Identifying the effect of Exchange Rate Volatility on the Composition and Volume of Trade

Christian Broda (FRBNY) and John Romalis (Chicago GSB and NBER). First Draft: January 2003. This Draft: July 2003.

Abstract

We use a model of international trade to show that (i) trade affects exchange rate volatility and (ii) exchange rate volatility impacts trade in goods differently according to their degree of differentiation. In particular, commodity goods are less affected by exchange rate volatility than more highly differentiated products. These insights allow us to structurally address one of the main shortcomings of the existing empirical literature on the effects of exchange rate volatility on trade – the failure to correct for reverse causality. Using disaggregate trade data for a large number of countries for the period 1970-1997 we find strong results supporting predictions (i) and (ii). We then use these results to uncover the effect of exchange rate volatility on trade. We find that once we address the reverse-causality problem, the large effects of volatility on trade found in previous literature are greatly reduced.

1 Introduction

A traditional criticism of flexible exchange rate regimes is that flexible rates increase the level of exchange rate uncertainty and thus reduce incentives to trade (see Taussig (1924) for an early advocate of this idea). This criticism has generated a large literature that focuses on the impact of exchange rate volatility on trade. However, Mundell's (1961) optimal currency area hypothesis suggests an opposite direction of causality, where trade flows stabilize real exchange rate fluctuations, thus reducing real exchange rate volatility.[1] These two seminal ideas of international trade imply the existence of a standard identification problem in the relationship between trade and exchange rate volatility. In other words, is the correlation between trade and exchange rate volatility indicative of the effect of volatility on trade or viceversa?

Few theoretical and empirical papers have attempted to answer this question. Most of the existing studies have focused on the effects of volatility on trade by assuming that the exchange rate process is driven by exogenous shocks and is unaffected by other endogenous variables (see Hooper and Kohlhagen (1978), Viane and Vries (1992), Baccheta and van Wincoop (2000) among others;[2] see McKenzie (1999) and Cote (1994) for surveys on the empirical papers). By definition this implies that the effect of trade on volatility is assumed inexistent rather than jointly estimated with the effect of trade on volatility.[3]

We argue that this is not a benign assumption. Figure 1 illustrates the possible impact of trade on exchange rate volatility. This figure shows a strong positive relationship between real exchange rate volatility and distance between trading partners. Since distance cannot be affected by volatility, this strong relationship suggests that greater distance between countries significantly increases bilateral exchange rate volatility through the effect of distance on the intensity of commercial relationships such as trade. This result is related to Engel and Rogers (1996) and Alesina et al. (2002), who examine the importance of distance in the co-movement of price shocks across cities and countries, respectively. It also relates to recent work by Hau (2002) who finds that differences in openness can explain the cross-country variation in the volatility of effective real exchange rates. These findings suggest that ignoring this reverse-causality effect would imply overestimating the true impact of exchange rate volatility on trade.

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[1] Central banks in many developing countries have targeted real effective exchange rates in the past. This implies that even if trade does not act as a automatic stabilizer, policy interventions will reduce bilateral volatility with major trading partners.

[2] A noticeable distinction exists between earlier work on this literature and that of Obstfeld and Rogoff (1998), Baccheta and van Wincoop (2000). These studies focus on general equilibrium models of exchange rate fluctuations. They highlight the importance of having fundamentals, such as monetary, fiscal and productivity shocks, drive exchange rate fluctuations. However, in their models the exchange rates are unaffected by other endogenous variables, and are also purely driven by exogenous shocks.

[3] The only exceptions are the empirical papers by Frankel and Wei (1996), Barro and Tenreyro (2002) and Tenreyro (2003). We discuss the identification strategies of these papers in the main text.

We use a model of bilateral trade to structurally estimate the relationship between trade and real exchange rate volatility. The model highlights the role of trade in determining bilateral real exchange rate volatilities (the source of reverse causality),[4] and the differences in the impact of real exchange rate volatility on trade in various types of goods. These features of the model constitute the main buildings block of our identification strategy. Our main identification assumption is that conditional on the average composition of each trading relationship, real exchange rate volatility affects trade in differentiated products more than it affects trade in commodities, but trade in all products equally affects exchange rate volatility. By differencing bilateral trade across different products we are able to eliminate the bias generated by reverse causality. This enables us to identify how exchange rate volatility affects the composition of trade. Moreover, since the model predicts that commodity trade is only affected by the level of the exchange rate and not by volatility, the effect of volatility on the composition of trade can be used to identify the effect of volatility on total trade.

The intuition behind the main predictions of the model is fairly simple. First, in our model all trade acts as an automatic stabilizer of real exchange rates. In *equilibrium* proximate countries have more similar consumption baskets than more distant countries. This implies that more proximate countries have lower real exchange rate volatility than more distant countries, as shown in Figure 1. This is because a shock that changes the price of a country's good will affect more the price of the consumption basket of a neighboring country than a more distant country. In the limit, if baskets are identical, real exchange rates are constant.

Second, in our model exchange rate volatility affects the composition of trade. Commodity products are sold in organized exchanges. Subject to transport costs, buyers and sellers do not care who they buy from or sell to, since what they end up paying or receiving is identical regardless of the counterparty. With differentiated products the same is not true. Rauch (1999) argues that the heterogeneity of most manufactured products in both characteristics and quality prevents traders from using organized exchanges for these products. Instead, connections between sellers and buyers are made through a costly search process. This cost can be associated with establishing networks, advertising, and marketing in general. Real-exchange rate volatility that occurs after these costs are sunk will affect the profitability of these connections. Therefore, in contrast to commodity products, the direction of trade in differentiated products is affected by exchange rate volatility.[5] Thus real exchange rate volatility affects the composition of trade between countries.

[4] In our model trade acts as an automatic stabilizer of real exchange rates. Therefore, the bilateral pattern of real exchange rate volatility can differ across countries even though the underlying shocks to each country are *identical.*

[5] The sign of the effect of volatility on trade in differentiated products depends on the degree of risk aversion of the firms that are exporting them. When firms are sufficiently risk averse (loving), relatively more differentiated products will be exported to countries that have low (high) exchange rate volatilities with the exporting country.

We use disaggregated data to exploit our identification structure and test the predictions of the model. Rauch (1999) provides a categorization of SITC Revision 2 industries according to three possible product types: differentiated, reference priced, and commodity. The lack of a reference price distinguishes "differentiated" products from the rest. Those industries with reference prices can be further divided into those whose reference prices are quoted on organized exchanges ("commodities") and those whose reference prices are quoted only in trade publications ("reference priced"). The data consists of annual flows of exports from a given country to different importing countries. For instance, Lead (SITC 685) is listed on an organized exchange and therefore treated as a commodity while Footwear (851) is not and is treated as a differentiated product. Bilateral trade data for each SITC industry is available for a large number of developed and developing countries during the period 1970-1997. We calculate several measures of bilateral real exchange rate volatility from monthly real exchange rate series for the same period.

The empirical findings of this paper provide support for the view that real exchange rate volatility depresses exports. We find that a 10 percent point fall in real exchange rate volatility increases exports of differentiated products relative to commodity products by 5 percent. Since our identification strategy assumes that commodity products are unaffected by volatility, and since differentiated products account for over 60 percent of world trade, this implies that total trade would increase on average by 3 percent.

The empirical methodology is also suitable for testing the overall role of exchange rate regimes in countries' trade performance. While several studies have found large positive effects of fixed regimes on trade (see for example Ghosh et al. (1997) and Frankel and Rose (2002)) they do not control for the reverse-causality problem. However, we observe many fixed regimes pegging their currency to that of countries which are their main trading partners suggesting that reverse causality can be an important problem.[6] Indeed, we find that the effect of fixed regimes on trade is smaller and less significant when simultaneity is controlled for. In particular, the effect of currency unions is substantially reduced (by a factor of 4) when we apply our methodology to Frankel and Rose's data.

This paper departs from the existing literature in several dimensions. First, this paper represents the first attempt to structurally estimate the relationship between trade and exchange rate volatility. We provide a model that incorporates both directions of causality and that suggests an identification structure. Previous attempts to correct for the problem of reverse causality relied on assumptions about appropriate instruments. Frankel and Wei (1996) use the standard deviation of relative money supplies as an instrument for the volatility of exchange rates. As Tenreyro (2003) points out, movements of money demand and supply are likely to be driven by factors that also affect trade directly. Barro and Tenreyro (2002) and Tenreyro (2003) model the formation of exchange rate regimes to derive an instrument for volatility.

