Remoteness and Real Exchange Rate Volatility

Prepared by Claudio Bravo-Ortega and Julian di Giovanni[1]

Abstract

This paper examines the impact of trade costs on real exchange rate volatility. The channel is examined by constructing a two-country Ricardian model of trade, based on the work of Dornbusch, Fischer, and Samuelson (1977), which shows that higher trade costs result in a larger nontradable sector. This, in turn, leads to higher real exchange rate volatility. We provide empirical evidence supporting the channel.

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Author(s) E-Mail Address: clbravo@econ.uchile.cl, jdigiovanni@imf.org

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[1] Claudio Bravo-Ortega is Professor of Economics at Universidad de Chile. The authors would like to thank Müge Adalet, Barry Eichengreen, Miguel Fuentes, Pierre-Olivier Gourinchas, Gian Maria Milesi-Ferretti, Maurice Obstfeld, and Andrew Rose for comments.

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I. INTRODUCTION

International trade has grown at a startling pace over the past two decades. This growth can be explained by many factors such as lowering of trade costs, improved technology, and reduction in trade barriers. This globalization also affects the macroeconomy. As Obstfeld and Rogoff (2001) show, small trade costs can have large effects on many macroeconomic phenomena. There has also recently been an open debate on the role of geography and institutions in contributing to economic growth,[1] where geographical barriers naturally lead to higher transport costs. Furthermore, another branch of the economic growth literature has shown that macroeconomic volatility tends to have a negative impact on growth.[2]

These different literatures point to potentially strong linkages between trade costs and the macroeconomy. Yet, there is still little rigorous work examining the channels through which trade imperfections affect macroeconomic variables. In this paper, we provide a simple and intuitive model and empirical evidence, which allow us to analyze the impact of trade costs on the *long-run* volatility of a key macroeconomic variable: the real exchange rate. In particular, we incorporate Ricardian comparative advantage into a macroeconomic model to highlight the fact that trade imperfections affect real exchange rate volatility.

The model shows how higher trade costs will lead to a greater range of nontradable goods thereby resulting in a country's having higher real exchange rate volatility.[3] Our model builds on the classic work of Dornbusch, Fischer, and Samuelson (1977). In particular, we incorporate uncertainty in the form of productivity shocks. We then present empirical results that support the model. The key intuition for our result is the following. In a Ricardian world without trade costs, productivity shocks will lead to changes in comparative advantage in producing goods across countries. However, the law of one price will continue to hold. Transport costs create a wedge between the prices for some goods that the domestic and foreign economy specialize in. This wedge will result in the production of nontradable goods in both economies, whose prices are independent of the other country's productivity shock. Therefore, relative prices of these goods will not equate across countries given country-shocks, and since a country's overall price index is made up of both tradable and nontradable goods, the real exchange rate will move. Therefore, the greater trade costs—measure as iceberg costs—the higher real exchange rate volatility.

We believe that this is a simple point that has not been full explored in the literature. Indeed,

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[1]Gallup, Sachs, and Mellinger (1998) and Acemoglu, Johnson, and Robinson (2001).

[2]See Ramey and Ramey (1995) for an early contribution and Rodrik (1999) for a more recent one.

[3]Bravo-Ortega, and di Giovanni (2004) highlights a different mechanism through which trade costs affect real exchange rate volatility. In this paper, the impact of heterogeneous suppliers of traded goods on real exchange rate volatility is examined using a multicountry model of trade.

our paper complements Hau's (2002) result that more open economies show less real exchange rate volatility although the mechanism we highlight is different from his. Hau shows that in an economy with nominal rigidities, imported goods provide a channel for quick adjustment of the domestic aggregate price level.[4] We, in turn, show that trade costs determine the size of the nontradable sector. In our model, a larger nontradable sector implies more heterogeneity in the diffusion of productivity shocks among different economies. Thus, our paper is related to trade costs (either tariffs or transport cost) whereas these trade imperfections play no explicit role in Hau's work.[5]

Measuring the potential impact of our channel for a large cross-section of countries is not easy given data constraints. Therefore, our main measure is based on a how close a country is to the world trade center. We refer to this proxy of trade costs as 'remoteness'. As can be seen in Figure 1, our proposed relationship appears to exist in the data, where countries that are more remote all exhibit greater real exchange rate volatility.

Section II presents the theoretical model for the two-country case. Section III presents empirical evidence supporting predictions from the two-country model. Section IV concludes.

