turbulent times*).

Interestingly, we consistently find that higher trade openness leads to more stable RERs while higher international financial integration generates more volatile RERs. We also find that the composition of flows of trade and capital matters for explaining the openness-RER volatility link. Why? Due to the different nature of the shocks that govern: (a) manufacturing vs. non-manufacturing trade, and (b) equity- vs. loan-related financial openness. Specifically, we find that the ability of trade openness to smooth shocks to the RERs is mainly driven by manufacturing trade while non-manufacturing trade plays a limited and, in most cases, negligible role. The results on the composition of capital flows are striking: we not only find that financial openness may reduce RER volatility in countries with low debt-to-equity ratios, but also that higher share of debt in foreign liabilities may amplify RER volatility and increase the likelihood of currency crisis episodes.

This paper consists of the following sections: Section 2 shows the main stylized facts of the model that draws the testable implications on the relationship between RER volatility and openness. Section 3 discusses the data and methodology of estimation. Section 4 presents the regression analysis of the RER volatility in the baseline scenario and the sensitivity analysis to different samples and different measures of the dependent variable. Section 5 explores in more detail the nature of the openness-RER volatility link by analyzing the role of the composition of trade and capital flows as well as vulnerabilities in the external sector while section 6 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 (which we will also call *fundamental volatility*), and (trade and financial) openness. Rather than calibrating the model, we will conduct econometric tests for a wide sample of countries on the relationship between: (a) RER volatility and trade openness, and (b) RER volatility and financial openness. Our theoretical framework is *redux* model augmented by the presence of the

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

government sector as outlined by Calderon (2004), and this model would render some testable implications for the relationship between RER volatility and trade openness. On the other hand, the testable implications of the relationship between RER volatility and financial openness are obtained from the simulation of a modified version of the *redux* model that incorporates cross-border financial restrictions (Sutherland, 1996). Sutherland's model finds that the relationship between RER volatility and financial openness in the event of different types of shocks, Finally, the details of the definition of the variables, the main assumptions of the model, its basic set up and the steady state analysis are outlined in Appendix I.

2.1 Introducing Some Notation

Given the two-sector model (i.e. traded and non-traded sectors), the degree of trade openness is defined as $\phi = \frac{P_T C_T}{P_T C_T + \overline{P}_N C_N}$, where P_T and P_N represent the price level of trade and non-traded sectors, while C_T and C_N represent the consumption of traded and non-traded goods (see definition in Appendix I, section I.1). Once the steady state is computed (Appendix I, section I.2), we analyze the dynamics of the model by taking a log-linear approximation around the benchmark steady state. Here, we define the *short-run* deviation of a certain variable X from the steady state as $\tilde{X} = (X_1 - \overline{X}_0)/\overline{X}_0$, while its *long-run* deviation from the steady state is defined as $\hat{X} = (\overline{X} - \overline{X}_0)/\overline{X}_0$. Note that we assume that the economy is initially in steady state (at period *0*).

2.2 Testable Implications

In this sub-section we present the relationship between: (a) volatility of RER fluctuations, fundamental volatility and trade openness, and (b) RER volatility, fundamental volatility and financial openness. The basic structural relationship between these variables is derived from the stylized Obstfeld-Rogoff *redux* model (1995) as well as the *redux* model that incorporates restrictions on cross-border transactions (Sutherland, 1996).

2.2.1 Trade Openness and RER Volatility

From the *redux* model outlined in Appendix I we will uncover the relationship between trade openness and real exchange rates in the face of shocks to productivity, money supply and government spending.

Productivity Shocks: Assume unanticipated permanent technology shocks in the non-traded sector of each country —*i.e.* $\hat{A}_N = \hat{A}_N^*$ (and also assume that this surge is similar across countries without loss of generality). By log-linearizing (I.10) we obtain the following equation: $-\tilde{P}_T - \tilde{C}_T = -\hat{A}_N + \tilde{y}_N$. Since we assume that there are constant endowments of traded goods, $\bar{y}_T$, a constant net foreign asset position, and the consumption-smoothing motive, we have that $\tilde{C}_T = 0$. If we log-linearize (I.9), $\tilde{C}_N = \tilde{P}_T$, given that $\tilde{P}_N = 0$ (since the model assumes price stickiness in the short-run). Then market-clearing conditions for non-tradables, $\tilde{C}_N = \tilde{y}_N$ determines that 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, fluctuations in real exchange rate are

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

The volatility of RER fluctuations is found using (1),

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

where the greater the degree of openness (rising ϕ), the smaller is the impact of volatile productivity shocks on the volatility of RER fluctuations. Note that expressing (2) in logs yields:

$$\ln\text{var}(\tilde{q}) = \ln h_A(\phi) + \ln\text{var}(\hat{A}_N) \tag{2a}$$

and we require to find a negative relationship between RER volatility and openness after controlling for shocks to productivity.

Monetary Shocks: Suppose that the economy only faces unanticipated permanent monetary shocks —that is, $\hat{M} = \tilde{M}$. Log-linearizing the money demand —eq. (I.11) — around the steady state:

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

and, since non-traded prices are fixed in the short-run, $\tilde{P}_N = 0$, and money non-neutrality holds, $\tilde{P}_T = \hat{M} = \tilde{M}$, we have $\tilde{P}_T = \frac{\beta + (1-\beta)\varepsilon}{\beta + (1-\beta)(1-\phi+\phi\varepsilon)}\hat{M}$.[3] Since the law of one

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

price holds for traded goods, these prices change in proportion to exchange rate fluctuations, i.e. $\tilde{P}_T = \tilde{E}$. Hence, changes in the RER are defined as,

$$\tilde{q} = \tilde{E} - \tilde{P} = \tilde{E} - \phi \tilde{P}_T = (1-\phi)\tilde{P}_T \tag{3}$$

and the volatility of RER changes becomes:

$$\text{var}(\tilde{q}) = h_M(\phi)\,\text{var}(\hat{M}) \tag{4}$$

where $h_M(\phi)$ is the function that relates the volatility of RER fluctuations and the degree of openness. We can show that this relationship is negative. Again, we can express (4) in logs as

$$\ln \text{var}(\tilde{q}) = \ln h_M(\phi) + \ln \text{var}(\hat{M}) \tag{4a}$$

Fiscal Shocks: Now we assume that the economy only faces unanticipated permanent fiscal shocks —that is, $\hat{G} = \tilde{G}$. If we log-linearize equation (I.18) and combine with the other dynamic equations in the model, we have $\tilde{P}_T = \dfrac{1}{(1-\beta)+\theta(1+\beta)}\hat{G}$ and changes in the RER are defined as:

$$\tilde{q} = \frac{1-\phi}{(1-\beta)+\theta(1+\beta)}\hat{G} \tag{5}$$

with the volatility of RERs being:

$$\text{var}(\tilde{q}) = h_G(\phi)\,\text{var}(\hat{G}) \tag{6}$$

where $h_G(\phi)$ is the function that relates the volatility of RER fluctuations and the degree of openness. It is also straightforward to show that this relationship is negative. Finally, the relationship between RER volatility (in logs) and openness is:

$$\ln \text{var}(\tilde{q}) = \ln h_G(\phi) + \ln \text{var}(\hat{G}) \tag{6a}$$

Intuitively, trade openness can mitigate the volatility of RERs in the event of a shock through higher import penetration by allowing a faster channel for adjustment of the domestic aggregate price (Obstfeld and Rogoff, 1995; Hau, 2000). This reduces the short-run impact of any shock (real or nominal) on real household balances and; hence, reduces the scope of such shock to generate real effects on the real effective exchange rate.

2.2.2 Financial Openness and RER Volatility

Rising financial integration was perceived as a factor associated with higher exchange rate instability. Dornbusch (1976) argued that freely operating foreign exchange rate markets would lead to an overshooting in nominal and real exchange rates in the short-run

in the face of nominal shocks. In turn, this excessive exchange rate volatility would destabilize the real economy.

Financial integration, on the other hand, is argued to allow agents within a country to share risks and individuals across countries to share country-specific risks. Thus, financial integration may allow agents to deal more effectively with random shocks. However, recent evidence shows that, during the current era of financial globalization, emerging markets have been unable to enjoy the benefits of financial integration —its degree of risk sharing has slightly declined (Kose, Prasad and Terrones, 2006).

Sutherland (1996) incorporates the notion of *financial market integration* in the *redux* model as a result of reducing frictions that prevent the free flow of capital across international borders. He introduces two modifications to the *redux* model: (a) there is imperfect capital mobility across international borders, and (b) varying degrees of nominal inertia are considered by introducing multi-period nominal contracts.

On the demand side of the model, consumption is determined intertemporally by agents and the presence of frictions in international financial transactions may reduce the ability to substitute intertemporally. On the supply side, goods markets do not clear period by period and shocks to the economy create short-run disequilibria that generate incentives for intertemporal substitutions of consumption and labor supply. Financial frictions would prevent intertemporal substitution from taking place. The model —as posed by Sutherland (1996) does not offer a closed-form solution and it is calibrated and simulated numerically.

In the event of (asymmetric) *money supply shocks*, domestic and foreign bonds would pay different returns with imperfect capital mobility. If agents accumulate assets, domestic interest would be driven down. The fall in domestic real interest rates encourages domestic consumer to raise present consumption. With imperfect capital mobility, consumption differential is more positive and interest rate differentials become negative. Hence, exchange rate should not depreciate as much as in the perfect capital mobility scenario. In short, rising financial integration would reduce the volatility of interest rates while both the volatility of nominal and real exchange rates rises. In turn, output is more volatile in integrated markets and, as expected, consumption is less volatile.

On the other hand, *goods demand shocks* (as captured in the model by increases in government spending) would cause domestic consumers to accumulate debt. With imperfect capital markets, debt accumulation drives interest rates up in domestic financial markets and, with higher real interest rates in the short run, individuals would be encouraged to shift towards future consumption. Domestic interest rates have increased

while present consumption has declined by more than in the perfect mobility case. Hence, the exchange rate must depreciated by more in the short run, and this greater depreciation would cause output to expand even more in the short run. In sum, financial integration would exacerbate debt levels and mitigate the volatility of nominal and real exchange rates in response to a goods demand shock.

3. Data and Methodology

In the present section we describe the data used for our empirical evaluation of RER volatility, fundamental volatility and openness, and we explain a detailed outline of the econometric technique used.

3.1 The Data

We have collected annual data on real effective exchange rates and its fundamentals (labor productivity, fiscal policy and monetary policy) for a sample of 82 countries over the period 1975-2005 (see list of countries in Table A.1). We have ignored the Bretton Woods period for two reasons (Levy-Yeyati and Sturzenegger, 2001): (a) to focus on the recent period of increasing integration to the world markets of goods and assets, and (b) the predominance of fixed exchange rate regimes implemented for political reasons.

Our dependent variable, the *volatility of RER fluctuations,* is the standard deviation of 12-month variation in the real effective exchange rate over a 5-year window computed using a monthly RER database. We chose the real effective exchange rate (instead of the bilateral real exchange rate of country *i* vis-à-vis the United States) due to its relevance for countries with more important macroeconomic and trade linkages with other countries rather than the United States and due to its equivalence to the exchange rate in models —as the one stated in section 2 —that summarizes foreign countries as a single foreign trading partner.

The real effective exchange rate index for country *i* at period *t*, Q_{it}, is defined as,

$$Q_{it} = P_{it} \Bigg/ \left\{ \left(s_{it} / s_{i0}\right) \prod_{k=1}^{n} \left[\frac{P_{kt}^{*}}{s_{kt}} \Big/ \frac{P_{k0}^{*}}{s_{k0}} \right]^{\omega_k} \right\}$$

where s_{it} is the nominal exchange rate for country *i* observed in period *t* expressed in units of local currency vis-à-vis the US dollar, P_{it} is the consumer price level of country *i* in period t, s_{kt} is the nominal exchange rate of the *k-th* trading partner in period *t* (with $k \neq i$),

and P_{kt}^{*} is the consumer price level of country *i*'s *k-th* trading partner in period *t*.[4] Price levels at time 0 represent the base period of our index numbers. Note that according to this definition, an increase in *q* implies a real appreciation of the local currency. Hence, the RER volatility is the standard deviation of the (natural logarithm of the) RER variation between period t and t-12:

$$Vol(q_{it}) = s.d.\left(q_{it} - q_{i,t-12}\right) = \left(\frac{1}{T}\sum\left(q_{i,t} - q_{i,t-12}\right)^2\right)^{1/2}$$

where q_{it} is the $\log(Q_{it})$. Note that for robustness purposes we also compute the RER volatility of the 2-year (24-month) variation of the RER as well as 3-, 4- and 5-year variation.

Openness: We now consider policy and outcome measures of trade and financial openness. Regarding *trade openness*, our *policy measure* 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 considered as an open one and 0 otherwise.[5] We use the share of years in the 5-year period that the country enjoys an open trade regime.

The *outcome measure* of openness to international trade in goods and services is the real value of exports and imports (that is, total trade) as a percentage of GDP. Further tests on the smoothing properties of trade openness will imply the analysis of the composition of trade flows. In our paper we break down total trade as percentage of GDP into manufacturing and non-manufacturing trade (both expressed as percentage of GDP). The data for total trade and its composition is obtained from the World Bank's World Development Indicators (WDI) and the United Nations' COMTRADE database.

Policy indicators of financial openness are measured by two different proxies: the first one is the IMF binary variable of capital account restrictions, which takes the value of 1 in the years when there are no restrictions on capital account transactions and 0 otherwise. We use the share of years in the 5-year period where there are no restrictions. The source of the data is Prasad, Rogoff, Wei and Kose (2003) based on the *IMF Annual Report on*

[4] 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 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.

[5] 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 covered 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 exchange rate (during the 1970s and 1980s), (iv) It has a socialist economic system, and (v) a state monopoly on major exports.

Exchange Rate Arrangements and Restrictions.[6] However, countries with closed capital account may try to increase the stringency of those controls by imposing restrictions on current account transactions, multiple exchange rate practices or the surrender of export proceeds while countries with an open capital may still restrict the flow of capital by imposing other restrictions on cross-border financial transactions (Chinn and Ito, 2007). Therefore, our second policy measure is the *Chinn-Ito index of financial openness* which incorporates the different types of restrictions on cross-border financial transactions stated above. Further details on the construction of this index are given in Chinn and Ito (2007).

Our *outcome measure* of financial openness involves data on foreign assets and liabilities from Lane and Milesi-Ferretti (2001, 2006). We construct the ratio of foreign liabilities as a percentage of GDP (which include stocks of liabilities in portfolio equity, foreign direct investment, debt and financial derivatives) and for robustness purpose the ratio of foreign assets and liabilities to GDP. Note that, for analogously to the case of trade openness, we would evaluate the role that the composition of capital flows may play in smoothing shocks to the RER. Hence, we break down our outcome measure of financial openness into equity- and loan-related foreign liabilities. While the former includes the foreign liability position in foreign direct investment and portfolio equity, the latter includes only the debt liability position. The same calculation is performed for the ratio of foreign assets and liabilities to GDP.

Volatility of Fundamentals: We describe the sources of the data on the RER fundamentals formulated in the model and used in this paper. First, the *volatility of productivity shocks* is computed as the standard deviation of annual changes in the ratio of Home to Foreign labor productivity. Labor productivity is the ratio of real GDP to total employment and the magnitude for the foreign country is computed as the trade-weighted average of labor productivity of the rest of the world. In turn, real output is the real GDP as constructed by Loayza, Fajnzylber and Calderón (2005) using Summers and Heston (1991) output figures as well as WDI.