[6] The European Monetary System and the Central Franc Zone are just two examples of this behavior.

They develop an instrument for membership in a currency union (or pegged regime) based on the probability that the countries independently adopt (or peg to) the same common currency. The probability that a single country adopts the currency of another country is a linear combination of the same "gravity" variables that affect trade directly. They get identification by assuming that "bilateral trade between countries i and j depends on gravity variables for countries i and j, but not on gravity variables involving third countries, notably the potential anchors". Their IV estimates of the effect of currency unions on trade are substantially *larger* than OLS estimates. By contrast, in the case of fixed exchange rates Tenreyro finds *no* effects of fixed exchange rates on trade. But their identification assumption is surely questionable. In most models of trade, the trade between countries i and j will greatly depend on the outside trading opportunities with third countries. That is an important feature of our relatively standard trade model. The coming tide of papers that examine the trade effects of the Euro are also of interest. The introduction of the Euro provides an exogenous shift (a "before" and an "after") that can be used to identify the effect of currency unions on trade. Early results using "gravity" regressions suggest very modest trade increases.[7] But the experiment may not be as clean as it appears. The introduction of the Euro was long anticipated. These papers will need to work hard to separate the trade effects of the common currency from the trade effects of other market integration measures adopted by the European Union in recent years.

Second, we know of no paper that models and estimates the effect of exchange rate volatility on the composition of trade. In previous empirical studies, Bini-Smaghi (1991) and Klein (1990) have attempted to use disaggregate data to test whether uncertainty has different effects for different products. They find that different products are affected differently by volatility but the characteristics of those products that have larger effects are not identified. Third, as in our model, Hau (2002) shows that openness can affect real exchange rates through the share of tradable goods in consumption. In his model, however, this share is exogenously given while in ours it is endogenously determined by trading and searching costs. This implies that in our model the bilateral pattern of real exchange rate volatility can differ across countries even though the underlying shocks to each country are identical.

Lastly, most of the existing empirical papers on the relation between exchange rate volatility and trade focus on a short-term volatility measure and on short-term frequency data (quarterly or monthly). This focus responds to the importance that the invoicing currency has on the theoretical literature. In most of this literature the invoicing currency plays a key role because prices are set before the exchange rate is observed. Therefore, the invoicing currency determines who bears the exchange rate risk. Note that in this setup uncertainty arises between the time in which prices are set and the final payment is made, which is usually a short period.[8] We depart from this tradition and focus on the medium-term, given that the channel being tested is the market entry decision of exporting firms, arguably involving a longer horizon

[7] See, for example, De Nardis and Vicarelli (2003).

[8] Informal evidence suggests that this can take between one and six months.

than the pricing decision.

The paper proceeds as follows. Section 2 sketches the biases that reverse causality generates and presents our main identification strategy. Section 3 provides a model that supports and refines this strategy. Section 4 describes the data used, presents evidence of the importance of reverse causality, and discusses the empirical strategy. Section 5 presents the main results of the paper and the comparisons with the exchange rate regime literature. Section 6 presents conclusions.

2 Our Identification Strategy

Most of the estimates of the effect of exchange rate volatility on trade in the current literature do not correct for the biases induced by reverse causality. In this section we demonstrate these biases using a simple system that describes the relationship between exchange rate volatility and trade. We then show that by exploiting the product dimension of bilateral trade, these biases can be eliminated or greatly reduced. In the next section we develop a model that provides a structural interpretation for this system and the identification strategy.

We start with the following simple system:

$$T_{ijt} = \alpha\sigma_{ijt} + \beta TC_{ijt} + \varepsilon_{ijt} \tag{1}$$

$$\sigma_{ijt} = \gamma T_{ijt} + \mu_{ijt} \tag{2}$$

where T_{ijt} is a measure of trade between countries i and j at time t, σ_{ijt} is a measure of expected exchange rate volatility between i and j, TC_{ijt} is a measure of trade costs between i and j, and $E(\varepsilon\mu) = 0$.[9] We expect the signs of the coefficients to be the following: $\alpha < 0$, $\beta < 0$ and $\gamma < 0$; and the stability of the system requires that $\gamma\alpha < 1$. By replacing (1) in (2) we get the reduced form expression for the exchange rate volatility variable:

$$\sigma_{ijt} = \frac{\gamma\beta}{(1-\gamma\alpha)} TC_{ijt} + \frac{\gamma}{(1-\gamma\alpha)}\varepsilon_{ijt} + \frac{1}{(1-\gamma\alpha)}\mu_{ijt}. \tag{3}$$

Now assume that we do not have data on trade costs TC_{ijt} and use OLS to estimate

$$T_{ijt} = \alpha\sigma^{e}_{ijt} + \upsilon_{ijt} \tag{4}$$

ignoring (2) and where $\upsilon_{ijt} = \beta TC_{ijt} + \varepsilon_{ijt}$. This implies that the first term in (3) will induce an *omitted variable* bias and the second term will produce an *endogeneity bias*. The bias term can be expressed as

$$E\widehat{\alpha} - \alpha = \frac{\gamma}{(1-\gamma\alpha)}\beta^2\frac{ETC^2}{E\sigma^2} + \frac{\gamma}{(1-\gamma\alpha)}\frac{E\varepsilon^2}{E\sigma^2}, \tag{5}$$

[9] In the next section it will be clear that exchange rate volatility is not only affected by transport costs, but by other reasons that may determine trade, such as preference parameters and factor supplies. This simple structure can also take account of the role of trade costs involving third countries; TC_{ijt} can be thought of as a measure that captures how all trade costs affect trade between countries i and j.

where both terms on the right hand side are negative. Thus, by not correcting for the reverse causality in the original system we obtain

$$|\widehat{\alpha}| > |\alpha| .$$

That is, we would overestimate the effect of σ on T. Moreover, for regions with little variability in σ to start with, the bias is larger.

In this paper we modify the basic system of equations in (1)-(2)to incorporate the differential effect of exchange rate volatility on different types of goods and fixed effects for every importer-exporter relationship. The basic system then becomes,

$$M_{ijt} = d_{ij} + \alpha\sigma^e_{ijt} + \beta_m TC_{ijt} + \varepsilon^m_{ijt} \quad (6)$$
$$C_{ijt} = d_{ij} + \beta_c TC_{ijt} + \varepsilon^c_{ijt} \quad (7)$$
$$\sigma_{ijt} = d_{ij} + \gamma\left(M + C\right)_{ijt} + \mu_{ijt} \quad (8)$$

where M_{ijt} is a measure of manufacturing trade between i and j; C_{ijt} is a measure of commodity trade between i and j; d_{ij} are importer-exporter fixed effects; errors across equations are assumed independent, $E\left(\varepsilon^m\mu\right) = E\left(\varepsilon^c\mu\right) = E\left(\varepsilon^c\varepsilon^m\right) = 0$, and variances for the trade errors are assumed equal, $E\left(\varepsilon^c\right)^2 = E\left(\varepsilon^m\right)^2$. Note that, consistent with our results in the next section, we assume that commodity trade is unaffected by exchange rate volatility and that trade in both goods affect exchange rate volatility. By taking differences across trade in different products we obtain the following modified system:

$$\overline{M}_{ijt} - \overline{C}_{ijt} = \alpha\overline{\sigma}^e_{ijt} + (\beta_m - \beta_c)\overline{TC}_{ijt} + \overline{\varepsilon}^m_{ijt} - \overline{\varepsilon}^c_{ijt} \quad (9)$$
$$\overline{\sigma}^e_{ijt} = \gamma\left(\overline{M}_{ijt} + \overline{C}_{ijt}\right) + \overline{\mu}_{ijt}. \quad (10)$$

where a bar on top of a variable indicates that it has been purged of d_{ij}. In this case, if we use OLS to estimate (9) treating TC as an omitted variable we would obtain the following expression for the bias term:

$$E\widehat{\alpha} - \alpha = \frac{\gamma}{(1-\gamma\alpha)}\left(\beta^2_m - \beta^2_c\right)\frac{E\overline{TC}^2}{E\overline{\sigma}^2}. \quad (11)$$

The bias term in (11) has two notable features. First, the endogeneity bias disappears. By differencing across bilateral trade in different products we are able to eliminate part of the problem that reverse causality generates. This is because $E\left(\overline{\varepsilon}^m_{ijt} - \overline{\varepsilon}^c_{ijt}, \overline{\varepsilon}^m_{ijt} + \overline{\varepsilon}^c_{ijt}\right) = 0$. Second, by taking differences across goods we are able to reduce the omitted variable bias. Rauch (1999) finds strong evidence that $\beta^2 > \beta^2_m - \beta^2_c$ for a sample period similar to ours. Using his estimates, and comparing the coefficients in the omitted variable terms from (5) and (11), suggests that differencing across goods can reduce the omitted variable bias by roughly 60 percent.[10] We also expect that $\frac{E\overline{TC}^2}{E\overline{\sigma}^2} < \frac{ETC^2}{E\sigma^2}$, therefore further reducing this bias.[11]

[10] The simple calculation uses the coefficients of distance to proxy for β_i for the Rauch's benchmark regressions. We average the coefficient for each decade and obtain $\beta_m = -0.837$ and $\beta_c = -0.687$.