II. Two-Country Model

The model that we build provides a simple illustration of how increases in trade costs can increase real exchange rate volatility by creating a wedge between the tradable and nontradable sectors, so that shocks to not transmit perfectly across countries. The model is setup in a two-country framework, but the foreign country represents the rest of the world. This distinction must be made because an individual country's range of nontradable goods depends on its trade costs with all of its potential trading partners. We also make this distinction in the empirical work by using a country's real effective exchange rate, and proxying overall trade costs by a country's closeness to the world trade center. Furthermore, this and the multicountry model are meant to explain *long-run* real exchange rate volatility. The two-country model borrows heavily from Obstfeld and Rogoff (1996), and makes one central prediction: real exchange rate volatility is increasing in trade costs, and therefore increasing in the distance between one country and its trade partners around the world. Sections A-C outline the model and solves for real exchange rate volatility.

[4]In Hau's paper the size of nontraded goods sector is fixed, and there exists only one traded good.

[5]Naknoi (2004) has also examined a similar channel in a dynamic general equilibrium framework. However, her work concentrates on short-run dynamics, whereas we argue that endogenous nontradability should be modeled in a long-run context. Furthermore, we provide direct evidence to test the hypothesis drawn from our model.

A. Consumers

The demand side is modeled using a representative agent who maximizes consumption of a continuum of goods z, which are defined on the line $[0, 1]$. The agent receives only labor income and maximizes the following utility function:

$$U(c) = \exp\left[\int_0^1 \log(c(z))dz\right], \tag{1}$$

where the elasticity of substitution is set to one.[6] Taking the good $z = 1$ to be the numéraire, so that the wage rates and commodity prices are expressed in units of good 1, the price index is:

$$P = \exp\left[\int_0^1 \log(p(z))dz\right]. \tag{2}$$

Similarly, the price index for the foreign country is:

$$P^* = \exp\left[\int_0^1 \log(p^*(z))dz\right]. \tag{3}$$

B. Producers

Production takes place in a “two-country world”, where the technology of the producers is stochastic and only requires labor input. Specifically, the home and foreign firms have the following labor requirement to production one unit of good z,

$$\text{Home} : a(z) = \alpha(z) \cdot \exp(\varepsilon)$$
$$\text{Foreign} : a^*(z) = \alpha^*(z) \cdot \exp(\varepsilon^*)$$

where ε and ε^* are technological shocks that are both distributed i.i.d. $N\left(0, \sigma^2\right)$ and are independent of each other.[7]

Firms in each sector at home (and abroad) maximize their profits ex ante conditional on the distribution of these shocks. Given a fixed labor supply in each country, firms in each sector choose labor such that the real wage is equated to the marginal product of labor, so given labor mobility across sectors, this is equivalent to $\frac{w}{p} = \frac{1}{a(z)}$.

Given this condition in each country, a relative labor schedule that regulates comparative advantage may then be defined as:

$$A(z) = \frac{a^*(z)}{a(z)}. \tag{4}$$

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[6]The results go through using the more general CES function, but greatly complicates the algebra. Therefore, the more specific function (i.e., logarithmic) is used for clarity.

[7]The assumption of independent productivity shocks, i.e., Cov $(\varepsilon, \varepsilon^*) = 0$, may seem strong. However, the assumption does not alter our main result. If there were covariance in the shocks one extra term would be added.

This schedule is used to solve for the equilibrium wages, prices, and distribution of production across countries. Furthermore, this schedule holds both before and after the shocks hit the economies.

C. Equilibrium

In equilibrium, the range of goods that a country produces or imports depends on productivity differentials and trade costs $\tau > 0$. We assume that the steady-state productive structure is such that there is a zero trade balance in equilibrium given the expected value of the relative productivity schedule A(z) defined by (4). We believe that this is a realistic assumption for the steady-state equilibrium. In particular, home will produce goods ex ante such that:[8]

$$\frac{w}{w^*} < \mathrm{E}\left\{\frac{A(z)}{1-\tau}\right\} = \mathrm{E}\left\{\frac{\alpha^*(z)\cdot\exp(\varepsilon^*)}{(1-\tau)\alpha(z)\cdot\exp(\varepsilon)}\right\},$$

and foreign will produce goods such that

$$\frac{w}{w^*} > \mathrm{E}\left\{(1-\tau)A(z)\right\} = \mathrm{E}\left\{(1-\tau)\frac{\alpha^*(z)\cdot\exp(\varepsilon^*)}{\alpha(z)\cdot\exp(\varepsilon)}\right\}.$$

Given the trade costs, a range of goods $z \in (z^F, z^H)$ are nontraded, where z^F are foreign goods and z^H are home goods. It is for these goods that prices in the domestic and foreign sector are given by: $p(z) = w \cdot a(z)$ and $p^*(z) = w^* \cdot a^*(z)$. The price of traded goods will not be equated, given trade cost τ that must be paid, across countries (i.e., the law of one price no longer holds). In short, the Ricardian nature of the model implies specialization of each country in a range of tradable goods whose prices differ between countries by a constant factor related to trade costs.