Next, the *volatility of fiscal policy*, $Vol(G_i)$, is constructed following the methodology outlined in Fatas and Mihov (2006). We collect data on general government consumption and we isolate movements in government consumption that can be attributed to exogenous policy decisions and not related to the state of the economy. To isolate these exogenous policy changes, we regress for each country the (log of) real government

[6] Data on capital account restrictions can be downloaded from: http://www.nber.org/~wei/data.html

consumption spending (G) on real output (Y), the initial level of real government spending, linear and squared inflation (π and π^2) and a deterministic time trend (t),

$$\ln(G_{i,t}) = \mu_i + \eta t + \beta_{i,0} \ln Y_{i,t} + \rho_{i,1} \ln G_{i,t-1} + \phi_1 \pi_{i,t} + \phi_2 \pi_{i,t}^2 + \varepsilon_{i,t}$$

To prevent reverse causality from government spending to growth we instrument output growth with lagged values of output growth and current and lagged values of oil prices. We consider the standard deviation of the residual of this regression, Vol($\varepsilon_{i,t}$) as the estimate of the volatility of discretionary fiscal policy. Note that data on government expenditure was obtained from WDI while inflation and the world price of oil were taken from the IMF's International Financial Statistics (IFS). [7]

We also construct a measure of *monetary policy volatility* in the same fashion as the measure of fiscal policy volatility described above in spite of the difficulties to implement this measure across countries —as outlined by Fatas and Mihov (2006). We use data on the monetary base from IFS and from national sources whenever the data was unavailable from the IMF.

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 three binary variables. The dummy for *fixed regimes* takes the value of 1 if the country has either a hard peg or de facto pegs —that is a fixed exchange rate regime (and 0 otherwise). On the other hand, the dummy for *intermediate regimes* takes the value of 1 if the country has a de facto crawling peg or band (i.e. intermediate regimes). Finally, the *flexible exchange rate regime* is the base category and it is excluded from our regression analysis. Note that the Reinhart-Rogoff database contains data up to 2001. From 2002 we have used the IMF's new exchange rate regime classification from the Annual Report on Exchange Arrangements and Exchange Restrictions that follows the natural classification stipulated by Reinhart and Rogoff (2004).

Inflation: The monthly data on CPI collected for the calculation of the real effective exchange rate is used to compute annual *inflation* measures. For the purpose of our regression analysis we compute the 5-year period average of the annual inflation in our monthly database.

Vulnerabilities: We construct our indicator of *output concentration* using the 9-sector classification from the 1-digit level ISIC code on economic activity, which comprises the following activities: (i) Agriculture, Hunting, Forestry, and Fishing; (ii) Mining and Quarrying; (iii) Manufacturing; (iv) Electricity, Gas, and Water; (v) Construction; (vi)

Wholesale and Retail Trade; (vii) Transport, Storage and Communication; (viii) Finance, Insurance, Real Estate, and Business Services, (ix) Community, Social, and Personal Services. The data was obtained from the United Nations' National Accounts database. We also construct the ratio of debt liabilities in total foreign liabilities as our proxy of the debt-equity ratio —our measure of vulnerabilities in financial openness. The data to construct this ratio was obtained from Lane and Milesi-Ferretti (2006).

Finally, Table A.2 presents a more detailed description of the sources of the data for all the variables involved in our econometric analysis.

3.2 Estimation Technique[8]

The proposed panel data regression poses some challenges for estimation. The first is the presence of unobserved period- and country-specific effects. The inclusion of period-specific dummy variables can account for the time effects while country dummies deal with country-specific effects. The second challenge is that our variables of interest —trade and financial openness —are likely to be jointly endogenous with shocks to the RER; hence we need to control for the biases resulting from simultaneous or reverse causation in our RER volatility equation.

Our baseline regression equation of RER volatility follows the following specification:

$$\ln \sigma(dq_{it}) = \mu_i + \eta_t + \mathbf{O}_{it}\mathbf{\Gamma} + \mathbf{Z}_{it}\mathbf{\Theta} + \varepsilon_{it} \qquad (7)$$

where the dependent variable is the standard deviation of annual changes in the RER (in logs) using monthly data for the 1975-2005 period. The matrix $\mathbf{O}_{it}$ contains information on our variables of interest: trade and financial openness. We use either the policy or outcome measures of trade and financial openness. However, our benchmark result would be the one that uses exports and imports as percentage of GDP (in logs) as our indicator of trade openness, and foreign liabilities as percentage of GDP (in logs) as our measure of financial openness. Finally, the matrix $\mathbf{Z}_{it}$ comprises the control variables for the RER volatility regression equation: the standard deviation of Home-Foreign labor productivity growth, monetary and fiscal policy volatility, dummy variables for fixed and intermediate exchange rate regimes, dummy for currency crisis, and the level of income per capita (at the start of the 5-year period).

However, as we said above, it is highly likely that shocks to the RER (or RER volatility) may have an effect on trade and financial openness. Hence, we need to find appropriate

[7] Note that all standard deviation measures were taken for annual changes during 5-year periods.
[8] The present sub-section draws heavily from Loayza, Fajnzylber and Calderón (2005).

instruments for our variables of interest. We first discuss the identification strategy for *trade openness*. Again, existing evidence shows that RER volatility may affect trade volumes (Broda and Romalis, 2003). As a result, it becomes necessary to control for reverse causation in trade openness. We follow the methodology of Frankel and Romer (1999) and we compute the *geographic component of trade openness* based on the gravity equation model of bilateral trade. This component is not only highly correlated with trade openness (given the empirical success of the gravity equation model) but also it is suspected to be uncorrelated with the volatility of RERs. The gravity equation model in its most parsimonious representation relates bilateral trade (expressed as a ratio to GDP) to geographic and size measures. In short, the amount of trade between two countries is inversely related to their distance and directly related to their size. The *predicted* trade to GDP ratio is a good instrument if it is highly correlated with trade since it is unlikely that geography would be related to economic outcomes through any channel other than trade (Cavallo and Frankel, 2007).[9] A detailed description on the construction of the instrument for trade openness is provided in Appendix II.

On the other hand, to instrument for financial openness we follow Faria, Lane, Mauro and Milesi-Ferretti (2007). The authors evaluate some dimensions of the external capital structure: total foreign liabilities (as % of GDP), and the share of equity (portfolio and FDI) in total foreign liabilities. Based on recent work by Faria and Mauro (2004), the authors choose a broad range of potential determinants of the external capital structure. Following their strategy we use an indicator of institutional quality (the ICRG index of political risk at the start of the five year period), the initial size of the country (as proxied by starting levels of GDP, population and area at the start of the five year period), the legal origin of countries (La Porta *et al.* 1998), secondary enrollment, and the abundance of natural resources. As we mentioned before, the timeline of these explanatory variables is the beginning of the 5-year period. As are consistent with the results in Faria and Mauro (2004) as well as in Faria *et al.* (2007), we find the following: first, countries with higher ratios of total foreign liabilities to GDP are smaller countries with better institutional quality, greater reliance on natural resources and with French civil code tradition. Second, a greater share of debt in external liabilities is achieved by smaller countries with lower levels of education attainment, poorer levels of institutional quality, and lower reliance on natural

[9] Cavallo and Frankel (2007) point out that this methodology still poses some limitation. For instance, it does not allow for variation in the instrument over time so as to estimate a model with country-fixed effects. However, the authors do not consider this a serious limitation since most of the variation in trade openness is cross-country and not over time.

resources. These results are consistent with Faria *et al.* (2007) where greater equity share in total liabilities is attained by larger countries with better institutional quality and greater reliance on natural resources.

4. Empirical Evidence

This section describes the main results of our empirical analysis of the determinants of RER volatility for our sample of 82 countries, using 5-year non-overlapping observations, over the period 1975-2005. 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 and Correlation Analysis

Table 1 presents the basic statistics on RER volatility, openness and the volatility of the RER 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 income level.

We first find that RER fluctuations are more volatile in developing countries than in industrial economies. On average, RER volatility in developing countries is almost twice as volatile as that of industrial economies. This reflects the higher volatility in the RER fundamentals in developing countries: productivity shocks and monetary policy shocks in developing countries are, on average, more than twice as volatile as those in advanced economies while fiscal policy shocks are almost five times as volatile in developing countries as those shocks in industrial countries.

Second, although industrial countries have a larger history of free trade regimes according to the Wacziarg-Welch policy indicator of trade openness, data on real exports and imports as percentage of GDP shows that, on average, developing countries are more integrated to the world markets of goods than industrial economies —particularly, in trade of non-manufacturing goods (that is, trade in commodities). On the other hand, industrial economies are more integrated to international financial markets than developing countries —either using policy or outcome measures of financial openness.

Third, low-income countries display higher RER volatility as well as higher fundamental volatility (i.e. productivity shocks, monetary and fiscal policy). They are not only less integrated to the world markets of goods but also have more restrictions on cross-border transactions and lower degree of international financial integration. Moreover low-

income countries exhibit lower levels of output diversification and a higher debt-equity ratio than countries in other income groups.

In Table 2 we report the panel correlation analysis for the 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.

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 and it is significant in most cases. 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 RER fluctuations. We should point out that the negative correlation between trade openness (as proxied by real exports and imports to GDP) and RER volatility is mainly explained by trade in manufacturing.

Figure 1 presents the simple scatter plot of RER volatility (as proxied by the standard deviation of 12-month RER variations) and the outcome measure of trade openness. Although countries more integrated to world goods markets tend to display lower RER volatility, the nature of the trade openness may affect its ability to smooth RER fluctuations. We specifically find that countries with less diversified structures of production tend to display more volatile RERs. This is consistent with the finding that countries with less diversified structures of production tend to display higher terms of trade volatility (Baxter and Kouparitsas, 2007; Loayza and Raddatz, 2006). Furthermore the correlation between trade openness and RER volatility changes when distinguishing between trade in manufacturing and non-manufacturing goods (expressed as % of GDP). In short, countries tend to display lower RER volatility when trade openness in manufacturing goods is larger while there is a positive although weak relationship between RER volatility and trade openness in non-manufacturing goods.

On the other hand, RER volatility does not show a robust correlation with financial openness: the sign of the correlation coefficient depends upon the measure of financial openness used and on the sample of countries evaluated. We find that RER volatility is inversely related to either *policy measure* of financial openness (either the IMF's index of capital account openness or Chinn-Ito's measure of financial openness), whereas the correlation of RER volatility and *outcome measures* of financial openness (foreign liabilities and foreign assets and liabilities) are negative and weak for the full sample of countries. For industrial economies as well as for high-income countries greater financial openness seems

to be associated with more stable RERs. However, this relationship is not robust for developing countries. We should also note that the composition of capital flows may matter for stabilizing the RER: more volatile RERs are associated to countries with higher loan-related financial openness and lower equity-related financial openness (see Figure 2). Consistent to the finding mentioned above, we find that RERs are more unstable in countries with higher debt-to-equity ratio.

Correlation between RER and Fundamental Volatility: We first find that RER volatility is positively correlated with the volatility of the RER fundamentals (say, productivity shocks, fiscal policy and monetary policy) for the full sample of countries as well as for the sub-samples of industrial and developing countries. The correlation between RER volatility and the volatility of productivity shocks is greater among industrial countries than among developing countries (0.49 vs. 0.29) and it is significant for both groups of countries. Monetary policy volatility is also positively related to RER volatility although the correlation coefficient is significant for the full sample of countries and for the sample of developing economies. The same result holds for the correlation between RER volatility and fiscal policy volatility.

4.2 Panel Regression Analysis: Baseline Regression Analysis

Using a sample of 82 countries over the period 1975-2005, we conduct our econometric analysis to test the basic implications of the model outline in Section 2 by formulating a *baseline* regression equation for the RER volatility. As we stated in the previous sections, our dependent variable is the standard deviation of changes in the real effective exchange rate (in logs) and our baseline specification is represented by equation (7) –see section 3.2. Recall that the matrix $\mathbf{O}_{it}$ comprises (outcome and policy) measures of trade and financial openness, and $\mathbf{Z}_{it}$ represents the matrix of control variables. In our analysis, $\mathbf{Z}$ is conformed by the (log) level of output per capita (in logs), dummy variables for fixed and intermediate exchange rate regimes and the vector of fundamental volatility —that is, volatility of Home-Foreign productivity differentials as well as monetary and fiscal policy volatility.

In Table 3 we present the estimation results of the baseline regression model using least squares estimators and controlling for country- and period-specific effects. We regress the RER volatility on our indicators of openness (integration to international goods and capital markets), dummies for fixed and intermediate exchange rate regimes, the level of output per capita and the volatility of fundamentals (such as productivity shocks, discretionary

fiscal and monetary policy shifts). In general, we find that RER volatility is higher in countries with more flexible exchange rate regimes, higher inflation, during periods of currency crises, and in low-income countries —although the coefficient of the latter is not significant for all specifications in Table 3. On the other hand, RERs are more unstable in countries that suffer from more volatile shocks to productivity and sharper shifts in discretionary monetary and fiscal policies. In most cases, the estimated coefficients of these determinants are statistically significant.

Our main goal is to test the relationship between RER volatility and openness. Using policy measures of openness, we find that there is no robust relationship between the Wacziarg and Welch (2003) trade liberalization measure and RER volatility while there is a negative and significant association between RER volatility and the Chinn-Ito (2007) index of financial openness.[10] In short, RER volatility will be higher in countries with more restrictions in cross-border transactions. On the other hand, using outcome measures of openness, we find that RERs are more volatile in countries less integrated with world goods markets and in countries more integrated to international capital markets. The latter result is inconsistent with the one obtained with the policy measure and we argue that the smoothing properties of financial openness may rely on the composition of capital flows.

Table 4 shows our baseline regression for the RER volatility equation using instrumental variables. As explained in section 3, we use the gravity equation model to instrument for trade openness in the same fashion as Frankel and Romer (1999), and we follow Faria *et al.* (2007) to select instruments for financial openness. What are the main lessons of the IV estimates of our baseline regressions? We first find that the higher the volatility of (Home to Foreign relative) productivity shocks, the higher the volatility of real exchange rate fluctuations is. Higher RER volatility could also be the result of erratic fiscal and monetary policies undertaken by the government and the Central Bank, respectively. According to our estimates in column [5] of Table 4 we find that if the volatility of productivity shocks is halved, then RER volatility would decrease by 19 percent. An analogous decline in both monetary and fiscal policy volatility would imply reductions in RER volatility of approximately 6 and 8 percent, respectively. On the other hand, if the volatility of the different RER fundamentals of the average developing country were to be reduce to the levels of the average industrial economy (see averages in Table 1), then RER volatility would have declined by 22 percent in the case of productivity shocks, 9% for

[10] Note that the policy measures of trade openness are a better indicator of whether the country is integrated or not to world markets of goods and do not provide any quantitative measure of their degree of integration.

reductions in the volatility of fiscal policy, and 14 percent due to more stable discretionary monetary policies.

Next, trade openness measured by outcome indicators has a negative relationship with RER volatility. Hence, the more open is the economy to international trade in goods and services, the less volatile its real exchange rate is. Note that, on average, real exports and imports represent slightly more than 50 percent of GDP among developing countries. An increase in trade openness to 75 percent of GDP for developing countries would lead to a reduction in the volatility of real exchange rate fluctuations between 7 and 12 percent.

Third, financial openness measured by outcome indicators has a positive relationship with RER volatility. As a result, the RER volatility is higher in countries that are more integrated to international capital markets. According to our estimates if foreign liabilities were to increase from approximately the average of developing countries to the average of industrial economies (that is, from 71 to 82 percent of GDP), then RER volatility would jump between 9 and 12 percent. On the other hand, an analogous increase in foreign assets and liabilities (from 98 to 146% of GDP) would increase RER volatility by 33-41 percent.

Finally, we find that RER is lower in less flexible exchange rate regimes and higher during times of currency crisis. Compared to floating regimes, RER volatility in fixed exchange rate regimes is lower by a third (33 percent) while RER volatility is almost 30 percent higher during times of crisis. Inflation exerts a destabilizing effect on the volatility of RERs. Thus, reducing inflation from the average of developing countries to that of industrial countries would reduce RER volatility by 8-12 percent. Moreover, the level of development plays a part in the story: richer countries display more stable exchange rate fluctuations.