[11] This is because there has been a substantial uptick in exchange rate volatility during our sample

3 The Model

A. Model Description

The model has four countries and two sectors, manufacturing and commodities. The manufacturing sector is an adaptation of the Krugman (1980) model of intraindustry trade driven by scale economies and product differentiation. The adaptation is that to serve an export market manufacturers must incur an additional fixed cost in each period before observing that period's exchange rates. After making the entry decision and observing the exchange rate, the manufacturer can set prices optimally for that period. Manufacturers' assumptions about the distribution of exchange rates will affect the entry decision. Exchange rates are affected by factors that are external to this model such as government expenditures that absorb domestic labor.[12] Commodity producers do not face a fixed cost of entry, they are always ready to sell in a market. The realized level of exchange rates affects where commodities are sent; exchange rate volatility has no independent effect on commodity trade. Finally we add 'iceberg' transport costs. The transport costs affect the distribution of exchange rates and affect manufacturers' decisions to export. Detailed assumptions are set out below.

1. There are 4 countries $i = 1, .., 4$ on 2 continents; Country 1 and 2 on one continent and 3 and 4 on the other.

2. Each country has its own currency that can be freely exchanged for that of another. The price of Country i's currency in terms of the currency of Country 1, which we call the dollar, at time t is s_{st}.

3. There is one factor of production, Labor, supplied inelastically. Monetary policy ensures that labor earns a factor reward of $w_{it} = 1$ unit of local currency. The total labor supply in each country is 1.

4. Trade is always balanced.

5. Exchange rate movements are driven by government demands for domestic labor, $G_{it} \in [0, 1)$, paid for by taxing current labor income. Government expenditure in this model is purely wasteful and represents a destruction of labor. High government expenditure makes domestic labor scarce, driving up its relative price. Since local currency wages are fixed, the exchange rate appreciates. Government demand for labor also reduces disposable income, reducing demand for imports.

6. All consumers in all countries are assumed to maximize identical constant-relative-risk-aversion preferences in each period over a composite manufactured good

following the collapse of fixed exchange rate regimes, which will not be removed by our fixed effects. Changes in most trade costs are likely to have been more modest.

[12] We could just as easily modelled productivity shocks.

M and a composite commodity C, with the fraction of income spent on M being b (Equation 12).

$$U_t = \frac{1}{a}\left(M_t^b C_t^{1-b}\right)^a \tag{12}$$

7. Commodity sector. The commodity C is a composite good. Perfectly competitive firms in Country i produce an identical commodity under constant returns to scale, requiring 1 unit of labor to produce 1 unit of the commodity. Each country produces a different commodity. For instance, Country 1 might produce wheat while Country 2 produces copper. C can be interpreted as a sub-utility function that depends on the quantity of each commodity consumed. We choose the CES function with elasticity of substitution between two different commodities being σ_c. Let q_{it}^D denote the quantity consumed of the commodity produced in Country i. C_t is defined by Equation 13:

$$C_t = \left(\sum_{i=1}^{4}\left(q_{it}^D\right)^{\frac{\sigma_c-1}{\sigma_c}}\right)^{\frac{\sigma_c}{\sigma_c-1}}. \tag{13}$$

8. Monopolistic competition in manufacturing. In manufacturing there are economies of scale in production and firms can costlessly differentiate their products. The output of manufacturing consists of a number of varieties that are imperfect substitutes for one another. The quantity produced of variety v is denoted by q_v^S, the quantity consumed by q_v^D. V is the endogenously determined set of varieties produced. M can be interpreted as a sub-utility function that depends on the quantity of each variety of M consumed. We choose the symmetric CES function with elasticity of substitution $\sigma_m > 1$:

$$M_t = \left(\int_{v\in V}\left(q_{vt}^D\right)^{\frac{\sigma_m-1}{\sigma_m}} dv\right)^{\frac{\sigma_m}{\sigma_m-1}}, \qquad \sigma_m > 1. \tag{14}$$

All manufacturers must serve their domestic market. Manufactures are produced using labor with a marginal cost w_i and a per-period fixed cost. The fixed cost must be paid before manufacturers observe the exchange rates for the period. Average costs of production decline at all levels of output, although at a decreasing rate. Production technology for a firm in Country e selling q_{vt} units in the domestic market is represented by a total cost function TC that is assumed to be identical for all firms selling in their domestic market:

$$TC_{et}(q_{vt}^S) = w_{et}(\alpha_1 + q_{vt}^S) \tag{15}$$

Manufacturers may enter foreign markets through exports only. At the beginning of each period before exchange rates are observed, each manufacturer sells licenses giving the licensee the exclusive right to export the manufacturer's product to a single export market.[13] There is an unlimited supply of potential licensees. The license permits the licensee to purchase unlimited quantities of the manufacturer's product at marginal cost. To export to a foreign market, the licensee must incur a per-period fixed cost for market development, which must be paid before observing exchange rates for that period.[14] The licensees cost for market development and procuring x_{vt} units for export from country e (exporter) to country i (importer) is represented by the Free On Board (FOB) export cost function XC:

$$XC_{ei,t}(x_{vt}^S) = w_{et}(\alpha_2 + x_{vt}^S) \tag{16}$$

9. Costly international trade. There may be a transport cost for international trade. To avoid the need to model a separate transport sector, transport costs are introduced in the convenient but special iceberg form. τ_{1m} units of a manufactured good must be shipped for 1 unit to arrive in the country on the same continent, τ_{2m} units must be shipped for 1 unit to arrive in a country on a different continent ($\tau_{2m} \geq \tau_{1m} \geq 1$). The equivalent transport costs for commodities are τ_{1c} and $\tau_{2c.}$

B. Equilibrium in Commodity Sectors

In general equilibrium consumers maximize utility, firms maximize profits, all factors are fully employed and trade is balanced. Government expenditures determine exchange rates s_{et}. The equilibrium for commodity sectors is straightforward. Firms always price at marginal cost. For their domestic market, marginal cost in local currency is simply equal to the wage rate, 1. For export markets marginal cost is higher due to the transport cost. The price, in dollars, of a commodity produced in country e (exporter) and sold in country i (importer) is given by Equation 17:

$$p_{ei,t} = \begin{cases} s_{et} & e = i; \quad \text{domestic sales} \\ s_{et}\tau_{1c} & e \neq i; \quad e, i \text{ on same continent} \\ s_{et}\tau_{2c} & e \neq i; \quad e, i \text{ on different continents} \end{cases} \tag{17}$$

Consumers spend a fixed proportion of their income on commodities. They demand some of each commodity. Denote after-tax income in Country i by $Y_{it} = 1 - G_{it}$. Maximizing Equation 12 yields the following demand functions in Country i for commodities produced in e:

[13] The reason for this assumption is to simplify the export market entry decision. The licensee takes no account of earnings in other markets, eliminating diversification considerations from the market entry decision. Performance in foreign markets is extremely correlated with performance in domestic markets, so diversification considerations are not important in this model.