For the sake of tractability and simplicity of exposition we suppose that there are two periods. In the first period, the firms choose the marginal good of production taking the expected value of the comparative advantage and trade is balanced. Up to here this has been the traditional approach in Dornbusch et al. (1977) and Krugman (1987) initial model setups. In a more general context this assumption may be equivalent to rational expectations. The production structure, z^F and z^H, will be determined in the first period, which represents the steady state of the economy. Thus, in the second period when a shock is realized the schedule $A(z)$ shifts only because of the shocks, and given the previously determined z^F, z^H, which we assume remain fixed, relative wages and prices will adjust to the extent of the relative shocks, thereby creating a trade imbalance ex post.[9] We believe that this a reasonable assumption given that countries' production structures change very slowly over time compared to wage and price movements. This in turn implies that the trade balance will no longer necessarily equal zero

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[8]Note that similar conditions will hold ex post.

[9]These assumptions allow us to introduce uncertainty in a tractable manner.

out of steady-state. We will not go through the whole derivation of equilibrium, but given home and foreign labor supplies, L and L^* respectively, and defining home's trade balance as total income less total consumption: $TB = wL - PC$ (similarly for the foreign country), the relative wages can be expressed as:

$$\frac{w_2}{w_2^*} = \left\{ \frac{-\left(z^H - z^F\right) TB}{[L^*/a^*(1)]} + z^F \right\} \frac{L^*/L}{(1 - z^H)}. \tag{5}$$

This equation illustrates that once that relative wages fully adjust to the extent of the relative shocks the trade balance must adjust to a new level that might be out of the steady-state equilibrium. We now move on to explore the properties of the real exchange rate in more detail.

D. Real Exchange Rate Volatility

Given equations (2) and (3), and the discussion on how one can solve for individual goods prices in Section C, the real exchange rate can be written as:

$$\frac{P}{P^*} = \exp\left\{ \int_{z^F}^{z^H} \log\left(\frac{w_1 \cdot \alpha(z)}{w_1^* \cdot \alpha^*(z)} \cdot \frac{\exp(\varepsilon)}{\exp(\varepsilon^*)} \right) dz + \left[z^F - (1 - z^H) \right] \log(1 - \tau) \right\}, \tag{6}$$

where the relative prices not only depend on the prices of nontradables, but also on the international specialization pattern. To solve for the volatility of the real exchange rate we take the variance of the logarithm of this equation. In doing so, it is only the shocks, ε and ε^*, that drive the volatility of the exchange rate. In particular, the volatility of the real exchange rate can thus be expressed as:

$$\text{Var}\left\{ \log\left(\frac{P}{P^*} \right) \right\} = 2\left(z^H - z^F\right)^2 \sigma^2. \tag{7}$$

See Appendix for the full derivation. Given this expression the main result of this section can then be stated (and proved) by the following proposition:

Proposition 1. *Real exchange rate volatility is increasing in trade costs, and therefore increasing in a country's closeness — due to both natural (e.g., distance) and artificial (e.g., tariffs) barriers to trade—with respect to the rest of the world.*

Proof: $\text{Var}\left\{\log\left(\frac{P}{P^*}\right)\right\} = 2\left(z^H - z^F\right)^2 \sigma^2$ and $z^F = A^{-1}\left(\frac{w_1}{w_1^*} \cdot \frac{1}{1-\tau}\right)$ with A^{-1} decreasing given the set up of the problem. Analogously $z^H = A^{-1}\left(\frac{w_1}{w_1^*} \cdot [1 - \tau]\right)$. Thus, $\frac{\partial z^F}{\partial \tau} < 0$ and $\frac{\partial z^H}{\partial \tau} > 0$. Therefore, one has that:

$$\frac{\partial}{\partial \tau}\left(\text{Var}\left\{ \int_{z^F}^{z^H} (\varepsilon(z) - \varepsilon^*(z)) \partial z \right\} \right) = \frac{\partial}{\partial \tau}\left[2\left(z^H - z^F\right)^2 \sigma^2 \right] = \frac{\partial z^H}{\partial \tau} - \frac{\partial z^F}{\partial \tau} > 0,$$

and then the volatility of the real exchange rate is increasing in trade costs. Further, if trade costs are assumed to increase with distance, as is standard in the trade literature, volatility increases with the degree of a country's geographical and commercial isolation. Q.E.D.