In sum, our results are consistent with the predictions of the *redux* model and its extensions (Obstfeld and Rogoff, 1995; Sutherland, 1996; Hau, 2002). Trade openness helps attenuate the effects of volatile fluctuations in RER fundamentals while financial openness amplifies shocks to the RER. The latter is consistent with the prevalence of nominal shocks. Our further interest is to investigate in this paper the robustness of these results and the role of the composition of trade and capital flows in smoothing shocks to the RER.

4.3 Sensitivity Analysis

In this section we conduct a sensitivity analysis of our results in section 4.2 by testing the robustness of our results to: (a) changes in the sample of countries, and (b) changes in the dependent variable.

4.3.1 Sensitivity to Changes in the Sample of Countries

Table 5 shows the instrumental variable (IV) estimates of our baseline RER volatility regression equation for the full sample of countries as well as for groups of countries classified by their level of development (industrial vs. developing countries) and by their level of income (high-, middle-, and low-income countries). We also include a regression for the sample of emerging market economies.

As observed in section 4.2 (see column [1] of Table 5), trade openness has a negative and significant relationship with RER volatility while financial openness (as proxied by foreign liabilities to GDP) has a positive and significant one. In short, while trade openness dampens shocks to the RER, financial openness amplifies them. Are these results robust across sub-samples of countries or are they driven by a specific group of countries?

We find that our findings for the full sample of countries also hold for the sample of developing countries, the samples of middle- and low-income countries as well as for emerging market economies. It is quite interesting that trade openness and financial openness have a negative estimated coefficient although not statistically significant for the samples of industrial economies and high-income countries.

Industrial Economies: We find that shifts in fiscal policy may affect the stability of the RERs and that more flexible exchange rate arrangements tend yield more volatile RERs. Relative to industrial countries with flexible exchange rate regimes, RER volatility is approximately 45% and 49% lower in industrial economies with intermediate and fixed exchange rate regimes, respectively.

Developing countries: Greater trade openness seems to help stabilizing RERs. Doubling the degree of trade openness in developing countries would help reduce RER volatility by approximately 9%. On the other hand, greater financial openness may destabilize RERs. Raising the level of foreign liabilities (as % of GDP) from the average developing country to the average industrial economy would increase the volatility of RERs by 10%. Also, inflation would significantly contribute to increasing the volatility of RERs. Finally, RER volatility would increase by approximately 30% during times of currency crisis and developing countries with higher income levels seem to enjoy more stable RERs.

Countries classified by income levels: We should point out that the results found for high-income countries are qualitatively similar to those found for industrial economies. Trade and financial openness did not seem to play a significant role in smoothing RER shocks, and RER volatility is larger not only for countries with more flexible exchange rate arrangements but also during episodes of currency crisis in high-income countries. For middle- and low-income countries, the results are also qualitatively similar to those of the sample of developing countries. Trade openness mitigates shocks to the RER while financial openness tends to amplify them. As we find before, doubling the degree of trade openness would lead to a reduction in RER volatility of 13% in both samples of middle- and low-income countries. However, if the ratio of foreign liabilities to GDP of both middle- and low-income countries were raised to the average level of high-income countries, the RER volatility would increase by approximately 19 and 14%, respectively. Higher inflation leads to higher RER volatility in middle- and low-income countries: a reduction of 5 percentage points on the annual average inflation rate would lead to a reduction of 2 and 4 percent in RER volatility, respectively. Note that volatile productivity shocks would also lead to a significantly higher RER volatility for middle- and low-income countries. Lastly, erratic shifts in fiscal policy seem to exert a destabilizing effect on RER volatility among middle-income countries.

Emerging markets: RER volatility is lower in countries with higher trade openness and lower financial openness among countries in this group. RER volatility would decline by 13% if trade openness doubles while it increases by more than 34% if their ratio of foreign liabilities to GDP increases to the level of high-income countries. On the other hand, RER volatility is smaller in emerging market economies with fixed exchange rate regimes (by approximately 40%) as well as with intermediate regimes (by 37%). Finally, volatile productivity shocks contribute to higher RER volatility.

4.3.2 Sensitivity to Changes in the Dependent Variable

So far the dependent variable in our regression analysis is the standard deviation of 12-month RER variation. Our current task is that we test the robustness of our results by enlarging the horizon of the RER variation over which the volatility is computed. Indeed we calculate the standard deviation of RER changes over horizons of 24 months, as well as 36, 48, and 60 months. We should point that Hau (2002) used only the 36-month (3-year) variation in the monthly series of real effective exchange rates. Table 6 reports our results using IV regression techniques.

In general, we find a robust negative relationship between RER volatility and trade openness as well as a robust positive relationship between RER volatility and financial openness. Other results: RER volatility is lower in countries with less flexible exchange rate regimes (especially, fixed rates), higher in episodes of high inflation and currency crisis, and higher whenever productivity shocks or fiscal policies are more volatile.

We should remark that the IV coefficients of trade openness are negative and significant (except in 4- and 5-year RER changes) while the estimates of financial openness are positive and significant regardless of the horizon over which changes in the RER are computed. The coefficient of trade openness also declines (in absolute value) as the horizon over which the changes in the RER increases. When controlling for fundamental volatility —see columns [6] through [10] in Table 6— we observe that doubling trade openness would reduce RER volatility by 16% in the case of the volatility of 12-month variation in RER, 13% for the volatility of 36-month variation in RER, and only 4% for the volatility of 60-month variation in RER —although this latter impact is not statistically significant. On the other hand, the coefficient of financial openness rises as the horizon over which the changes in the RER reach 36 months. For instance, if the ratio of foreign liabilities jumps from the average developing country to the average industrial economy, RER volatility increases by 12% for the volatility of 12-month RER variation, and by 13.5% for the volatility of the 36-month variation in RER.

5. Extensions

In Section 4 we evaluated the relationship between RER volatility and (trade and financial) openness. Our empirical analysis rendered a robust negative correlation between (policy and outcome) measures of trade openness and real exchange rate volatility and a robust positive relationship between (outcome measures of) financial openness and RER volatility. Rising trade integration would reduce RER volatility while higher international financial integration would lead to more unstable real exchange rates.

The fact that trade openness may help dampen shocks to the RER is supported not only by theoretical foundations (Obstfeld and Rogoff, 1995; Hau, 2000; Drozd and Nosal, 2007) but also by cross-section empirical evidence (Hau, 2002). However, we further investigate the properties of trade openness to shield the RER from shocks by decomposing trade openness into trade in manufacturing goods and trade in non-manufacturing goods. We expect that the latter is more volatile to terms of trade fluctuations; therefore, may destabilize the real exchange rate.

As the theoretical model by Sutherland (1996) suggests that the relationship between financial openness and real exchange rate volatility depends on the nature of the shocks, we might expect a negative correlation in the presence of real shocks and a positive one in the presence of nominal shocks. Our results show that there is a negative relationship between our policy measure of financial openness (Chinn-Ito index of financial openness) and RER volatility but a positive one for outcome measures (foreign assets and liabilities). In order to disentangle the different results obtained with policy and outcome measures of financial openness on RER volatility, we argue that in order to capture more accurately the effects of financial openness on RER volatility we need to decompose financial openness into equity-related vs. loan-related foreign assets and liabilities. In short, the composition of capital flow matters to understand the role of financial openness in smoothing shocks to the RER.

Finally, the incidence of sudden stops among developing economies (and especially among emerging markets) may also explain the destabilizing nature of the relationship between financial openness and RER volatility. Therefore, we will test the relationship between RER volatility and openness in *turbulent* times —that is, we will evaluate the impact of financial openness on the likelihood of a drop in the RER or a currency crisis.

5.1 RER Volatility and the Composition of Trade and Capital Flows

Now we test whether the composition of capital and trade flows plays a role in the ability of trade and financial openness in smoothing shocks to the RER. Our analysis will be undertaken in two dimensions: first, we will interact trade openness with a measure of real vulnerability (say, a measure of output concentration) and financial openness with a measure of financial vulnerability (say, the debt-equity ratio), and test whether the smoothing abilities of trade and financial openness are affected by these characteristics. Second, we decompose trade openness into the ratio of trade manufacturing vs. trade in non-manufacturing goods (as a percentage of GDP) as well as financial openness into equity-related foreign (assets and) liabilities and loan-related foreign (assets and) liabilities (also as percentage of GDP) to test whether the composition of trade and capital flows matters for the smoothing properties of trade and financial openness.

5.1.1 The Role of Real and Financial Vulnerabilities

In this sub-section we include the interaction between (trade and financial) openness with (real and financial) vulnerabilities. We specifically include in our regression analysis not only measures of real and financial vulnerabilities —such as, the Herfindahl index of

output concentration and the debt-to-equity ratio —but also the interaction between trade openness and output concentration as well as financial openness and the ratio of debt-to-equity. In this framework, the impact of openness on RER volatility will depend on the measures of real and financial vulnerabilities:

$$\frac{\partial Vol(q_{it})}{\partial TO_{it}} = \alpha_1 + \alpha_2 H(y)_{it} \text{ and } \frac{\partial Vol(q_{it})}{\partial FO_{it}} = \beta_1 + \beta_2 \left(\frac{D}{E}\right)_{it}$$

where TO and FO represent trade and financial openness, $H(y)$ is the Herfindahl index of output concentration, and (D/E) is the debt-equity ratio (proxied by the ratio of debt liabilities to total foreign liabilities). We expect that the more vulnerable the economy is to either real or financial shocks —as captured by higher output concentration or higher debt-to-equity ratio —the poorer is the ability of trade and financial openness to smooth shocks to the RER. That is, we expect $\alpha_1, \beta_1 < 0$ and $\alpha_2, \beta_2 > 0$.

Table 7 reports the regression analysis including the vulnerabilities and their interaction with openness using the 5-year non-overlapping sample over the period 1975-2005 and for the sake of brevity we will discuss the IV estimates. Our estimates show that RER volatility would be lower in more open economies with less diversified economic structure. The interaction between trade openness and output concentration is positive and significant in most of the cases, thus rendering the expected result.

The response of RER volatility to doubling the extent of trade openness conditional on the Herfindahl index of output concentration is presented in the panel I of Figure 3. We observe that trade openness can mitigate shocks to the RER in countries with well-diversified structures of production. Our Herfindahl index takes values between 0.13 and 0.50 and the turning point when trade openness amplifies RER volatility fluctuates between 0.27 and 0.29. We should also emphasize that approximately 95 percent of our sample lies below the turning point specified above. This implies that for most country observations in our sample, the integration to international markets of goods may help reduce the volatility of RERs. Economically speaking, doubling the extent of trade openness would lead to a reduction in RER volatility of 33 percent for countries with very diversified production structure (10^{th} percentile in the distribution of the Herfindahl index of output = 0.145), while RER volatility declines only 14 percent for countries with very concentrated structures of production (90^{th} percentile in the distribution of the Herfindahl index of output = 0.236).

On the other hand, we find that the coefficient of financial openness is negative and significant while the interaction between financial openness and the debt-to-equity ratio is

positive and significant regardless of the specification and econometric technique used in Table 7. Our measure of debt-equity ratio —the percentage of foreign debt in total foreign liabilities (in logs) —ranges between 2.79 and 4.61 (that is, between 16 and 100 percent), and the turning point where financial openness amplifies shocks to RER is when foreign liabilities to GDP is higher than 80% of GDP. Panel I in Figure 4 shows that rising financial openness would lead to less volatile RERs in countries with lower debt-to-equity ratio, and it would destabilize RERs in countries with a higher share of debt rather than equity flows. Economically speaking, if we raise the level of financial openness of developing countries to the average among industrial economies then RER volatility would decline by 18% for countries with low debt-equity ratio (10^{th} percentile = 3.93 in logs or 51%) and would increase by 5% in countries with high debt-equity ratio (90^{th} percentile = 4.54 or 94%). Also note that depending on the specification the turning point of the debt-equity ratio ranges between 71 to 81%.

In sum, our analysis of the interaction of openness and vulnerability renders the following results: (i) Differences in the RER volatility response for non-diversified and well-diversified economies is significant for developing countries. (ii) Although RER volatility rises in response to higher output concentration in countries with low and high trade openness, the extent of openness does not explain differences in the response of RER volatility to higher output concentration. (iii) Financial openness dampens shocks to the RER for countries with low debt-equity ratios while it amplifies them for countries with high debt-equity ratios. The role played by the structure of external capital is crucial to explain cross-country differences in the sensitivity of RER volatility to financial openness. (iv) Rising debt-equity ratios (that is, a higher share of debt in total foreign liabilities) generate more volatile RERs in countries with medium to high levels of financial openness. (v) The two latter results are consistent with the view that a high share of equity in the structure of external liabilities is desirable for improving the country's resilience to external shocks (Rogoff, 1999).

5.1.2 Composition of Trade and Financial Flows

We have already shown that the ability of trade and financial openness to smooth shocks to the RER depends on the degree of diversification of the real economy and the degree of vulnerability to capital flows (as measured by the debt-to-equity ratio). At present we conduct further tests on the smoothing properties of openness by decomposing trade openness into trade in manufacturing and trade in non-manufacturing goods, and financial

openness into equity-related foreign (assets and) liabilities as well as loan-related foreign (assets and) liabilities. Following Lane and Milesi-Ferretti (2003), the measure of *equity-related financial openness* is computed as:

$$EQIFI_{it} = \left(\frac{PEQL_{it} + FDIL_{it}}{GDP_{it}} \right) x100$$

where *PEQL* and *FDIL* are the stocks of portfolio equity and FDI liabilities.[11] Note that we have also used the ratio of the stocks of portfolio equity and FDI assets and liabilities to GDP. This variable indicates the level of equity (portfolio and FDI cross-holdings). In addition, the measures of *loan-related financial openness* are computed as either the ratio of loan liabilities to GDP or the ratio of loan assets and liabilities to GDP.

In Table 8 we present the regression results where we include trade in manufacturing and non-manufacturing goods as well as equity- and loan-related financial openness for our sample of 5-year of non-overlapping observations. Our following discussion of the results will focus on the IV regression estimates in columns [5] through [8] in Table 8.

We find a robust negative relationship between trade in manufacturing and RER volatility regardless of the specification and econometric technique used. At the same time, the coefficient estimate of trade in non-manufacturing goods shows a negative coefficient although statistically not different from zero. This result may suggest the superior ability of manufacturing trade in smoothing shocks to the RER.

On the other hand, equity-related financial openness —as measured by either foreign liabilities and foreign assets and liabilities in FDI and equity —has a negative and significant coefficient (in some cases) while loan-related financial openness —that is, either loan liabilities or loan assets and liabilities — has a robust positive relationship with RER volatility. Hence, RERs are more volatile the larger is the extent of loan-related financial openness and the smaller the degree of equity-related financial openness —although this latter relationship is not robust).

We use the regression estimates of column [8] in Table 8 to provide some economic interpretation of our results. Assume an increase in manufacturing trade from the average of developing countries to the one among industrial economies (that is, an increase from 13 to 34% of GDP), and an analogous increase for equity-related and loan-related financial openness. This implies an increase in equity-related foreign assets and liabilities from 12.1 to 32.5% of GDP, and an increase in loan-related foreign assets and liabilities from 77.4 to 105.5 percent of GDP. Our estimates suggest that RER volatility would decline by 32% in

the event of rising manufacturing trade. On the other hand, RER volatility is reduced by 18% if equity-related financial openness elevates, and it increases by 34% in the event of higher loan-related financial openness. Note that if both (the log of the ratio of) equity-related and loan-related financial openness were to increase at the same rate (say each ratio increases by 20%), RER volatility would decline by 4% due to equity-related financial openness and would increase by 21% due to loan-related financial openness. In sum, RER volatility would increase if equity and loan positions experience a similar rate of growth.