[14] The critical assumption is not the fixed cost α_1 for commencing domestic production, but how large the fixed cost α_2 for entering each export market is relative to α_1.

$$q^D_{ei,t} = \frac{(s_{et}\tau_{eic})^{-\sigma}}{\sum_{e'} (s_{e't}\tau_{e'ic})^{1-\sigma}} (1-b) Y_{it} s_{it} \tag{18}$$

where $\tau_{eic} = 1, \tau_{1c}$, or τ_{2c}, according to Model Assumption 9. Note how trade costs involving third countries e' directly affect the trade between e and i. It is convenient to define the ideal price index for commodities in Country i, P_{ic}:

$$P_{ict} = \left(\sum_e (s_{et}\tau_{eic})^{1-\sigma_c} \right)^{\frac{1}{1-\sigma_c}} \tag{19}$$

Equations 17 through 19 can be solved for log of the value of commodity imports into Country 1 from Country e:

$$\ln p_{e1,t} q^D_{e1,t} = (1-\sigma_c) \ln s_{et} + (1-\sigma_c) \ln \tau_{e1c} + \ln(1-b) Y_{1t} - (1-\sigma_c) \ln P_{1ct} \tag{20}$$

We can eliminate Country 1 specific effects such as its commodity price index P_{1ct} and income spent on commodities $(1-b)Y_{1t}$ by differencing. In particular, the log value of Country 1 imports from Country e less the log value of Country 1 imports from Country e' is:

$$\ln p_{e1t} q^D_{e1t} - \ln p_{e'1t} q^D_{e'1t} = (1-\sigma_c)(\ln s_{et} - \ln s_{e't}) + (1-\sigma_c)(\ln \tau_{e1c} - \ln \tau_{e'1c}) \tag{21}$$

C. Equilibrium in Manufacturing Sectors

The equilibrium in manufacturing sectors is more involved. The crucial difference is that some manufacturers may not end up exporting to some or all foreign markets, and that this proportion will depend on the perceived volatility of exchange rates. The properties of the model's demand structure for manufactures have been analyzed in Helpman and Krugman (1985).[15] Let $p_{ei,v}$ be the price paid by consumers in country i, inclusive of transport costs, for a variety v that happens to be produced in country e, expressed in dollars. Maximization of Equation 12 yields the following demand functions for variety v in country i:

$$q^D_{ei,v} = \frac{p^{-\sigma_m}_{ei,v}}{\int_{v' \in V} p^{1-\sigma_m}_{ei,v'} dv'} bY_{it} s_{it}; \qquad \forall v \in V. \tag{22}$$

[15]See Sections 6.1, 6.2 and 10.4 in particular.

A firm's share of industry revenues depends on its own price and on the prices set by all other firms in that industry. It is convenient to define the ideal price index for manufactures in Country i, P_{im}:

$$P_{im} = \left[\int_{v \in V} p_{ei,v}^{1-\sigma_m} dv \right]^{\frac{1}{1-\sigma_m}} \tag{23}$$

Each firm produces a different variety of the product. Each country produces different varieties. Consumers demand some of every variety made available to them. Profit maximizing firms perceive a demand curve that has a constant elasticity, and therefore set price at a constant markup over marginal cost.[16] An individual firm in country e and its licensees set a single factory gate dollar price of $\widehat{p}_{e,v}$:

$$\widehat{p}_{e,vt} = \frac{\sigma_m}{\sigma_m - 1} s_{et} \tag{24}$$

For export markets marginal cost is higher due to the transport cost. The consumer price $p_{ei,v}$, in dollars, of a manufactured good v produced in country e and sold in country i is given by Equation 25:

$$p_{ei,vt} = \widehat{p}_{ei,vt} \tau_{eim} \tag{25}$$

Country e's products sell in its own domestic market at the factory gate price $\widehat{p}_{e,vt}$, but in export markets the transport cost raises the price to $\widehat{p}_{e,vt}\tau_{eim}$. The ideal manufacturing industry price index for Country i, P_{im}, is given in Equation 26. We assume a symmetric equilibrium if each country faces the same distribution of shocks to government expenditure. Prior to the realization of the exchange rate shock, all countries are alike with n firms manufacturing in each country, and that nf_{ei} manufacturing firms from Country e export to Country i. Let $f_{ei} = f_1$ if e and i are on the same continent, and $f_{ei} = f_2$ if e and i are on different continents. Note that $f_{ei} = 1$ if $e = i$ (domestic sales). Conditions for f_1 and f_2 are examined below. Except where needed, the 't' notation is suppressed.

$$P_{im} = \frac{\sigma_m}{\sigma_m - 1} \left[\sum_e n f_{ei} \left(s_e \tau_{eim} \right)^{1-\sigma_m} \right]^{\frac{1}{1-\sigma_m}} \tag{26}$$

Let V_e be the set of all manufacturing varieties produced in Country e. Equations 22 through 26 solve for the log of the value of manufacturing imports into Country 1 from Country e:

$$\ln \int_{v \in V_e} p_{e1v} q_{e1v}^D = \ln f_{e1} + \ln n + (1-\sigma_m) \ln s_e + (1-\sigma_m) \ln \tau_{e1m} + \ln bY_1 - (1-\sigma_m) \ln P_{1m} \tag{27}$$

[16] The demand curve faced by a firm has a constant elasticity if there are an infinite number of varieties.

We can again employ differencing to eliminate Country 1 specific effects. Equation 28 gives the log value of Country 1 imports from Country e less the log value of Country 1 imports from Country e':

$$\ln \int_{v \in V_e} p_{e1v} q_{e1v}^D - \ln \int_{v \in V_{e'}} p_{e'1v} q_{e'1v}^D = \ln f_{e1} - \ln f_{e'1} + (1-\sigma_m)(\ln s_e - \ln s_{e'}) + (1-\sigma_m)\left(\ln \tau_{em} - \ln \tau_{e'm}\right) \tag{28}$$

We can now employ differences in differences to derive our estimating equation. Equation 28 less Equation 21 gives:

$$\begin{aligned} &\ln \int_{v \in V_e} p_{e1v} q_{e1v}^D - \ln \int_{v \in V_{e'}} p_{e'1v} q_{e'1v}^D - \left(\ln p_{e1} q_{e1}^D - \ln p_{e'1} q_{e'1}^D\right) \\ &= \ln f_{e1} - \ln f_{e'1} + (\sigma_c - \sigma_m)(\ln s_e - \ln s_{e'}) \\ &\quad + (1-\sigma_m)\left(\ln \tau_{e1m} - \ln \tau_{e'1m}\right) - (1-\sigma_c)\left(\ln \tau_{e1c} - \ln \tau_{e'1c}\right) \end{aligned} \tag{29}$$

The difference in the difference of manufactured less commodity trade depends on the difference in the proportions f_{e1} and $f_{e'1}$ of manufacturer's licensees who choose to pay the fixed cost to enter Country 1's market, which will depend on the distribution of exchange rates and attitudes to risk. Assuming that some but not all licensees enter foreign markets, the equilibrium condition will have a licensee indifferent to whether it enters or not. Equation 30 gives real profits in period t for a licensee in Country e that exports to Country 1: $\frac{1}{\sigma_m}$ is the profit margin; $\alpha_2 s_{et}$ is the fixed market development cost in dollars; the remainder of the term in brackets are sales revenues in dollars; while $P_{et} = (P_{emt})^b (P_{ect})^{1-b}$ is the ideal price index in Country e.

$$\left[\frac{1}{\sigma_m}\left(\frac{\frac{\sigma_m}{\sigma_m-1} s_{et} \tau_{e1m}}{P_{1mt}}\right)^{1-\sigma_m} bY_{1t} - \alpha_2 s_{et}\right]\frac{1}{P_{et}} \tag{30}$$

Assume that Country e is Country 2 and therefore on the same continent as Country 1, so that $f_{e1} = f_1$. f_1 is determined by the expected utility of entering nearby markets. Licensees ignore the earnings of the manufacturer and its licensees in other markets. With free entry, licensees in Country 2 enter Country 1 until:

$$E\left(\left[\frac{1}{\sigma_m}\left(\frac{\frac{\sigma_m}{\sigma_m-1} s_{2t} \tau_{1m}}{P_{1mt}}\right)^{1-\sigma_m} bY_{1t} - \alpha_2 s_{2t}\right]\frac{1}{P_{2t}}\right)^a = 0 \tag{31}$$

Assume that Country e' is Country 3 and therefore on a different continent to Country 1, so that $f_{e'1} = f_2$. f_2 is determined by the expected utility for licensees entering distant markets. Licensees in Country 3 enter Country 1 until:

$$E\left(\left[\frac{1}{\sigma_m}\left(\frac{\frac{\sigma_m}{\sigma_m-1}e_{3t}\tau_{2m}}{P_{1mt}}\right)^{1-\sigma_m} bY_{1t}-\alpha_2 e_{3t}\right]\frac{1}{P_{3t}}\right)^a = 0 \qquad (32)$$

Conditional on the distribution of exchange rates the left side of Equation 31 is declining in f_1, since the Country 1 price index P_{1mt} declines as more firms enter and because $\sigma_m > 1$. Likewise, Equation 32 is declining in f_2. In general, f_1 and f_2 depend on the parameter governing risk aversion, a, and the distribution of exchange rates. f_2 will in general differ from f_1 directly due to the higher transport cost (which reduces the proportion of firms willing to enter) and indirectly through the impact of transport costs on the distribution of exchange rates.

f_1 and f_2 are therefore different functions of expected exchange rate volatility. We therefore set up our basic empirical specification based on Equation 29, recognizing that f_1 and f_2 are a function of exchange rate volatility.