This completes the theoretical part for the two-country model.[10] Empirical results in Section III confirm that Proposition 1 holds.

III. Empirical Evidence

According to the model in Section II, we expect that a country's real exchange rate volatility increases with transport costs. Given that we do not have a good direct measure of transport costs, we use a distance proxy (to be discussed below). We therefore estimate the following empirical model:

$$\sigma_{i,t}^{RER} = \beta_0 + \beta_1 \log\left(\text{Remoteness}_{i,t-1}\right) + \gamma \mathbf{X} + \nu_{i,t}, \tag{8}$$

where σ_i^{RER} is the measure of country i's real exchange rate volatility, which is calculated over the periods $t-1$ and t. The methodology used to calculate this measure is discussed in Section A. Remoteness$_{i,t-1}$ is country i's transport cost proxy at the beginning of the time period, and $\mathbf{X}$ includes country i's (log) real GDP per capita at $t-1$, and measures of import tariffs and export duties for robustness checks. Income per capita is included to capture other potential country characteristics that are correlated with exchange rate and general macroeconomic volatility. Indeed, there is empirical and theoretical literature that relates a country's income level to its macroeconomic volatility (e.g., Acemoglu and Zilibotti 1997).[11]

The model predicts the testable hypothesis that $\beta_1 > 0$. That is, the higher our mesaure of trade costs the greater the bilateral real exchange rate volatility. In examining Figure 1, this relationship does appear to hold unconditionally when looking at the full sample of countries over a twenty year period. Furthermore, this result also appears to show up in the different sub-samples of countries, though the strength of this relationship varies across groups.[12]

[10]Note, that as argued in footnote 7 above, the assumption of independent domestic and foreign shocks does not alter our results. Specifically, given the setup of the model, the solution for real exchange rate volatility, equation (7), would have the additional term Cov $(\varepsilon, \varepsilon^*)\left(z^H - z^F\right)$. Therefore, volatility will always be increasing in trade costs.

[11]We also experimented with fixed vs. floating exchange rate dummies, but our results were robust to the inclusion of these variables.

[12]We include some countries that have experienced hyperinflation, such as Bolivia (BOL), Uganda (UGA), and the Dem. Rep. of the Congo (ZAR), where measured exchange rate volatility is very high due to a small part of the whole sample period. However, if anything, including these countries will bias our estimation away from finding a strong relationship between volatility and Remoteness.

Equation (8) is estimated both cross-sectionally, over the time period 1980–2000, and over a "mini-panel" for the time periods 1980–89, and 1990–2000. We choose starting of period exogenous values to deal with potential endogeneity problems. Our model is meant to explain a long-run relationship, so we do not expect results to vary greatly over different specifications. Furthermore, we estimate this model for the whole sample, as well as splitting the countries into three income groups: (i) high, (ii) middle, and (iii) low.

A. Data

Given that the empirical specification is for a country with respect to the rest of the world, we must measure a country's real exchange rate relative to the rest of the world. As a first pass at the data, we therefore use the monthly real effective exchange rate found in the International Financial Statistics (IFS) database. The volatility measure is calculated by first taking the annual real exchange rate change (in log differences) each month; e.g., we take the change between Feb94–Feb95, and then Mar94–Mar95, and so on (i.e., a "rolling window" of annual real exchange rate changes).[13] We then compute the standard deviation of these annual changes over different time periods (i.e., between $t-1$ and t, which is either the whole sample period or by decade) as our measure of long-run volatility.[14]

The crucial variable that we construct is Remoteness. Specifically, this variable is defined as the distance from country i to the world trade center. This measure captures a country's trade remoteness viz. the rest of the world. We use this measure rather the size of the nontradable sector for several reasons. First, remoteness captures the strength of a country's commercial ties with the rest of the world, which plays an important role in defining the size of the nontradable sector. This point follows from the fact that it is not a country's distance to its closest economic pole that defines the nontradable sector since each country has different comparative advantages. Second, Remoteness is easy to measure homogeneously across countries. Third, trying to explicitly measure a country's tradable and nontradable sector is inherently difficult given that this nexus is not obvious. For example, the price of tradable goods incorporate nontradable components due to the distribution channel within a country, and similarly nontradable goods often incorporate traded inputs. Fourth, given the previous two points and other issues, the Remoteness measure is most probably subject to less measurement error than other potential controls. Following Frankel and Romer (1999) and

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[13]Taking the volatility of the log change has two advantages over taking the volatility of the log level: (i) the resulting measure is in invariant to the country, and (ii) the measure allows us to interpret the coefficients in the regressions as essentially elasticities.

[14]We also experimented in detrending the real exchange rate data using common filtering techniques: Hodrick and Prescott (1997) and Baxter and King (1999), but our results did not vary qualitatively. Results do not vary greatly using these data instead of the annual changes.

Wei (2000), we define Remoteness from country i to the world trade center as follows:

$$\text{Remoteness}_i = \sum_{j \neq i} \pi_j \cdot \log(\text{distance}_{i,j}),$$

where j is an index for all countries in the world, and with

$$\pi_j = \frac{\text{Trade}_j}{\sum_k \text{Trade}_k},$$

where each country j is one of i's trading partners, k represents all countries in the world, and Trade is defined as the sum of Exports and Imports. The term π_j is a weighting that captures how much total trade country j does compared to total world trade. Therefore, if country j is very close to country i and country j also trades a lot, the $\pi_j \cdot \log(\text{distance}_{i,j})$ term will be larger, which implies that the index Remoteness$_i$ is larger, and country i is thus closer to the world trade center (i.e., less remote). The intuition behind this index is that the closer a country is to countries that trade a lot, the more likely the country is to be more open/have lower trade costs. The advantage of using this index rather than an openness measure is that it does not include country i's actual trade, and therefore reduces any simultaneity concerns. The trade data are from the IMF's Direction of Trade Database, and the distance between country capitals' are taken from the U.S. Central Intelligence Agency (CIA).

We also collect data on import taxes and export duties from the World Development Indicators (WDI). We take the ratios of these measures viz. total imports and exports, respectively. These ratios are used as additional potential measures of trade imperfections. However, the data are quite sparse for many countries and subject to potential measurement error (especially for the low income countries). Therefore, we consider the regressions with these measures as simple robustness checks for the significance of the Remoteness measure. Income per capita data are primarily taken from the Penn World Tables (Heston, Summers, and Aten 2002), with holes filled in from the WDI and the IFS. Country income groups are taken from the WDI.

B. Empirical Results

This section presents results for estimates of equation (8). As discussed above, we estimate this equation for the cross-section as well as a panel of two decades. We also examine different sub-samples of the data based on income groups. This analysis allows us to check for robustness across different types of countries around the world. In general, we find that the coefficient on the remoteness index (a semi-elasticity) both positive and significant, thus confirming the prediction of our model. However, the relative size and significance of the estimation relationship varies across sub-samples and specifications.

Whole Sample Results

The results in Table 1 support the model's main prediction. First, turning to the cross-sectional results (1980–2000), the measure of transport costs, Remoteness, is positive and significant as expected in all specifications. Furthermore, the coefficient is quite stable in looking across specifications (1), (3) and (4). A higher export duties to exports ratio correspond to higher real exchange rate volatility, whereas the opposite is true for the imports ratio. This latter result is puzzling and varies across specifications, thus we place little weight on it. The negative coefficient on the income variable supports the hypothesis that richer countries also exhibit less economic volatility. Turning to the panel results (1980–89/1990–2000), the estimates are similar to the cross-sectional regressions, though the Remoteness coefficient drops more dramatically in size in specifications (3) and (4) relative to specification (1) compared to the cross-sectional results.

High Income Country Sample Results

Table 2 presents results using only the high income country sample. The Remoteness coefficient is both positive and significant in both the cross-sectional and panel regressions. This is re-assuring, particularly given the strong relationship, which appears in Fig. 1(b). The export and import ratios are rarely significant and vary highly over the different specifications. The income per capita variable is actually positive and significant in this sub-sample. This fact may be explained by the fact that countries such as the U.S. and Japan had volatile nominal rates during the period.

Middle Income Country Sample Results

Table 3 presents results using only the middle income country sample. The Remoteness coefficient is again positive and significant across almost all the specifications, though the coefficient is not significant in column (4) of the panel regressions. The export and imports ratio are again changing sizes and signs, though the import ratio is consistently negative and more or less significant. The income per capita coefficient is negative as expected, though is not significant in the panel estimation.

Low Income Country Sample Results

Table 4 presents results using only the low income country sample. The Remoteness coefficient is positive in all the specifications, but has very large standard errors and is thus never significant. Given the small sample size (as well as the weak unconditional relationship depicted in Fig. 1(d)) this result is not very surprising. The export ratio coefficient is always positive, while the import ratio is negative. On the net, they appear to cancel each other out, though. Meanwhile, the income per capita coefficient is negative, but not significant.

Overall, this section has presented reduced form results that confirm the main prediction of the two-country model of Section II. That is, a country’s long-run real exchange rate volatility decreases with the trade costs that it faces (as measured by Remoteness). This result is robust across specifications when using the whole sample of data, and is significant across most sub-samples.

IV. Conclusion

This paper examines the impact of trade costs on real exchange rate volatility. The channel studied implies that the size of the nontradable sector is determined by trade costs. This channel then affects the degree to which idiosyncratic shocks diffuse between countries, which is reflected in the dissimilarities of their price indexes. We endogenize this channel using a simple Ricardian model of trade. Finally, we take the model to the data and directly test our theoretical prediction, which is indeed supported.

TWO-COUNTRY REAL EXCHANGE RATE VOLATILITY

The variance of the real exchange rate can be expressed as follows:

$$\begin{aligned}\text{Var}\left\{\log\left(\frac{P}{P^*}\right)\right\} &= \text{Var}\left\{\int_{z^F}^{z^H} \log\left(\frac{w_1 \cdot a(z)}{w_1^* \cdot a^*(z)} \cdot \frac{\exp(\varepsilon)}{\exp(\varepsilon^*)}\right)_{TB=0} dz\right\} \\ &= \text{Var}\left\{\int_{z^F}^{z^H} \log\left(\frac{w_1 \cdot a(z)}{w_1^* \cdot a^*(z)}\right)_{TB=0} dz\right\} \\ &+ \text{Var}\left\{\int_{z^F}^{z^H} \log\left(\frac{\exp(\varepsilon)}{\exp(\varepsilon^*)}\right) dz\right\} \\ &= \text{Var}\left\{\int_{z^F}^{z^H} (\varepsilon - \varepsilon^*) dz\right\} \\ &= 2\left(z^H - z^F\right)^2 \sigma^2.\end{aligned} \tag{A.1}$$

where we have used the fact that only ε and ε^* are stochastic, and that z^F and z^H remain fixed after shocks are realized.

Table 1. Determinants of Real Exchange Rate Volatility: Whole Sample

	1980–2000				1980–89/1990–2000			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Remoteness	0.349**		0.350**	0.302**	0.314**		0.283**	0.213*
	(0.098)		(0.111)	(0.092)	(0.084)		(0.102)	(0.100)
Export duties/Exports		1.556**	1.541**	0.757		1.461**	1.473**	0.949*
		(0.429)	(0.451)	(0.532)		(0.468)	(0.458)	(0.463)
Import taxes/Imports		−0.037	0.021	−0.540*		−0.093	−0.204	−0.702**
		(0.171)	(0.160)	(0.228)		(0.159)	(0.166)	(0.249)
Log(GDP/capita)				−0.061**				−0.060**
				(0.017)				(0.018)
Constant	−0.591**	0.110**	−0.615**	0.058	−0.531**	0.094**	−0.479*	0.229
	(0.197)	(0.017)	(0.219)	(0.206)	(0.169)	(0.015)	(0.203)	(0.304)
Observations	78	76	70	70	156	115	115	115
R^2	0.06	0.20	0.30	0.47	0.04	0.23	0.26	0.42

Exchange rate volatilities are calculated using rolling twelve month log exchange rate changes over specified time period. All other variables are beginning of period. Robust clustered standard errors in parentheses; $^+$ significant at 10%; * significant at 5%; ** significant at 1%.