5.2 Openness and RER Volatility in "Turbulent" Times

Fluctuations in RER can be determined by fluctuations of fundamentals at regular business cycle frequencies. However, drastic reversals in terms of trade, drops in output and productivity and sudden stops in capital inflows can produce sharp swings in the real exchange rate. In the present sub-section, we test whether the relationship between openness and RER volatility in "*periods of tranquility*" (associated with regular business cycle fluctuations) remains invariant in "*turbulent times*" (associated with episodes of currency crisis).

We capture RER volatility in turbulent times by either of the two binary variables: (a) *RER drops* that takes the value of one whenever the real exchange rate depreciates more than 25 percent,[12] and (b) *currency crisis* that takes the value of one for episodes of currency crisis as defined by Frankel and Rose (1996).[13] Hence, we run probit regressions for *RER drops* and for *currency crisis* using annual data for the period 1975-2005. The determinants on the incidence of either RER drops or currency crisis follows Milesi-Ferretti and Razin (1998): lagged values of economic growth, the ratio of reserves to imports, the extent of RER overvaluation, fixed exchange rate regimes, and external shocks such as shifts in terms of trade, external demand and international real interest rates. Again, our variables of interest are trade and financial openness.

Openness and RER Volatility in "Turbulent Times." Our probit regression results are reported in Table 9. We find that the likelihood of RER drops or currency crisis is smaller in countries with increasing growth, higher ratio of reserves to imports, lower inflation,

[11] We also used the ratio of the stocks of portfolio equity and FDI assets and liabilities to GDP. Note that this variable indicates the level of equity (portfolio and FDI cross-holdings).
[12] We have also defined a real exchange rate drop for declines in the RER of 15, 20, 30 and 40 percent, and the results have remained invariant. Although the results are not reported, they are available from the authors upon request.
[13] Frankel and Rose (1996) define a currency crisis episode as the event where the local currency depreciates at least 25% and where the rate of depreciation has risen at least 10%.

lower RER overvaluation, and with favorable shocks to terms of trade and external demand.

We interestingly find that if we focus on our IV estimates, there is no robust relationship between *RER drops* and (trade and financial) openness. Apparently, trade and financial openness does not seem to act as a buffer in the event of a drastic drop in the RER. However, we may further investigate whether the composition of trade and capital flows may play a role in explaining the non-significance of these coefficients.

The incidence of *currency crisis* is smaller when the economy is more integrated to the world goods markets, and it is more likely to happen when the economy is integrated to international capital markets. Note that this result is qualitatively similar to the findings in Tables 3 and 4: higher RER volatility in countries with lower (higher) integration to international goods (capital) markets. This implies that (trade and financial openness) may qualitatively have the same smoothing properties in periods associated with regular business cycle frequencies and during currency crisis episodes.

Openness, Composition and RER Volatility in "Turbulent times." As earlier, we include manufacturing and non-manufacturing trade as well as equity-related and loan-related financial openness in our probit regressions for real exchange rate drops and currency crisis. Our estimates are reported in Table 10 and we will discuss our IV regression results, where we account for the likely reverse causality of trade and financial openness.

As we see before, we find that RER overvaluation may precede the occurrence of either RER drops or currency crisis episodes, and that these turbulent events may be more likely to happen with low growth, high inflation and lower reserves to imports ratio. The likelihood of RER drops or currency crisis is less likely to happen in the event of favorable shocks to terms of trade and external demand.

Regarding our variables of interest, *RER drops* are more likely to happen whenever there is higher increase in non-manufacturing trade and rising loan-related financial openness. These collapses in RER are less likely to happen if there is a surge in manufacturing trade and an increase in equity-related financial openness. As a result, the ability of trade and financial openness to shield the economy from drastic swings in the RER would depend on whether the share of manufacturing in total trade as well as the share of equity-related financial flows increases over time.

On the other hand, higher manufacturing trade would reduce the likelihood of *currency crisis* while there is no robust relationship between non-manufacturing trade and the incidence of currency crisis. Hence, manufacturing trade may play a buffer role to shocks

to the RER during times of crisis. Equity-related financial openness reduces the likelihood of currency crisis while loan-related financial openness increases this likelihood. Note that the marginal effects of loan-related financial openness to currency crisis double that of equity-related financial openness. Therefore, for financial openness to reduce the likelihood of currency crisis, it is required a faster increase in equity-related flows (relative to debt flows). This result is consistent with the finding that equity —and, in particular, foreign direct investment —appears to be more stable in (and, hence, shield the economy against) sudden stops to financial flows (Levchenko and Mauro, 2006).

6. Conclusions

Based on the *exchange rate redux* model and its variations (Obstfeld and Rogoff, 1995; Sutherland, 1996; Hau, 2002), we find that including measures of trade and financial openness will increase the explanatory power of the volatility of shocks to fundamentals in our RER volatility regressions. We gather information for 82 countries (of which 22 are industrial economies) over the period 1975-2005 on real effective exchange rates, labor productivity in Home and Foreign country, measures of discretionary fiscal and monetary policies *a la* Fatas and Mihov (2006), policy and outcome measures of trade and financial openness, inflation and *de facto* exchange rate regimes.

In general, we find that highly volatile shifts in labor productivity as well as sharp fluctuations in monetary and fiscal policy would result in high RER volatility. Cutting fundamental volatility in half would reduce RER volatility by 19 percent in the case of productivity shocks and by 6 and 8 percent for monetary and fiscal policy volatility, respectively.[14]

Countries that are more integrated with world goods markets tend to exhibit more stable RERs. This result holds regardless of using outcome or policy measures of trade openness, and provides empirical validity to the implications the *exchange rate redux* model (Obstfeld and Rogoff, 1995; Hau, 2002). Note that the fact that countries with higher trade linkages display more stable exchange rates is consistent with the evidence presented by Devereux and Lane (2003) and Broda and Romalis (2003). Economically speaking, doubling the degree of trade openness would result in a reduction of RER volatility between 7 and 12 percent. In contrast to the mitigating role of trade openness, *outcome measures* of financial openness seem to amplify the shocks to RERs. Since Sutherland (1996) predicts a positive RER volatility-financial openness correlation in the presence of nominal

[14] These results are obtained using the coefficient estimates in column [5] of Table 4.

shocks and a negative one for real shocks, our estimated coefficient may hint the predominance of nominal shocks over real shocks. Note that these results are robust to changes in sample of countries, definition of the dependent variable and the organization of the dataset.

Interestingly, our *policy measure* (Chinn-Ito index of financial openness) renders a different result: it dampens shocks to the RER. We argue that the composition of capital flows may play a role in the resilience of countries to external shocks. Specifically, we argue that countries with higher share of equity (debt) in total foreign liabilities would be more (less) resilient to shocks to the RER. This implies that the sign of the coefficient of total foreign liabilities becomes an empirical issue: it is positive (negative) if the amplifying (mitigating) role of debt- (equity-) related liabilities prevails.

We conduct further explorations of the openness-RER volatility link. Specifically, we investigate whether the nature of the link between openness and RER volatility may be affected by the *composition of trade and capital flows*. This experiment is conducted at two different levels: (a) we test the role of output concentration and the debt-equity ratio in the smoothing properties of trade and financial openness, and (b) we evaluate the smoothing ability of manufacturing vs. non-manufacturing trade, and equity- vs. loan-related foreign (assets and) liabilities.

Our analysis renders some interesting results: (i) trade openness helps attenuate shocks to the RER, and the ability of trade openness to smooth shocks to RERs is weaker in countries with higher levels of output concentration, (ii) financial openness mitigates (amplifies) RER volatility in countries with lower (higher) shares of debt in total foreign liabilities, (iii) RER are more stable in countries with well-diversified output structures and greater share of equity in total foreign liabilities, (iv) manufacturing trade helps attenuate shocks to the RER while non-manufacturing trade seems to play no role, and, finally, (v) equity-related financial openness helps reduce RER volatility whereas loan-related financial openness amplifies it. Note that these results are consistent with the fact that greater equity-related financial openness may enhance the resilience of the country against shocks —especially, shocks to the RER (Rogoff, 1999).

Finally, we find that trade openness (mainly driven by manufacturing trade) helps to reduce the likelihood of severe drops in the real exchange rate or currency crisis —which is consistent with the findings of Cavallo and Frankel (2007). On the other hand, higher international financial integration seems to increase the likelihood of RER drops or currency crisis. Interestingly, the composition of capital flows plays a key role in

disentangling the effects of financial openness on currency crisis. While higher loan-related financial openness increases the likelihood of currency crisis episodes, rising equity-related financial openness seems to reduce this probability. This result is consistent with the findings of Levchenko and Mauro (2006) where greater equity share in total liabilities may reduce the probability of sudden stops.

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Appendix I: The Model

We use the *redux* model (Obstfeld and Rogoff, 1995, 1996) as a general framework to generate inferences on the real exchange rate volatility. 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 ∈ [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:

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

where $\beta \in (0,1)$, and $\sigma, \kappa > 0$.[15] On the other hand, C_T represents the consumption of traded goods, and C_N is the composite consumption of non-traded goods:

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

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

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

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:

[15] 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 $y_N = A \ell_N^{\alpha}$ ($\alpha < 1$), then $\kappa = 2\psi / A^{1/\alpha}$. The output term in equation (I.1) is obtained when $\alpha = 0.5$. A rise in productivity A is here captured by a fall in κ (Obstfeld and Rogoff, 1996).

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

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),

$$\frac{M_t - M_{t-1}}{P_t} + \tau_t = 0 \quad \text{(I.5)}$$

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

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

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:

$$C_{T,t+1} = C_{T,t} \quad \text{(I.7)}$$

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

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

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

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 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.[16]

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

Now 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 $\bar{y}_T$, and the first-order condition of consumption smoothing in tradables, equation (I.7), we find that $C_{T,t} = \bar{y}_T$, 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

[16] 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 $\theta/(\theta-1)$ is added by monopolistically competitive firms.

(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.

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[17]

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 faces 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.

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

Appendix II: Instrumenting Trade Openness

Our outcome measure of trade openness is the real value of exports and imports as a percentage of GDP. Clearly, shocks to the RER can affect the level of trade openness and, hence, the OLS estimation of our regression equation may yield inconsistent coefficient estimates. To instrument for trade openness we will follow the identification strategy developed by Frankel and Romer (1999) and used in empirical work by Cavallo and Frankel (2007) and Cavallo (2007).

We use the gravity equation model of bilateral trade where the trade between two countries depends positively on the size of the countries and inversely related to their distance. A parsimonious specification of this model is:

$$\ln\left(\frac{x_{jk}+m_{jk}}{GDP_j}\right)=\beta_0+\beta_1\ln D_{jk}+\beta_2 S_j+\beta_3\ln S_k+\varepsilon_{jk}$$

where $x_{jk}+m_{jk}$ is bilateral trade (exports and imports) between countries *j* and *k* as a ratio to *GDP* of country *j*, D_{jk} represents the distance between those countries, and S_j and S_k are measures of country size.

Our full specification includes geographical variables such as the distance between countries *j* and *k*, a variable that captures the number of *landlocked* countries in the pair, a dummy for countries sharing a *border* and a *common language*. Our size variables are the log of area and population for countries *j* and *k*. Following Frankel and Romer (1999) we also include interaction terms of all determinants of bilateral trade with the dummy of common border in order to identify geographic influences on overall trade.

The final specification and the results for all non-overlapping 5-year periods of our data are reported in Table A.3.[18] Given the empirical success of gravity models, the results are the expected ones. That is, bilateral trade between countries j and k increases if the countries are closer in distance, they share a common border or they speak the same language, if they are larger in size (as measured by the population), and if they are not landlocked.

The instrument for trade openness is constructed by aggregating the fited values from the gravity equation model of bilateral trade. If we assume that the specification of the model regressed in Table A.3 is

[18] For the non-overlapping data set we run annual regressions of the gravity equation model —as specified in Table A.3. We should remark that the results are qualitatively similar and although they are not reported in the paper, they are available from the authors upon request.

$$\ln\left(\frac{x_{jk}+m_{jk}}{GDP_j}\right)=\beta' X_{j,k}+e_{jk}$$

where β is the vector of coefficient estimates in our gravity equation model, and $X_{j,k}$ is the vector of explanatory variables (which includes geographic and interactions between size and geographic variables). Hence, we can estimate the *geographic component* of country *j*'s overall trade share as:

$$\hat{T}_j=\sum_{j\neq k}\exp\left(\hat{\beta}' X_{j,k}\right)$$

In sum, the *geographic component of country j's trade* is the sum of estimated geographic components of its bilateral trade with other countries in the world. As in Frankel and Romer (1999) and Cavallo and Frankel (2007) we construct our instrument for trade openness not only for the countries covered in the bilateral trade data set but over all countries in the world —in effect, we have computed $\hat{T}_j$ for 147 countries. Our results find that the instrument is positively correlated with actual trade openness and that this correlation fluctuates between 0.51 and 0.56.

Table 1
Real Exchange Rate Volatility and Openness: Statistics
Sample of 82 countries, 1975-2005 (5-year period observations)

	All Countries	By level of development		By income level		
		Industrial	Developing	High	Middle	Low
Volatility of the real effective exchange rate (REER), in logs						
Std. Dev. 12-month REER variation	2.00	1.52	2.17	1.53	2.09	2.34
Std. Dev. 24-month REER variation	2.23	1.80	2.39	1.81	2.31	2.54
Std. Dev. 36-month REER variation	2.32	1.89	2.48	1.90	2.42	2.62
Std. Dev. 48-month REER variation	2.36	1.92	2.51	1.93	2.46	2.63
Std. Dev. 60-month REER variation	2.38	1.96	2.53	1.96	2.49	2.64
Fundamental Volatility (standard deviation, in logs)						
Home-Foreign Productivity Differentials	0.73	0.13	0.95	0.20	0.92	0.99
Fiscal Policy 1/	-3.12	-4.27	-2.70	-4.16	-2.94	-2.35
Monetary Policy 1/	-3.94	-4.52	-3.73	-4.49	-3.85	-3.51
Trade Openness (TO)						
TO Policy Measure (*Wacziarg-Welch*) 2/	0.71	0.98	0.58	0.97	0.63	0.45
Trade as % GDP, in logs	3.98	3.93	4.00	4.02	3.98	3.95
- Trade in manufacturing goods	2.85	3.51	2.59	3.62	2.65	2.32
- Trade in non-manufacturing goods	3.09	2.37	3.36	2.44	3.36	3.38
Financial Openness						
Policy Measure:						
- IMF's capital account openness 3/	0.33	0.60	0.23	0.59	0.28	0.15
- Chinn-Ito measure of financial openness 4/	0.18	1.53	-0.31	1.50	-0.19	-0.60
Outcome Measure:						
- Foreign Liabilities, % of GDP, in logs	4.31	4.40	4.27	4.44	4.22	4.29
(i) Equity-related foreign liabilities	2.53	2.85	2.41	2.90	2.64	1.94
(ii) Loan-related foreign liabilities	3.99	4.09	3.96	4.11	3.85	4.09
- Foreign Assets & Liabilities, % of GDP, in logs	4.70	4.98	4.59	5.03	4.60	4.51
(i) Equity-related foreign assets & liabilities	2.78	3.48	2.52	3.52	2.76	2.00
(ii) Loan-related foreign assets & liabilities	4.45	4.66	4.37	4.70	4.32	4.36
Vulnerabilities						
Output concentration (Herfindahl index)	0.19	0.18	0.19	0.18	0.17	0.22
Debt liabilities (% total liabilities, in logs)	4.30	4.29	4.30	4.28	4.23	4.42
Other Control Variables						
Real income per capita (in logs)	7.73	9.76	6.99	9.74	7.60	5.92
CPI Inflation (in logs) 5/	4.77	4.66	4.81	4.67	4.81	4.81