3.1 Endogenous Exchange Rate Volatility

In most of the existing theoretical literature the exchange rate process is purely driven by exogenous shocks. The earlier literature relied on a partial equilibrium approach in which the exchange rate was assumed to be an exogenous random variable (see Ethier (1973), Viane and Vries (1992) and Hooper and Kohlhagen (1978)). More recently, Obstfeld and Rogoff (1998) and Baccheta and van Wincoop (2000) have focused on general equilibrium models of exchange rate fluctuations. They highlight the importance of having fundamentals, such as monetary, fiscal and productivity shocks, drive exchange rate fluctuations. However, in these models, exchange rates are unaffected by other endogenous variables, and are purely driven by exogenous shocks.[17]

In our model trade acts as an automatic stabilizer of real exchange rates. This implies that *in equilibrium* proximate countries have more similar consumption baskets than more distant countries. More similar consumption baskets, in turn, reduce real exchange rate volatility. The intuition for this result is simple. Since real exchange rates are the ratio of price levels P_{it} across countries (denominated in a common currency), a shock to the price of one country's output shifts the relative price level between itself and more proximate countries less than it shifts the relative price levels between itself and more distant countries.[18] Hau (2002) obtains a similar

[17] An exception is in the case where the degree of local currency pricing is decided depending on the distribution of shocks. See

[18] Nominal exchange rate volatility is also affected by the trade costs. Consider the effect of Government expenditure in Country 3, for example. Country 3's nominal exchange rate rises against all currencies. This tends to drag up the exchange rates of countries whose output is more substitutable for its own. The exchange rate of Country 2 against Country 1 remains unchanged, since Country 1 and 2 remain identical. The exchange rate of Country 4 falls relative to Country 3 but may appreciate or depreciate relative to the other currencies. The higher is σ_m relative to σ_c, the more likely Country 4's nominal exchange rate will rise against those of Country 2 and Country 1

cross-country prediction using a small open economy model by assuming that the share of tradable goods in preferences vary by country. Our model differs from his in several dimensions. First, Hau assumes different consumption baskets across countries, while in our setup they are endogenously determined by trading and searching costs. Second, in our framework the bilateral pattern of real exchange rate volatility can differ across countries even though the underlying shocks to each country are *identical*. Lastly, our predictions are specific to bilateral relations and are based on a multi-country model. Hau's predictions are country-specific as they are based on different parameterizations of the same two-country model.

Figure 2 illustrates the impact that trade costs have on real exchange rate volatility in the model. In particular, it shows the relationship between inter-continental trading costs and the relative real exchange rate volatility between countries in the same continent and between countries in different continents. We assume that shocks hitting each individual country are *identical*; $\sigma_m = 4$ and $\sigma_c = 5$; intra-continental trading costs $\tau_{1m} = \tau_{1c} = 1$ and inter-continental trading costs are the same for commodities as for manufactured goods, $\tau_{2m} = \tau_{2c}$. The figure shows that with $\tau_2 > \tau_1$, volatility with distant countries is larger than with proximate countries. It also shows that when the trading costs between continents increase, the inter-continental bilateral real exchange rate volatility rises relative to the intra-continental volatility.

For the empirical section that follows, this means that we face a simultaneous equations system similar to that in (6)-(8). Bilateral trade is a function of exchange rate volatility and trade costs. But there is another equation: for a given distribution of shocks to government expenditures, bilateral exchange rate volatility in our model is a function of trade. Simply running OLS regressions of trade on exchange rate volatility will overstate the effect of exchange rate volatility on trade, as argued in Section 2. In Section 4.2 we present evidence suggesting that this bias may be substantial.

4 Data and Empirical Strategy

4.1 Trade and Real Exchange Rate Data.

Rauch (1999) provides a categorization of SITC Revision 2 industries according to three possible product types: differentiated or "branded" , reference priced, and commodity. The lack of a reference price distinguishes differentiated products from the rest. Those industries with reference prices can be further divided into those whose reference prices are quoted on organized exchanges (commodities) and those whose reference prices are quoted only in trade publications (reference priced). The data consists of annual flows of exports from a given country to different importing countries. This data is available for a large number of developed and developing countries during the period 1970-1997. Table A1 shows the share of each type of product for different regions and time periods. A summary of the sample used in the

because Country 4's labor in effect becomes more substitutable for the labor that is being wasted by Country 3's government.

estimation is listed in Table A1 in the Appendix.

Another essential part of the estimation is to obtain a measure of exchange rate volatility. We use monthly data on real exchange rate series from IFS to compute standard deviations. We de-trend these series using a Hodrick-Prescott filter and take standard deviations of the filtered data in five year periods.[19] Table A1 also shows the descriptive statistics of these series. The additional data needed for the main specifications are taken from the World Development Indicators.

The paper also uses data on exchange rate regimes. The basic reference for classification of exchange rate regimes is the International Monetary Fund's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER).[20] This classification is a *de jure* classification that is based on the publicly stated commitment of the authorities in the country in question. The IMF report captures the notion of a formal commitment to a regime, but fails to capture whether the actual policies were consistent with the stated commitment. Since we mainly use bilateral data in the paper, we use the currency to which a country is pegged to create a fixed exchange rate regime dummy that takes the value of one if one country's currency is pegged to the other country's currency or if two countries are pegged to the same currency. The Rogoff and Reinhart (2003) classification can partly solve the problems that arise from a *de jure* classification. Rogoff and Reinhart use information based on the observed behavior of parallel exchange rates which can better capture the behavior of the monetary authority.[21] A similar bilateral exchange rate dummy is constructed from Rogoff and Reinhart's database.

4.2 Evidence of Endogenous Exchange Rate Volatility

In Section 2 we showed that estimates the effect of exchange rate volatility on trade will be biased if we fail to control for the reverse causality present in exchange rate process. Figure 1 illustrates that the volatility of the real exchange rate is highly correlated with distance between trading partners. In this subsection we show that the effect of volatility on trade, β, can be identified using the log of distance ($\ln dist_{ij}$) as an instrument for trade in Equation (2). As suggested by Engel and Rogers (1996) and Hummels (2000), trade costs are highly correlated with distance between trading partners. Note that identifying β requires that $E(\ln dist_{ij}, \ln T_{ijt}) \neq 0$ and $E(\ln dist_{ij}, \upsilon_{ijt}) = 0$.

Table 1 presents the IV estimates for the single equation in (2) using $\ln dist_{ij}$ as an instrument for the log of total trade, $\ln T_{ijt}$. The first stage regression suggests that

[19] Our focus is mostly on medium-term volatility. We first identify the trend from the monthly log real exchange rate data using a smoothing parameter of 1,000,000. The deviation around this trend is then decomposed into short-term volatility and medium-term volatility, by smoothing these deviations using a smoothing parameter of 400. We use different measures of volatility in the robustness checks.

[20] The AREAER classification consists of nine categories, broadly grouped into pegs, arrangements with limited flexibility, and "more flexible arrangements", which include managed and pure floats. This description is based on the AREAER (1996).

[21] Such *de facto* classifications, however, fail in principle to distinguish between stability that results from policy commitments and that which results from the absence of shocks.

$E\left(\ln dist_{ij}, \ln T_{ijt}\right) \neq 0$. The table shows that β is negative and highly significant. The point estimate of -0.018 implies that a 1 percent increase in bilateral trade implies a fall of around 0.02 percentage points in monthly real exchange rate volatility. The effect is large and suggests the need for controlling for reverse causality when estimating equation (1). We turn next to this estimation.