Table 2. Determinants of Real Exchange Rate Volatility: High Income Country Sample

	1980–2000				1980–89/1990–2000			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Remoteness	0.187**		0.253**	0.289**	0.177**		0.176**	0.186**
	(0.040)		(0.079)	(0.081)	(0.040)		(0.052)	(0.051)
Export duties/Exports		7.407	−11.230	−19.894+		1.913	−0.151	−0.685
		(9.272)	(9.108)	(9.586)		(2.276)	(1.464)	(1.350)
Import taxes/Imports		0.197	−0.211	−0.137		0.166	−0.046	−0.005
		(0.273)	(0.294)	(0.163)		(0.160)	(0.194)	(0.139)
Log(GDP/capita)				0.035**				0.025*
				(0.011)				(0.011)
Constant	−0.321**	0.053**	−0.447**	−0.858**	−0.300**	0.052**	−0.297**	−0.556**
	(0.081)	(0.006)	(0.156)	(0.242)	(0.080)	(0.006)	(0.102)	(0.182)
Observations	22	21	21	21	44	42	42	42
R^2	0.36	0.07	0.38	0.52	0.27	0.06	0.24	0.30

Exchange rate volatilities are calculated using rolling twelve month log exchange rate changes over specified time period. All other variables are beginning of period. Robust clustered standard errors in parentheses; + significant at 10%; * significant at 5%; ** significant at 1%.

Table 3. Determinants of Real Exchange Rate Volatility: Middle Income Country Sample

	1980–2000				1980–89/1990–2000			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Remoteness	0.302^{**}		0.344^{*}	0.320^{*}	0.196^{*}		0.246^{*}	0.196
	(0.100)		(0.134)	(0.123)	(0.088)		(0.116)	(0.146)
Export duties/Exports		0.117	−1.493	−1.960		0.022	−0.198	−0.310
		(1.352)	(1.513)	(1.793)		(0.603)	(0.627)	(0.641)
Import taxes/Imports		-0.744^{+}	-0.591^{+}	-0.719^{*}		−0.494	-0.506^{+}	-0.613^{+}
		(0.371)	(0.346)	(0.314)		(0.304)	(0.290)	(0.304)
Log(GDP/capita)				-0.065^{*}				−0.044
				(0.027)				(0.033)
Constant	-0.504^{*}	0.195^{**}	-0.521^{+}	0.093	−0.297	0.157^{**}	−0.352	0.136
	(0.200)	(0.043)	(0.270)	(0.276)	(0.180)	(0.034)	(0.246)	(0.493)
Observations	38	37	32	32	76	49	49	49
R^2	0.09	0.13	0.20	0.31	0.03	0.07	0.11	0.15

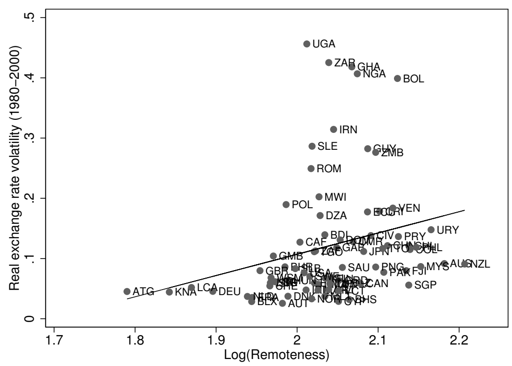
Exchange rate volatilities are calculated using rolling twelve month log exchange rate changes over specified time period. All other variables are beginning of period. Robust clustered standard errors in parentheses; $^{+}$ significant at 10%; * significant at 5%; ** significant at 1%.

Table 4. Determinants of Real Exchange Rate Volatility: Low Income Country Sample

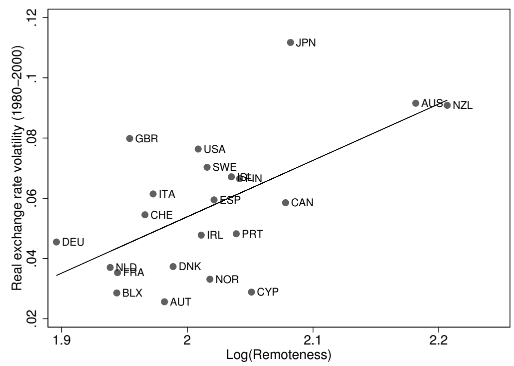
	1980–2000				1980–89/1990–2000			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Remoteness	0.455		0.375	0.547	0.145		0.259	0.709
	(0.698)		(0.444)	(0.513)	(0.713)		(0.730)	(0.656)
Export duties/Exports		1.181^{+}	1.125^{+}	0.939		1.182^{*}	1.217^{*}	1.168^{*}
		(0.573)	(0.640)	(0.654)		(0.450)	(0.412)	(0.528)
Import taxes/Imports		-0.700^{+}	−0.846	−0.528		-1.337^{*}	-1.372^{*}	-1.043^{+}
		(0.345)	(0.577)	(0.702)		(0.613)	(0.608)	(0.511)
Log(GDP/capita)				−0.085				−0.132
				(0.053)				(0.084)
Constant	−0.718	0.232^{**}	−0.508	−0.289	−0.096	0.310^{**}	−0.221	−0.244
	(1.423)	(0.065)	(0.895)	(0.893)	(1.481)	(0.100)	(1.532)	(1.361)
Observations	17	17	16	16	34	22	22	22
R^2	0.02	0.33	0.37	0.42	0.00	0.42	0.43	0.51

Exchange rate volatilities are calculated using rolling twelve month log exchange rate changes over specified time period. All other variables are beginning of period. Robust clustered standard errors in parentheses; $^{+}$ significant at 10%; * significant at 5%; ** significant at 1%.

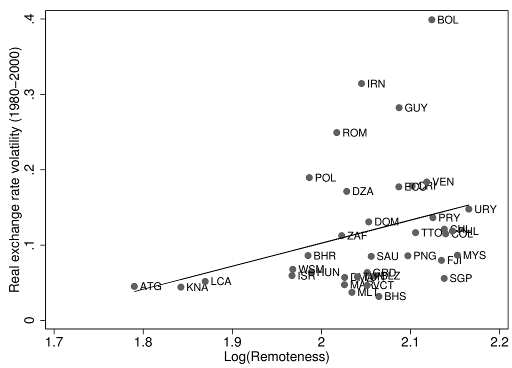
Figure 1. Real Exchange Rate Volatility and Remoteness Relationship



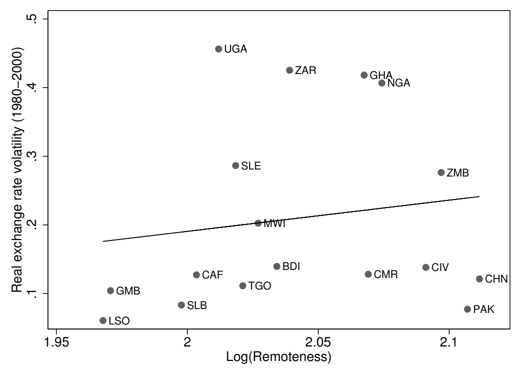
(a) Whole sample



(b) High income countries



(c) Middle income countries



(d) Low income countries

Notes: The country codes refer to the following countries. ANT (Netherlands Antilles), ATG (Antigua and Barbuda), AUS (Australia), AUT (Austria), BDI (Burundi), BHR (Bahrain), BHS (Bahamas), BLX (Belgium-Luxembourg), BLZ (Belize), BOL (Bolivia), CAF (Central African Republic), CAN (Canada), CHE (Switzerland), CHL (Chile), CHN (China), CIV (Cote d'Ivoire), CMR (Cameroon), COL (Colombia), CRI (Costa Rica), CYP (Cyprus), DEU (Germany), DMA (Dominica), DNK (Denmark), DOM (Dominican Republic), DZA (Algeria), ECU (Ecuador), ESP (Spain), FIN (Finland), FJI (Fiji), FRA (France), GAB (Gabon), GBR (United Kingdom), GHA (Ghana), GMB (Gambia, The), GRD (Grenada), GUY (Guyana), HUN (Hungary), IRL (Ireland), IRN (Islamic Rep. of Iran), ISL (Iceland), ISR (Israel), ITA (Italy), JPN (Japan), KNA (St. Kitts and Nevis), LCA (St. Lucia), LSO (Lesotho), MAR (Morocco), MLT (Malta), MWI (Malawi), MYS (Malaysia), NGA (Nigeria), NLD (Netherlands), NOR (Norway), NZL (New Zealand), PAK (Pakistan), PHL (Philippines), PNG (Papua New Guinea), POL (Poland), PRT (Portugal), PRY (Paraguay), ROM (Romania), SAU (Saudi Arabia), SGP (Singapore), SLB (Solomon Islands), SLE (Sierra Leone), SWE (Sweden), TGO (Togo), TTO (Trinidad and Tobago), TUN (Tunisia), UGA (Uganda), URY (Uruguay), USA (United States), VCT (St. Vincent and the Grenadines), VEN (Venezuela), WSM (Samoa), ZAF (South Africa), ZAR (Dem. Rep. of the Congo), ZMB (Zambia).

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