*1/ Monetary and Fiscal Policy volatility are calculated using the methodology of Fatas and Mihov (2003, 2006). For fiscal policy volatility we regress government spending (as a ratio to GDP) on output, lagged government spending and we instrument output growth with lagged output growth and current and lagged values of oil prices. The same methodology is applied to monetary policy using the ratio of money supply to GDP. 2/ The policy measure of trade openness is the dummy of trade liberalization updated by Wacziarg and Welch (2003) from Sachs and Warner (1995). It takes the value of 1 when the trade regime is considered "open". 3/ The IMF policy measure of financial openness is the dummy that takes the value of 1 whenever there are no restrictions on capital account transactions, and 0 otherwise. The source fo the data is the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER). 4/ The Chinn-Ito measures of financial openness is based on the binary dummy variables that codify the tabulation of restrictions on cross-border financial transactions reported by the IMF's AREAER (presence of multiple exchange rates, restrictions on current account transactions, restrictions on capital account transactions and the requirement of the surrender of export proceeds). The aggregate index is the fist standardized principal component of these 4 indicators. 5/The log of the CPI inflation rate is computed as: ln[(1+dp)*100], where dp is the log differences of the CPI index.*

Table 2

Real Exchange Rate Volatility and Openness: Panel Correlation Analysis

Sample panel correlation between real exchange rate volatility (12-month variation) with determinants

Sample of 82 countries, 1975-2005 (5-year period observations)

	All	By level of development		By income level		
	Countries	Industrial	Developing	High	Middle	Low
Fundamental Volatility (standard deviation, in logs)						
Home-Foreign Productivity Differentials	0.43	0.49	0.29	0.44	0.32	0.26
Fiscal Policy 1/	0.46	0.16	0.36	0.17	0.28	0.40
Monetary Policy 1/	0.35	0.28	0.23	0.26	0.25	0.14
Trade Openness						
Policy Measure 2/	-0.35	-0.10	-0.25	-0.21	-0.27	-0.13
Trade as % GDP, in logs	-0.30	-0.41	-0.34	-0.35	-0.52	-0.04
- In manufacturing goods	-0.41	-0.50	-0.30	-0.43	-0.34	-0.16
- In non-manufacturing	0.05	-0.20	-0.11	-0.18	-0.32	0.06
Financial Openness						
Policy Measure:						
- IMF's capital account openness 3/	-0.24	-0.01	-0.17	-0.05	-0.16	-0.08
- Chinn-Ito measure of financial openness 4/	-0.38	-0.12	-0.27	-0.17	-0.31	-0.12
Outcome Measure:						
- Foreign Liabilities, % of GDP, in logs	-0.08	-0.29	0.00	-0.29	-0.22	0.28
(i) Equity-related foreign liabilities	-0.32	-0.26	-0.30	-0.29	-0.29	-0.23
(ii) Loan-related foreign liabilities	0.01	-0.30	0.11	-0.28	-0.09	0.33
- Foreign Assets & Liabilities, % of GDP, in logs	-0.19	-0.31	-0.06	-0.32	-0.26	0.26
(i) Equity-related foreign assets & liabilities	-0.36	-0.24	-0.30	-0.28	-0.27	-0.23
(ii) Loan-related foreign assets & liabilities	-0.12	-0.32	0.01	-0.32	-0.19	0.30
Vulnerabilities						
Output concentration (Herfindahl index)	0.16	-0.06	0.17	-0.12	0.04	0.22
Debt liabilities (% total liabilities, in logs)	0.23	0.05	0.28	0.13	0.25	0.21
Other Control Variables						
Real income per capita (in logs)	-0.36	0.01	-0.15	-0.02	0.12	-0.14
CPI Inflation (in logs) 5/	0.55	0.33	0.55	0.31	0.52	0.59

We compute the pairwise correlation between the volatility of the real exchange rate and the different variables presented in the Table for different samples of countries.

For 1/, 2/, 3, 4/ and 5/ see footnote in Table 1.

Table 3

Openness and Real Exchange Rate Volatility: Basic Regression Analysis

Dependent Variable: Standard deviation of the 12-month variation in the real effective exchange rate (in logs)
Sample of 82 countries, 1975-2005 (5-year period observations)
Methodology: Least squares

	[1]	[2]	[3]	[4]	[5]	[6]
Trade Openness (TO)						
Policy Measure 1/	0.047	..	..	0.070	..	
Wacziarg and Welch measure	(0.11)			(0.10)		
Real exports and imports	..	-0.266 **	-0.256 **	..	-0.243 **	-0.232 **
as % of GDP (in logs)		(0.12)	(0.12)		(0.12)	(0.12)
Financial Openness (FO)						
Policy Measure 2/	-0.040	..	..	-0.032	..	
Chinn-Ito index	(0.03)			(0.03)		
Foreign Liabilities	..	0.236 **	..	..	0.193 **	
as % of GDP (in logs)		(0.08)			(0.08)	
Foreign Assets and Liabilities	..	..	0.215 **	..	..	0.171 **
as % of GDP (in logs)			(0.09)			(0.08)
Basic Controls						
Fixed Exchange Rate Regime	-0.429 **	-0.452 **	-0.438 **	-0.308 **	-0.309 **	-0.297 **
(dummy variable)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)
Intermediate Exchange Rate Regime	-0.430 **	-0.361 **	-0.360 **	-0.356 **	-0.285 **	-0.285 **
(dummy variable)	(0.10)	(0.10)	(0.10)	(0.09)	(0.09)	(0.09)
Inflation	0.804 **	0.645 **	0.655 **	0.668 **	0.519 **	0.526 **
(CPI inflation rate, in logs)	(0.11)	(0.10)	(0.10)	(0.11)	(0.09)	(0.10)
Currency crisis 3/	0.352 **	0.497 **	0.506 **	0.270 **	0.423 **	0.430 **
(Dummy = 1 when crisis occurs)	(0.10)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
Income per capita	-0.080	-0.246 *	-0.276 **	-0.068	-0.248 **	-0.271 **
(in logs)	(0.16)	(0.13)	(0.13)	(0.15)	(0.12)	(0.12)
Fundamental Volatility						
Home-Foreign Productivity Differential	..	..	..	0.177 **	0.208 **	0.207 **
				(0.05)	(0.04)	(0.04)
Monetary Policy 4/	..	..	..	0.133 **	0.122 **	0.122 **
				(0.04)	(0.04)	(0.04)
Fiscal Policy 4/	..	..	..	0.130 **	0.122 **	0.125 **
				(0.04)	(0.04)	(0.04)
Observations	426	479	479	425	476	476
R**2	0.699	0.693	0.691	0.736	0.731	0.729

*Our basic regression equation includes a constant and accounts for country- and time-specific effects. Note that although the country dummies and time dummies are not reported, they are available from the authors upon request. The numbers in parenthesis below the coefficient estimates are robust standard errors. * (**) implies statistical significance at 10 (5) % level. 1/ The policy measure of trade openness is the dummy of trade liberalization updated by Wacziarg and Welch (2003) from Sachs and Warner (1995). It takes the value of 1 when the trade regime is considered "open". 2/ The Chinn-Ito measure of financial openness is based on the binary dummy variables that codify the tabulation of restrictions on cross-border financial transactions reported by the IMF's AREAER (presence of multiple exchange rates, restrictions on current account transactions, restrictions on capital account and the requirement of the surrender of export proceeds). The aggregate index is the fist standardized principal component of these 4 indicators. 3/ The currency crisis variable is a binary dummy variable that takes the value of 1 whenever there is a currency crisis. To define this episode we follow the Frankel and Romer (1996) methodology. 4/ Monetary and fiscal policy volatility are calculated using using the methodology of Fatas and Mihov (2003, 2006). For fiscal policy volatility we regress government spending (as a ratio to GDP) on output, lagged government spending, and we instrument output growth with lagged output growth and current and lagged values of oil prices. The same methodology is applied to monetary policy using the money supply to GDP ratio.*

Table 4

Openness and Real Exchange Rate Volatility: Instrumental Variables in the Basic Regression

Dependent Variable: Standard deviation of the 12-month variation in the real effective exchange rate (in logs)
Sample of 82 countries, 1975-2005 (5-year period observations)
Methodology: Instrumental Variables

	[1]	[2]	[3]	[4]	[5]	[6]
Trade Openness (TO)						
Policy Measure 1/	-0.004	..	..	0.191	..	..
Wacziarg and Welch measure	(0.22)			(0.19)		
Real exports and imports	..	-0.295 **	-0.371 **	..	-0.229 **	-0.314 **
as % of GDP (in logs)		(0.08)	(0.11)		(0.09)	(0.11)
Financial Openness (FO)						
Policy Measure 2/	-0.201	..	..	-0.179	..	..
Chinn-Ito index	(0.17)			(0.16)		
Foreign Liabilities	..	0.713 **	..	..	0.920 **	..
as % of GDP (in logs)		(0.26)			(0.27)	
Foreign Assets and Liabilities	..	..	0.850 **	..	..	1.050 **
as % of GDP (in logs)			(0.30)			(0.32)
Basic Controls						
Fixed Exchange Rate Regime	-0.319 *	-0.453 **	-0.446 **	-0.217	-0.331 **	-0.319 **
(dummy variable)	(0.19)	(0.12)	(0.12)	(0.18)	(0.12)	(0.13)
Intermediate Exchange Rate Regime	-0.446 **	-0.180 *	-0.108	-0.418 **	-0.061	0.020
(dummy variable)	(0.11)	(0.12)	(0.14)	(0.10)	(0.12)	(0.14)
Inflation	0.689 **	0.802 **	0.811 **	0.585 **	0.623 **	0.642 **
(CPI inflation rate, in logs)	(0.16)	(0.13)	(0.13)	(0.16)	(0.13)	(0.13)
Currency crisis 3/	0.335 **	0.387 **	0.382 **	0.291 **	0.284 **	0.286 **
(Dummy = 1 when crisis occurs)	(0.12)	(0.11)	(0.12)	(0.11)	(0.12)	(0.12)
Income per capita	-0.270	-0.809 **	-0.940 **	-0.175	-0.845 **	-0.982 **
(in logs)	(0.19)	(0.21)	(0.24)	(0.19)	(0.22)	(0.25)
Fundamental Volatility						
Home-Foreign Productivity Differential	..	..	..	0.189 **	0.269 **	0.271 **
				(0.05)	(0.05)	(0.06)
Monetary Policy 4/	..	..	..	0.126 **	0.089 *	0.084 *
				(0.05)	(0.05)	(0.06)
Fiscal Policy 4/	..	..	..	0.122 **	0.117 **	0.116 **
				(0.05)	(0.05)	(0.05)
Observations	404	449	449	403	447	447
R**2	0.682	0.693	0.693	0.715	0.714	0.721

*Our basic regression equation includes a constant and accounts for country- and time-specific effects. Note that although the country dummies and time dummies are not reported, they are available from the authors upon request. The numbers in parenthesis below the coefficient estimates are robust standard errors. * (**) implies statistical significance at 10 (5) % level. Our instrumental variable (IV) approach controls for the endogeneity of trade openness as well as financial openness. Our outcome measure of trade openness is instrumented using the the gravity equation model as in Frankel and Romer (1999) and Cavallo and Frankel (2007). On the other hand, our outcome measure of financial openness is instrumented with the origin of the country's legal system, initial value of natural resource abundance, institutional quality, concentration of exports, and other geographical and size factors following Faria, Lane, Mauro and Milesi-Ferreti (2006). Finally, for 1/, 2/, 3/ and 4/, see footnote in Table 3.*

Table 5

Sensitivity Analysis I: Robustness across different samples, Instrumental Variables (IV)

Dependent Variable: Standard deviation of the 12-month variation in the real effective exchange rate (in logs)

Sample of 82 countries, 1975-2005 (5-year period observations)

Methodology: Instrumental Variables (accounting for country- and time-specific effects)

	All	By level of Development		By Income Level			Emerging
	Countries	Industrial	Developing	High	Middle	Low	Markets
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Trade Openness (TO)							
Real exports and imports	-0.229 **	-0.073	-0.136 *	0.038	-0.142	-0.193 *	-0.194 *
as % of GDP (in logs)	(0.09)	(0.10)	(0.07)	(0.17)	(0.11)	(0.12)	(0.12)
Financial Openness (FO)							
Foreign Liabilities	0.920 **	-0.129	0.778 **	-0.468	0.894 **	0.704 **	0.912 *
as % of GDP (in logs)	(0.27)	(0.34)	(0.21)	(0.69)	(0.41)	(0.27)	(0.47)
Basic Controls							
Fixed Exchange Rate Regime	-0.331 **	-0.491 **	-0.074	-0.383 *	-0.182	-0.088	-0.397 **
(dummy variable)	(0.12)	(0.15)	(0.15)	(0.22)	(0.22)	(0.25)	(0.19)
Intermediate Exchange Rate Regime	-0.061	-0.454 **	-0.178	-0.517 **	-0.370 **	0.143	-0.373 **
(dummy variable)	(0.12)	(0.15)	(0.12)	(0.24)	(0.17)	(0.24)	(0.18)
Inflation	0.623 **	1.569	0.666 **	0.050	0.508 **	0.874 **	0.214
(CPI inflation rate, in logs)	(0.13)	(1.19)	(0.13)	(0.50)	(0.16)	(0.22)	(0.16)
Currency crisis 1/	0.284 **	0.187	0.303 **	0.320 *	0.113	0.558 **	0.114
(Dummy = 1 when crisis occurs)	(0.12)	(0.17)	(0.12)	(0.18)	(0.15)	(0.21)	(0.20)
Income per capita	-0.845 **	0.059	-0.501 **	0.079	-0.365 *	-0.604 **	-0.665 **
(in logs)	(0.22)	(0.70)	(0.16)	(1.07)	(0.24)	(0.27)	(0.32)
Fundamental Volatility							
Home-Foreign Productivity Differential	0.269 **	0.054	0.274 **	0.012	0.180 **	0.400 **	0.238 **
	(0.05)	(0.07)	(0.06)	(0.09)	(0.08)	(0.09)	(0.09)
Monetary Policy 2/	0.089 *	0.082	0.086	0.030	0.105	0.106	0.047
	(0.05)	(0.06)	(0.06)	(0.06)	(0.09)	(0.11)	(0.08)
Fiscal Policy 2/	0.117 **	0.125 **	0.126 **	0.117 *	0.155 **	0.156	0.110
	(0.05)	(0.06)	(0.06)	(0.07)	(0.07)	(0.10)	(0.08)
Observations	447	127	320	139	194	114	118
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R**2	0.615	0.594	0.569	0.592	0.533	0.525	0.570

*Our basic regression equation includes a constant and accounts for country- and time-specific effects. Note that although the country dummies and time dummies are not reported, they are available from the authors upon request. The numbers in parenthesis below the coefficient estimates are robust standard errors. * (**) implies statistical significance at 10 (5) % level.*

See footnote in Table 4 for the instrumentation and for the definition of currency crisis (1/) and fiscal and monetary policy volatility (2/).

Table 6

Sensitivity Analysis II: Robustness to Changes in the Dependent Variable, Instrumental Variables (IV)

Dependent Variable: Standard deviation of the variation in the real effective exchange rate at different horizons (in logs)

Sample of 82 countries, 1975-2005 (5-year period observations)

Methodology: Instrumental Variables (accounting for country- and time-specific effects)

	Standard Deviation of the changes in REER:					Standard Deviation of the changes in REER:				
	12-month	24-month	36-month	48-month	60-month	12-month	24-month	36-month	48-month	60-month
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
Trade Openness (TO)										
Real exports and imports	-0.295 **	-0.262 **	-0.230 **	-0.098	-0.074	-0.229 **	-0.206 **	-0.186 **	-0.061	-0.056
as % of GDP (in logs)	(0.08)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
Financial Openness (FO)										
Foreign Liabilities	0.713 **	0.768 **	0.835 **	0.596 **	0.711 **	0.920 **	0.948 **	1.013 **	0.774 **	0.849 **
as % of GDP (in logs)	(0.26)	(0.28)	(0.28)	(0.28)	(0.28)	(0.27)	(0.29)	(0.30)	(0.29)	(0.30)
Basic Controls										
Fixed Exchange Rate Regime	-0.453 **	-0.253 **	-0.127	-0.141	-0.138	-0.331 **	-0.144	-0.046	-0.065	-0.072
(dummy variable)	(0.12)	(0.13)	(0.13)	(0.13)	(0.13)	(0.12)	(0.13)	(0.13)	(0.13)	(0.13)
Intermediate Exchange Rate Regime	-0.180 *	-0.114	0.009	0.005	0.114	-0.061	-0.008	0.097	0.092	0.191
(dummy variable)	(0.12)	(0.13)	(0.13)	(0.13)	(0.13)	(0.12)	(0.13)	(0.14)	(0.13)	(0.14)
Inflation	0.802 **	0.863 **	0.850 **	1.042 **	1.084 **	0.623 **	0.703 **	0.722 **	0.930 **	1.011 **
(CPI inflation rate, in logs)	(0.13)	(0.13)	(0.14)	(0.13)	(0.13)	(0.13)	(0.14)	(0.14)	(0.14)	(0.14)
Currency crisis 1/	0.387 **	0.363 **	0.303 **	0.324 **	0.188 *	0.284 **	0.271 **	0.216 *	0.246 **	0.141
(Dummy = 1 when crisis occurs)	(0.11)	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)	(0.13)	(0.12)	(0.13)
Income per capita	-0.809 **	-0.819 **	-0.842 **	-0.675 **	-0.571 **	-0.845 **	-0.840 **	-0.874 **	-0.721 **	-0.610 **
(in logs)	(0.21)	(0.22)	(0.23)	(0.22)	(0.22)	(0.22)	(0.23)	(0.24)	(0.23)	(0.24)
Fundamental Volatility										
Home-Foreign Productivity Differential	..	..	..	..	..	0.269 **	0.237 **	0.231 **	0.219 **	0.158 **
						(0.05)	(0.06)	(0.06)	(0.06)	(0.06)
Monetary Policy 2/	..	..	..	..	..	0.089 *	0.090 *	0.047	0.028	-0.007
						(0.05)	(0.06)	(0.06)	(0.06)	(0.06)
Fiscal Policy 2/	..	..	..	..	..	0.117 **	0.097 *	0.065	0.056	0.049
						(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Observations	449	449	449	449	449	447	447	447	447	447
R**2	0.693	0.653	0.657	0.644	0.636	0.714	0.665	0.676	0.665	0.647

Our basic regression equation includes a constant and accounts for country- and time-specific effects. Note that although the country dummies and time dummies are not reported, they are available from the authors upon request.

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

Our instrumental variable (IV) approach controls for the endogeneity of trade openness as well as financial openness. Our outcome measure of trade openness is instrumented using the gravity equation model as in Frankel and Romer (1999), and Cavallo and Frankel (2007). On the other hand, our outcome measure of financial openness is instrumented with the origin of the country's level system, initial values of natural resource abundance, institutional quality, concentration of of exports, and other geographical and size factors following Faria, Lane, Mauro and Milesi-Ferreti (2006). Finally, for 1/ and 2/, see footnote 3/ and 4/ in Table 3.

Table 7

Openness, Vulnerabilities and Real Exchange Rate Volatility

Dependent Variable: Standard deviation of the 12-month variation in the real effective exchange rate (in logs)
Sample of 82 countries, 1975-2005 (5-year period observations)

	Least Squares				Instrumental Variables			
Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Trade Openness (TO)								
TO: Real exports and imports	-0.513 **	-0.402 *	-0.480 **	-0.367 *	-1.074 **	-0.836 **	-0.997 **	-0.706 *
as % of GDP (in logs)	(0.24)	(0.23)	(0.25)	(0.24)	(0.45)	(0.39)	(0.45)	(0.38)
TO x Output Concentration	1.269	0.933	1.441	0.925	3.953 **	3.039 **	3.519 **	2.404 *
	(1.13)	(1.07)	(1.13)	(1.08)	(1.75)	(1.50)	(1.74)	(1.50)
Output Concentration	-2.355	-1.746	-2.974	-1.668	4.285 **	3.251 **	5.050 **	4.367 **
(Herfindahl index of output concentration)	(3.85)	(3.64)	(3.86)	(3.68)	(1.76)	(1.54)	(1.87)	(1.62)
Financial Openness (FO)								
FO: Foreign Liabilities	-1.366 *	-0.870	-0.993	-0.759	-18.151 **	-13.695 **	-17.497 **	-12.865 **
as % of GDP (in logs)	(0.80)	(0.76)	(0.81)	(0.77)	(6.08)	(5.28)	(5.66)	(4.81)
FO x Debt-Equity ratio	0.338 *	0.236	0.279	0.216	4.224 **	3.211 **	3.996 **	2.924 **
	(0.18)	(0.18)	(0.19)	(0.18)	(1.41)	(1.22)	(1.33)	(1.13)
Debt-Equity ratio	-0.952	-0.705	-0.933	-0.718	-18.094 **	-14.023 **	-15.039 **	-10.469 *
(Debt liabilities as % of total liabilities)	(0.81)	(0.77)	(0.81)	(0.77)	(6.52)	(5.61)	(6.69)	(5.69)
Basic Controls								
Fixed Exchange Rate Regime	-0.365 **	-0.282 **	-0.415 **	-0.286 **	-0.422 **	-0.345 **	-0.220	-0.102
(dummy variable)	(0.11)	(0.11)	(0.12)	(0.11)	(0.18)	(0.15)	(0.24)	(0.20)
Intermediate Exchange Rate Regime	-0.371 **	-0.302 **	-0.376 **	-0.298 **	-0.622 **	-0.496 **	-0.534 **	-0.406 **
(dummy variable)	(0.10)	(0.09)	(0.10)	(0.10)	(0.18)	(0.16)	(0.19)	(0.16)
Inflation	0.636 **	0.498 **	0.596 **	0.488 **	0.563 **	0.523 **	0.583 **	0.504 **
(CPI inflation rate, in logs)	(0.10)	(0.10)	(0.10)	(0.10)	(0.18)	(0.16)	(0.17)	(0.15)
Currency crisis 1/	0.479 **	0.417 **	0.488 **	0.421 **	0.381 **	0.353 **	0.383 **	0.348 **
(Dummy = 1 when crisis occurs)	(0.09)	(0.09)	(0.09)	(0.09)	(0.14)	(0.12)	(0.14)	(0.12)
Income per capita	-0.282 **	-0.224 *	-0.212 *	-0.209 *	-0.276	-0.342	0.171	0.169
(in logs)	(0.13)	(0.12)	(0.13)	(0.13)	(0.30)	(0.26)	(0.44)	(0.38)
Fundamental Volatility								
Home-Foreign Productivity Differential	..	0.201 **	..	0.191 **	..	0.208 **	..	0.147 **
		(0.04)		(0.05)		(0.07)		(0.07)
Monetary Policy 2/	..	0.117 **	..	0.116 **	..	0.099 *	..	0.143 **
		(0.04)		(0.04)		(0.06)		(0.07)
Fiscal Policy 2/	..	0.121 **	..	0.122 **	..	0.080	..	0.117 *
		(0.04)		(0.04)		(0.06)		(0.06)
Observations	467	464	467	464	432	430	432	430
Time Dummies	No	No	Yes	Yes	No	No	Yes	Yes
Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R**2	0.430	0.465	0.702	0.735	0.268	0.330	0.385	0.552

*Our basic regression equation includes a constant and accounts for country- and time-specific effects. Note that although the country dummies and time dummies are not reported, they are available from the authors upon request. The numbers in parenthesis below the coefficient estimates are robust standard errors. * (**) implies statistical significance at 10 (5) % level.*
See footnote in Table 6 for the instrumentation procedure as well as the definition of variables 1/ and 2/

Table 8

Composition Effects of Openness on Real Exchange Rate Volatility

Dependent Variable: Standard deviation of the 12-month variation in the real effective exchange rate (in logs)

Sample of 82 countries, 1975-2005 (5-year period observations)

	Least Squares				Instrumental Variables			
Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Trade Openness (TO)								
Trade in Manufacturing Goods	-0.130 *	-0.132 **	-0.122 *	-0.126 *	-0.499 **	-0.441 **	-0.369 *	-0.348 *
as % of GDP (in logs)	(0.07)	(0.06)	(0.07)	(0.06)	(0.20)	(0.19)	(0.20)	(0.19)
Trade in Non-Manufacturing Goods	0.018	0.030	0.016	0.029	-0.043	-0.038	-0.065	-0.069
as % of GDP (in logs)	(0.09)	(0.09)	(0.09)	(0.09)	(0.28)	(0.25)	(0.28)	(0.25)
Financial Openness (FO)								
Equity-related Liabilities	-0.052	-0.057	..	..	-0.186	-0.045	..	..
as % of GDP (in logs)	(0.05)	(0.05)			(0.14)	(0.13)		
Loan-related Liabilities	0.233 **	0.206 **	..	..	1.232 **	1.009 **	..	..
as % of GDP (in logs)	(0.07)	(0.07)			(0.31)	(0.28)		
Equity-related Assets and Liabilities	..	..	-0.051	-0.059	..	..	-0.356 **	-0.190
as % of GDP (in logs)			(0.05)	(0.05)			(0.16)	(0.15)
Loan-related Assets and Liabilities	..	..	0.213 **	0.184 **	..	..	1.368 **	1.156 **
as % of GDP (in logs)			(0.09)	(0.09)			(0.40)	(0.37)
Basic Controls								
Fixed Exchange Rate Regime	-0.421 **	-0.283 **	-0.420 **	-0.281 **	-0.260 *	-0.225 *	-0.226 *	-0.191
(dummy variable)	(0.11)	(0.11)	(0.11)	(0.11)	(0.15)	(0.14)	(0.15)	(0.13)
Intermediate Exchange Rate Regime	-0.330 **	-0.250 **	-0.338 **	-0.258 **	0.013	0.009	0.043	0.041
(dummy variable)	(0.10)	(0.09)	(0.10)	(0.09)	(0.15)	(0.13)	(0.16)	(0.14)
Inflation	0.845 **	0.694 **	0.857 **	0.706 **	0.551 **	0.481 **	0.575 **	0.488 **
(CPI inflation rate, in logs)	(0.11)	(0.11)	(0.11)	(0.11)	(0.18)	(0.16)	(0.18)	(0.16)
Currency crisis 1/	0.471 **	0.397 **	0.473 **	0.399 **	0.299 **	0.274 **	0.322 **	0.285 **
(Dummy = 1 when crisis occurs)	(0.09)	(0.09)	(0.09)	(0.09)	(0.13)	(0.12)	(0.13)	(0.12)
Income per capita	-0.103	-0.074	-0.122	-0.089	-0.092	-0.121	-0.206	-0.229
(in logs)	(0.15)	(0.14)	(0.15)	(0.14)	(0.22)	(0.20)	(0.22)	(0.20)
Fundamental Volatility								
Home-Foreign Productivity Differential	..	0.192 **	..	0.196 **	..	0.189 **	..	0.188 **
		(0.04)		(0.04)		(0.05)		(0.05)
Monetary Policy 2/	..	0.131 **	..	0.130 **	..	0.124 **	..	0.126 **
		(0.04)		(0.04)		(0.05)		(0.05)
Fiscal Policy 2/	..	0.138 **	..	0.138 **	..	0.123 **	..	0.125 **
		(0.04)		(0.04)		(0.05)		(0.05)
Observations	461	458	461	458	441	439	441	439
R**2	0.696	0.738	0.692	0.735	0.613	0.629	0.646	0.586

*Our basic regression equation includes a constant and accounts for country- and time-specific effects. Note that although the country dummies and time dummies are not reported, they are available from the authors upon request. The numbers in parenthesis below the coefficient estimates are robust standard errors. * (**) implies statistical significance at 10 (5) % level.*

See footnote in Table 6 for the instrumentation procedure as well as the definition of variables 1/ and 2/

Table 9

Openness and Real Exchange Rate Volatility in "Turbulent Times"

Dependent Variable: Incidence of real exchange rate drops or currency crisis
Sample of 82 countries, 1975-2005 (annual observations)
Estimation: Probit (accounting for fixed and time-effects)

	Real Exchange Rate Drops 1/				Currency Crises 2/			
	LS	LS	IV	IV	LS	LS	IV	IV
Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Trade Openness (TO)								
Real exports and imports	-0.376 **	-0.274 *	0.008	0.007	-0.525 **	-0.420 **	-0.059	-0.056
as % of GDP (in logs)	(0.16)	(0.16)	(0.04)	(0.04)	(0.16)	(0.17)	(0.04)	(0.04)
Financial Openness (FO)								
Foreign Liabilities	0.220 *	..	0.057	..	0.352 **	..	0.140	
as % of GDP (in logs)	(0.13)		(0.11)		(0.13)		(0.11)	
Foreign Assets and Liabilities	..	0.051	..	-0.067	..	0.169		-0.008
as % of GDP (in logs)		(0.13)		(0.11)		(0.13)		(0.11)
Domestic Controls								
Economic Growth	-1.641	-1.893	-2.063	-2.146	-1.751	-1.878 *	-1.987 *	-2.025 *
(log differences of real GDP per capita)	(1.50)	(1.48)	(1.47)	(1.46)	(1.19)	(1.18)	(1.16)	(1.15)
Ratio of Reserves to Imports	-0.172 **	-0.202 **	-0.168 **	-0.185 **	-0.226 **	-0.262 **	-0.203 **	-0.216 **
(in logs)	(0.08)	(0.07)	(0.08)	(0.07)	(0.08)	(0.08)	(0.08)	(0.07)
Real Exchange Rate Overvaluation	0.515 **	0.498 **	0.526 **	0.504 **	1.166 **	1.073 **	1.033 **	0.930 **
(Index in logs)	(0.15)	(0.16)	(0.16)	(0.16)	(0.31)	(0.31)	(0.29)	(0.28)
Inflation	0.285 **	0.328 **	0.387 **	0.396 **	0.400 **	0.441 **	0.492 **	-0.628 **
(CPI inflation rate, in logs)	(0.13)	(0.13)	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)	(0.17)
Fixed Exchange Rate Regime	-0.365 *	-0.352 *	-0.367 *	-0.348 *	-0.626 **	-0.624 **	-0.645 **	0.524 **
(Dummy variable)	(0.19)	(0.19)	(0.19)	(0.19)	(0.18)	(0.18)	(0.17)	(0.12)
External Shocks								
Terms of trade shocks	-0.004	-0.004	-0.004	-0.004	-0.001	-0.001	-0.001	-0.001
(log differences of terms of trade index)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
Terms of trade shocks, Lagged	-0.013 **	-0.013 **	-0.013 **	-0.013 **	-0.010 **	-0.010 **	-0.011 **	-0.011 **
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
International interest rate	4.077	3.508	3.823	3.295	10.803 **	9.928 **	10.292 **	9.335 **
(Prime rate in real terms, in logs)	(6.24)	(6.20)	(6.22)	(6.18)	(4.74)	(4.70)	(4.69)	(4.64)
International interest rate, Lagged	-8.135	-6.989	-7.244	-6.309	-14.259 **	-12.687 **	-13.060 **	-11.530 **
	(5.63)	(5.60)	(5.60)	(5.55)	(4.50)	(4.46)	(4.45)	(4.38)
Growth in external demand	0.035	0.040	0.038	0.042	-0.084 **	-0.076 **	-0.073 **	-0.067 *
(log differences of real GDP of trading partners)	(0.05)	(0.05)	(0.05)	(0.05)	(0.04)	(0.04)	(0.04)	(0.04)
Growth in external demand, Lagged	-0.096 **	-0.097 **	-0.095 **	-0.096 **	-0.079 **	-0.079 **	-0.074 **	-0.074 **
	(0.05)	(0.05)	(0.05)	(0.05)	(0.04)	(0.04)	(0.04)	(0.04)
Countries	79	79	79	79	79	79	79	79
Observations	1875	1875	1875	1875	1875	1875	1875	1875
Pseudo-R2	0.338	0.334	0.330	0.330	0.330	0.325	0.322	0.321

*Our basic regression equation includes a constant and accounts for country- and time-specific effects. Note that although the country dummies and time dummies are not reported, they are available from the authors upon request. The numbers in parenthesis below the coefficient estimates are robust standard errors. * (**) implies statistical significance at 10 (5) % level.*
Our instrumental variable (IV) approach controls for the endogeneity of trade openness as well as financial openness. Our outcome measure of trade openness is instrumented using the gravity equation model as in Frankel and Romer (1999) and Cavallo and Frankel (2007). On the other hand, our outcome measure of financial openness is instrumented with the origin of the country's legal system, initial values of natural resource abundance, institutional quality, concentration of exports, and other geographical and size factors following Faria, Lane, Mauro and Milesi-Ferretti (2006). Finally, for 1/ and 2/ see footnote in Table 5.
1/ We define an episode of real exchange rate drop whenever the real effective exchange rate depreciates by more than 25%. 2/ Our definition of currency crisis follows the methodology in Frankel and Rose (1996).

Table 10

Composition Effects of Openness and Real Exchange Rate Volatility in "*Turbulent Times*"

Dependent Variable: Incidence of real exchange rate drops or currency crisis

Sample of 82 countries, 1975-2005 (annual observations)

Estimation: Probit (accounting for fixed and time-effects)

	Real Exchange Rate Drops 1/				Currency Crises 2/			
	LS	LS	IV	IV	LS	LS	IV	IV
Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Trade Openness (TO)								
Trade in manufacturing goods	-0.212 **	-0.197 **	-0.141 **	-0.136 **	-0.205 **	-0.175 **	-0.095 **	-0.086 **
as % of GDP (in logs)	(0.06)	(0.06)	(0.04)	(0.04)	(0.07)	(0.07)	(0.05)	(0.04)
Trade in non-manufacturing goods	0.034	0.046	0.223 **	0.211 **	-0.068	-0.043	0.093	0.078
as % of GDP (in logs)	(0.09)	(0.08)	(0.06)	(0.06)	(0.09)	(0.09)	(0.07)	(0.06)
Financial Openness (FO)								
Equity-related Foreign Liabilities	-0.115 **	..	-0.114 **	..	-0.169 **	..	-0.190 **	..
as % of GDP (in logs)	(0.06)		(0.06)		(0.07)		(0.07)	
Loan-related Foreign Liabilities	0.230 *	..	0.186 *	..	0.483 **	..	0.415 **	..
as % of GDP (in logs)	(0.12)		(0.11)		(0.14)		(0.14)	
Equity-related Foreign Assets and Liabilities	..	-0.126 **	..	-0.118 **	..	-0.181 **	..	-0.188 **
as % of GDP (in logs)		(0.06)		(0.06)		(0.07)		(0.07)
Loan-related Foreign Assets and Liabilities	..	0.164	..	0.112	..	0.363 **	..	0.293 **
as % of GDP (in logs)		(0.13)		(0.12)		(0.15)		(0.14)
Domestic Controls								
Economic Growth	-0.994	-1.062	-1.373	-1.410	-1.609	-1.681	-1.782	-1.816 *
(log differences of real GDP per capita)	(1.46)	(1.44)	(1.45)	(1.44)	(1.20)	(1.18)	(1.19)	(1.18)
Ratio of Reserves to Imports	-0.102	-0.135 **	-0.110	-0.141 **	-0.157 *	-0.213 **	-0.148 *	-0.196 **
(in logs)	(0.07)	(0.07)	(0.07)	(0.07)	(0.08)	(0.08)	(0.08)	(0.08)
Real Exchange Rate Overvaluation	0.519 **	0.511 **	0.545 **	0.530 **	1.280 **	1.180 **	1.248 **	1.135 **
(Index in logs)	(0.15)	(0.15)	(0.15)	(0.15)	(0.32)	(0.32)	(0.32)	(0.31)
Inflation	0.298 **	0.321 **	0.360 **	0.375 **	0.386 **	0.435 **	0.416 **	0.464 **
(CPI inflation rate, in logs)	(0.13)	(0.12)	(0.12)	(0.12)	(0.13)	(0.13)	(0.13)	(0.13)
Fixed Exchange Rate Regime	-0.363 *	-0.373 **	-0.393 **	-0.395 **	-0.627 **	-0.649 **	-0.636 **	-0.654 **
(Dummy variable)	(0.19)	(0.19)	(0.19)	(0.19)	(0.18)	(0.18)	(0.18)	(0.18)
External Shocks								
Terms of trade shocks	-0.003	-0.003	-0.004	-0.004	-0.002	-0.002	-0.002	-0.002
(log differences of terms of trade index)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Terms of trade shocks, Lagged	-0.012 **	-0.012 **	-0.012 **	-0.012 **	-0.011 **	-0.011 **	-0.011 **	-0.011 **
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
International interest rate	3.164	2.764	3.301	2.872	10.653 **	9.687 **	10.645 **	9.635 **
(Prime rate in real terms, in logs)	(6.28)	(6.23)	(6.30)	(6.25)	(4.87)	(4.79)	(4.86)	(4.77)
International interest rate, Lagged	-6.886	-6.193	-6.751	-6.134	-14.938 **	-13.322 **	-14.467 **	-12.926 **
	(5.60)	(5.55)	(5.60)	(5.55)	(4.62)	(4.53)	(4.60)	(4.50)
Growth in external demand	0.027	0.029	0.025	0.027	-0.090 **	-0.084 **	-0.087 **	-0.081 **
(log differences of real GDP of trading partners)	(0.04)	(0.04)	(0.05)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Growth in external demand, Lagged	-0.090 **	-0.093 **	-0.099 **	-0.101 **	-0.070 *	-0.072 *	-0.069 *	-0.071 *
	(0.04)	(0.04)	(0.05)	(0.05)	(0.04)	(0.04)	(0.04)	(0.04)
Countries	79	79	79	79	79	79	79	79
Observations	1834	1834	1834	1834	1834	1834	1834	1834
Pseudo-R2	0.363	0.362	0.364	0.363	0.350	0.344	0.346	0.342

See footnote in Table 9.

Table A.1
Sample of Countries

Latin America and the Caribbean

ARG	Argentina	ECU	Ecuador	PAN	Panama
BOL	Bolivia	GTM	Guatemala	PER	Peru
BRA	Brazil	HND	Honduras	PRY	Paraguay
CHL	Chile	HTI	Haiti	SLV	El Salvador
COL	Colombia	JAM	Jamaica	TTO	Trinidad and Tobago
CRI	Costa Rica	MEX	Mexico	URY	Uruguay
DOM	Dominican Republic	NIC	Nicaragua	VEN	Venezuela

East Asia and the Pacific

CHN	China	MYS	Malaysia	SGP	Singapore
IDN	Indonesia	PHL	Philippines	THA	Thailand
KOR	Korea, Rep.	PNG	Papua New Guinea		

Industrial Economies

AUS	Australia	ESP	Spain	JPN	Japan
AUT	Austria	FIN	Finland	NLD	Netherlands
BEL	Belgium-Luxembourg	FRA	France	NOR	Norway
CAN	Canada	GBR	United Kingdom	NZL	New Zealand
CHE	Switzerland	GRC	Greece	PRT	Portugal
DEU	Germany	IRL	Ireland	SWE	Sweden
DNK	Denmark	ISL	Iceland	USA	United States
		ITA	Italy		

Middle East and North Africa

EGY	Egypt, Arab Rep.	JOR	Jordan	TUN	Tunisia
IRN	Iran, Islamic Rep.	MAR	Morocco	TUR	Turkey
ISR	Israel	SYR	Syrian Arab Republic		

South Asia

BGD	Bangladesh	IND	India	PAK	Pakistan
		LKA	Sri Lanka		

Sub-Saharan Africa

BFA	Burkina Faso	KEN	Kenya	SLE	Sierra Leone
BWA	Botswana	MDG	Madagascar	TGO	Togo
CIV	Cote d'Ivoire	MWI	Malawi	ZAF	South Africa
GHA	Ghana	NER	Niger	ZMB	Zambia
GMB	Gambia, The	NGA	Nigeria	ZWE	Zimbabwe
		SEN	Senegal		

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

Variable	Definition and Construction	Source
Real effective exchange rate (REER)	Multilateral real exchange rate index (trade-weighted), monthly observations.	Authors' construction using the IMF's International Financial Statistics.
Real Exchange Rate Volatility	Standard Deviation of the annual (12-month) changes in the Real Effective Exchange Rate (in logs)	Authors' construction using the IMF's International Financial Statistics
GDP	Real Gross Domestic Product. GDP is in 1985 PPP-adjusted US$.	Authors' construction using Summers and Heston (1991) and The World Bank's World Development Indicators
Growth Rate in GDP	Log differences of Real GDP.	Authors' construction using Summers and Heston (1991) and The World Bank's World Development Indicators
Trade Openness: Policy Measure	Average years of trade openness according to Sachs and Warner criteria.	Sachs and Warner (1995), Wacziarg and Welch (2003).
Trade Openness: Outcome Measure	Exports and imports (in 1995 US$) as a percentage of GDP (in 1995 US$).	The World Bank's World Development Indicators.
Trade in Manufacturing Goods	Exports and imports in manufacturing goods (in 1995 US$) as a percentage of GDP (in 1995 US$).	The World Bank's World Development Indicators and UN COMTRADE.
Trade in Non-Manufacturing Goods	Exports and imports in non-manufacturing goods (in 1995 US$) as a percentage of GDP (in 1995 US$).	The World Bank's World Development Indicators and UN COMTRADE.
Financial Openness: Policy Measure 1	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).
Financial Openness: Policy Measure 2	First principal component of indicators of absence of resrtictions in cross-border transactions: multiple exchange rates, current account and capital account transactions, and surrender of export proceeds.	IMF's Exchange Arrangements and Exchange Restrictions (Various Issues), and Chinn and Ito (2006)
Financial Openness: Outcome Measure	The stock of: (a) Foreign Assets and Liabilities as % of GDP (in logs), and (b) Foreign Liabilities as % of GDP (in logs).	Lane and Milesi-Ferreti (2001, 2006).
Financial Openness: Composition	We use both the equity-related foreign liabilities and foreign assets and liabilities as % of GDP (portfolio equity and FDI) as well as the ratio of loan-related foreign liabilities and foreign assets and liabilities to GDP.	Lane and Milesi-Ferreti (2001, 2006).
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)
Volatility of Productivity Shocks	Standard deviation of the log difference of real GDP per worker of the countries and its main trading partners.	Authors' construction using Summers and Heston (1991) and The World Bank's World Development Indicators
Volatility of Fiscal Policy	Standard Deviation of the discretionary measure of fiscal policy (general government consumption). This measure was obtained using the methodology in Fatas and Mihov (2003, 2006)	Authors' construction using the World Bank's World Development Indicators, and International Monetary Fund's International Financial Statistics
Volatility of Monetary Policy	Standard Deviation of the discretionary measure of monetary policy. This measure was obtained using the methodology in Fatas and Mihov (2003, 2006)	Authors' construction using International Monetary Fund's International Financial Statistics
Terms of Trade	Net barter terms of trade index (1995=100)	The World Bank's World Development Indicators.
Terms of Trade Changes	Log differences of the terms of trade index	Authors' construction using The World Bank's World Development Indicators.
Volatility of Terms of Trade Changes	Standard deviation of the log difference of the terms of trade.	Authors' construction using The World Bank's World Development Indicators.
Period-specific Shifts	Time dummy variables.	Authors' construction.

Table A.3

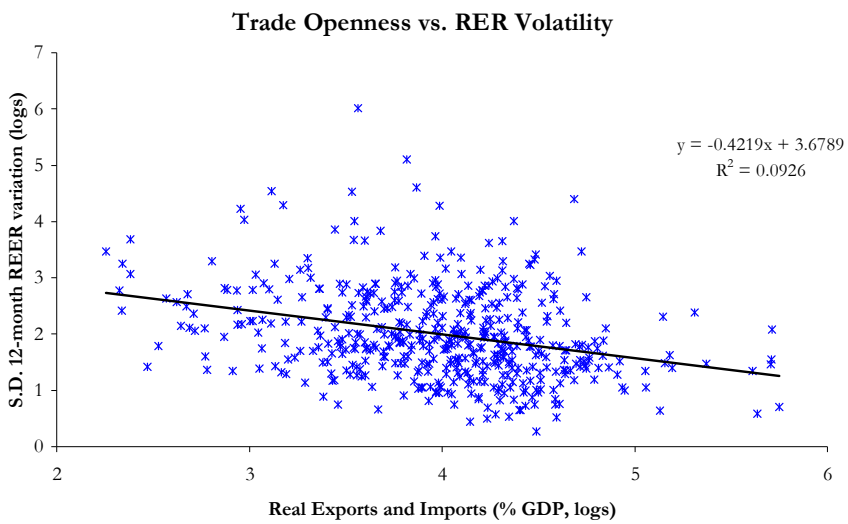
Constructing the Trade Instrument: Gravity model of bilateral trade

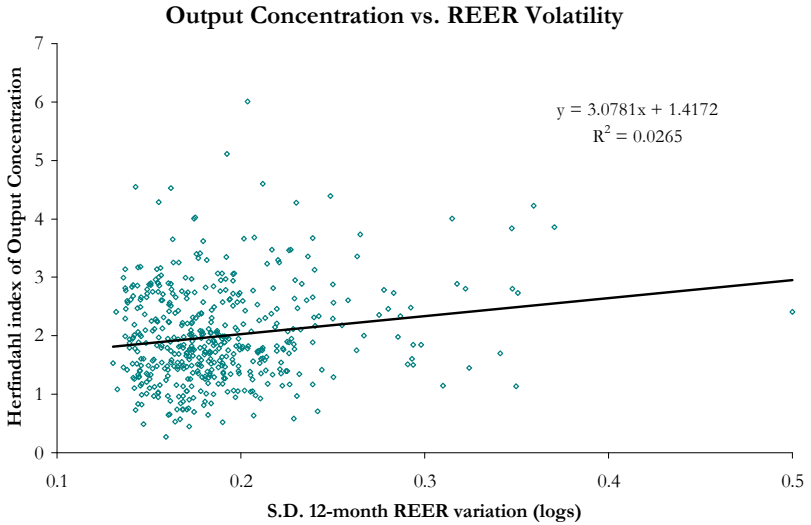
Dependent Variable: Bilateral trade (exports and imports) in the country pair (j,k) as a ratio of country j's GDP (in logs)

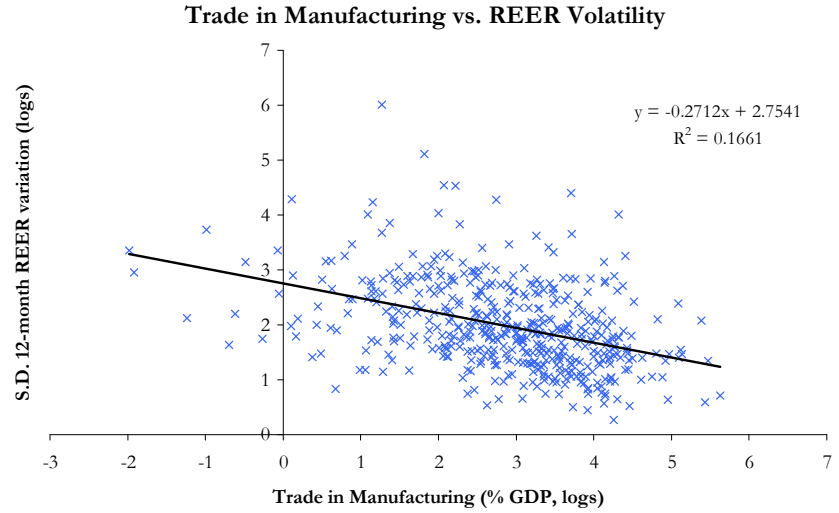
Sample of 82 countries, 1975-2005 (annual observations)

Variable	1976-80	1981-85	1986-90	1991-95	1996-00	2001-05
Border	10.645 *	12.350 *	10.335 *	13.233 **	16.974 **	17.269 **
(dummy=1 of country pair share border)	(6.92)	(6.97)	(6.86)	(6.68)	(6.09)	(6.13)
Distance *(in logs)*	-2.027 **	-1.919 **	-1.730 **	-1.878 **	-1.840 **	-1.869 **
(great circle distance between pair in km.)	(0.11)	(0.10)	(0.09)	(0.09)	(0.08)	(0.08)
Distance x Border	1.647	2.466 *	2.840 **	2.197 *	1.645 *	1.622
	(1.34)	(1.31)	(1.28)	(1.23)	(1.09)	(1.08)
Landlocked	-1.670 **	-1.679 **	-1.664 **	-1.622 **	-1.367 **	-1.774 **
(number of landlocked countries in pair)	(0.17)	(0.16)	(0.15)	(0.14)	(0.11)	(0.12)
Landlocked x Border	0.826	0.951	0.966	0.780	0.553	1.082 *
	(0.72)	(0.71)	(0.70)	(0.66)	(0.55)	(0.56)
Country j's population	0.897 **	0.725 **	0.663 **	0.655 **	0.614 **	0.604 **
(number of inhabitants, initial value, in logs)	(0.06)	(0.05)	(0.05)	(0.05)	(0.04)	(0.05)
Country j's population x Border	-0.666 *	-0.320	-0.676	-0.629	-0.693 *	-0.633 *
	(0.44)	(0.45)	(0.46)	(0.43)	(0.39)	(0.39)
Country k's population	1.720 **	1.742 **	1.681 **	1.647 **	1.589 **	1.618 **
(number of inhabitants, initial value, in logs)	(0.05)	(0.05)	(0.05)	(0.05)	(0.04)	(0.04)
Country k's population x Border	-0.808 *	-0.801 *	-0.461	-0.629	-0.647 *	-0.624 *
	(0.46)	(0.46)	(0.48)	(0.43)	(0.40)	(0.40)
Country j's area	-0.659 **	-0.545 **	-0.545 **	-0.415 **	-0.406 **	-0.362 **
(surface area in sq. km., in logs)	(0.05)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Country j's area x Border	0.304	-0.480	-0.226	-0.365	-0.215	-0.314
	(0.52)	(0.51)	(0.52)	(0.49)	(0.45)	(0.45)
Country k's area	-0.514 **	-0.429 **	-0.467 **	-0.375 **	-0.362 **	-0.338 **
(surface area in sq. km., in logs)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Country k's area x Border	-0.176	-0.313	-0.563	-0.180	-0.199	-0.241
	(0.57)	(0.57)	(0.57)	(0.52)	(0.48)	(0.48)
Common language	1.301 **	1.216 **	1.254 **	1.378 **	1.002 **	0.997 **
(dummy=1 of country pair share language)	(0.20)	(0.18)	(0.18)	(0.16)	(0.15)	(0.15)
Constant	-20.281 **	-21.666 **	-20.879 **	-21.450 **	-20.073 **	-20.699 **
	(1.29)	(1.16)	(1.12)	(1.04)	(0.93)	(0.95)
Number of observations	5212	6198	6436	6762	7340	6976
R**2	0.2765	0.2681	0.2596	0.2867	0.2974	0.3105
Correlation with dependent variable	0.53	0.52	0.51	0.54	0.55	0.56

Figure 1
Trade Openness and Real Exchange Rate Volatility







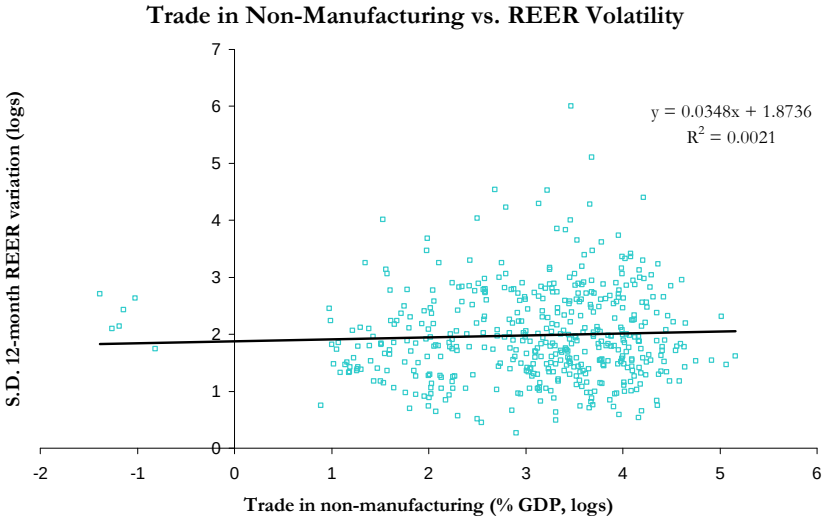


Figure 2
Financial Openness and Real Exchange Rate Volatility

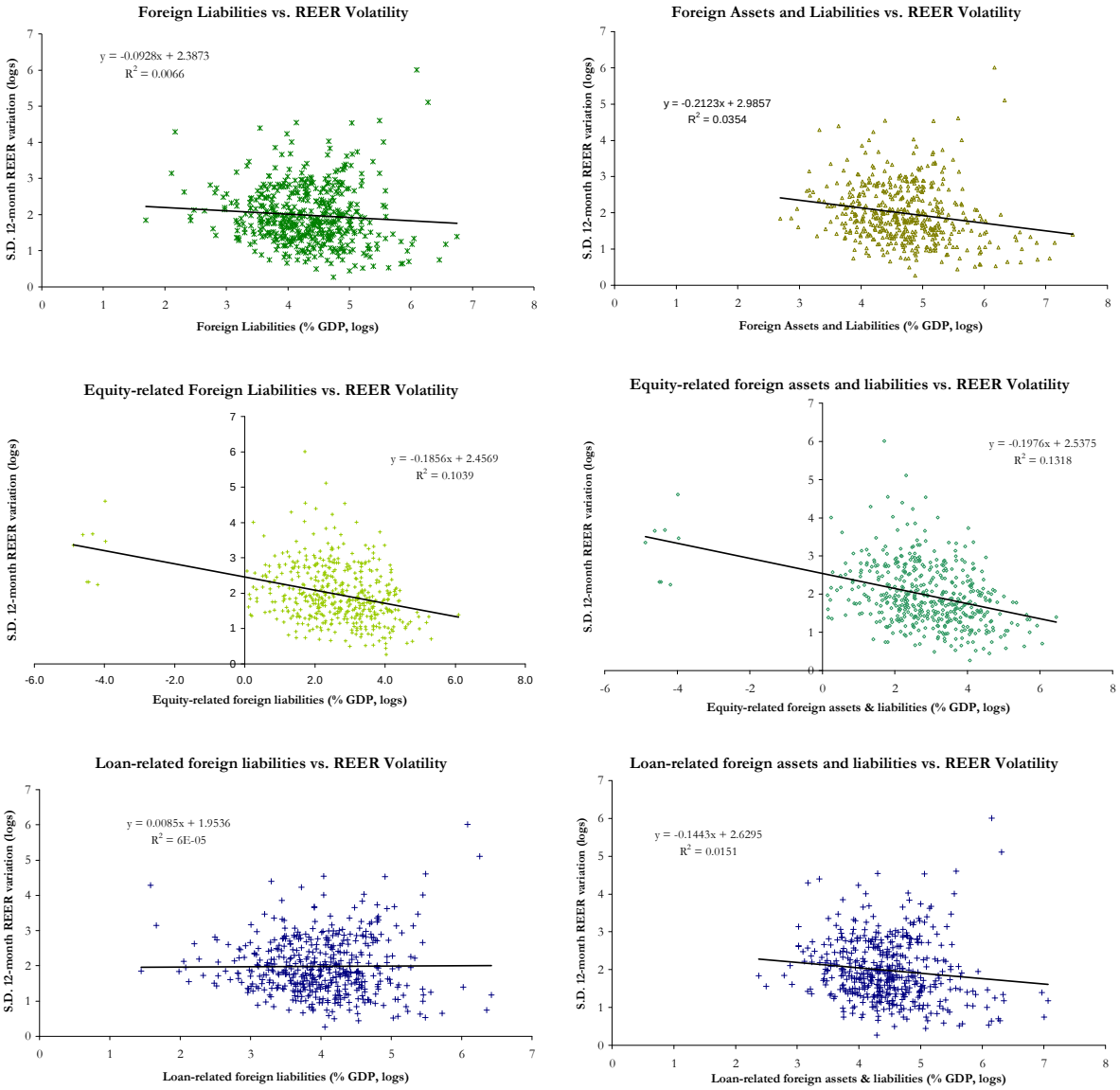
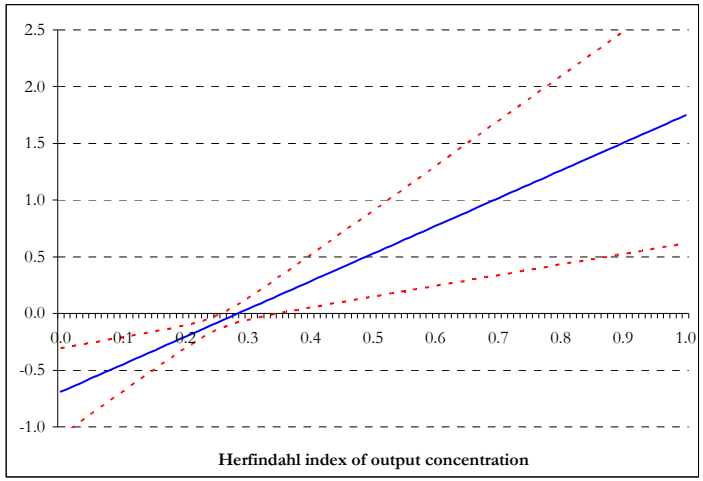


Figure 3
Trade Openness and Real Exchange Rate Volatility

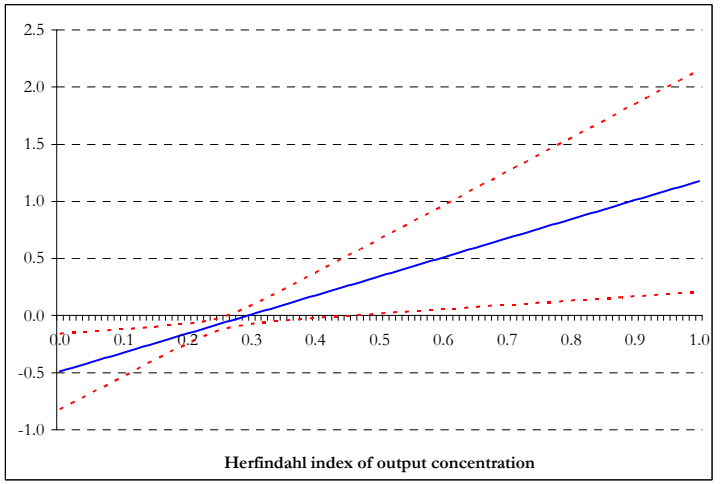
Sample of non-overlapping 5-year period observations

3.1 RER Volatility response to higher trade openness conditional on output concentration

3.1.1 Regression [7] of Table 7

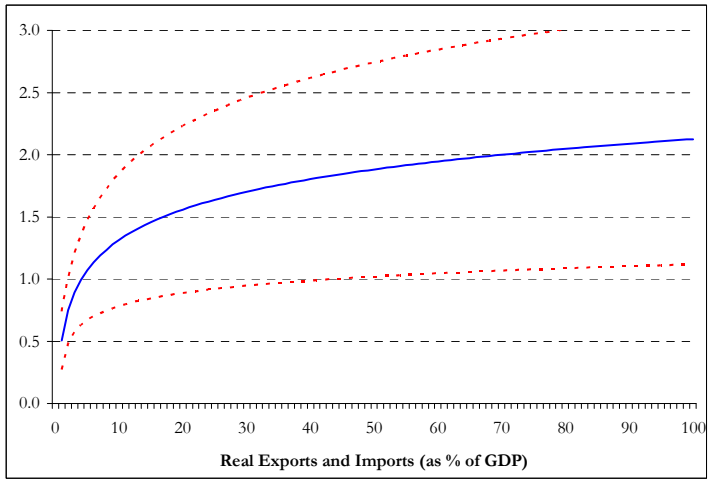


3.1.2 Regression [8] of Table 7



3.2 RER Volatility response to rising output concentration conditional on trade openness

3.2.1 Regression [7] of Table 7



3.2.2 Regression [8] of Table 7

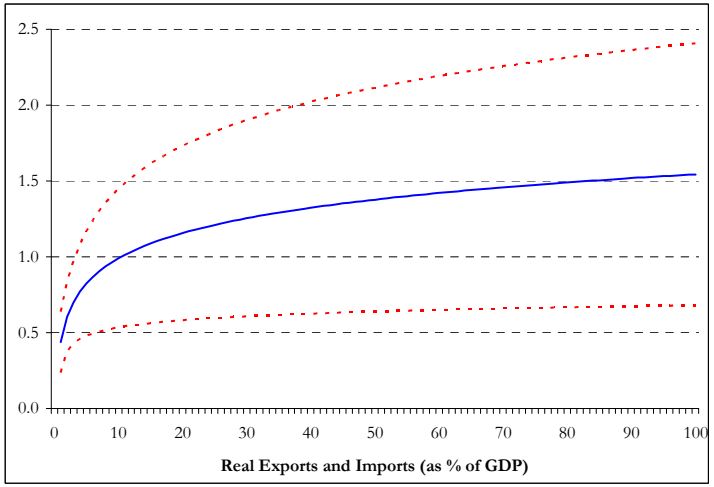
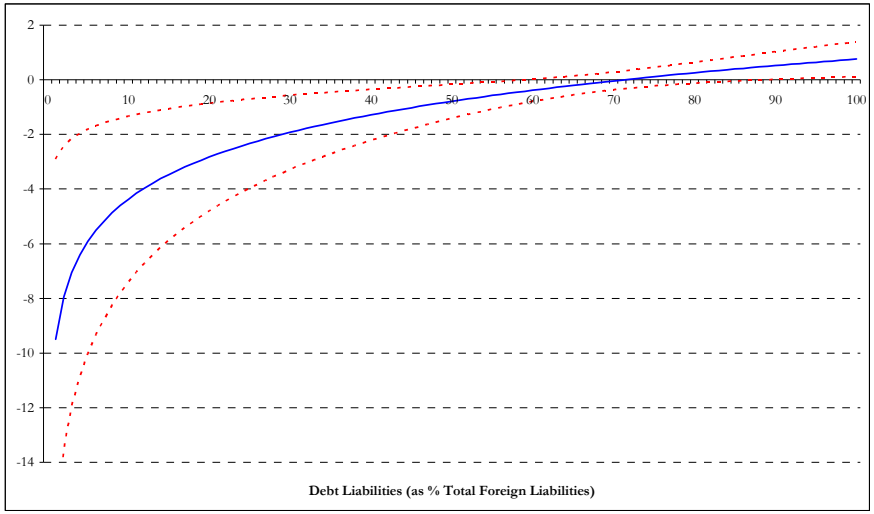


Figure 4
RER Volatility Response to Higher Financial Openness
conditional on the share of debt in total liabilities
Sample of non-overlapping 5-year period observations

4.1 Regression [7] of Table 7



4.2 Regression [8] of Table 7