4.3 Empirical Strategy

Our basic empirical specification used to estimate the effect of exchange rate volatility on trade is based on Equation 29. The rationale behind differencing trade across different product types was described using the simple system of equations presented in Section 2; it should substantially reduce and potentially eliminate the endogeneity and omitted variables bias. The differencing across exporting countries should further help us eliminate any remaining omitted variables bias, which will disappear if we can fully capture the direct effect of trade costs on our dependent variable. In our model this effect is approximately equal to $(1-\sigma_m)(\ln \tau_{e1m} - \ln \tau_{e'1m}) - (1-\sigma_c)(\ln \tau_{e1c} - \ln \tau_{e'1c})$.[22] The empirical model uses a full set of importer-exporter fixed effects γ_{ei} which must be able to reproduce $(1-\sigma_m)(\ln \tau_{eim} - \ln \tau_{e'im}) - (1-\sigma_c)(\ln \tau_{eic} - \ln \tau_{e'ic}$ in a cross-section. But this specification suggests that the direct effect of trade costs on our dependent variable should not move much through time. If it becomes more expensive to ship a product to a particular destination, this has no direct impact on our dependent variable if the increase is uniform across exporting countries; the differencing across exporting countries eliminates this effect. If trade costs move differently for a particular trade route, then the differencing across products should ameliorate this effect, especially since we estimate σ_m to be close to σ_c.[23] The differencing across countries and products helps us to identify the effect of exchange rate volatility on trade. Finally, we add time fixed-effects and also recognize that f_1 and f_2 are a function of exchange rate volatility (σ^e_{eit}). Our baseline estimating equation becomes:

$$Dd \ln mc_{eit} = \lambda_t + \gamma_{ei} + \alpha(\sigma^e_{eit} - \sigma^e_{e'it}) + \psi(\ln s_{eit} - \ln s_{e'it}) + \varepsilon_{ijt} \tag{33}$$

where

$$Dd \ln mc_{eit} = d \ln mc_{eit} - d \ln mc_{e'it} \tag{34}$$

and

$$d \ln mc_{eit} = \ln \int_{v \in V_e} p_{ei,vt} q_{ei,vt} - \ln p_{ei,ct} q_{ei,ct}$$

That is, (34) is a difference in difference variable. The first difference is taken between the exports of differentiated goods of e to i and exports of commodity products from

[22] Note that trade costs also enter indirectly through the way they affect manufacturer's export decisions, see the text near Equations 30 to 32, effectively increasing the responsiveness of manufacturing trade to trade costs. Exporter-importer fixed effects can take care of this also in a cross-section.

[23] In our estimates $\sigma_c > \sigma_m$ by 0.4, but the responsiveness of manufacturing trade to trade costs gets boosted through the impact of trade costs on manufacturers' market entry decisions.

country e to country i (ie., $d \ln mc_{eit}$). The second difference is taken across exporting countries e and e' for a given importing country i. We choose the US as e' since it is always a large exporter of both manufactured goods and commodities. The differencing helps us control for the endogeneity and omitted variables bias, as we discussed above. The main interest of this paper is on the sign and magnitude of α in Equation (33). When α is negative (positive), real exchange rate risk reduces (increases) trade in differentiated products relative to commodity products. In other specifications we include controls that are common in gravity equations, such as cross products of GDP and GDP per capita.

5 Results

The main results of the paper are reported in Tables 2 and 3. Table 2 reports estimates of Equation 33. The estimates suggest that an increase in exchange rate volatility decreases trade in differentiated products relative to trade in commodities. Although the estimate is statistically significant, the magnitude of the effect does not appear to be that large, with a 1 percentage point reduction in our measure of volatility increasing manufacturing trade by 0.5 percent. This estimate suggests that eliminating all real exchange rate volatility would increase trade in manufactures by less than 5 percent, and total trade by less than 3 percent. However, some countries with particularly volatile exchange rates, especially developing countries, would see a more pronounced increase in their trade. The estimated effect of exchange rate volatility is barely changed by the addition of more explanatory variables.

Our identification strategy can also be adapted for identifying the effect of currency unions and of fixed exchange rates on trade. This can be simply seen in Section 2 of the paper, by replacing σ_{eit} with dummy variables for the presence of either currency unions or fixed exchange rates. Currency unions and fixed exchange rates are not likely to be randomly formed. The bias in estimating the effect of currency unions can be pronounced if currency unions are more likely to be formed between countries that have lower impediments to trade. Modelling the difference between manufacturing and commodity trade can also substantially reduce the upwards bias in estimating the effects of currency unions on trade. Table 3 reports the results from our regressions. Column (1) replicates Frankel and Rose (2002), while Column (2) uses our methodology. The estimated currency union effect is significantly lower than in Frankel and Rose (2002). The standard errors of our estimates are not much higher than for the Frankel and Rose estimates, almost all of the action has been a reduction in the estimated level of the currency union effect. A currency union is estimated to increase manufacturing trade by under 40 percent, and therefore total trade by about 25 percent. The Frankel and Rose estimate is far outside the 95 percent confidence interval for the effect of currency unions based on our methodology. Columns 4 through 9 of Table 3 examine the impact of fixed exchange rates. When the econometrician does not directly address the endogeneity and omitted variables problem, fixed exchange rates are estimated to greatly increase trade. Taking into account these problems, the estimated effect of fixing an exchange rate is much more modest.

5.1 Robustness Section

We check the robustness of our results to a number of changes to our empirical model. Table 4 reports sensitivity of our results to alternative measures of exchange rate volatility. We construct four measures to capture volatility at different frequencies by adjusting the smoothing parameters used in the Hodrick-Prescott filters. The data is filtered to isolate very low-frequency movements that we term “long-run” volatility, very high-frequency movements that we term “short-run” volatility, and all-other movements that we term “medium-run” volatility. The estimates of the impact of exchange rate volatility are qualitatively similar in each case. The estimate based on short-run volatility is about twice as high as the other estimates, but our estimated measure of short-run volatility is typically only slightly above half the amount of our measure of medium-run volatility, so the total estimated effect on trade volumes is about the same.

Table 5 performs our basic regression for different regions. In particular we are interested if our results depend on whether the exporting country is developed or developing, and whether the importing country is developed or developing. All of our result comes from when developing countries are exporters, particularly when exporting to another developing country. Developed country exporters are not adversely affected by exchange rate volatility. This suggests that developing country exporters are more risk-averse or are less able to hedge the real-exchange rate risk.

Table 6 examines the behavior of the third class of goods in Rauch’s classification that we have so far ignored; the “reference-priced” goods. These goods are more homogeneous than differentiated products but do not appear to be sufficiently standardized to trade on organized exchanges. We would therefore expect them to be less affected by exchange-rate volatility than are differentiated products, but more affected than commodities that trade on organized exchanges. The point estimates are all consistent with this story, but in most regressions these estimates lack statistical significance.

6 Conclusion

Most of the studies on the effect of exchange rate volatility on trade assume that the volume of trade has no impact on exchange rate volatility, thus assuming away an endogeneity problem. We present strong evidence that this problem is severe. We present a model in which both directions of causality are considered which allows us to structurally identify the impact of exchange rate volatility on trade. Our model suggests that commodity goods that are traded on organized exchanges are less affected by volatility than more highly differentiated products. However, trade in all goods affect exchange rate volatility. These insights combined allow us to address the endogeneity problem that is present in this literature.

Using disaggregate trade data for a large number of countries for the period 1970-1997 we find results supporting our predictions. An increase in bilateral exchange rate volatility causes bilateral trade in manufactures to contract relative to bilateral trade in commodities. The size of the effect is fairly small but unevenly distributed. While total trade appears to be depressed by about 3 percent, developing country exports of manufactures may be much more greatly affected due to a combination of greater exchange rate volatility and greater sensitivity of their exporters to that volatility. We also apply our methodology to assess the effects of currency unions or fixed exchange rates on trade since the partner countries are far from random. We find that the large estimated effects found in some previous literature are greatly reduced.

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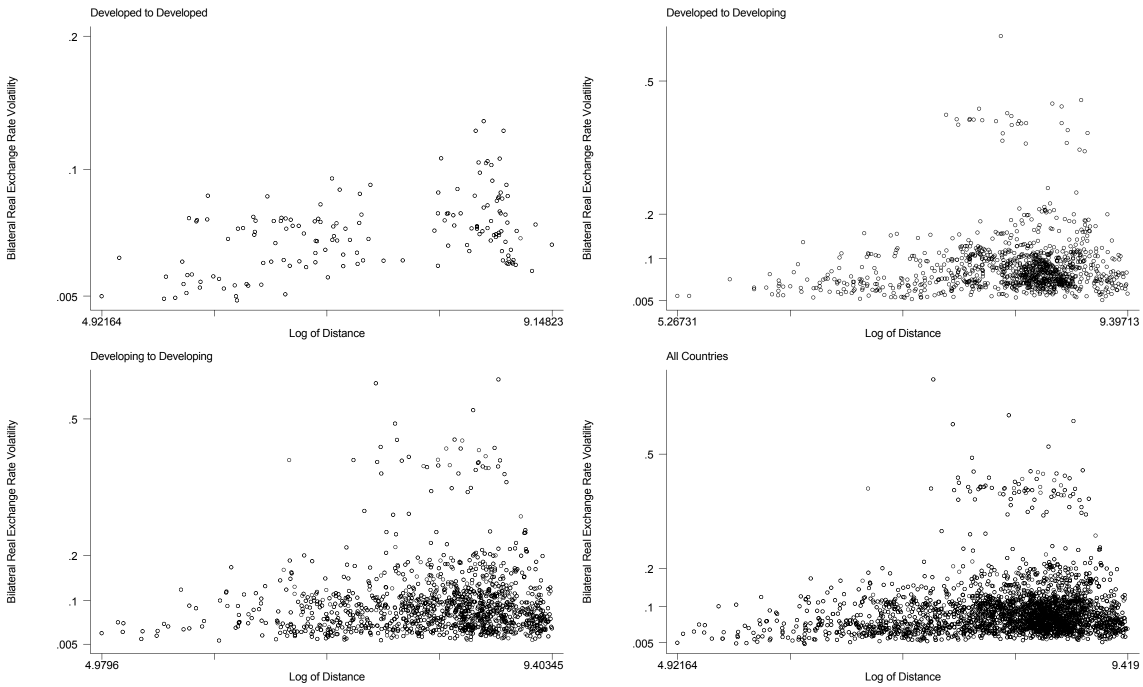

Exchange Rate Volatility and Distance between Countries in 1997

Figure 2

Difference between Inter-Continental and Intra-Continental
Real Exchange Rate Volatility

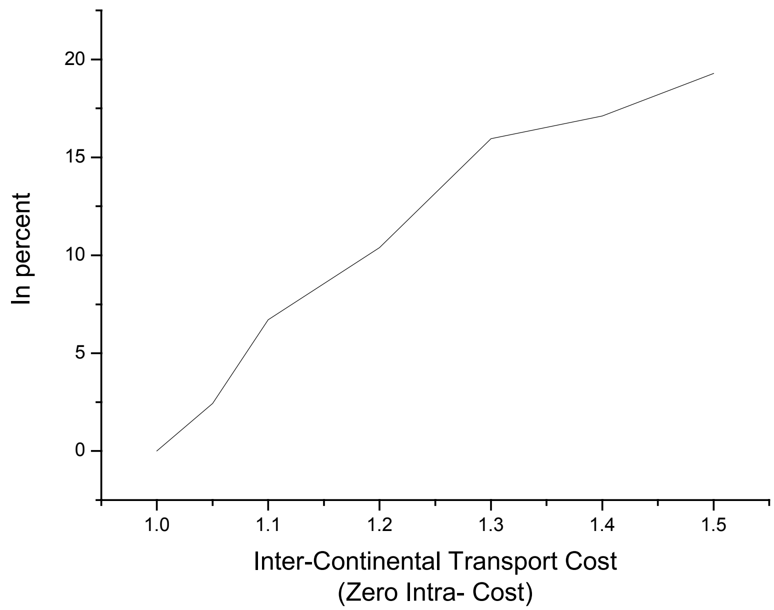

TABLE A1: DESCRIPTIVE STATISTICS

EXPORTER FROM:	Number of Pairs	Share of Exports in Differentiated Products	Share of Exports in Reference Products	Share of Exports in Commodity Products	Real Exchange Rate Volatility (Medium-Term)	Real Exchange Rate Volatility (Short-Term)	IMF Fixed Exchange Rate Regime Pairs (1)	Rogoff-Reinhart Fixed Exchange Rate Regime Pairs (1)
					1970s			
AFRICA	4260	0.17	0.17	0.66	7.0%	4.6%	11.7%	3.7%
N.AMERICA	1191	0.59	0.20	0.21	6.1%	3.5%	0.4%	0.3%
C.AMERICA and S.AMERICA	6977	0.11	0.15	0.73	8.1%	6.0%	20.5%	9.7%
ASIA	4921	0.60	0.17	0.23	7.6%	4.6%	14.4%	3.6%
EUROPE	9081	0.65	0.24	0.12	5.7%	3.8%	3.5%	6.1%
ALL	26430	0.58	0.21	0.21	6.9%	4.6%	11.6%	5.9%
					1980s			
AFRICA	5332	0.17	0.18	0.66	13.6%	7.0%	3.7%	1.8%
N.AMERICA	1341	0.63	0.20	0.17	10.1%	4.8%	0.0%	0.0%
C.AMERICA and S.AMERICA	8327	0.20	0.17	0.63	15.2%	8.2%	10.4%	1.2%
ASIA	7085	0.73	0.11	0.17	10.2%	5.0%	2.5%	0.1%
EUROPE	10820	0.66	0.21	0.13	10.8%	5.1%	3.5%	0.6%
ALL	32905	0.62	0.19	0.19	12.2%	6.2%	4.9%	0.8%
					1990s			
AFRICA	7514	0.24	0.23	0.53	11.1%	7.6%	2.8%	1.1%
N.AMERICA	1346	0.70	0.18	0.12	8.1%	5.1%	0.0%	0.0%
C.AMERICA and S.AMERICA	9143	0.41	0.20	0.39	11.8%	8.0%	1.4%	0.2%
ASIA	8346	0.76	0.10	0.14	8.5%	5.2%	1.0%	0.4%
EUROPE	12197	0.71	0.20	0.09	8.8%	5.7%	1.1%	1.4%
ALL	38546	0.69	0.17	0.13	9.8%	6.5%	1.4%	0.8%

Notes: Pairs are included only if real exchange rate volatility data is available. For Exchange Rate Regimes not all number of pairs have data.

Table 1 : The Effect of Trade on Exchange Rate Volatility

Regressand:	Log Total Trade	Real Exchange Rate Volatility
Importer-Exporter Fixed Effects	no	no
Year Fixed Effects	yes	yes
	(1)	(3)
Log of Distance (1st stage)	**-0.816**	
	(71.7)	
Predicted Log Total Trade (2nd stage)		**-0.018**
		(29.6)
Constant		**0.218**
		(37.3)
R^2	**0.11**	**0.09**
Nobs	59695	59695

Notes: T-statistics are reported in parenthesis based on robust standard errors.

Table 2 : The Effect of Exchange Rate Volatility on Trade Composition

Regressand:	dlnNW(C1,C2) - dlnNW(US,C2)		
Importer-Exporter Fixed Effects	yes	yes	yes
Year Fixed Effects	yes	yes	yes
	(2)	(3)	(4)
Real Exchange Rate Volatility	**-0.58**	**-0.53**	**-0.54**
	-(3.4)	**-(3.1)**	**-(3.2)**
Real Exchange Rate Level	**0.42**	**0.41**	**0.41**
	(8.6)	**(7.4)**	**(7.5)**
Log Product Real GDP		**1.72**	**1.84**
		(10.6)	**(0.6)**
Log Product Real GDP/capita		**-1.38**	**-3.10**
		-(8.9)	**-(1.0)**
Exporters' Real GDP			**-0.12**
			(0.0)
Exporters' real GDP/capita			**1.73**
			(0.6)
Constant	**0.02**	**0.02**	**0.02**
	(2.3)	**(2.3)**	**(2.3)**
R^2	**0.75**	**0.75**	**0.75**
Nobs	59695	59695	59695

Notes: The regressand is a difference in differences variable. The first difference is taken between the imports of country 2 (C2) from country 1 (C1) in differentiated goods minus the imports of C2 from C1 in goods that are traded in organized exchanges. The second difference is taken between the imports of C2 from C1 and those from the US. All RHS variables are also differenced relative to the US. T-statistics are reportedin parenthesis. Standard errors corrected for heteroscedasticity and autocorrelation.

Table 3: The Effect of Currency Unions and Exchange Rate Regimes on Bilateral Trade

Regressand:	Log of bilateral trade	dlnNW (bilateral)	dlnNW (bilateral)	Log of bilateral trade	dlnNW (bilateral)	dlnNW (bilateral)	Log of bilateral trade	dlnNW (bilateral)	dlnNW (bilateral)
Year fixed effects:	yes	yes	yes	yes	yes	yes	yes	yes	yes
Importer-Exporter fixed effects	no	no	no	no	no	no	no	no	no
Estimation method/Exchange Rate Regime Data	Rose/Rose	BR/Rose	BR/Rose	Rauch/Rogoff	BR/Rogoff	BR/Rogoff	Rauch/IMF	BR/IMF	BR/IMF
	(1)	(2)	(3)	(4)	(5)	(6)	(6)	(7)	(6)
Exchange Rate Volatility (Rose)			**-1.69**			**-1.18**			**-1.02**
			-(4.5)			**-(3.0)**			**-(2.4)**
Currrency union dummy	**1.58**	**0.32**	**0.25**						
	(12.7)	**(1.8)**	**(1.4)**						
Currency board dummy	**1.69**	**-0.39**	**-0.41**						
	(3.6)	**-(0.6)**	**-(0.6)**						
Fixed Exchange Rate Regime dummy				**0.51**	**0.13**	**0.12**	**0.45**	**-0.24**	**-0.27**
				(6.9)	**(1.4)**	**(0.9)**	**(5.4)**	**-(1.3)**	**-(1.7)**
Log distance	**-(0.88)**	**-(0.27)**	**-(0.26)**	**-0.89**	**-0.23**	**-0.21**	**-0.92**	**-0.24**	**-0.23**
	-(60.9)	**-(10.6)**	**-(10.2)**	**-(36.3)**	**-(5.3)**	**-(5.0)**	**-(31.4)**	**-(4.7)**	**-(4.5)**
Log product real GDP	**0.69**	**0.09**	**0.09**	**0.74**	**0.10**	**0.10**	**0.77**	**0.09**	**0.09**
	(121.8)	**(8.7)**	**(8.8)**	**(87.5)**	**(7.1)**	**(7.2)**	**(77.6)**	**(5.7)**	**(5.7)**
Log product real GDP/capita	**0.49**	**0.23**	**0.22**	**0.18**	**0.14**	**0.13**	**0.14**	**0.13**	**0.12**
	(52.3)	**(12.9)**	**(12.1)**	**(16.3)**	**(7.2)**	**(6.6)**	**(11.1)**	**(5.9)**	**(5.3)**
Adjacent				**0.41**	**-0.18**	**-0.14**	**0.44**	**-0.26**	**-0.22**
				(4.0)	**-(1.2)**	**-(1.0)**	**(3.7)**	**-(1.4)**	**-(1.2)**
Links				**0.60**	**0.30**	**0.31**	**0.52**	**0.24**	**0.25**
				(11.8)	**(3.6)**	**(3.8)**	**(8.7)**	**(2.4)**	**(2.5)**
EEC				**-0.34**	**0.05**	**0.06**	**-0.23**	**0.14**	**0.13**
				-(5.0)	**(0.5)**	**(0.5)**	**-(2.9)**	**(0.9)**	**(0.9)**
EFTA				**-0.39**	**0.71**	**-0.48**	**-0.50**	**0.79**	**-0.52**
				-(4.2)	**(2.8)**	**-(6.5)**	**-(3.9)**	**(2.5)**	**-(6.8)**
Constant	**-22.77**	**-5.80**	**-5.72**	**-21.75**	**-4.45**	**-0.10**	**-22.02**	**-3.83**	**0.11**
	-(78.9)	**-(12.6)**	**-(12.4)**	**-(57.5)**	**-(7.2)**	**-(0.7)**	**-(49.8)**	**-(5.3)**	**(0.8)**
R^2	**0.67**	**0.04**	**0.04**	**0.72**	**0.07**	**0.07**	**0.69**	**0.05**	**0.04**
nobs	**13947**	**13947**	**13947**	**7252**	**7252**	**7252**	**5184**	**5184**	**5184**

Notes: Column (1) replicates Column (1) from Table 1 in Rose for those datapoints for which Rauch data is available (years included are 1970, 1975, 1980, 1985 and 1990). The regressand for (2), (3), (5), (7), (9) and (11) is the difference in the bilateral trade in differentiated products between C2 and C1 and the bilateral trade in goods traded in organized exchanges between C2 and C1. Column (2) summarizes the findings using the method in this paper, and Column (3) also includes real exchange rate volatility. Columns (4) - (11) compares this paper's methodology (odd columns higher than 3) to Rauch's which also include Exchange Rate Regime dummy (even columns higher than 2).

Table 4: Basic Regressions with Different Exchange Volatility Measures

Regressand: dlnNW(C1,C2) - dlnNW(US,C2)				
Volatility Measure	Long	Medium	Medium-Short	Short
Importer-Exporter Fixed Effects	yes	yes	yes	yes
Year Fixed Effects	yes	yes	yes	yes
	(1)	(2)	(3)	(4)
Real Exchange Rate Volatility	**-0.56**	**-0.53**	**-0.56**	**-1.10**
	-(2.8)	**-(3.1)**	**-(3.5)**	**-(3.2)**
Real Exchange Rate Level	**0.41**	**0.41**	**0.41**	**0.42**
	(7.5)	**(7.4)**	**(7.4)**	**(7.6)**
Log Product Real GDP	**1.74**	**1.72**	**1.72**	**1.72**
	(10.7)	**(10.6)**	**(10.6)**	**(10.6)**
Log Product Real GDP/capita	**-1.39**	**-1.38**	**-1.38**	**-1.38**
	-(9.0)	**-(8.9)**	**-(9.0)**	**-(8.9)**
Constant	**0.02**	**0.02**	**0.02**	**0.02**
	(2.4)	**(2.1)**	**(2.4)**	**(2.4)**
R^2				
nobs	59695	59695	59695	59695

Notes: Same notes as in Table 1 apply.

Table 5 : Basic Regression for Different Regions

Regressand: dlnNW(C1,C2) - dlnNW(US,C2)				
Importer	Developing	Developed	Developing	Developed
Exporter	Developing	Developing	Developed	Developed
Importer-Exporter Fixed Effects	yes	yes	yes	yes
Year Fixed Effects	yes	yes	yes	yes
	(1)	(4)	(2)	(3)
Real Exchange Rate Volatility	**-1.03**	**-0.56**	**0.48**	**0.54**
	-(3.4)	**-(2.2)**	**(1.2)**	**(1.4)**
Log Product Real GDP	**2.09**	**-1.31**	**2.89**	**5.32**
	(5.6)	**-(4.5)**	**(10.3)**	**(17.3)**
Log Product Real GDP/capita	**-1.71**	**1.13**	**-1.94**	**-4.78**
	-(4.9)	**(4.2)**	**-(6.5)**	**-(15.4)**
Real Exchange Rate Level	**0.30**	**0.47**	**0.38**	**0.66**
	(3.3)	**(6.0)**	**(2.2)**	**(4.5)**
Constant	**0.01**	**0.03**	**0.03**	**0.02**
	(0.7)	**(1.7)**	**(1.7)**	**(0.9)**
R^2				
nobs	17778	17722	17797	7995

Notes: Same notes as in Table 1 apply.

Table 6: Basic Regression using Reference Goods

Regressand: dln (C1,C2) - dln (US,C2) :	Differentiated Minus Reference	Differentiated Minus Reference	Reference Minus Organized	Reference Minus Organized
Importer-Exporter Fixed Effects	yes	yes	yes	yes
Year Fixed Effects	yes	yes	yes	yes
	(1)	(2)	(3)	(4)
Real Exchange Rate Volatility	**-0.35**	**-0.18**	**-0.14**	**-0.23**
	-(2.4)	**-(1.2)**	**-(0.7)**	**-(1.2)**
Log Product Real GDP		**0.60**		**0.84**
		(5.0)		**(5.0)**
Log Product Real GDP/capita		**-0.25**		**-0.90**
		-(2.1)		**-(5.6)**
Real Exchange Rate Level		**0.17**		**0.24**
		(3.8)		**(4.2)**
Constant	**0.00**	**0.01**	**0.01**	**0.01**
	(0.3)	**(0.8)**	**(1.2)**	**(0.9)**
R^2				
nobs	58463	55905	58463	55905

Notes: