INTERNATIONAL MONETARY FUND

Exchange Rate Volatility and Trade Flows - Some New Evidence

Prepared by Peter Clark, Natalia Tamirisa, and Shang-Jin Wei,
with Azim Sadikov, and Li Zeng

Approved by Raghuram Rajan

May 2004

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PREFACE

This paper examines the effect of exchange rate volatility on trade, prepared in response to a request from the Director General of the World Trade Organization to the IMF. The IMF produced a study in 1984 for the General Agreement on Tariffs and Trade (GATT) on this subject. Since then, there have been major developments in the world economy, some perhaps having exacerbated fluctuations in exchange rates whereas others perhaps having reduced the impact of volatility on trade. It is therefore appropriate to revisit the issue some 20 years later.

This paper was prepared by a team led by Peter Clark and Shang-Jin Wei and consisted of Natalia Tamirisa, Azim Sadikov (summer intern), and Li Zeng (research assistant). It has benefited from comments from Mary Amiti, Giovanni Dell'Ariccia, Raghuram Rajan, Stephen Tokarick, the Management and various departments of the IMF as well as from Marc Auboin, Richard Eglin, and other staff of the WTO. The views expressed are those of the authors and do not necessarily reflect the views of national authorities or IMF Executive Directors.

Raghuram Rajan
Economic Counsellor and Director
IMF Research Department

EXECUTIVE SUMMARY

In 1984 the IMF produced a study for the General Agreement on Tariffs and Trade (GATT) on the impact of exchange rate volatility on world trade. As there have been major developments in the world economy since then, it is appropriate to revisit the issue some 20 years later.

Some of the developments would appear to have exacerbated fluctuations in exchange rates. The liberalization of capital flows in the last two decades and the enormous increase in the scale of cross-border financial transactions have increased exchange rate movements. Currency crises in emerging market economies are special examples of high exchange rate volatility. In addition, the transition to a market-based system in Central and Eastern Europe often involves major adjustments in the international value of these economies' currencies.

Other changes in the world economy may have reduced the impact of exchange rate volatility. The proliferation of financial hedging instruments over the last 20 years could reduce firms' vulnerability to risks arising from volatile currency movements. In addition, for multinational firms, fluctuations in different exchange rates may have offsetting effects on their profitability. As a growing fraction of international transactions is undertaken by these multinational firms, exchange rate volatility may have a declining impact on world trade.

As these different developments in the world economy may have opposing effects in altering the impact of exchange rate fluctuations on trade over the last two decades, it is not clear what the net effect is without undertaking a careful empirical study.

The review of the theoretical literature on this topic indicates that there is no clear-cut relationship between exchange rate volatility and trade flows. The presumption that trade is adversely affected by exchange rate volatility depends on a number of specific assumptions and does not necessarily hold in all cases, especially in a general equilibrium setting where other variables change along with exchange rates. The ambiguity of the theoretical predictions reinforces the importance of investigating the issue empirically.

The empirical research in this study differs from the earlier one (IMF, 1984) in a number of dimensions. First, the country coverage is considerably broader. While the earlier study focused exclusively on the G-7 countries, this study covers all Fund members for which data are available. Second, this study explores a range of different exchange rate volatility measures. Third, in addition to examining aggregate trade, the study also divides all products into two groups—differentiated and homogeneous products—and tests whether volatility has a differential effect on them. Fourth, the estimation techniques are also quite different, as recent theoretical advances in the specification of a gravity equation are incorporated to assess the impact of exchange rate volatility on trade.

The main empirical findings of the study can be summarized as follows. First, while exchange rate fluctuations have increased in times of currency and balance of payments crises during the 1980s and 1990s, there has not been any increase, on average, in such

volatility between the 1970s and the 1990s. It is also noteworthy that an exchange rate regime that is classified as “pegged ” does not necessarily have lower overall exchange rate volatility than an arrangement that permits some degree of exchange rate flexibility. Pegging to an anchor currency still leaves a country exposed to fluctuations in the anchor against other currencies, and a peg that becomes misaligned can subsequently generate exchange market pressures and large, discrete changes in currency values, and hence volatility.

Second, a negative relationship between exchange rate volatility and trade is borne out by some of the empirical evidence in this study. However, such a negative relationship is not robust to reasonable perturbations of the specification linking bilateral trade to its determinants. Overall, if exchange rate volatility has a negative effect on trade, this effect would appear to be fairly small and is by no means a robust, universal finding.

These results suggest that, from the perspective of enhancing trade, exchange rate volatility is probably not a major policy concern. This does not necessarily rule out the possibility that a large exchange rate volatility could affect an economy through other channels.

I. Introduction and Overview

In 1984 the IMF (1984) produced a study for the General Agreement on Tariffs and Trade (GATT) on the impact of exchange rate volatility on world trade. That study was motivated by an increase in protectionist pressures, large exchange rate movements among the major currencies, and a significant slowdown in world trade. Some of these developments have reappeared. For example, the growth in world exports of goods and services declined sharply in 2001 and 2002 from the double-digit pace in 2000, and the exchange value of the U.S. dollar has fluctuated fairly sharply in the last year. The 1984 study also reflected a desire to take stock of the implications for currency volatility and trade of the shift from the largely fixed rates among the major currencies to floating after the breakdown of the Bretton Woods system in 1971–1973. As there have been other major developments in the international monetary system since then, it is appropriate to revisit the issues addressed in that study some 20 years later.

Some of these developments would appear to have exacerbated fluctuations in exchange rates. The liberalization of capital flows in the last 30 years and the enormous increase in the scale and variety of cross-border financial transactions have clearly increased the magnitude of exchange rate movements in those countries with underdeveloped capital markets and where there is not yet a track record of consistently stable economic policies.[1] Currency

[1] Some aspects of this development have recently been analyzed in Prasad, Rogoff, Wei and Kose (2003).

crises in emerging markets, which have become more frequent in the last two decades, are especially notable cases of large exchange rate volatility.[2] This has been of particular concern to developing countries and emerging market economies. In addition, the transition to a market-based system in Central and Eastern Europe often involves major adjustments in the international value of these economies' currencies.

Other changes in the world economy may have reduced the impact of exchange rate volatility. The proliferation of financial hedging instruments over the last 20 years could reduce firms' vulnerability to the risks arising from volatile currency movements. In addition, for multinational firms, fluctuations in different exchange rates may have offsetting effects on their profitability. As a growing fraction of international transactions is undertaken by these multinational firms, exchange rate volatility may have a declining impact on world trade.

On balance, it is not clear whether the major changes in the world economy over the past two decades have operated to reduce or increase the extent to which international trade is adversely affected by fluctuations in exchange rates. One aspect of this issue is the extent to which such volatility itself has changed, and another is the degree to which firms are sensitive to exchange rate risk and can take steps to mitigate it at low cost. It is therefore necessary to examine new empirical evidence at this issue.

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[2] Issues related to balance of payments adjustment in response to capital account crises were discussed in a recent note to the WTO prepared by staff at the IMF. See World Trade

(continued…)

There are a number of differences between the current study and the earlier one. Most importantly, the country coverage is considerably broader. In IMF (1984) the analysis was almost exclusively focused on the G-7 countries. This reflected the view that the fluctuations in the major currencies were the most important factor for the "environment" within which other countries have to plan their policies.[3] While these currencies are the most important for the functioning of the international monetary system, fluctuations in other exchange rates are now also relevant for systemic reasons as well as for their implications for other countries themselves. Therefore this study takes a more comprehensive view of the subject and covers the exchange rates of all Fund members for which data are available.

This study also explores a range of different exchange rate volatility measures. Moreover, aside from examining aggregate trade, the study divides all products into two groups—differentiated and homogeneous products—and tests whether volatility has a differential effect on them.

Given the large number of countries in the data set, it is possible to estimate the degree to which volatility has a differential effect depending on whether the country is advanced or developing. The estimation techniques are also quite different, as recent theoretical advances in gravity-equation specification are employed to assess the impact of exchange rate volatility on trade.

Organization (2003).

[3] For an analysis of the impact of G-3 exchange rate volatility on developing countries, see the essay, "How Concerned Should Developing Countries be About G-3 Exchange Rates," in the Chapter III of the World Economic Outlook (2003).

Finally, following the work of Rose (2000), the study looks at the effect of common currency arrangements on trade. This is a related yet distinct issue from the impact of exchange rate volatility, as a currency union is more than just an elimination of exchange rate volatility among members. It reduces other transactions costs relevant for trade and provides a commitment device for macroeconomic policies.

Anticipating some of the findings below, this study shows that while exchange rate fluctuations have increased in times of currency and balance of payments crises during the 1980s and 1990s, there does not appear to have been any increase, on average, in such volatility between the 1970s and the 1990s. It is also noteworthy that an exchange rate regime that is classified as "pegged" does not necessarily have lower overall exchange rate volatility than an arrangement that permits some degree of rate flexibility. Pegging to an anchor currency still leaves a country exposed to fluctuations in the anchor against other currencies, and a peg that becomes misaligned can subsequently generate exchange market pressures and large, discrete changes in currency values, and hence volatility.

The review of the theoretical literature since the 1984 study has, if anything, reinforced the conclusion there that there is no unambiguous relationship between exchange rate volatility and trade flows. The general presumption that trade is adversely affected by an increase in the exchange rate fluctuations depends on a number of specific assumptions and does not necessarily hold in all cases, especially in general equilibrium models where other variables change along with exchange rates. These models show that exchange rate volatility is the

result of the volatility in underlying shocks to the economy and the policy regime which determines how the shocks are reflected in exchange rates and other variables.

For the world as a whole, there is no obvious association between periods of low exchange rate volatility and periods of fast growth in trade. In other words, at an aggregate level, there is no evidence of a negative effect of exchange rate on world trade. Once one goes to trade and exchange rate volatility at a bilateral level, a negative relationship between the two is borne out by some of the empirical evidence in this study. However, this negative relationship is not robust to a more general specification of the equation linking bilateral trade to its determinants that embodies the recent theoretical advances in a gravity model. Thus, if there is a negative impact of exchange rate volatility on trade, it is not likely to be quantitatively large and the effect is not robust.

These findings suggest that, from the perspective of world trade, exchange rate volatility is probably not a major policy concern. Note that this does not imply necessarily that exchange rate fluctuations should be viewed with equanimity. For example, currency crises – special cases of exchange rate volatility - have required painful adjustments in output and consumption. However, in this case, what is important is not that measures need to be taken to moderate currency fluctuations directly, but that appropriate policies need to be pursued in order to avoid the underlying causes of large, unpredictable and damaging movements in exchange rates.

There are a number of aspects related to exchange rate volatility that are not covered in this study. First, it does not deal with the determination of the level of exchange rates. Second, it does not deal with the optimal choice of exchange rate arrangement, e.g., fixed versus floating.[4]

Part II of the paper reviews the relevant theoretical and empirical literature over the last two decades. Part III describes the recent history of exchange rate volatility in different parts of the world. Part IV presents some new evidence on the effect of exchange rate volatility on trade. Finally, Part V offers concluding remarks.

II. Brief Review of the Theoretical and Empirical Literature

Since the appearance of the IMF (1984) study of the effects of exchange rate volatility on trade, two survey papers of the literature on the topic have appeared: Cote (1994) and McKenzie (1999). In addition, the U.K. Treasury (2003) recently commissioned a number of studies, and invited submissions from numerous academics, to inform their assessment of the desirability of joining EMU. Therefore it is not necessary to present a comprehensive discussion of the many contributions to the field. Rather, the focus here will be on certain key issues which highlight why it has been difficult to reach clear-cut conclusions on the impact of exchange rate variability on trade flows, as well as on some of the more recent work in the area. These two surveys conclude that from a theoretical perspective there is no unambiguous

[4] For an extensive analysis of the performance of alternative exchange rate regimes, see the recent Board paper, "Evolution and Performance of Exchange Rate Regimes."

response in the level of trade to an increase in exchange rate volatility, as differing results can arise from plausible alternative assumptions and modeling strategies. The same ambiguity pervades much of the empirical literature, which may reflect the lack of clear-cut theoretical results as well as the difficulty in arriving at an appropriate proxy for exchange rate risk. Nonetheless, some recent studies as well as some of the evidence presented here appear to suggest that a negative relationship has some support from the data.

A. Theoretical Aspects of the Relationship Between Exchange Rate Volatility and Trade

It is useful to begin with the example of a rudimentary exporting firm to illustrate how (real) exchange rate volatility can affect the level of the firm's exports. The simplest case described by Clark (1973), for example, considers a competitive firm with no market power producing only one commodity which is sold entirely to one foreign market and does not import any intermediate inputs. The firm is paid in foreign currency and converts the proceeds of its exports at the current exchange rate, which varies in an unpredictable fashion, as there are assumed to be no hedging possibilities, such as through forward sales of the foreign currency export sales. Moreover, because of costs in adjusting the scale of production, the firm makes its production decision in advance of the realization of the exchange rate and therefore cannot alter its output in response to favorable or unfavorable shifts in the profitability of its exports arising from movements in the exchange rate. In this situation the variability in the firm's profits arises solely from the exchange rate, and where the managers of the firm are adversely affected by risk, greater volatility in the exchange rate – with no change in its average level -

leads to a reduction in output, and hence in exports, in order to reduce the exposure to risk. This basic model has been elaborated by a number of authors, e.g., Hooper and Kohlhagen (1978), who reach the same conclusion of a clear negative relationship between exchange rate volatility and the level of trade.

However, this strong conclusion rests on a number of simplifying assumptions. First, it is assumed that there are no hedging possibilities either through the forward exchange market or through offsetting transactions. For advanced economies where there are well developed forward markets, specific transactions can be easily hedged, thus reducing exposure to unforeseen movements in exchange rates.[5] But it needs to be recognized that such markets do not exist for the currencies of most developing countries. Moreover, even in advanced economies the decision to continue to export or import would appear to reflect a series of transactions over time where both the amount of foreign currency receipts and payments, as well are the forward rate, are not known with certainty.

Moreover, there are numerous possibilities for reducing exposure to the risk of adverse exchange rate fluctuations other than forward currency markets. The key point is that for a multinational firm engaged in a wide variety of trade and financial transactions across a large number of countries, there are manifold opportunities to exploit offsetting movements in currencies and other variables. For example, there is a clear tendency for exchange rates to

[5] For an analysis of the effects of forward cover on the level of trade, see Ethier (1973), Kawai and Zilcha (1986), and Viaene and de Vries (1992). However, Wei (1999) does not find empirical support for the hypothesis that the availability of hedging instrument reduces the impact of exchange rate volatility on trade.

adjust to differences in inflation rates, and recent evidence suggests that such adjustment may be quicker than indicated by earlier studies. Thus, if exports are priced in a foreign currency that is depreciating, the loss to the exporter from the declining exchange rate is at least partly offset by the higher foreign-currency export price (Cushman, 1983 and 1986). In a similar vein, as noted by Clark (1973), to the extent that an exporter imports intermediate inputs from a country whose currency is depreciating, there will be some offset to declining export revenue in the form of lower input costs. In addition, when a firm trades with a large number of countries, the tendency for some exchange rates to move in offsetting directions will provide a degree of protection to its overall exposure to currency risk. Finally, as analyzed by Makin (1978), a finance perspective suggests that there are many possibilities for a multinational corporation to hedge foreign currency risks arising from exports and imports by holding a portfolio of assets and liabilities in different currencies.

One reason why trade may be adversely affected by exchange rate volatility stems from the assumption that the firm cannot alter factor inputs in order to adjust optimally to take account of movements in exchange rates. When this assumption is relaxed and firms can adjust one or more factors of production in response to movements in exchange rates, increased variability can in fact create profit opportunities. This situation has been analyzed by Canzoneri, et al. (1984), De Grauwe (1992), and Gros (1987), for example. The effect of such volatility depends on the interaction of two forces at work. On the one hand, if the firm can adjust inputs to both high and low prices, its expected or average profits will be larger with greater exchange rate variability, as it will sell more when the price is high, and vice versa. On the other hand, to the extent that there is risk aversion, the higher variance of profits has an

adverse effect on the firm and constitutes a disincentive to produce and to export. If risk aversion is relatively low, the positive effect of greater price variability on expected profits outweighs the negative impact of the higher variability of profits, and the firm will raise the average capital stock and the level of output and exports. In a more general setting analyzing the behavior of a firm under uncertainty, Pindyck (1982) has also shown that under certain conditions, increased price variability can result in increased average investment and output as the firm adjusts to take advantage of high prices and to minimize the impact of low prices.

One aspect of the relationship between trade and exchange rate volatility that needs to be mentioned is the role of "sunk costs." Much of international trade consists of differentiated manufactured goods that typically require significant investment by firms to adapt their products to foreign markets, to set up marketing and distribution networks, and to set up production facilities specifically designed for export markets. These sunk costs would tend to make firms less responsive to short-run movements in the exchange rate, as they would tend to adopt a "wait and see" approach and stay in the export market as long as they can recover their variable costs and wait for a turnaround in the exchange rate to recoup their sunk costs. Following the finance literature on real options (e.g., McDonald and Segel, 1986), Dixit (1989) and Krugman (1989) have explored the implications of sunk costs in the context of an "options" approach, which has been applied by Franke (1991) and Sercu and Vanhulle (1992). The key idea is that an exporting firm can be viewed as owning an option to leave the export market, and a firm not currently exporting can be regarded as owning an option to enter the foreign market in the future. The decision to enter or exit the export market involves considering explicit fixed and variable costs, but also the cost of exercising the option to

enter or leave the market. The greater the volatility in exchange rates, the greater the value of keeping the option, and hence the greater the range of exchange rates within which the firm stays in the export market, or stays out if it has not yet entered. This suggests that increased exchange rate volatility would increase the inertia in entry and exit decisions.

It is useful to note that in most theoretical models, what is being studied is the volatility of the real exchange rate as opposed to the nominal exchange rate. The two are distinct conceptually but do not differ much in reality: prices of goods tend to be "sticky" in local currency in the short-to-medium run. In this case, real and nominal exchange rate volatilities are virtually the same for practical purposes. For this reason, after reviewing the literature on the effect of real exchange rate volatility, we do not present a separate discussion on the effect of nominal exchange rate volatility. The exceptions are episodes of high inflation when nominal exchange rate volatility tends to be bigger than real exchange rate volatility. For this reason, in the empirical analysis that will be presented later, we examine explicitly whether real versus nominal exchange rate volatilities have different effects on trade or not.

Up to this point the discussion of the impact of volatility on trade has been within a partial equilibrium framework, i.e., the only variable that changes is some measure of the variability of the exchange rate, and all other factors that may have an influence on the level of trade are assumed to remain unchanged. However, those developments that are generating the exchange rate movements are likely to affect other aspects of the economic environment which will in turn have an effect on trade flows. Thus it is important to take account in a

general equilibrium framework the interaction of all the major macroeconomic variables to get a more complete picture of the relationship between exchange rate variability and trade.

Such an analysis has recently been provided by Bacchetta and Van Wincoop (2000). They develop a simple, two-country, general equilibrium model where uncertainty arises from monetary, fiscal, and technology shocks, and they compare the level of trade and welfare for fixed and floating exchange rate arrangements. They reach two main conclusions. First, there is no clear relationship between the level of trade and the type of exchange rate arrangement. Depending on the preferences of consumers regarding the tradeoff between consumption and leisure, as well as the monetary policy rules followed in each system, trade can be higher or lower under either exchange rate arrangement. As an example of the ambiguity of the relationship between volatility and trade in a general equilibrium environment, a monetary expansion in the foreign country would depreciate its exchange rate, causing it to reduce its imports, but the increased demand generated by the monetary expansion could offset part or all of the exchange rate effect. Thus the nature of the shock that causes the exchange rate change can lead to changes in other macroeconomic variables that offset the impact of the movement in the exchange rate. Second, the level of trade does not provide a good index of the level of welfare in a country, and thus there is no one-to-one relationship between levels of trade and welfare in comparing exchange rate systems. In their model, trade is determined by the certainty equivalent of a firm's revenue and costs in the home market relative to the foreign market, whereas the welfare of the country is determined by the volatility of consumption and leisure.

Obstfeld and Rogoff (1998) also provide an analysis of the welfare costs of exchange rate volatility. They extend the "new open economy macroeconomic model" to an explicitly stochastic environment where risk has an impact on the price-setting decisions of firms, and hence on output and international trade flows. They provide an illustrative example whereby reducing the variance of the exchange rate to zero by pegging the exchange rate could result in a welfare gain of up to one percent of GDP. Bergin and Tchakarov (2003) provide an extension of this type of model to more realistic situations involving incomplete asset markets and investment by firms. They are able to calculate the effects of exchange rate uncertainty for a wide range of cases and find that the welfare costs are generally quite small, on the order of one tenth of one percent of consumption. However, they explore the implications of two cases where risk does matter quantitatively, on the order of the effect in the example cited above by Obstfeld and Rogoff (1998): first, where consumers exhibit considerable persistence in their pattern of consumption, such that welfare is adversely affected by sudden changes in consumption, and second, where asset markets are asymmetric in that there is only one international bond, such that the country without its own bond is adversely affected.

Finally, Koren and Szeidl (2003) develop a model which brings out clearly the interactions among macroeconomic variables. They show that what matters is not the unconditional volatility of the exchange rate as a proxy for risk, as used in many empirical papers in the literature, but rather that exchange rate uncertainty should influence trade volumes and prices through the covariances of the exchange rate with the other key variables in the model. In this general equilibrium context, they stress that it is not uncertainty per se in the exchange

rate that matters, but rather whether this uncertainty magnifies or reduces the firm's other risks on the cost and demand side, and ultimately whether it exacerbates or moderates the risk faced by consumers. In addition, they analyze the extent to which local currency vs. producer currency pricing by exporters affects the risks facing the firm; their empirical evidence suggests that risk is higher with the former pricing rule.

B. Empirical Results on the Relationship Between Exchange Rate Volatility and Trade

The early empirical work on the effect of exchange rate variability and trade surveyed in the IMF (1984) study did not yield consistent results, with many studies yielding little or no support for a negative effect. For example, the early work by Hooper and Kohlhagen (1978) utilized the model of Ethier (1973) for traded goods and derived equations for export prices and quantities in terms of the costs of production reflecting both domestic and imported inputs, other domestic prices, domestic income, and capacity utilization. Exchange rate risk was measured by the average absolute difference between the current period spot exchange rate and the forward rate last period, as well as the variance of the nominal spot rate and the current forward rate. They examined the impact of exchange rate volatility on aggregate and bilateral trade flow data for all G-7 countries except Italy. In terms of the effect of volatility on trade flows, they found essentially no evidence of any negative effect. Cushman (1983) used a model similar to that of Hooper and Kohlhagen (1978) but extended the sample size and used real as opposed to nominal exchange rates. Of fourteen sets of bilateral trade flows between industrial countries, he found a negative and significant effect of volatility for six

cases. Finally, the IMF (1984) used a simplified version of Cushman's model to estimate bilateral exports between the G-7 countries from the first quarter of 1969 to the fourth quarter of 1982, with real GNP, the real bilateral exchange rate, relative capacity utilization, and variability measured as the standard deviation of the percentage changes in the exchange rate over the preceding five quarters. In only two cases did variability have a significantly negative coefficient, while positive coefficients were significant in several cases.

A number of factors may have contributed to the lack of robust findings in this early work. First, as noted above, theoretical considerations do not provide clear support for the conventional assumption that exchange rate volatility has a negative impact on the level of trade. Second, the sample period over which exchange rates showed significant variation was relatively short. Finally, the specification of the estimating equations was typically rather crude, consisting of a few macro variables from standard trade equations in use at the time.

McKenzie (1999) surveys a large number of empirical papers on the topic, most of which appeared after the IMF study. He stresses the point made above that at a theoretical level, models have been constructed which lead to negative or positive effects of variability on trade, and that a priori there is no clear case that one model is superior to another. His survey of the empirical work leads to the same mixed picture of results, with many studies finding no significant effect, or where significant, no systematic effect in one direction or the other. He finds, however, that the most recent contributions to the literature have been more successful in obtaining a statistically significant relationship between volatility and trade, which he attributes to more careful attention to the specification of the estimation technique

and the measure of volatility used. Similarly, the U.K. Treasury (2003) cites (Box 4.1, p. 29) a number of recent studies (De Grauwe (1987), Rose (2000), Dell'Ariccia (1999), Anderton and Skudelny (2001), Arize (1998) and Fountas and Aristotelous (1999)) which find a negative link, but these effects are not very large: complete elimination of volatility would raise trade by a maximum of 15 percent, compared to the consensus estimate of the effect as typically less than ten percent.

Recent work on this topic employing the gravity model has found some significant evidence of a negative relationship between exchange rate variability and trade.[6] The gravity equation has been widely used in empirical work in international economics and has been highly successful in explaining trade flows.[7] In its basic form, the gravity model explains bilateral trade flows between countries as depending positively on the product of their GDPs and negatively on their geographical distance from each other. Countries with larger economies tend to trade more in absolute terms, while distance can be viewed as a proxy for transportation costs which act as an impediment to trade. In addition, population is often included as an explanatory variable as an additional measure of country size. In many applications a host of dummy variables are added to account for shared characteristics which would increase the likelihood of trade between two countries, such as common borders, common language, and a membership in a free trade association. To this basic equation

[6] See Frankel and Wei (1993), Wei (1999), Dell'Ariccia (1999), Rose (2000), and Tenreyro (2003).

[7] See, for example, McCallum (1995) and Coe, Subramanian, and Tamirisa (2002). For discussions of the gravity equation, see Deardorff (1998), Anderson and van Wincoop (2003), and Annex D in U.K. Treasury (2003).

researchers add some measure of exchange rate variability to see if this proxy for exchange rate risk has a separate, identifiable effect on trade flows after all other major factors have been taken into account.

The work by Dell'Ariccia (1999) provides a systematic analysis of exchange rate volatility on the bilateral trade of the 15 EU members and Switzerland over the 20 years from 1975 to 1994, using four different measures of exchange rate uncertainty: the standard deviation of the first difference of the logarithm of the monthly bilateral nominal and real (CPI) exchange rate, the sum of the squares of the forward errors, and the percentage difference between the maximum and the minimum of the nominal spot rate. In the basic regressions, exchange rate volatility has a small but significantly negative impact on trade: eliminating volatility to zero in 1994 would have increased trade by an amount ranging from 10 to 13 percent, depending on the particular measure of variability.[8] The results for both nominal and real variability are very close, which is not surprising, given that in the sample the two exchange rate measures are highly correlated.

Dell'Ariccia then goes on to take account of the simultaneity bias that can result from central banks trying to stabilize their exchange rates with their main trading partners. If they were successful, there would be a negative association between exchange rate variability and the level of trade, but it would not reflect causation from the former to the latter. He first uses an instrument (the sum of squares of the three-month logarithmic forward error) for the

measures of exchange rate volatility to account for possible endogeneity in this variable. The results confirm the negative relationship between volatility and trade, with the magnitude of the effect about the same as before. In addition, he uses both fixed effects and random effects estimation methods to account for the simultaneity bias. In this case the effect is still significant, but the magnitude is much smaller: total elimination of exchange rate volatility in 1994 would have increased trade by only 3 – 4 percent.

Rose (2000) also employs the gravity approach and uses a very large data set involving 186 countries for the five years 1970, 1975, 1980, 1985, and 1990. His main objective in the paper is to measure the effect of currency unions on members' trade – an issue which is dealt with at length below – but he also uses his model to test for the effects of exchange rate volatility on trade. His primary measure of volatility is the standard deviation of the first difference of the monthly logarithm of the bilateral nominal exchange rate, which is computed over the five years preceding the year of estimation. In his benchmark results using the pooled data, he finds a small but significant negative effect: reducing volatility by one standard deviation (7 percent) around the mean (5 percent) would increase bilateral trade by about 13 percent, which is similar to the finding of Dell'Ariccia described above.[9] This result is robust when using three alternative measures of volatility, but not when the standard

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[8] In 1994, the average standard deviation of the monthly nominal exchange rate change was roughly 5.5 percent, and over the sample period the annual average bilateral trade growth was 3.5 percent.

[9] Parsley and Wei (2001) look at the effect of reducing nominal exchange rate variability on relative price variability across countries, and find that reducing the former diminishes the latter. However, they also find a much stronger effect arising from participating in a hard peg, such as a currency union, which is consistent with Rose's finding of a large impact of a currency union on trade.

deviation over the previous five years of the *level* of the exchange rate is used. However, when random effects are incorporated in the estimation, the magnitude of the effect of volatility on trade is reduced to about a third of the benchmark estimate, or roughly 4 percent. Thus the estimation results of Rose and Dell'Ariccia appear to be quite consistent.

However, a recent paper by Tenreyro (2003) casts some doubt on the robustness of these results. She utilizes a gravity equation similar to that of Rose for a broad sample of countries using annual data from 1970 to 1997. The measure of volatility is the same as that employed by Rose, except that the standard deviation of the log change in monthly exchange rates is measured only over the current year. Her main objective is to address several estimation problems in previous studies of the effect of volatility on trade. When these problems are not addressed and ordinary least squares is used, she finds a small effect: reducing volatility from its sample mean of about 5 percent to zero results in an increase in trade of only 2 percent. When the more appropriate method is used, but without taking account of endogeneity, eliminating exchange rate uncertainty lead to an estimated 4 percent increase in trade. However, when endogeneity is taken into account through the use of instruments, volatility has an insignificant effect on trade, a result that is robust on the choice of instruments.

Finally, it should be noted that there has been some recent work looking at the effects of exchange rate volatility on disaggregated trade flows. Broda and Romalis (2003) find that volatility decreases trade in differentiated products relative to trade in commodities, although the effect is rather small: eliminating all real exchange rate volatility would increase trade in manufactures by less than 5 percent and total trade by less than 3 percent. They note,

however, that some countries with particularly volatile exchange rates, especially developing countries, would experience a more pronounced increase in trade. Koren and Szeidl (2003) also use disaggregated data and find small effects: eliminating exchange rate variability would result in a change in export prices of only a few percentage points.

III. Recent History and Geography of Exchange Rate Volatility

A. Measuring Exchange Rate Volatility

In the voluminous literature on exchange rate volatility and trade, there is no consensus on the appropriate method for measuring such volatility. This lack of agreement reflects a number of factors. As noted in the section below, there is no generally accepted model of firm behavior subject to risk arising from fluctuations in exchange rates and other variables. Consequently theory cannot provide definitive guidance as to which measure is most suitable. Moreover, the scope of the analysis will to some extent dictate the type of measure used. If the focus is on advanced countries, then one could take into account forward markets for the assessment of exchange rate volatility on trade, whereas this would not be possible if the analysis extended to a large number of developing countries. In addition, one needs to consider the time horizon over which variability is to be measured, as well as whether it is unconditional volatility or the unexpected movement in the exchange rate relative to its predicted value, that is the relevant measure. Finally, the level of aggregation of trade flows being considered will also play a role in determining the appropriate measure of the exchange rate to be used.

This study provides a comprehensive picture of volatility in exchange rates across the entire Fund membership for which data are available. In the empirical analysis, the paper starts with an examination of the relationship between aggregate exchange rate volatility and aggregate trade. Recognizing the limitations of looking at the aggregate data, the paper then turns to analyzing the effect of exchange rate volatility on trade across different country pairs and over time. Methodologically, the switch to bilateral trade and volatility allows one to better control a variety of other factors that could affect trade other than volatility. As a consequence, the chance to detect an effect of exchange rate volatility on trade improves. Given this methodological approach, the basic building block in the analysis is the volatility in the exchange rate between the currencies of each pair of countries in the sample. For the descriptive part of the study below, which looks at the exchange rate volatility facing a country as a whole, it is necessary to aggregate the bilateral volatilities using trade shares as weights to obtain what is referred to as the "effective volatility" of a country's exchange rates. This ensures that the measures of volatility in the descriptive and econometric parts of the study are fully consistent.

Such a measure of "effective volatility" presupposes that the exchange rate uncertainty facing an individual firm is an average of the variability of individual bilateral exchange rates (Lanyi and Suss, 1982). However, if a trading firm engages in international transactions with a wide range of countries, any tendency for exchange rates to move in offsetting directions would reduce the overall exposure of the firm to exchange rate risk. This would argue for using the volatility of a country's effective exchange rate as the measure of the exchange rate uncertainty facing a country. This would seem particularly appropriate for advanced

economies where much trade is undertaken by diversified multinational corporations. This was the approach taken in the original IMF (1984) study, which focused almost exclusively on the G-7 countries. However, the present study covers nearly all developing countries, where the role of diversified firms is less pronounced. For this reason, as well as to have consistency with the econometric analysis below, effective volatility is used in the descriptive part of the study.

It is important to realize that the degree of exchange rate variability a country is exposed to is not necessarily closely related to the type of exchange rate regime it has adopted. A country may peg its currency to an anchor currency, but it will float against all other currencies if the anchor does as well. Thus, as with effective exchange rates, effective volatility is a multi-dimensional concept (Polak, 1988). Pegging can reduce nominal exchange rate volatility vis-à-vis one trading partner, but it can by no means eliminate overall exchange rate variability. This is shown below, where measured volatility is related to two different classifications of a country's exchange rate arrangement.

The choice between using nominal and real exchange rates depends in part on the time dimension that is relevant for the economic decision being taken. In the short- run where costs of production are known and export and import prices have been determined, the exchange rate exposure of a firm is a function of the nominal exchange rate. However, the decision to engage in international transactions stretches over a longer period of time during which production costs and export and import prices in foreign currency will vary. From this perspective, exchange rates measured in real terms are appropriate. Nonetheless, as nominal

and real exchange rates tend to move closely together, given the stickiness of domestic prices, the choice of which one to use is not likely to affect significantly measured volatility or the econometric results. Nonetheless, real rates are preferable on theoretical grounds and are used in the benchmark measures of volatility below. Consumer prices are used to construct the real rates, as they are the most widely available measures of domestic prices. As a robustness check, results using nominal exchange rates are also reported.

While exchange rates are often highly volatile, the extent to which they are a source of uncertainty and risk depends on the degree to which exchange rate movements are foreseen. When hedging instruments are available, the predicted part of exchange rate volatility can be hedged away and hence may not have much effect on trade. This suggests that the appropriate measure of risk should be related to deviations between actual and predicted exchange rates. One possibility along these lines would be to use the forward rate as a prediction of the future spot rate, and to use the difference between the current spot rate and the previous period forward rate as an indicator of exchange rate risk. One problem with this approach is that the forward rate is not a good predictor of future exchange rates. In addition, quotations are available only for the major currencies. More generally, there are a wide variety of methods—ranging from structural models to time series equations using ARCH/GARCH approaches, for example—that could be used to generate predicted values of exchange rates (McKenzie, 1999). However, as pointed out by Meese and Rogoff (1983), there are inherent difficulties in predicting exchange rates. Therefore this study adopts the approach followed in much of the work on the topic and uses a measure of the observed

variability of exchange rates as the benchmark. GARCH estimates are included as an alternative measure of volatility.

The most widely used measure of exchange rate volatility is the standard deviation of the first difference of logarithms of the exchange rate.[10] This measure has the property that it will equal zero if the exchange rate follows a constant trend, which presumably could be anticipated and therefore would not be a source of uncertainty. Following the practice in most other studies, the change in the exchange rate is computed over one month, using end-of-month data. The standard deviation is calculated over a one-year period, as an indicator of short-run volatility, as well as over a five-year period to capture long-run variability.

Finally, it is useful to take note of the role of currency invoicing here. Very often trade between a pair of countries, especially between two developing countries, is not invoiced in the currency of either country. Instead, a major currency, especially the U.S. dollar, is often used as the invoicing currency. It might appear to be the case that the volatility of the exchange rate between the currencies of the two trading partners is not the relevant volatility to consider. For example, if Chinese exports to India are invoiced in U.S. dollars, it might seem that the Chinese exporters would only care about the fluctuations between the U.S. dollar and the Chinese yuan, but not between the Indian rupee and the Chinese yuan. However, this view is not correct. Any fluctuation between the Chinese yuan and the Indian rupee holding constant the Chinese yuan/U.S. dollar rate, must reflect fluctuations in the

[10] See, for example, Brodsky (1984), Kenen and Rodrick (1986), Frankel and Wei (1993), Dell'Ariccia (1999), Rose (2000), and Tenreyro (2003).

Indian rupee/U.S. dollar rate. As the latter could affect the Indian demand for Chinese exports, fluctuations in the Chinese yuan/Indian rupee exchange rate would also affect the Chinese exports to India even if the trade is invoiced in the U.S. dollar. Generally speaking, the choice of invoicing currency does not alter the effect of exchange rate volatility on trade.

B. Comparisons Using the Benchmark Measure of Volatility

It is useful to begin the analysis of exchange rate volatility over time and across countries by examining the evolution of fluctuations in exchange rates for broad groups of countries shown in Figure 3.1.[11] This shows the short-run effective volatility since 1970 of exchange rates reported in the IMF's *International Financial Statistics (IFS)*, converted to real terms using consumer prices, for advanced, transition, emerging market, and developing economies.[12] As noted in the Introduction, there were several developments in the international monetary system over this period, including crises in emerging market economies, capital account liberalization, and the breakup of the former Soviet Union, all of which tended to be associated with an increase in exchange rate volatility.

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[11] Figure 3.1 shows equal-weighted averages of the effective volatilities of the exchange rates of the countries in each group, as each individual country is viewed as the unit of interest. Alternatively, one could weight the effective volatility of each country by its trade share. This weighted average volatility was computed for each group, and the results are not markedly different from what is shown in Figure 3.1.

[12] The list of countries in each group is given in Appendix Table III.1. The list of advanced countries follows that in the *World Economic Outlook*, Table A in the Statistical Appendix, except that the four newly industrialized Asian economies are included in the group of emerging markets. The transition economies comprise the countries in transition in Table A. The group of emerging market economies is a fairly narrow list of 20 countries. All other countries are included in the list of developing countries.

First, looking at the how variability has changed over the sample period, it is noteworthy that there is no obvious trend increase over time. In the first three years of the sample period, 1970–1972, lower-than-average effective volatility is evident for the advanced economies, which reflects the fixed-rate system of most of these countries. Since then, the exchange rates of these countries have exhibited greater volatility, but not markedly so. In fact, the average effective volatility from 1991–2002 is about the same as in 1970–1980. There is also no clear upward trend in exchange rate volatility in emerging market economies and developing countries over the entire period. While transition economy exchange rates exhibited much greater variability, on average, in the 1990–2002 period, this reflects the very large change in exchange rates associated with the breakup of the former Soviet Union and the shift to market economies from 1989 to 1993. The unprecedented high level of volatility during these years was a reflection by and large of adjustments in real exchange rates that were needed to accommodate the structural transformation of these economies. These adjustments now appear to be essentially complete and in recent years (1999–2002) the effective volatility in their real exchange rates has been less than that of emerging and developing countries.

Second, looking across the major country groupings, it is not surprising that measured volatility is lowest for the advanced economies. This reflects both that these countries trade relatively more with each other and that their bilateral exchange rates with each other tend to exhibit smaller fluctuations than with other countries. (See the discussion below.) The lower volatility within the group presumably arises from the greater stability in economic policies

in the advanced economies, as well as their ability to adjust relatively smoothly to shocks. In addition, the foreign exchange markets in which these currencies are traded are very large and liquid, with instruments available to hedge volatility, which enables these markets to clear quickly, dampening potentially large fluctuations in exchange rates.

Figure 3.2 shows the same measure of volatility for the G-7 countries individually, as well as for the group as a whole. While variability is, on average, very similar to that for advanced countries as a whole, there are notable differences. The high average volatility for Japan, at 3.50 percent, is double that of Canada, at 1.75 percent; this low figure would appear to reflect the close integration of the Canadian and U.S. economies, as well the strategy of the Canadian authorities to avoid large swings in the Canadian-U.S. dollar exchange rate over part of the sample period. Also noteworthy is the increased volatility for France, Germany, and Italy surrounding the ERM turmoil in 1991–1993 (which also affected the United Kingdom in 1992), as well as noticeable reduction in effective volatility in the exchange rates of these three countries with the introduction of the euro in 1999.

To illustrate the reasons for the relatively low effective volatility of the advanced economies, it is useful to decompose the variability in their exchange rates into the contributions of each of the major country groups. This is done in Table 3.1 for the G-7 countries. Part A of Table 3.1 decomposes the effective volatility of each of the G-7 into the share of volatility from each group for each year 1970, 1980, 1990, and 2000, so that the row sum equals the overall effective volatility for that country shown in the last row. It is clear that with two exceptions (Japan and the United States in 1970) the largest component of volatility is that

arising from the exchange rates of the other advanced economies. This reflects, in part, the fact that the trade weights of the industrial countries are very high as well as the lower volatility of the individual bilateral exchange rates among the advanced countries. This is shown in Part B of Table 3.1, which gives the volatility of the exchange rates of the G-7 with each of the major country groupings, computed with the trade weights summing to unity for each group. It shows that with only a few exceptions, the volatility of the exchange rates of the G-7 with other advanced economies was less than that of their exchange rates with the other country groups.

As noted above, of the major country groups, the transition economies have had the highest level of exchange rate variability, which was associated with the breakup of the former Soviet Union. Data for this group are shown only starting in 1988, as most countries did not exist in the 1970s and 1980s. Only starting in 1995 are data available for all 22 transition countries, and over the period 1995–2002 the exchange rate volatility of this group was comparable to that of emerging market economies and developing countries. Volatility in these two groups, while on average not quite double that of the advanced countries for the period as a whole, nonetheless declined between the 1980s and 1990s, especially for the emerging market economies.

Some additional detail is shown in Figure 3.3, which gives a geographic breakdown of developing countries (WEO classification), and in Figure 3.4 for two analytical groups (fuel

exporters and exporters of non-fuel primary products.)[13] Among the geographic regions, sub-Saharan Africa (excluding South Africa and Nigeria) shows the highest average level of volatility of real exchange rates over the sample period, although this may reflect the unusually large 14.5 percent figure in 1994, which is related in large part to the dramatic devaluation of the CFA franc that year. By contrast, the developing countries in Asia have fairly consistently exhibited below-average volatility, especially if one excludes the exceptionally high degree of variability associated with the Asian crisis in 1997–1998. For the developing countries in the Western Hemisphere, exchange rate fluctuations have been below-average, except for the turbulence associated with the "lost decade" of the 1980s. Regarding the analytic groupings shown in Figure 3.4, fuel exporters have experienced increasing exchange rate volatility over the sample period, and exporters of non-fuel primary products have had the highest average level of real exchange volatility over the entire period, which likely reflects the effects of movements in the terms of trade of these countries.

The average figures for the country groups embody wide variation in the level of exchange rate volatility of the individual countries in each group. It is therefore useful to examine the variation across the members in each group. This is done in Table 3.2, which presents figures for the average effective volatility of real exchange rates over the entire sample period 1970–2002 for the five countries with the highest and lowest volatilities.[14] As expected, the dispersion of exchange rate volatility across the advanced economies is quite low, compared

[13] The list of countries in each group is given in Appendix Table III.2.

[14] As noted above, the group of transition countries only attained its full complement of 22 in 1995, and so the ranking is only relevant for the 1990s.

with the other groups. It is noteworthy, however, that Japan has the highest measured volatility in this group, with another G-7 country, the United Kingdom, ranking fifth. The dispersion is much higher within the other country groups.

Table 3.3 provides information on the frequency (number of years) each country appeared in the top five or bottom five in terms of effective real exchange rate volatility. This indicates which countries exhibited persistently high or low variability over the sample period. The results are often similar to what is shown in Table 3.2; for example, Japan is in the top five advanced economies in 30 out of the 33 years in the sample. Similarly, in the emerging markets group, Argentina is in the top five in 20 of the 33 years.[15]

C. Alternative Measures of Volatility

It is useful to compare the benchmark measure of volatility with a number of alternatives. Figure 3.5 provides figures for the short-run effective volatility of the *nominal* official exchange rate. A comparison with Figure 3.1 shows that while there are no major differences between these two measures, it is generally the case that real exchange rate volatility is somewhat higher than nominal volatility. This is particularly the case in 1970, when fixed nominal rates were more widespread and inflation differentials generated larger movements

[15] The results for Myanmar in Table 3.3 need to be interpreted with caution, given that the bulk of trade appears to occur at the unofficial parallel market rate. Only public sector enterprises, accounting for about 30 percent of reported trade, conduct transactions at the official rate. However, the parallel market rate, as reported by Reinhart and Rogoff (2002), exhibits somewhat greater volatility than the official rate.

in real rates.[16] Lower volatility in nominal exchange rates is also more pronounced among developing countries over the entire sample period, which would appear to reflect the "fear of floating" described by Reinhart and Rogoff (2002).

Figure 3.6 shows the longer-run measure of exchange rate volatility, namely, the standard deviation of monthly log differences in exchange rates calculated over the five years preceding the year in question. As one would expect, the measured volatility is larger than the average of the short-run volatilities over the same years. Figure 3.7 shows a measure of conditional volatility, namely, that estimated for each currency assuming it follows a GARCH process. The underlying idea is that part of the volatility can be forecasted, based on past values of the exchange rate, and firms engaged in trade would naturally make an effort to develop such a forecast. Figure 3.7 plots the conditional—or forecasted—exchange rate volatility (for a description of this methodology, see the Appendix). A comparison with Figure 3.6 shows that this measure is in general somewhat lower than the standard measure, particularly the case for the transition economies in 1995. Figure 3.8 gives the long-run volatility for the G-7 countries.

Up to this point, exchange rates in *IFS*, i.e., those compiled and reported by the authorities to the IMF, have been used in the analysis. Recently, however, attention has focused on the classification of exchange rate regimes and the appropriateness of using these exchange rates

[16] It is also interesting to note that the introduction of EMU in 1999 reduced, but by no means eliminated, effective nominal exchange rate volatility of the three G-7 members of EMU. Average nominal effective volatility from 1995–1998 before EMU was 1.91, 2.07,

(continued…)

as the basis for such a classification. In particular, Reinhart and Rogoff (2002) have put together an extensive dataset for 153 countries of monthly market-determined parallel exchange rates going back to 1946. They find striking and widespread differences between the official *de jure* regime, as reported in the IMF's *Annual Report on Exchange Rate Arrangements and Exchange Restrictions* (*AREAER*), and that implied by the information they gathered on actual *de facto* exchange rate practices.[17] As the exchange rates reported by Reinhart and Rogoff may be more representative of the price of foreign exchange at which international trade transactions were conducted, it would also appear worthwhile to calculate exchange rate volatility using these market-determined rates.

In order to compare the volatility implied by both *IFS* and market-determined rates, it is necessary to use the same set of countries. As the usable data for real market-determined rates is significantly smaller (107 countries) than what is available for real *IFS* rates (172), the benchmark measure of volatility for the latter had to be recomputed.[18] This is shown in Appendix Table III.4, where the sample period extends only through 1998 because of data limitations. Comparing the benchmark measure of exchange rate volatility with the same

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2.34 percent, in France, Germany and Italy, respectively, whereas in 1999–2002, average effective nominal volatility was 1.41, 1.68, and 1.63 percent, respectively.

[17] The correspondence between the official IMF and the Reinhart/Rogoff "Natural" regime classifications is shown in Appendix Table III.6. Also shown are the distributions of the major country groups by type of exchange rate regime for the IMF classification (Appendix Table III.7) and for the Natural classification (Appendix Table III.8). It should be noted that since 1998, the IMF's *AREAER* reports exchange rate classifications that are based on *de facto*, rather than *de jure* exchange rate arrangements. For an analysis that applies retroactively to the *de facto* classification back to 1990, see Bubula and Ötker-Robe (2002).

[18] The list of countries in each group is given in Appendix Table III.3.

measure, but using the larger sample of countries, the evolution of exchange rate volatility over time and between major country groupings is quite similar. The difference in measured volatility for the same country group reflects only the difference in the sample of countries and the fact that the variability of the currencies of the countries included in the larger sample is not the same as that of the currencies in the smaller sample.

Appendix Table III.5 shows the benchmark measure of volatility using parallel market exchange rates, which can be compared directly with Appendix Table III.4, as both utilize the same list of countries. It is immediately clear that, in almost all cases, the volatility of parallel market rates is larger than that of *IFS* rates.[19] This is true for advanced countries as well. Even though there are unlikely to be significant differences between *IFS* and market quotations for the bilateral rates between advanced countries, there would tend to be much larger differences for the bilateral rates between the advanced economies and countries in other groups. The only exceptions occur in 1991, 1992, 1997 and 1998 for transition economies, when movements in *IFS* rates exceeded those in parallel market rates. However, it should be noted that the difference between the two measures of volatility declined from the 1970s to the 1990s for all the country groups except emerging markets, where there was a slight increase. This largely reflects the fact that, except for transition economies, the effective volatility of the market exchange rate declined between the 1970s and the 1990s,

[19] The behavior of the two measures of volatility is quite different; the average of the simple correlation coefficient between the official and the parallel real exchange rate volatility measure for each bilateral exchange rate over the entire sample was 0.58. The correlation coefficient between the two measures of one-year volatility in the nominal exchange rate was even lower at 0.45.

whereas the volatility of the *IFS* rate increased for transition and developing economies, was about unchanged for advanced countries, but decreased for emerging market economies.

In comparing the volatility of currencies across countries, it is relevant to consider the type of exchange rate regime, as this would likely have a bearing on the degree of variability of a country's currency against other currencies. This is done in Table 3.4, which shows the real effective exchange rate volatility across country groupings in terms of both the official IMF exchange rate classification as well as the Reinhart-Rogoff Natural classification. It is noteworthy that a currency that is classified as "pegged" is by no means insulated from exchange rate fluctuations. Indeed, the average effective volatility of "freely floating" advanced countries (2.94 percent with the IMF classification and 3.09 percent with the Natural classification, respectively) is *less than* the average volatility of "pegged" currencies of other country groups, except for the emerging market countries in the Natural classification. Also, looking across types of currency regimes within country groupings, "limited flexibility" confers less exchange rate volatility than "pegged," except for the advanced countries under the Natural classification; and "managed floating" is not associated with a great deal more volatility than "pegged" regimes. Only "freely floating" and "freely falling" regimes have distinctly greater average volatility; the latter category in the Natural classification includes those countries that had annual inflation rates exceeding 30 percent, which not surprisingly caused considerable exchange rate volatility.

Table 3.5 shows how effective volatility has varied over time by exchange rate regime. Again, "limited flexibility" is associated with less variability than a "pegged" regime. If one

ignores the 1970s, when the major industrial countries were pegged early in the decade, volatility declined from between the 1980s to the 1990s, except in the category "freely floating" in the Natural classification.

IV. New Evidence on the Effect of Exchange Rate Volatility on Trade

As discussed in Part II, theoretical models do not point unambiguously to a negative effect of exchange rate volatility on trade. Moreover, empirical analysis in the existing literature has not uncovered a strong, causal, and consistently negative impact. In the empirical analysis we report in this section, there is no obvious negative relationship between aggregate exchange rate volatility and aggregate trade. When we turn to bilateral trade, we do find some evidence that exchange rate volatility tends to reduce trade. However, this negative effect is not robust to alternative ways of controlling for factors that could affect trade. The key findings of our empirical analysis are summarized below, and an Appendix describes the statistical results in more detail.

The objective of our empirical analysis is to examine the role of exchange rate volatility in trade in a comprehensive manner. Compared to the existing academic literature and the Fund (1984) paper on the topic, the contribution of our analysis lies in exploring the effect of exchange rate volatility on trade along several dimensions:

- *By the type of exchange rate volatility*: We examine a range of different exchange rate volatility measures – short- and long-run, real and nominal, official, *IFS*-based and parallel market-based, and conditional and unconditional.

- *By country group*: We test if the impact of exchange rate volatility differs across country groupings, including industrial and developing countries.

- *By the type of trade*: We examine the impact not only on aggregate but also on sectoral trade, which allows us to test if the effect of exchange rate volatility varies in direction and magnitude across different types of goods. The role of exchange rate volatility has not yet been explored extensively using disaggregated trade data.

In addition to the disaggregation of the volatility effect, we test its robustness to alternative ways of controlling for joint causality between trade and exchange rates and for trade-related factors other than exchange rate volatility. Finally, while our focus is on exchange rate volatility, we take this opportunity to revisit a related topic – the role of a common currency in enhancing trade flows – and explore the robustness of the finding by Rose (2002) that this positive effect is very large.

A. Aggregate Volatility and Aggregate Trade – A First Look

It is instructive to look at the time paths of world trade and exchange rate volatility, and examine if there is any obvious negative association between the two. Figure 4.1 shows the

evolution of world trade since 1970 together with the average real effective volatility for all countries in the sample. There is a clear bulge in exchange rate volatility from 1989 to 1993, which reflects the large fluctuations in the currencies of a number of transition economies during this period in the aftermath of the breakup of the Soviet Union.[20] If one excludes transition economies from the measure of world currency volatility, the bulge disappears. What one then sees is an upward trend in average volatility from the early 1970s through the end of the 1980s, but a general moderation in the overall level of currency volatility since then.

In comparison, the world trade has increased steadily since 1970 and the growth rate is much more smooth than that of the exchange rate volatility. Looking at the movement of world trade and aggregate volatility over time, there does not appear to be any clear relationship between them. Therefore, at the aggregate level, there is no evidence of a negative effect of real exchange rate volatility on trade.

It may be useful to examine the relationship between the two by breaking down the sample by major country groups (Figure 4.2) and developing countries by geographic region (Figure 4.3) and by type of export (Figure 4.4). In some of the sub-samples and for some of the years, there appears to be a negative association between exchange rate volatility and the level of trade in certain country groupings. This is most evident in the case of transition economies

[20] Data for transition countries are not reported before 1988 because most of these countries did not exist before 1991. Data are available only for Yugoslavia from 1970 and for Hungary beginning in 1976. However, the effective volatilities for the major country groupings shown

(continued…)

in 1990-1994 (lower left graph of Figure 4.2), the Asian crisis in 1997-1998 (upper right graph of Figure 4.3), and non-fuel primary product exporting economies in the early 1980s (lower graph of Figure 4.4). However, this negative association may not reflect a causal relationship, but rather is a manifestation of the effects of a common set of factors that both raises currency volatility and reduces trade. For example, the Asian crisis led to a large decline in the imports of the affected countries and major movements in their exchange rates, but the fall in domestic demand was the most important factor reducing import volumes, not currency volatility. Similarly, the breakup of the Soviet Union caused widespread dislocations in many transition economies, resulting in substantial falls in output and trade, and huge changes in many exchange rates that were part and parcel of the transition process.

In order to estimate the specific impact of exchange rate volatility on trade flows, it is necessary to take account of the separate effects of the myriad of factors that determine the level of exports and imports. In what follows, we move away from aggregate trade and discuss a methodology that exploits the much richer variations in the data on bilateral trade and bilateral exchange rates that permits identifying the distinct contribution of volatility on trade.

B. The Conceptual Framework for the Analysis of the Volatility Effect in Trade

To investigate the effect of exchange rate volatility on trade, there are several "building blocks" to consider. First, there are factors other than exchange rate volatility that affect trade

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in Figures 4.2-4.4 do include the available bilateral exchange rate data for transition countries, weighted by appropriate trade shares.

and it is important to account for them in a way that is consistent with economic theory. Otherwise, one runs the risk of mis-attributing the effect of these other factors to exchange rate volatility. Second, the measure of exchange rate volatility should be conceptually reasonable. Third, it may be useful to allow exchange rate volatility to have different effects on different types of trade or trade in different country groupings. We explain these building blocks in turn.

As part of the first building block, we seek to account for the determinants of trade patterns other than exchange rate volatility in a modified gravity model. This model relates trade between a given pair of countries to characteristics of each of these two countries and the characteristics of their relationship. The characteristics that are most important—which the model owes its name to—are the economic mass (i.e., GDP) and the distance between the countries. In addition, the empirical specifications of the gravity model typically control for other factors augmenting or reducing trade, such as land areas, cultural similarity, geographical position, historical links, and preferential trading arrangements, all of which tend to affect the transaction costs relevant for bilateral trade and have been found to be statistically significant determinants of trade in various empirical applications. The model also typically controls for the level of economic development, which is expected to have a positive effect on trade, as more developed countries tend to specialize and trade more (e.g., Frankel and Wei, 1993). The gravity model has been empirically successful in terms of its ability to explain a large part of the variations in the observed trade patterns. It also has the merit of being grounded in international trade theories, ranging from those based on country

differences in factor endowments or technology to models of increasing returns to scale and monopolistic competition.

A relatively recent development in the theoretical foundation of the gravity model emphasizes "remoteness" or "multilateral resistance" effects. These effects were proposed by Anderson and van Wincoop (2003) and are defined as a function of unobservable equilibrium price indices, which depend on bilateral trade barriers and income shares of all the trading partners. In other words, the "multilateral resistance" effects are catch-all expressions that summarize the effects on a given bilateral trade from differential, possibly unobserved, trade costs between this country pair and all other trading partners. The gravity equation can then be interpreted as indicating that bilateral trade depends on the bilateral trade barrier between the two countries in question, relative to the two countries' multilateral resistance indices: for a given bilateral trade barrier between the two countries, higher barriers between them and their other trading partners would reduce the relative price of goods traded between them, raising bilateral trade. In empirical applications, the multilateral resistance indices can be conveniently proxied by country effects (fixed or time varying). We also include time effects in the model to control for time-specific factors such as world business cycles, global shocks, etc.

The second building block is the measure of exchange rate volatility. In the benchmark model we focus on the long-run measure of *IFS*-based real exchange rate volatility. Its value in any given year t is calculated as the standard deviation of the first-difference of the monthly natural logarithm of the bilateral real exchange rate in the five years preceding year

t, which is a conventional measure most commonly used in the current literature on the subject. To check the robustness of results, we examine alternative, yet analogously calculated measures of exchange rate volatility: long-run *IFS*-based nominal exchange rate volatility, short-run, contemporaneous *IFS*-based real and nominal exchange rate volatility, and the short- and long-run volatility of real parallel market rates using data from Reinhart and Rogoff (2002). As additional robustness analysis, we also consider the conditional volatilities of real exchange rates estimated using a GARCH (1, 1) model. To ensure the stationarity of the GARCH model, we exclude countries with hyper-inflation episodes, extreme exchange rate fluctuations and/or incomplete data, focusing our estimation on 124 industrial, developing, emerging and transition economies.

The third building block for the model is the consideration of different country groups and different types of trade. We analyze the exchange rate volatility effect separately for industrial countries and developing countries. We also examine how the exchange rate volatility effect depends on the type of product trade – differentiated or homogeneous. In classifying products into differentiated and homogenous varieties, we follow the strategy in Rauch (1999). Conceptually, Rauch first identifies two types of homogenous products: those traded on an organized exchange ("commodities"), and those whose prices are reported regularly in a professional trade publication ("referenced price products"). All other products are then defined as differentiated products.

C. What Do the Data Tell Us?

The gravity model performs well empirically, yielding precise and generally reasonable estimates. The coefficient on distance is negative and statistically significant, while the coefficient on the economic mass is positive and statistically significant. Most other control variables are also mostly significant and have the expected signs.

Does exchange rate volatility hamper trade? As a benchmark specification using country and time fixed effects, we find that the long-run real exchange rate volatility has a statistically significant negative effect on trade (Table 4.1, Column 1 Row 1). If exchange rate volatility were to rise by one standard deviation (from 0.12 to 0.15, for example, in our sample), trade would fall by about 7 percent (Table 4.1, Column 2 Row 1).[21] This effect is comparable to the estimates found by previous studies, e.g., Rose (2000) and Tenreyro (2003).

[21] This impact is computed as the estimated coefficient in the regression equation multiplied by one standard deviation of the volatility measure, multiplied by 100 to convert to percent.

Table 4.1 Effect of Long-Run Real Exchange Rate Volatility on Aggregate Trade [1/]

Model Specification	Not Controlling for Joint Causality between Trade and Exchange Rates	Implied Pecentage Change in Trade by One Standard Deviation Increase in Volatility	Controlling for Joint Causality between Trade and Exchange Rates	Implied Pecentage Change in Trade by One Standard Deviation Increase in Volatility
	(1)	(2)	(3)	(4)
With Country and Time Fixed Effects	-2.37* (0.67)	-6.64%	-22.64* (12.50)	-63.39%
With Country Pair and Time Fixed Effects	-2.40* (0.47)	-6.72%	-6.49 (6.24)	-18.17%
With Time-Varying Country Effects	2.89* (1.78)	8.09%	-23.82 (28.87)	-66.70%
With Country and Time Fixed Effects on the Full Sample	-1.16* (0.22)	-8.82%	...	...

1/ Standard errors are in parentheses. An asterisk denotes significance at the 90 percent level or higher. For details, see Appendix Tables IV.2 and IV.6A.

Is the negative effect on trade robust to alternative ways of controlling for factors other than bilateral exchange rate volatility? The answer is "No." On the one hand, a negative effect is still observed when we control for unobservable cultural, economic, historical, geographical and other factors specific to a given *pair* of countries rather than individual countries (Table 4.1, Column 1 Row 2). On the other hand, no negative effect is found when we allow country-specific effects to vary over time, as appears justified theoretically, given the dynamic nature of "multilateral resistance." Indeed, this specification could result in some cases in even a positive coefficient (e.g., Table 4.1, Column 1 Row 3) . While this does not necessarily imply that volatility promotes trade, it suggests that the finding of a negative effect of exchange rate volatility on trade is not robust.

A note of caution is in order here. Recent developments in the theoretical foundation of a gravity specification suggest that it is important to include time-varying country fixed effects in order to fully absorb the "multilateral resistance" effects. Otherwise, one might mis-

attribute to exchange rate volatility those effects on bilateral trade that should have been attributed to other factors. At the same time, we note that part of the forces underlining bilateral exchange rate volatility is time-varying and country-specific. The inclusion of the time-varying country fixed effects could also "overcorrect." For example, an unexpected increase in one country's money supply could raise all the bilateral exchange rate volatility involving that country. Even if this increase in volatility depresses all bilateral trade involving that country, a specification that controls for that country's time-varying fixed effects would not be able to reveal a negative effect of exchange rate volatility on trade. We have to keep this qualification in mind in interpreting the result.

Sorting out causality. To the extent that countries implement policies aimed at lowering exchange rate volatility in order to increase bilateral trade, the model considered so far would suffer from an endogeneity bias. We control for this possibility using two instrumental variable approaches: (i) that proposed by Frankel and Wei (1993), whereby the volatility in the relative quantity of money is used as an instrumental variable for exchange rate volatility, and (ii) that implemented by Tenreyro (2003) which relates the exchange rate volatility to the propensity of countries to adopt a common currency anchor. Neither of these approaches is perfect and each has its advantages: the Frankel-Wei approach appeals to the monetary theory of exchange rate determination, and is simple and easy to implement, while the Tenreyro approach appeals to the optimal currency framework as described in Alesina, Barro, and Tenreyro (2002). There is no significant effect of exchange rate volatility on trade in the models with country-pair and time-varying country effects (Table 4.1, Column 3 Row

2 and Column 3 Row 3). However, the negative volatility effect found in the model with constant country effects survives (Table 4.1, Column 3 Row 1).

Would the conclusion change when one employs alternative measures of volatility? The short answer is "no." Table 4.2 reports results from the same regression which includes our standard long-run measure together with all three alternative measures of exchange rate volatility (as differences from the long-run real *IFS*-based measure). The short-run volatility in the real exchange rate appears to discourage trade, albeit to a smaller extent than the long-run volatility. The volatility in the parallel market exchange rates has a similar effect on trade as the volatility in the *IFS*-reported exchange rates, but only in the long run. As shown in Appendix Tables IV.3 and IV.4 the volatilities of the nominal and real exchange rates are highly correlated and thus have similar effects on trade. In addition, conditioning the measure of exchange rate volatility on historical information using the GARCH approach, instead of using the simple statistical measure of volatility, also preserves the negative relationship with trade. As in Table 4.1, when time-varying country fixed effects are controlled for, there is no longer evidence of a negative and significant association between volatility and trade.

Table 4.2 Alternative Measures of Exchange Rate Volatility [1/]

Model Specification	Long-Run Real Exchange Rate Volatility	Short-Run Real Exchange Rate Volatility [2/]	Long-Run Real Parallel Market Exchange Rate Volatility [2/]	Short-Run Real Parallel Market Exchange Rate Volatility [2/]
	(1)	(2)	(3)	(4)
With Country and Time Fixed Effects	-3.92* (1.3)	-2.72* (1.04)	-1.20* (0.63)	-0.55 (0.73)
Implied Pecentage Change in Trade by One Standard Deviation Increase in Volatility	-10.98%	-6.80%	-6.48%	-2.15%
With Country Pair and Time Fixed Effects	-4.72* (0.76)	-4.15* (0.55)	-0.42 (0.34)	-1.14* (0.41)
Implied Pecentage Change in Trade by One Standard Deviation Increase in Volatility	-13.22%	-10.38%	-2.27%	-4.45%
With Time-Varying Country Effects	7.52* (3.89)	6.70* (3.24)	-2.20 (2.71)	-1.55 (2.8)
Implied Pecentage Change in Trade by One Standard Deviation Increase in Volatility	21.06%	16.75%	-11.88%	-6.05%

1/ Standard errors are indicated in parentheses. An asterisk denotes significance at the 90 percent level or higher. For details, refer to Appendix Tables IV.3., IV.4, and IV.5.

2/ In excess of long-run real official exchange rate volatility.

Does exchange rate volatility have a different effect on trade in differentiated or homogeneous products? Recent developments in the economics of trade suggest that a given increase in transaction costs (of which exchange rate volatility is a component) could have a larger, negative effect on trade in differentiated products than on trade in homogenous products. But, as with aggregate trade, the estimation results show that this theoretical prior is not robust. When we control for country and time effects separately, exchange rate volatility indeed has a negative effect on trade in differentiated products, but not on trade in homogenous products (Table 4.3, Column 1). However, when we include time-varying country fixed effects (Table 4.3, Column 3), the conclusion is overturned, as in the aggregate trade model.

Table 4.3 Effect of Exchange Rate Volatility on Trade in Different Types of Products [1/]

Model Specification	With Country and Time Effects	Implied Pecentage Change in Trade by One Standard Deviation Increase in Volatility	With Time-Varying Country Effects	Implied Pecentage Change in Trade by One Standard Deviation Increase in Volatility
	(1)	(2)	(3)	(4)
Trade in Homogeneous Products	-0.59 (2.12)	-1.65%	-2.97 (4.39)	-8.32%
Trade in Differentiated Products	-2.89* (1.66)	-8.09%	0.98 (3.06)	2.74%

1/ Standard errors are indicated in parentheses. An asterisk denotes significance at the 90 percent level or higher. For details, refer to Appendix Table IV.8.

Do members in currency unions trade more? Our core results confirm Rose's (2000) finding that common currency arrangements triple trade. The trade-enhancing benefits of currency unions apparently by far exceed gains from a reduction in exchange rate volatility and are preserved over time (Appendix Tables IV.2 and IV.3). They are also robust to controlling for time-varying country effects, but break down in a model with country-pair fixed effects (Appendix Table IV.4). This suggests that currency union membership may be correlated with other country-pair characteristics. Once these characteristics are controlled for by the inclusion of country-pair fixed effects, there is no additional trade-promoting effect from currency unions.

Does the volatility effect differ across country groups? In principle, the effects could be different. Foreign exchange markets are typically less developed and less liquid in developing countries, limiting firms' opportunities for hedging foreign exchange risk. Indeed, we do find that volatile exchange rates are more likely to be associated with smaller trade of developing countries than for trade among advanced economies in the specification

with country fixed effects. However, the negative effect disappears for both country groups when county effects are time varying (Appendix Table IV.7). As hedging instruments are more readily available for the currencies of industrial countries, one might expect that their trade would be less affected by exchange rate volatility. However, Wei (1999) finds little support for the hypothesis that the growing availability of hedging instruments is responsible for the small impact of volatility on trade.

On balance, for both aggregate and disaggregated trade, there is empirical evidence pointing to a generally small negative effect of exchange rate volatility on trade. But this evidence is not overwhelming and not robust across different empirical specifications.

V. Summary and Concluding Remarks

This study has provided a much more comprehensive analysis of exchange rate volatility and trade than the previous IMF (1984) analysis. It has examined exchange rate variability over the past thirty years for all countries for which data are available and has employed state-of the-art statistical techniques to test the natural presumption that volatility in exchange rates reduces the level of international trade.

In terms of observed variability, the analysis here shows that while exchange rate fluctuations have increased in times of currency and balance of payments crises, there has been no clear increase in exchange rate volatility, on average, between the 1970s and the 1990s. It is not surprising that the currencies of the advanced economies have had lower average volatility

than other country groups. Nonetheless, many transition, emerging market, and developing countries have recently exhibited exchange rate variability on a par, or close to that of many advanced economies.

In terms of the impact of exchange rate volatility on trade flows, the current study does not find a robustly negative effect. To be more precise, the study reports some evidence that is consistent with a negative effect of volatility on trade. However, such a relationship is not robust to certain reasonable perturbation of the specification. Specifically, when time-varying country fixed effects are allowed, which are suggested by recent theoretical work on the gravity model specification, the analysis does not reveal a negative association between volatility and trade.

The lack of a robustly negative impact of exchange rate volatility on trade may well reflect the ambiguity of the theoretical results in the general equilibrium models. These models show that exchange rate variability is the result of the volatility of the underlying shocks to technology, preferences, and policies, for example, as well as the overall policy regime. Changes in the volatility of the exchange rate may reflect changes in the volatility of the underlying shocks and/or changes in the policy regime. For example, trade liberalization undertaken together with a move to greater exchange rate flexibility could well be associated with increased trade flows as well as increased exchange rate volatility. This possibility is a reason for the ambiguity of the theoretical results as well as the difficulty in finding consistent and robust empirical results regarding the impact of volatility on trade. An additional implication is that the empirical results do not provide clear policy guidance. Even

if it were the case that such volatility is associated with reduced trade flows, this does not necessarily mean that trade would expand if the authorities stabilized the exchange rate in the face of shocks that occur.

These considerations suggest that there do not appear to be strong grounds to take measures to reduce exchange rate movements from the perspective of promoting trade flows. Note that this does not rule out the possibility that exchange rate fluctuations can affect an economy through other channels. For example, currency crises – special cases of exchange rate volatility - have required painful adjustments in output and consumption. However, in this case, appropriate policies are those that help to avoid the underlying causes of large and unpredictable movements in exchange rates, rather than measures to moderate currency fluctuations directly for the purpose of enhancing trade.

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DO COUNTRIES WITH STABLE EXCHANGE RATES AND COMMON CURRENCY TRADE MORE? AN EMPIRICAL ANALYSIS

While there is some evidence of a negative effect of exchange rate volatility on trade, it is not robust to certain specifications. This is true both for aggregate trade as well as for trade in homogeneous and differentiated products separately. Therefore, the overall message from the empirical analysis is that, if the exchange rate volatility depresses trade, the effect is unlikely to be quantitatively large. Below we discuss the basis for these conclusions in more detail.

I. THE GRAVITY MODEL

The empirical analysis in this study is based on the standard "gravity" framework, whereby trade between two countries is modeled as a function of incomes (economic mass) of these countries and distance between them. It has proved to be robust and successful in a wide variety of empirical applications. Moreover, the gravity model has strong foundations in international trade theories, from those based on country differences in factor endowments or technology to models of increasing returns to scale and monopolistic competition. Entering incomes in the product form is theoretically well-established in the trade literature.[22]

Besides the economic mass and distance, the empirical specifications of the gravity model typically control for other factors augmenting or reducing trade, such as land areas, cultural similarity, geographical position, historical links, and preferential trading arrangements, all of

[22] See Anderson (1979), Helpman and Krugman (1985), Bergstrand (1985), Deardorff (1998), and Anderson and van Wincoop (2003).

which tend to affect the transaction costs relevant for bilateral trade and have been found to be statistically significant determinants of trade in various empirical applications. The model also typically controls for the level of economic development, which is expected to have a positive effect on trade, as more developed countries tend to specialize and trade more. With all of these by now fairly standard explanatory variables included in the gravity equation as controls, the focus of interest here is on the introduction of alternative measures of exchange rate variability to see to what extent this particular variable may affect transaction costs and thereby affect the level of bilateral trade between two trading partners.

To control for "remoteness" or "multilateral resistance" effects, we include country-specific fixed effects in the model. The concept of "multilateral resistance" was proposed by Anderson and Van Wincoop (2003) and is defined as a function of unobservable equilibrium price indices, which depend on all bilateral trade barriers and income shares of the trading partners. The gravity equation can then be interpreted as indicating that bilateral trade depends on the bilateral trade barriers between the two countries in question, relative to the product of their multilateral resistance indices: for a given bilateral trade barrier between the two countries, higher barriers between them and their other trading partners would reduce the relative price of goods traded between them, raising bilateral trade. In empirical applications, the multilateral resistance indices can be conveniently proxied by country-specific fixed effects. We also include time effects in the model to control for time-specific factors such as global business cycles, oil price shocks, etc., so that the intercept in our model is allowed to change both across countries and over time. In addition, we experiment with including time-varying country fixed effects, which are more general than including time dummies and

country fixed effects separately. The time-varying country fixed effects are arguably more consistent with the notion of a time-varying multilateral resistance emphasized in recent trade theories. At the same time, we note that part of the forces underlying bilateral exchange rate volatility is time-varying and country-specific. The inclusion of the time-varying country fixed effects could also "overcorrect." For example, an unexpected increase in one country's money supply could raise all the bilateral exchange rate volatility involving that country. Even if this increase in volatility depresses all bilateral trade involving that country, a specification that controls for that country's time-varying fixed effects would not be able to capture a negative effect of exchange rate volatility on trade. We have to keep this qualification in mind in interpreting the result.

It might be useful to note that up to very recently, the literature that fits a gravity model to trade data seldom included any type of country fixed effects. It is still rarer to include time-varying country fixed effects. Augmenting the empirical trade equation with various kinds of fixed effects may be considered one of the value-added of this paper from a methodological point of view.

A. Aggregate Trade

The benchmark panel specification for the analysis of aggregate trade is similar to that used by Rose (2002). We estimate the model using ordinary least squares with robust standard errors, based on the log-linear transformation:

$$ltrade_{ijt} = \beta_0 + \beta_1 lrgdp_{ijt} + \beta_2 lrgdppc_{ijt} + \beta_3 lareap_{ij} + \beta_4 ldist_{ij} + \beta_5 lreal_{ijt} + \beta_6 custrict_{ijt} + \beta_7 comlang_{ij} + \beta_8 island_{ij} + \beta_9 landl_{ij} + \beta_{10} border_{ij} + \beta_{11} comcol_{ij} + \beta_{12} curcol_{ijt} + \beta_{13} colony_{ij} + \beta_{14} comctry_{ij} + \beta_{15} fta_{ijt} + \beta_{16} gsp_{ijt} + \beta_{17} onein_{ijt} + \beta_{18} bothin_{ijt} + \Gamma fe + \Phi te + \varepsilon_{ijt},$$

where $ltrade_{ijt}$ denotes the logarithm of the real value of aggregate bilateral trade between country *i* and *j* at time *t*; $lrgdp_{ijt}$ is the logarithm of the product of real GDPs of countries *i* and *j* at time *t*; $lrgdppc_{ijt}$ is the logarithm of the product of real GDP per capita of countries *i* and *j* at time *t*; $lareap_{ij}$ is the logarithm of the product of the land areas of countries *i* and *j*; $ldist_{ij}$ is the logarithm of distance between *i* and *j*; $lreal_{ijt}$ is the long-run real *IFS*-based measure of volatility in the bilateral exchange rate of countries *i* and *j* at time *t*; and $custrict_{ijt}$ is a dummy variable taking the value of 1 if countries *i* and *j* share a common currency at time *t*, and zero otherwise. The coefficients of interest are those on the measure of exchange rate volatility, $lreal_{ijt}$, and the currency union dummy, $custrict_{ijt}$.

Other variables control for various cultural, geographical, and historical factors: $comlang_{ij}$ is a dummy taking the value of 1 if *i* and *j* have a common language; $island_{ij}$ is the number of islands and $landl_{ij}$ is the number of landlocked countries in the country pair; $border_{ij}$ is a dummy taking a value of 1 when *i* and *j* share a common border; $comcol_{ij}$ is a dummy taking a value of 1 if after 1945 *i* and *j* were colonies with the same colonizer; $curcol_{ijt}$ is a dummy taking the value of 1 if *i* was a colony of *j* at time *t*, or vice versa; $colony_{ijt}$ is a dummy taking a value of 1 if *i* ever colonized *j*, or vice versa; and $comctry_{ijt}$ is a dummy taking a value of 1 if *i* and *j* belong to the same nation.

There are also several controls for trade policy factors:[23] fta_{ijt} is a dummy variable if *i* and *j* are members in the same regional trading arrangement; gsp_{ijt} is a dummy taking the value of 1 if *i* were a Generalized System of Preferences beneficiary of *j* or vice versa at time *t*.; and $onein_{ijt}$ and $bothin_{ijt}$ are dummies taking a value of 1 if either *i* or *j,* or both were members of GATT/WTO at time t, respectively. Finally, the vectors *fe* and *te* denote country- and year-specific dummies. The error term ε_{ijt} is assumed to be well-behaved.

B. Disaggregated Trade

For the analysis of disaggregated trade, we consider a system of two equations separately for trade in differentiated products and in homogenous products, which are estimated by the Seemingly Unrelated Regressions (SUR) technique. This specification allows the parameters on the same variables to be different for different types of trade, while the error terms for a given country pair are correlated in the two equations.

A few comments are needed to motivate the less familiar analysis of disaggregated trade. Higher exchange rate volatility can be viewed as an increase in a type of transaction costs in international trade. More concretely, it may add noise to the price signal and hence make it more difficult and more costly for buyers and sellers in the international market to find the right match for trading goods. However, a given increase in search costs could play a different role in the overall transaction costs for trade in homogeneous products versus in differentiated products. For homogeneous products such as wheat, an importer is not

[23] Bilateral tariff and non-tariff barriers are excluded from the model due to unavailability of data.

concerned with who the producer is, as the products are easily comparable, and price is the primary decision factor. On the other hand, heterogeneous products, such as digital cameras or tennis shoes tend to be "branded," as there are additional characteristics other than price that would affect importer's purchase decision. For even more differentiated products, such as machine tools, price would also not necessarily be the key factor affecting the purchase decision.

Noting the difference in search costs in international trade in these two types of goods, Rauch (1999) presented some evidence suggesting that a given increase in transaction costs has a bigger negative effect on the volume of trade in differentiated products than in homogeneous products. However, he did not look into the effect of exchange rate volatility on trade. Extending his logic, one might hypothesize that a given increment in exchange rate volatility would also dampen trade in differentiated products more than trade in homogenous products. A recent paper by Broda and Romalis (2003) contains a theoretical model that *assumes* (as opposed to *derives*) this difference in the effects of exchange rate volatility. The authors also report some empirical evidence demonstrating that exchange rate volatility deters trade in differentiated products more than trade in homogenous products. However, their regression specification does not include as control variables most of the usual country-pair characteristics described above. Given that many developing countries are striving to move towards producing and exporting more differentiated products, it is interesting to test this hypothesis using a regression specification similar to that used for the analysis of aggregate trade.

II. Data and Sources

A. Aggregate Trade

Estimating the aggregate trade model requires data on bilateral total trade, incomes, population, distance, as well as geographical, cultural, and historical information. The study uses a panel data set which covers 178 Fund member countries every fifth year from 1975 to 2000.[24] Summary statistics and correlations for the dataset are presented in Appendix Table IV.1A and B. The list of countries in the sample is presented in Appendix Table III.1.

Our data set is an updated version of Rose's (2002) data set.[25] To extend the data to 2000, we construct bilateral trade data series exactly following Rose's (2002) study: bilateral merchandise trade data are from the IMF's *Direction of Trade Statistics*. Bilateral trade is measured in U.S. dollars, as total trade (exports plus imports) between the two countries in question, deflated by U.S. CPI (1982-1983 prices) for urban areas (available from www.freelunch.com). Real GDP and population data come exclusively from the World Bank's *World Development Indicators* (WDI). [26]

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[24] A key regressor in our analysis is long-run exchange rate volatility, which is constructed from five-year intervals. When trade is sampled every fifth year, exchange rate volatility can then be constructed from non-overlapping five-year periods.

[25] We thank Andy Rose for making his data set available on his web-site. Rose (2002) describes the data set in detail, and we will only highlight a few pertinent data issues here.

[26] In contrast, Andrew Rose used several sources: WDI, Penn World Tables, and *International Financial Statistics*. WTO and FTA dummies for 2000 are extended based on the information available from the WTO official web site (www.wto.org).

In the benchmark model we focus on the long-run measure of *IFS*-based real exchange rate volatility calculated as the standard deviation of the first-difference of the monthly natural logarithm of the bilateral real exchange rate in the five years preceding year *t*. The monthly bilateral exchange rates are obtained from the *IFS*. To obtain exchange rates for each EMU member currency for the years 1999-2000, the euro exchange rates were converted using the irrevocably fixed conversion rates obtained from the official ECB website. Real exchange rates are constructed by using consumer prices from *IFS*.

To check the robustness of results, we examine alternative, yet analogously calculated measures of exchange rate volatility: long-run *IFS*-based nominal exchange rate volatility; short-run, contemporaneous *IFS*-based real and nominal exchange rate volatility, and short-run and long-run volatility of real parallel market rates, data for which come from Reinhart and Rogoff (2002). For more details on these measures of exchange rate volatility, see Part III of the study.

As part of the robustness analysis, we also consider the conditional volatilities of the exchange rates estimated using a GARCH (1, 1).[27] The underlying equation for the model is an ARIMA(0, 1, 0) process of the exchange rates (in the logarithmic form), which implies that the log difference of the exchange rates is a random walk with drift. This model yields an

[27] As an alternative to estimating volatility using parametric models such as GARCH, Andersen, *et al*. (2001) propose examining the realized volatility directly, which has the advantage of being model-independent. This approach, however, is very data intensive and thus cannot be implemented in our study.

estimate of volatility which is the standard deviation of the error term in the underlying equation conditional upon historical information from all previous months in the five-year period. We use the last estimated conditional standard deviation of each country pair as the approximation of the conditional volatility at the beginning of next period. For example, the conditional volatility of 1975 equals the estimated conditional standard deviation for December 1974 in the GARCH regressions.

We run the GARCH regressions on the monthly exchange rates for six five-year panels, with the first one being 1970-1974 and the last one being 1995-1999. In each five-year panel, exchange rate data are further grouped into three categories, those of developed country pairs, of developing country pairs, and of country pairs between developed and developing countries, which bring the total number of GARCH regressions to 15. To ensure that the estimated coefficients satisfy the stationarity conditions,[28] we exclude countries with hyper-inflation episodes and countries with extreme exchange rate fluctuations, defined as the change in the log exchange rate in absolute value in any month exceeding a threshold of 1, or $|[d\log(exrt)]_t| > 1$. The threshold amounts to a monthly appreciation over 170 percent or a monthly depreciation over 60 percent.[29] In addition, we require that in each panel the series

[28] The estimated coefficients of the regressions ensure that all time-varying variance ($\sigma^2{}_t$) processes are stable. Furthermore, the results of nine regressions satisfy the sufficient conditions that will guarantee the GARCH processes to be covariance stationary (see Greene 2000, p. 802).

[29] The following countries are excluded from all regressions: Angola, Argentina, Bolivia, Brazil, Nicaragua, Congo, Dem Rep of, Congo, Republic of, Armenia, Azerbaijan, Tajikistan, Ukraine, Turkmenistan, Yugoslavia, Israel, Chile, Mexico, Ghana, Uganda, Peru, Dominican Republic, Zambia, Honduras, Suriname, Iran, Sudan, Bulgaria, Lithuania,

(continued…)

length of the exchange rate for each country pair to be greater or equal than 30. This process renders 124 countries in total for the estimation sample, which we use throughout the study.[30]

B. Disaggregated Trade

For disaggregated trade, data on the value of bilateral imports for 98 industries are obtained from the United Nations' *COMTRADE* database and cover 39 (Appendix Table IV.9.) countries during the period from 1975 to 2000.[31] Import data are disaggregated at the SITC-4 level (rev. 1) and are deflated by US urban CPI (1982-1984 prices).

In classifying products into differentiated and homogenous varieties, we follow the strategy in Rauch (1999). Conceptually, Rauch first identifies two types of homogenous products: those traded on an organized exchange ("commodities"), and those whose prices are reported regularly in a professional trade publication ("referenced price products"). All other products are then defined as differentiated products. Rauch implemented the classification on SITC rev. 2 industries.

There were instances when the classification for a given product was ambiguous. Hence, Rauch produced two separate classification systems, one ("conservative aggregation", in his

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Romania, Nigeria. For regressions using 1995-1999 data, five more countries are excluded. These countries are: Sri Lanka, Indonesia, Belarus, Sierra Leone, Venezuela.

[30] Owing to missing data, the number of countries in the estimation samples for different years is less than 124.

[31] We thank M. Koren and A. Szeidl for sharing the disaggregated trade data set with us.

words) attributed all ambiguous products to the homogeneous category, and the other ("liberal aggregation") attributed all ambiguous products to the differentiated category. Rauch (1999) provides an appendix that lists the classification results of all SITC rev. 2 industries at the 4-digit level. We use a concordance from SITC rev1. to SITC rev. 2 (available from www.nber.org) and then apply the Rauch classification to our data. To minimize the impact of mis-classified products on our conclusions, we exclude all products whose classification is ambiguous and only work with those products whose degree of classification is relatively clear. That leaves 81 industries for which the classification is relatively unambiguous, 22 of them being classified as homogeneous and the remaining 59 as differentiated products. The classification lists are presented in Appendix Table IV.10.

To obtain the series for bilateral imports of homogeneous products, we sum sectoral import data across all sectors classified as homogeneous for a given country pair in a given year. Bilateral imports of differentiated products are constructed similarly. GDP and GDP per capita data are from the World Bank Indicators (WDI) database. All other variables are from our aggregate trade data set described above.

Appendix Table IV.1C presents some summary statistics on the two types of products in our sample over the years. As one can see, the total value of trade in differentiated products has been more than twice that of trade in homogeneous products in our sample. There is a modest increase in the share of trade in differentiated products in total trade in our sample, from 75 percent in 1975 to 83 percent in 2000.

III. KEY FINDINGS

The gravity model performs well empirically, yielding precise and generally reasonable estimates (Appendix Table IV.2), which are broadly consistent with the results of other papers employing a gravity model using trade data. The coefficient on distance is negative and statistically significant, ranging around -1.50 across the different variations of the model. The coefficient on the economic mass is positive and generally statistically significant, ranging from 0.83 in the model with time-varying fixed effects estimated on a sample excluding high-inflation countries, to 0.06 in the same model including such countries. The high sensitivity of the coefficient for the economic mass to the inclusion of high-inflation countries suggests that high-inflation episodes tend to distort economic relations between trade and other behavioral and policy variables, indirectly justifying the exclusion of such countries from the sample on which baseline regressions are estimated in this study.

Other control variables are also mostly significant and have the expected signs. For example, a common language, FTA membership, GSP preferences, being a colonizer and a colony, and the colonization by the same country all have a positive and statistically significant effect on trade. The role of some controls, however, is sensitive to the specification of the model. For example, the level of economic development, as measured by the real GDP per capita, has a positive and statistically significant effect on trade only in the model which includes high-inflation countries and time-varying country effects (Appendix Table IV.2, column 5). WTO membership is positive and statistically significant in most specifications, on balance suggesting that the WTO membership has a trade-enhancing effect over and above other factors.

A. The Effect of Exchange Rate Volatility on Trade - Main Results

Some benchmark results of using the gravity equation to estimate the effect of exchange rate variability on aggregate trade are given in Appendix Table IV.2. These equations use the standard measure of volatility, i.e., that of the long-run real *IFS* exchange rate, the coefficient of which is shown in the first row of the table.[32] As shown in column (1), which uses both time and country fixed effects, there is a statistically significant negative impact on the level of trade.[33] This impact can be computed as the effect of increasing volatility by one standard deviation around its mean, which implies a reduction in trade flows of almost 7 percent. [34] Employing this same specification but using the full sample of countries, as shown in column (4), the estimated reduction in trade generated by a one standard deviation increase in volatility generates a reduction in trade of somewhat over 9 percent.[35] These estimates are comparable to those found by other authors using the same methodology, e.g., Rose (2000), who estimates a reduction of 13 percent, and Tenreyro (2003) with estimates ranging from 4 –8 percent.

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[32] In the next table (Appendix Table IV.3) the effects of alternative measures of exchange rate variability are reported.

[33] This equation was also estimated without country fixed effects, and an F-test confirmed that the inclusion of such effects is warranted.

[34] This impact is computed as the estimated coefficient in the regression equation multiplied by one standard deviation of the volatility measure, multiplied by 100 to convert to percent.

[35] While the coefficient of volatility in this regression is about one half that in column (1), the standard deviation of volatility is over twice as large, as shown in Appendix Table IV.1, with the overall result being a somewhat bigger trade impact. Given that the larger sample includes countries with substantial exchange rate changes, this is not at all surprising.

An alternative specification is used in the results reported in column (2) of Appendix Table IV.2, where individual country fixed effects are replaced with country *pair* fixed effects. The main advantage of this approach is that it allows one to control for unobserved cultural, economic, historical, geographical and other factors which are specific to a given pair of countries.[36] Omitting such factors may bias the estimation results if they are correlated with other regressors in the model. An F-test indicates that the estimated coefficients for the country pair fixed effects are jointly significant. It turns out that there is very little effect on the coefficient of exchange rate volatility, which is essentially the same as in column (1) of the same table.[37]

However, the finding of a negative impact of exchange rate volatility is not evident in a more general specification in which country and time fixed effects are replaced with time-varying fixed effects. Allowing for time variation in country fixed effects is more consistent with the theoretical concept of "multilateral resistance" proposed by Anderson and van Wincoop (2003), as such multilateral resistance indices are likely to vary over time. Moreover, an F-test comparing the two specifications indicates that the latter is preferred on statistical grounds. As shown in Appendix Table IV.2 column (3), this modification of the model results in a positive estimated impact of exchange rate volatility on trade (but not significant at the 90 percent confidence level). Using the time-varying country effects approach for the

[36] In this specification, distance, land area, and other time-invariant bilateral variables become redundant in regressions with country pair fixed effects and therefore are excluded from the regression.

[37] However, as discussed below, this is not true for all of the other estimated coefficients, and in particular, for the dummy variable for a common currency union.

full sample, as reported in column (5), the estimated effect of volatility is negative and the same size as in column (4), but not statistically different from zero.

What may account for the difference in the results? One possible explanation runs as follows: time-varying country fixed effects in principle control for all unidentified country-specific time-varying factors, including the effective, i.e., overall exchange rate volatility for each of the trading partners in question. Indeed, when we include the measure of effective volatility (at the country as opposed to bilateral level) in the basic model with time-invariant country effects,[38] the coefficient on this measure of effective volatility is negative and statistically significant, while the coefficient on the bilateral measure of exchange rate volatility becomes positive and similar in magnitude to that in the model with time-varying fixed effects. This shows that the negative effect of the bilateral volatility on trade is not robust to controlling for broader aspects of exchange rate volatility, and more generally, for all aspects of multilateral resistance.

These benchmark results show that there is evidence of a negative effect of exchange rate volatility on the level of trade, but the magnitude of the estimated impact appears to be small. However, this finding is not robust to the choice of estimation technique. In particular, the negative effect disappears in a general model which controls for time-varying country-specific factors and is in line with the most recent theoretical work on the gravity model of trade. This disparity in the findings characterizes not only the results above using our benchmark measure of exchange rate volatility for aggregate trade, but also for the results

reported below that use alternative measures of volatility, that look at different country groupings and different types of traded goods, and that use alternative estimation techniques which attempt to control for the possibility that exchange rate volatility is not exogenous. Thus to anticipate our overall conclusion, while there is evidence that increased exchange rate variability reduces the volume of international trade, this finding depends on the particular estimation technique employed, so that it cannot be considered an overwhelmingly robust empirical result.

Alternative Measures of Volatility

The estimated impact of alternative measures of volatility on trade using time and individual country fixed effects are reported in Appendix Table IV.3. When we include in column (1) a measure of the short-run real exchange rate volatility in the model as the difference from the long-run real volatility,[39] we find that short-run volatility has an additional dampening effect on trade over and above the negative effect arising from the long-run volatility. The magnitude of this additional effect is about one half of the long-run volatility effect. This finding could be interpreted as indicating that trading firms form their expectations of the future exchange rate volatility based on both historical and contemporaneous volatility.

The volatility in the parallel market exchange rate has a broadly similar effect on trade as the volatility in the official, *IFS*-based exchange rate. Appendix Table IV.3, columns 2-3 report

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[38] See Appendix Table IV.5, column 4.

[39] Short-run volatility is not strongly correlated with long-run volatility in our sample: the correlation coefficient is 0.38.

regressions where the volatility measures based on the parallel market rates are included as differences from the *IFS*-based volatility measures, in addition to the official volatility measures. The coefficient on the long-run parallel market volatility is negative and statistically significant, about the same as the coefficient on the official exchange rate volatility in column 2, but about one third the size in column 3. However, in the short-run, the volatility of the parallel market exchange rate does not appear to affect trade.[40] These results suggest that parallel market rates are also relevant for trade transactions in addition to the official exchange rates.[41]

Given that nominal and real exchange rates are highly correlated, it is probably not too surprising that their volatilities have similar effects on trade. In Appendix Table IV.3, column 4, the coefficient on the nominal exchange rate volatility (–2.60) is close to that on the real exchange rate volatility (–2.37) in Appendix Table IV.2, column 1.

[40] When the alternative measures of exchange rate volatility are included as separate regressors in the gravity equation, the estimated coefficients are similar to those reported above and are statistically significant, except for the volatility of the short-run parallel rate.

[41] It is also worth noting that the *IFS*-based exchange rates we use in the benchmark regressions are not only official rates but also include market and principal rates. The exchange rates in *IFS* are classified into three broad categories, reflecting the role of the authorities in the determination of the exchange rates and/or the multiplicity of exchange rates in a country. The market rate is used to describe exchange rates determined largely by market forces: the official rate is used to describe an exchange rate determined by the authorities, sometimes in a flexible manner. For countries maintaining multiple exchange arrangements, the rates are labeled principal rate, secondary rate, and tertiary rate. The official rate is included in the series only if neither the market nor principal rate is available. The *IFS*-based measures are thus reasonably well correlated with parallel market rates, with the coefficient of correlation of 0.65.

So far we have considered a simple statistical measure of exchange rate volatility. We now replace it with a conditional measure of exchange rate volatility as estimated from a GARCH model (Appendix Table IV.3, column 5). The coefficient of the conditional volatility measure is virtually identical to that of the unconditional measure (–2.20 versus –2.37). Irrespective of whether one assumes that trading firms condition their expectations on the available historical information (GARCH) or that they project volatility using a simple statistical approach, exchange rate volatility has a statistically significant negative effect on trade, of a broadly similar magnitude. In terms of the impact of exchange rate volatility on the level of trade, the estimates are comparable to those discussed above in connection with the benchmark results. They range from a low of about 5 percent for the GARCH estimate of volatility (column 5), to 25 percent for the combined effect of short- and long-run real official volatilities.

These results using various measures of exchange rate volatility are broadly robust to an alternative model specification where country fixed effects are replaced with country *pair* effects (Appendix Table IV.4). The estimated coefficient of volatility is consistently negative, in nearly all cases statistically significant, and tends to be somewhat higher.[42] As a consequence, the impact of higher exchange rate volatility on trade is also larger, ranging from a reduction of 8 percent for the long-run nominal exchange rate, to a decline of 26 percent for the combined impact of short- and long-run real official rates.

However, when country fixed effects and time effects are replaced with time-varying country effects (Appendix Table IV.5), this modification of the model reverses the impact of our standard measures of bilateral exchange rate volatility on trade in the long and short run – it becomes positive and statistically significant – and the effect of the parallel market volatility becomes insignificant. This lack of robustness to alternative specifications is in line with that discussed above in connection with the results for the benchmark measure of volatility. With this particular model, increased exchange rate variability now has an estimated *positive* impact on trade, ranging from 10 percent (column 4) to 34 percent (column 3).

However, it should be noted that the equation results reported in column (4) of Appendix Table IV.5 include the effective or overall exchange rate volatility of a country that is used in Part III. As bilateral trade flows are the dependent variable, the sum of the effective volatilities of the country pairs is used as the regressor. The idea in this specification is to examine the effect of bilateral exchange rate volatility *relative to* the aggregate measure of volatility, which is a component of "multilateral resistance" to trade mentioned above. One would expect that an increase in the variability of the bilateral exchange rate between two countries would have a negative effect on their bilateral trade, and that an increase in the variability of all other exchange rates would tend to raise trade between the two countries in question, as such trade would become relatively less risky. In fact, the empirical results are counter to this expectation. Nonetheless, the net impact of a one standard deviation increase in volatility is a reduction in trade of about 13 percent, as the

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[42] Again, when the alternative measures of volatility are entered in the equation by themselves, the coefficients are similar to those reported in Appendix Table IV.4 and are

(continued…)

negative effect of the higher effective volatility more than offsets the positive effect of the rise in bilateral volatility.[43]

Controlling for Endogeneity of Exchange Rate Volatility

So far we have assumed that exchange rate volatility is exogenous to trade. This assumption, however, may not be warranted: to the extent that countries implement policies aimed to lower exchange rate volatility in order to increase their trade, the baseline equation would suffer from endogeneity bias. We control for this possibility using two instrumental variable (IV) approaches:[44] (i) that proposed by Frankel and Wei (1993), whereby the volatility in the relative quantity of money is an instrumental variable for exchange rate volatility, and (ii) that proposed by Tenreyro (2003) which relates exchange rate volatility to the incidence and the propensity of countries' to share a common anchor.[45] Neither of these instruments is perfect, but each has its advantages: the Frankel-Wei approach is simple and easy to

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statistically significant.

[43] In estimating the equation in column (4), country fixed effects are included in the model instead of time-varying country effects, on the assumption that the impact of effective volatility would be largely absorbed by the time-varying country dummies. However, when this same equation was estimated with time-varying country effects instead of the time and fixed country effects used in column (4), the results were very similar, with a significant negative impact on trade somewhat higher at 19 percent.

[44] The third alternative instrumental variable approach, based on Devereaux and Lane (2002), combines the factors underlying the optimal currency area theory with the factors underlying financial links to explain the volatility of the bilateral exchange rate for trading partners. While appealing conceptually, this approach is highly data intensive and was not implemented due to data unavailability.

[45] We thank S. Tenreyro for sharing her data on the dummy variable for countries' sharing a common anchor.

implement, while that of Tenreyro's instrumental variable (IV) appeals to the modern optimal currency framework of Alesina, Barro, and Tenreyro (2002).

Controlling for endogeneity using the Frankel-Wei instrumental-variable approach (Appendix Table IV.6A) modifies the basic results of the role of exchange rate volatility. While the coefficient on exchange rate volatility remains negative in every specification, it is statistically significant only in the equation with country and time effects for both real and nominal exchange rates. In these two cases, the estimated coefficients are much larger than those reported above. The negative trade effects are also considerably larger: about 90 percent for the real rate and 125 percent for the nominal exchange rate, which seem implausible compared to the findings described above.

The results using the Tenreyro instrumental variable approach are reported in Appendix Tables IV.6.B and IV.6.C. When the IV is the dummy for a common anchor, the coefficients on the exchange rate volatility measure become statistically insignificant across all specifications. When the propensity to share a common anchor is used as an IV, these coefficients are negative in all specifications, and statistically significant in the specifications with both country and time fixed effects and with time-varying fixed effects. In both cases the estimated coefficients are extremely large, implying reductions in trade ranging from 115 percent to 265 percent (column 1) for a one standard deviation increase in volatility. These are far beyond any other estimates in this paper or in the literature, and as such should probably be viewed as outliers.

Several reasons may account for differences in the magnitude and sign of our coefficients on the volatility measure and those obtained by Tenreyro (2003). The most important one is that in Tenreyro's regressions volatility appears as log(1 + standard deviation of the exchange rate) whereas our regressions include just the volatility or the standard deviation of the exchange rate for consistency with our benchmark OLS estimations and IV regressions *a la* Frankel and Wei (1993). Our specification differs from Tenreyro (2003) in other respects as well: (i) we include the common language and border dummies, which we find significant, in the logit regressions estimating the propensity to adopt a common anchor; (ii) we control for whether the trading partners are related as a colony and a colonizer, as well as the WTO membership, common colonizer, and for whether the trading partners are island economies, and (iii) we use trade between the two countries rather than just bilateral exports as the left-hand side variable.

Differentiation Across Country Groups

Across countries, we find that the impact of exchange rate volatility on trade is not uniform. In particular, volatile exchange rates appear to be more damaging for trade among developing countries than for trade among advanced economies. As shown in Appendix Table IV.7, column 1, the coefficients on the exchange rate volatility measures interacted with dummies for trade among advanced and developing countries (denoted by *NS*) and among developing countries (denoted by *SS*) are negative and statistically significant; their net magnitude is –2.23 and –3.22, respectively. This is consistent with the possibility that developing countries are less able to manage currency risks. Foreign exchange markets are typically nascent and less liquid in developing countries, limiting

firms' opportunities for hedging foreign exchange risk. However, with time-varying fixed effects, shown in column (2), there is essentially no impact of volatility on trade flows among NS and SS.

B. Do Members of Currency Unions Trade More?

Our main results confirm Rose's (2000) remarkable finding that common currency arrangements triple trade (Appendix Table IV.2, column 1), as the coefficient on the currency union dummy is comparable to that found in his paper. The trade-enhancing benefits of currency unions appear to exceed by far the gains from a substantial reduction in exchange rate volatility, although as discussed above, the IV estimation results also indicate a very large benefit in trade gains arising from a decline in volatility.

However, while the trade-enhancing effect of a common currency is robust to controlling for time-varying fixed effects (Appendix Table IV.5, columns (1) and (5)), it breaks down in a model with country-pair fixed effects (Appendix Table IV.2, columns 2 and Appendix Table IV.5, columns 1, 4, and 5), in line with the findings in Pakko and Wall (2001). The statistical insignificance of the currency union dummy in the model with country pair effects (which Rose (2002) did not utilize in his analysis) suggests that the trade-enhancing effect of a common currency found in specifications omitting country pair effects reflects an estimation bias, as the omitted factors apparently are correlated with trade volume and with the likelihood that countries use a common currency (for example, common history or institutional and regulatory similarities between countries members in the currency union). Of course, currency unions are country-pair characteristics, which evolve slowly over time. It

thus appears that the power of the test for an effect of currency unions on trade becomes much weaker when country-pair fixed effects are included.

Moreover, the beneficial effect of a common currency on trade is also not uniform across country groupings, as it appears to be limited to currency unions between developing countries. When the currency union dummy is interacted with the dummy for the developing country pairs, the coefficient on this product term is positive and significant, while the general currency union dummy becomes negative and statistically significant, suggesting that currency unions other than between developing countries impair trade between them (Appendix Table IV.7, columns 1 and 2). This result suggests that currency unions may have a large positive impact on trade only in cases where transaction costs are high, where policy credibility problems are acute, or where hedging opportunities are limited.

C. Disaggregated Trade: Does Exchange Rate Volatility Have a Different Effect on Trade in Differentiated versus Homogeneous Products?

The finding that the negative effect of exchange rate volatility on trade is not robust also carries over when we look at disaggregated trade. As discussed in the text, recent development in the economics of trade suggests that a given increase in transaction costs (of which exchange rate volatility is a component) could have a larger, negative effect on trade in differentiated products than on trade in homogenous products. We examine the evidence for this possibility in this sub-section.

In the first specification (reported in the first two columns of Appendix Table IV.8), we estimate a system of two equations by the Seemingly Unrelated Regression (SUR) technique with time and country fixed effects. In this case, the coefficients on exchange rate volatility are negative in both equations, the volatility effect is statistically significant only in the equation on trade in differentiated products. In other words, consistent with the conjecture above, exchange rate volatility has a negative effect on trade in differentiated products, but not on trade in homogenous products. However, this conclusion is not robust. In the last two columns of Appendix Table IV.8, when we include time-varying country fixed effects (which are more general than the inclusion of a combination of time and country fixed effects and are dictated by the recent theory underlying the gravity specification used here), the conclusion is overturned. More precisely, the coefficients on exchange rate volatility are not statistically different from zero for trade both in differentiated and in homogenous products. As extensions, we have also examined the effects of short-run exchange rate volatility and volatility of parallel market exchange rate, the results are qualitatively the same as described above.

Thus, the overall conclusion on disaggregated trade is the same as that for aggregated trade, namely, the evidence is not overwhelmingly robust that exchange rate volatility has a negative effect on trade. Using an array of alternative formulations involving different measures of exchange rate volatility, estimation techniques, different country groupings and disaggregation by type of product, one does find fairly systematic evidence of a negative effect of volatility on trade. However, once one takes into account other factors that would affect trade in a more general model involving the time-varying “multilateral resistance” as

emphasized by recent trade theory, this negative effect disappears. Thus whether one finds evidence that exchange rate volatility depresses the volume of trade, and in particular, has a larger negative effect on differentiated than homogeneous products, depends on the particular methodology that is employed in the estimation.

Table 3.1A Short-Run Effective Volatility of Real I.F.S. Exchange Rates in G-7 Countries by Major Country Groups: Decomposition of Volatility

Country	Year	Advanced Economies	Transition Economies	Emerging Economies	Rest Countries of the World	Total Effective Volatility
United States	1970	0.616	0.005	1.808	0.101	2.529
United States	1980	1.751	0.021	0.364	0.321	2.457
United States	1990	1.397	0.045	0.648	0.283	2.372
United States	2000	1.385	0.028	0.811	0.111	2.335
United Kingdom	1970	0.602	0.006	0.321	0.176	1.105
United Kingdom	1980	1.957	0.029	0.251	0.415	2.651
United Kingdom	1990	1.827	0.061	0.301	0.208	2.396
United Kingdom	2000	2.569	0.085	0.334	0.132	3.119
France	1970	0.427	0.008	0.263	0.200	0.899
France	1980	1.213	0.049	0.239	0.520	2.020
France	1990	0.951	0.109	0.254	0.244	1.558
France	2000	0.998	0.090	0.302	0.224	1.614
Germany	1970	0.523	0.022	0.360	0.115	1.019
Germany	1980	1.353	0.143	0.347	0.365	2.209
Germany	1990	0.964	0.283	0.347	0.130	1.724
Germany	2000	1.102	0.228	0.401	0.117	1.847
Italy	1970	0.624	0.044	0.407	0.180	1.255
Italy	1980	1.355	0.136	0.355	0.575	2.421
Italy	1990	0.950	0.258	0.361	0.334	1.903
Italy	2000	0.908	0.218	0.386	0.260	1.772
Canada	1970	1.144	0.002	0.261	0.041	1.448
Canada	1980	1.706	0.006	0.140	0.090	1.943
Canada	1990	1.384	0.022	0.199	0.054	1.660
Canada	2000	1.443	0.008	0.197	0.039	1.687
Japan	1970	0.663	0.002	1.315	0.170	2.150
Japan	1980	1.885	0.009	1.173	0.898	3.966
Japan	1990	2.354	0.029	1.343	0.351	4.077
Japan	2000	1.789	0.036	1.465	0.229	3.519

Table 3.1B Short-Run Effective Volatility of Real I.F.S. Exchange Rates in G-7 Countries by Major Country Groups: Volatility within Groups

Country	Year	Advanced Economies	Transition Economies	Emerging Economies	Rest Countries of the World	Total Effective Volatility
United States	1970	0.806	1.358	11.589	1.318	2.529
United States	1980	2.913	6.231	1.565	1.972	2.457
United States	1990	2.134	11.444	2.409	3.882	2.372
United States	2000	2.478	2.346	2.236	1.670	2.335
United Kingdom	1970	0.767	1.200	3.286	1.570	1.105
United Kingdom	1980	2.442	6.656	3.739	3.256	2.651
United Kingdom	1990	2.137	8.954	3.660	3.709	2.396
United Kingdom	2000	3.162	3.079	2.909	2.905	3.119
France	1970	0.496	1.525	6.524	2.164	0.899
France	1980	1.571	7.338	4.467	3.094	2.020
France	1990	1.130	10.462	4.268	2.764	1.558
France	2000	1.220	2.444	3.979	3.237	1.614
Germany	1970	0.606	1.414	5.756	1.921	1.019
Germany	1980	1.644	7.666	5.095	4.048	2.209
Germany	1990	1.141	8.243	4.228	3.331	1.724
Germany	2000	1.453	2.059	3.938	3.989	1.847
Italy	1970	0.758	1.574	6.205	2.169	1.255
Italy	1980	1.786	7.381	4.836	3.844	2.421
Italy	1990	1.152	8.950	4.969	4.532	1.903
Italy	2000	1.220	2.516	3.893	3.721	1.772
Canada	1970	1.224	2.058	6.704	1.622	1.448
Canada	1980	1.907	6.210	2.208	2.215	1.943
Canada	1990	1.514	14.301	3.018	3.009	1.660
Canada	2000	1.597	2.342	2.496	2.721	1.687
Japan	1970	0.988	1.680	5.766	1.699	2.150
Japan	1980	3.748	6.892	4.227	4.119	3.966
Japan	1990	3.852	10.566	4.320	4.663	4.077
Japan	2000	3.502	3.389	3.552	3.455	3.519

Table 3.2 Average Effective Volatility Ranking (1970-2002)

Advanced (Avg =2.42)		**Emerging (Avg =4.43)**		**Other (Avg = 4.59)**	
Top 5 (Avg = 3.21)		Top 5 (Avg = 6.70)		Top 5 (Avg = 16.05)	
Japan	3.50	Argentina	9.36	Angola	27.32
Israel	3.48	Chile	6.52	Zambia	15.59
Australia	3.23	Mexico	5.92	Nicaragua	13.51
New Zealand	3.03	Peru	5.89	Congo, Dem. Rep. of	13.07
United Kingdom	2.81	Uruguay	5.80	Uganda	10.77
Bottom 5 (Avg = 1.78)		Bottom 5 (Avg = 2.33)		Bottom 5 (Avg = 1.30)	
Austria	1.64	Panama	1.89	Réunion	1.08
Canada	1.76	Singapore	2.17	Martinique	1.20
Bel_Lux	1.77	China,P.R.:Hong Kong	2.38	Aruba	1.33
Netherlands	1.81	Malaysia	2.40	Guiana, French	1.34
Denmark	1.91	Thailand	2.80	China,P.R.:Macao	1.55

Sub-Sahara (Avg = 5.89)		**Developing Asia (Avg = 3.66)**		**Middle-East andTurkey (Avg = 4.28)**		**Western Hemisphere (Avg = 4.54)**		**Fuel Export (Avg = 6.18)**		**Nonfuel Export (Avg = 6.15)**	
Top 5 (Avg = 15.46)		Top 5 (Avg = 5.44)		Top 5 (Avg = 6.65)		Top 5 (Avg = 9.55)		Top 5 (Avg = 11.25)		Top 5 (Avg = 11.65)	
Angola	27.32	Afghanistan, I.S. of	6.82	Iran, I.R. of	8.39	Nicaragua	13.51	Angola	27.32	Zambia	15.59
Zambia	15.59	Maldives	5.73	Lebanon	8.27	Bolivia	10.26	Iran, I.R. of	8.39	Congo, Dem. Rep. of	13.07
Congo, Dem. Rep. o	13.07	Lao People's Dem.Rep	5.43	Yemen, Republic of	6.07	Argentina	9.36	Equatorial Guinea	7.86	Uganda	10.77
Uganda	10.77	Indonesia	4.87	Syrian Arab Republic	5.48	Suriname	8.11	Nigeria	6.61	Bolivia	10.26
Sudan	10.53	Sri Lanka	4.37	Turkey	5.04	Chile	6.52	Yemen, Republic of	6.07	Ghana	8.56
Bottom 5 (Avg = 2.60)		Bottom 5 (Avg = 2.43)		Bottom 5 (Avg = 2.46)		Bottom 5 (Avg = 2.11)		Bottom 5 (Avg = 2.67)		Bottom 5 (Avg = 2.90)	
Mali	2.16	Tonga	2.19	Malta	2.15	Panama	1.89	Bahrain, Kingdom of	2.22	Mali	2.16
Liberia	2.63	Bangladesh	2.23	Bahrain, Kingdom of	2.22	Netherlands Antilles	2.13	Kuwait	2.51	Liberia	2.63
Cape Verde	2.72	Malaysia	2.40	Kuwait	2.51	Bahamas, The	2.14	Saudi Arabia	2.58	Solomon Islands	3.10
Mauritius	2.72	Fiji	2.55	Saudi Arabia	2.58	Barbados	2.14	Oman	2.93	Guyana	3.30
Cameroon	2.75	Thailand	2.80	Yemen, P.D. Rep.	2.85	Dominica	2.24	Gabon	3.13	Côte d'Ivoire	3.31

Table 3.3 Frequency Counting (f) for Top 5 (High Vol) and Bottom 5 (Low Vol) Lists (1970-2002)

Advanced		Emerging		Developing Countries	
Frequency in Top 5		Frequency in Top 5		Frequency in Top 5	
Japan	28	Argentina	21	Congo, Dem. Rep. of	17
Australia	21	Uruguay	21	Sudan	13
Israel	18	Turkey	14	Angola	9
New Zealand	16	Chile	14	Bolivia	9
United Kingdom	15	Indonesia	13	Ghana	8
Frequency in Bottom 5		Frequency in Bottom 5		Frequency in Bottom 5	
Austria	28	Panama	22	Martinique	25
Bel_Lux	28	Singapore	21	Guiana, French	22
Canada	19	Malaysia	18	Réunion	20
Netherlands	17	Venezuela, Rep. Bol.	18	Netherlands Antilles	14
Denmark	13	Mexico	17	Bahamas, The	9

Sub-Sahara		Developing Asia		Middle East and Turkey		Western Hemisphere		Fuel-Export		Nonfuel-Export	
Frequency in Top 5		Frequency in Top 5		Frequency in Top 5		Frequency in Top 5		Frequency in Top 5		Frequency in Top 5	
Congo, Dem. Rep. of	23	Sri Lanka	22	Turkey	30	Argentina	19	Nigeria	25	Congo, Dem. Rep. of	24
Sudan	21	Myanmar	21	Syrian Arab Republic	29	Paraguay	15	Iran, I.R. of	20	Bolivia	12
Ghana	11	Pakistan	19	Egypt	24	Chile	14	Algeria	19	Ghana	12
Angola	10	Samoa	17	Iran, I.R. of	19	Haiti	11	Venezuela, Rep. Bol.	16	Sierra Leone	11
Uganda	9	Indonesia	16	Jordan	17	Bolivia	11	Angola	12	Burkina Faso	11
Frequency in Bottom 5		Frequency in Bottom 5		Frequency in Bottom 5		Frequency in Bottom 5		Frequency in Bottom 5		Frequency in Bottom 5	
Cameroon	24	Malaysia	28	Malta	32	Netherlands Antilles	20	Kuwait	25	Côte d'Ivoire	19
Gabon	16	Thailand	23	Bahrain, Kingdom of	26	Panama	16	Bahrain, Kingdom of	24	Rwanda	17
Côte d'Ivoire	13	Fiji	22	Kuwait	23	Bahamas, The	13	Gabon	23	Togo	15
Madagascar	12	Philippines	13	Saudi Arabia	21	Mexico	13	Venezuela, Rep. Bol.	22	Liberia	15
Mauritius	12	Samoa	12	Egypt	12	Trinidad and Tobago	12	Saudi Arabia	21	Bolivia	15

Table 3.4. Real Effective Volatility Across Country Groups by Type of Exchange Rate Regime

OFFICIAL IMF CLASSIFICATION /1

Country Groups	Peg	Limited Flexibility	Managed Floating	Freely Floating
Advanced	2.14	2.07	2.81	2.94
Emerging	3.74	2.28	4.30	6.90
Transition	5.73		4.56	6.37
Developing	4.35	2.94	4.95	6.47

NATURAL CLASSIFICATION /2

Country Groups	Peg	Limited Flexibility	Managed Floating	Freely Floating	Freely Falling
Advanced	1.81	2.37	2.81	3.09	4.76
Emerging	2.98	2.81	4.02	4.66	8.31
Transition	3.75	3.11	3.48	11.15	9.95
Developing	3.28	3.16	4.53	5.26	13.47

Note: Based on a sample of 150 countries for the period 1970-2001.
1/ Based on the IMF's annual publication *Exchange Arrangements and Exchange Restrictions*
2/ Based on Reinhart and Rogoff (2003)

Table 3.5. Real Effective Volatility Across Regimes and Time

OFFICIAL IMF CLASSIFICATION /1

	1970-1980	1981-1990	1991-2001	1970-2001
Peg	**3.12**	**4.96**	**4.11**	**3.99**
Limited Flexibility	**2.13**	**2.20**	**2.13**	**2.15**
Managed Floating	**4.93**	**4.75**	**4.18**	**4.43**
Freely Floating	**3.05**	**6.95**	**5.01**	**5.22**

NATURAL CLASSIFICATION /2

	1970-1980	1981-1990	1991-2001	1970-2001
Peg	**2.80**	**3.17**	**3.03**	**2.98**
Limited Flexibility	**2.58**	**2.97**	**2.88**	**2.83**
Managed Floating	**3.48**	**4.27**	**4.16**	**4.02**
Freely Floating	**3.32**	**4.11**	**4.64**	**4.26**
Freely Falling	**7.99**	**13.04**	**9.31**	**10.56**

Note: Based on a sample of 150 countries for the period 1970-2001.
1/ Based on the IMF's annual publication *Exchange Arrangements and Exchange Restrictions*
2/ Based on Reinhart and Rogoff (2003)

Figure 3.1 Short-Run Effective Volatility of the Real Exchange Rate by Country Groups, 1970-2002

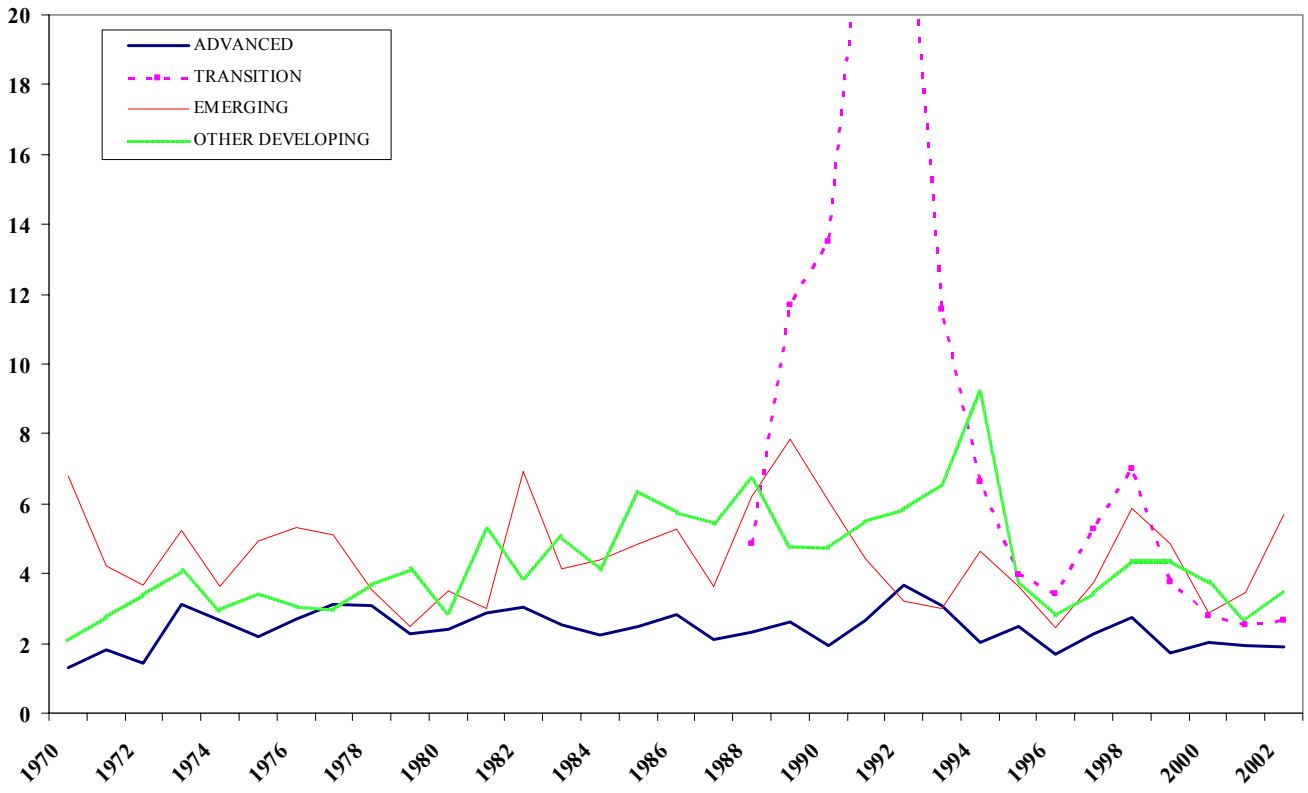


Figure 3.2 Short-Run Effective Volatility of the Real Exchange Rate for the G-7 Countries

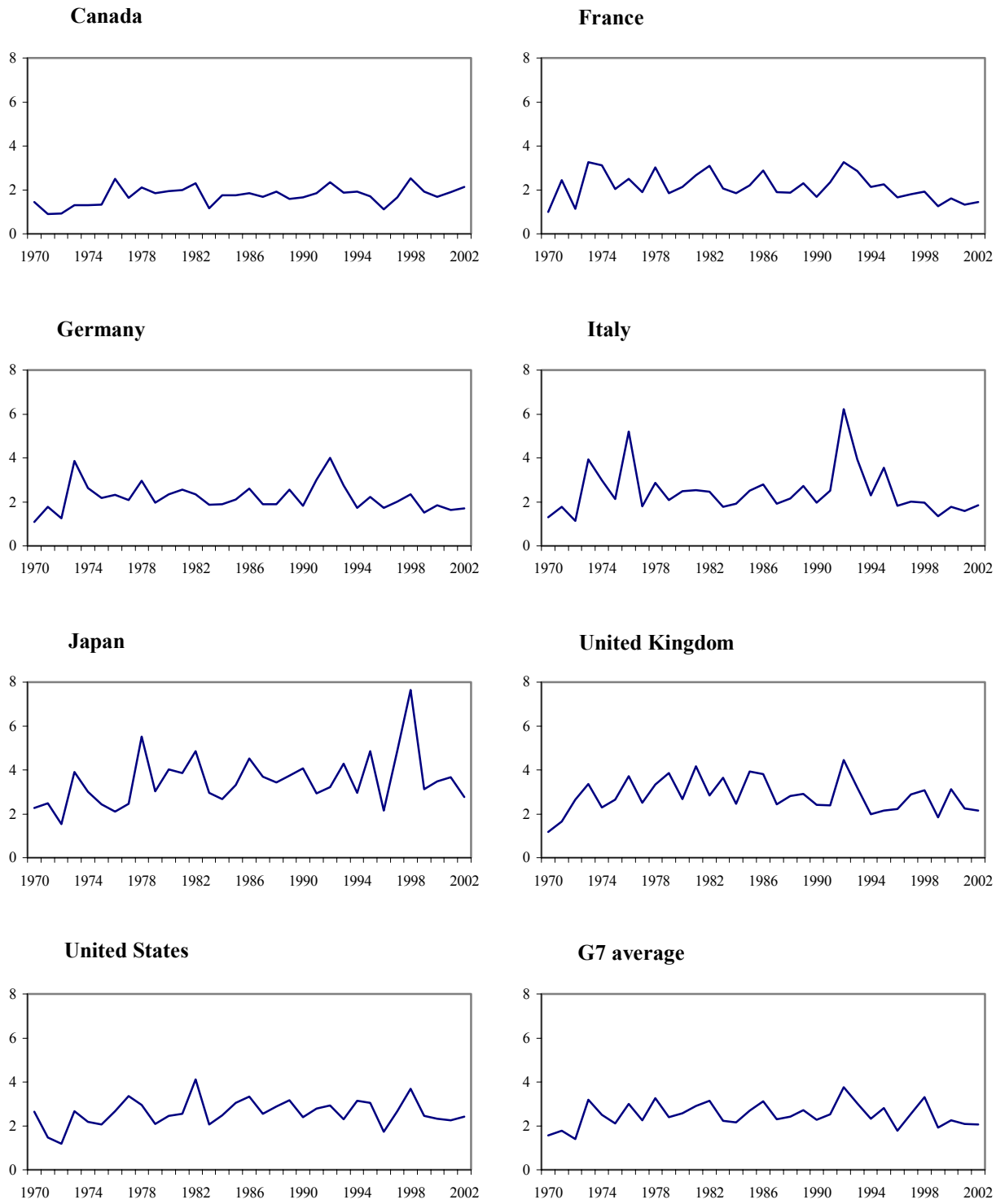


Figure 3.3 Short-Run Effective Volatility of the Real Exchange Rate in Developing Countries Grouped by Geographic Region

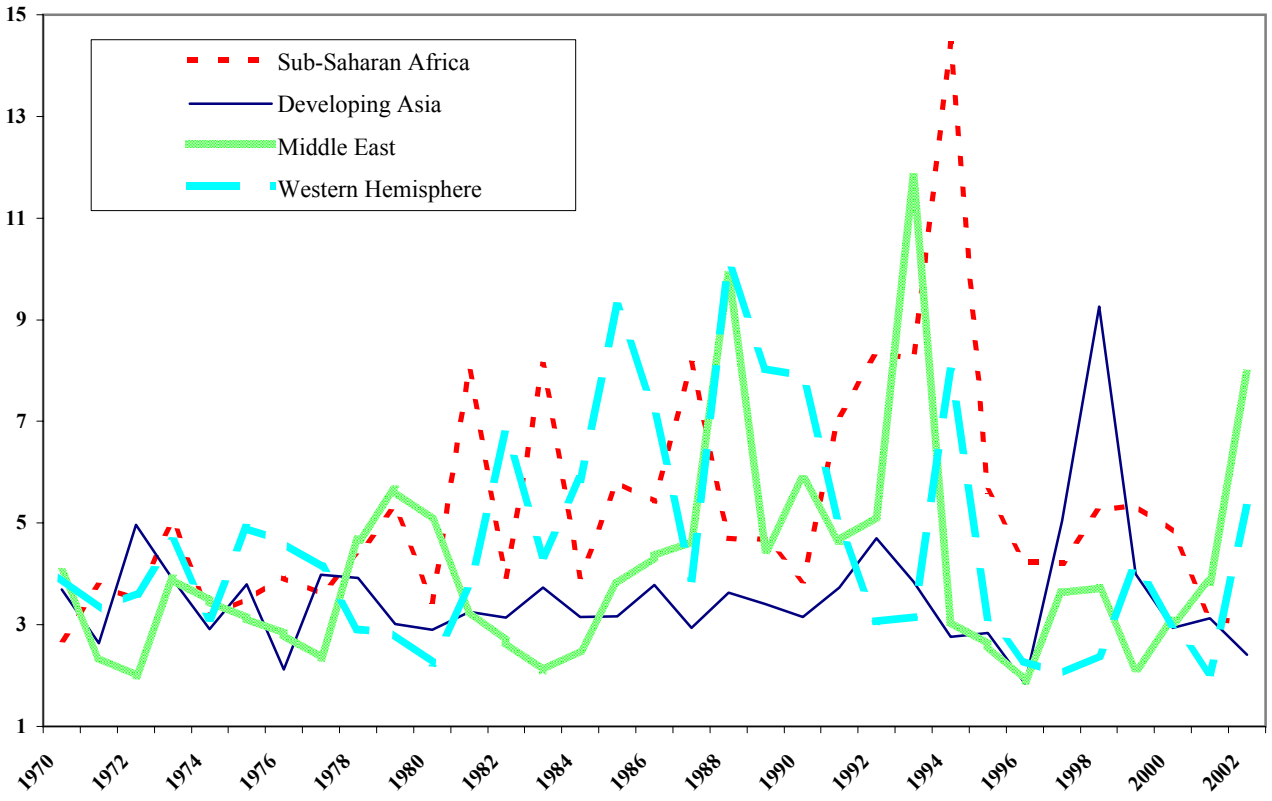


Figure 3.4 Short-Run Effective Volatility of the Real Exchange Rate in Two Developing Country Groups by Source of Export Earnings

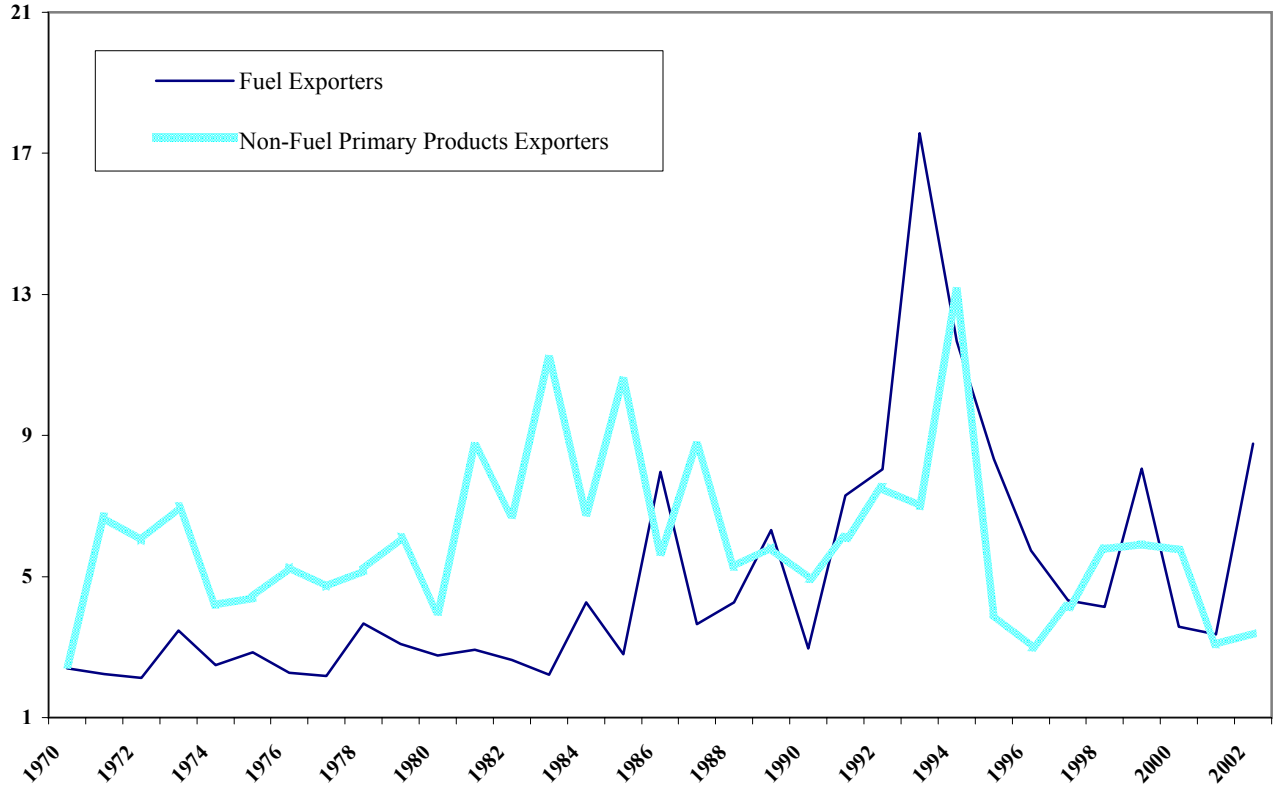


Figure 3.5 Short-Run Effective Volatility of the Nominal Exchange Rate by Major Country Groups 1970-2002

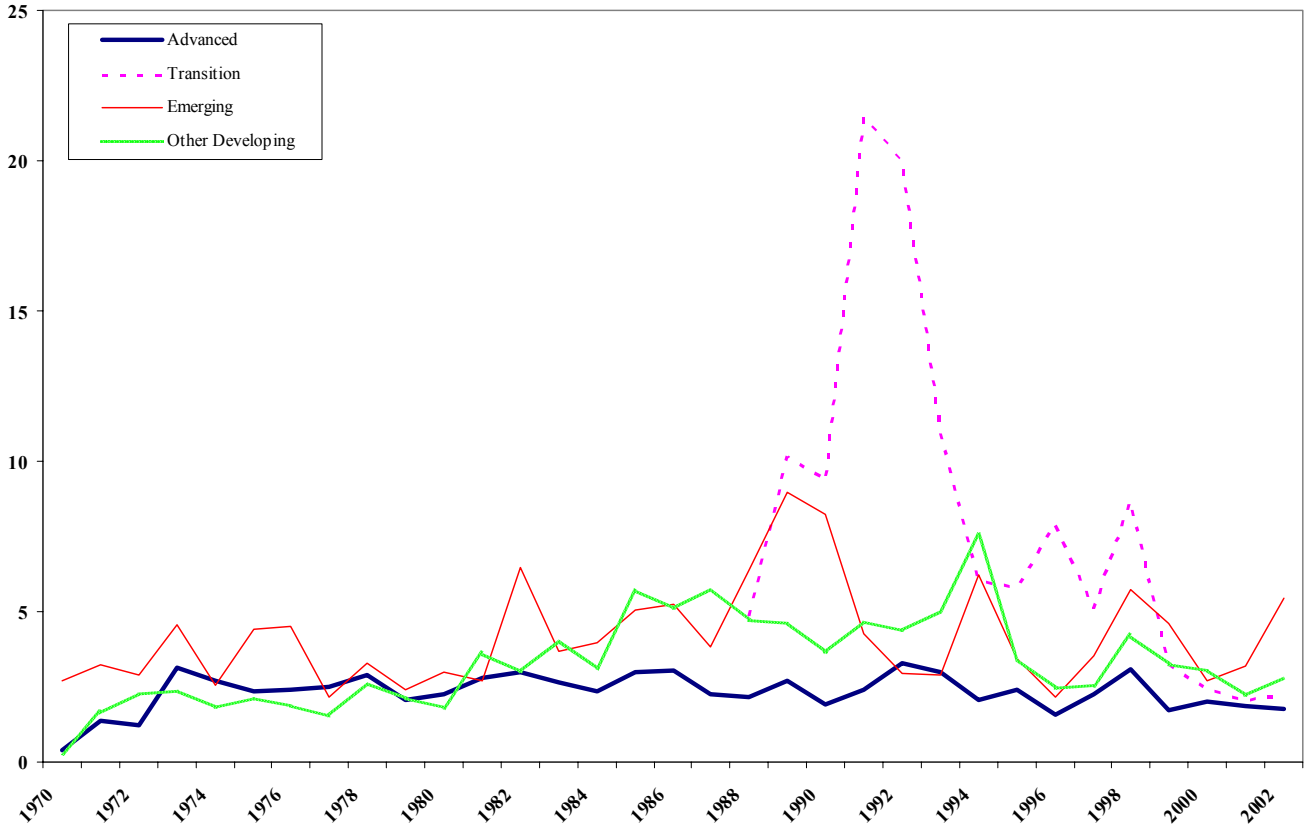


Figure 3.6 Long-Run Effective Volatility of the Real Exchange Rate by Major Country Groups

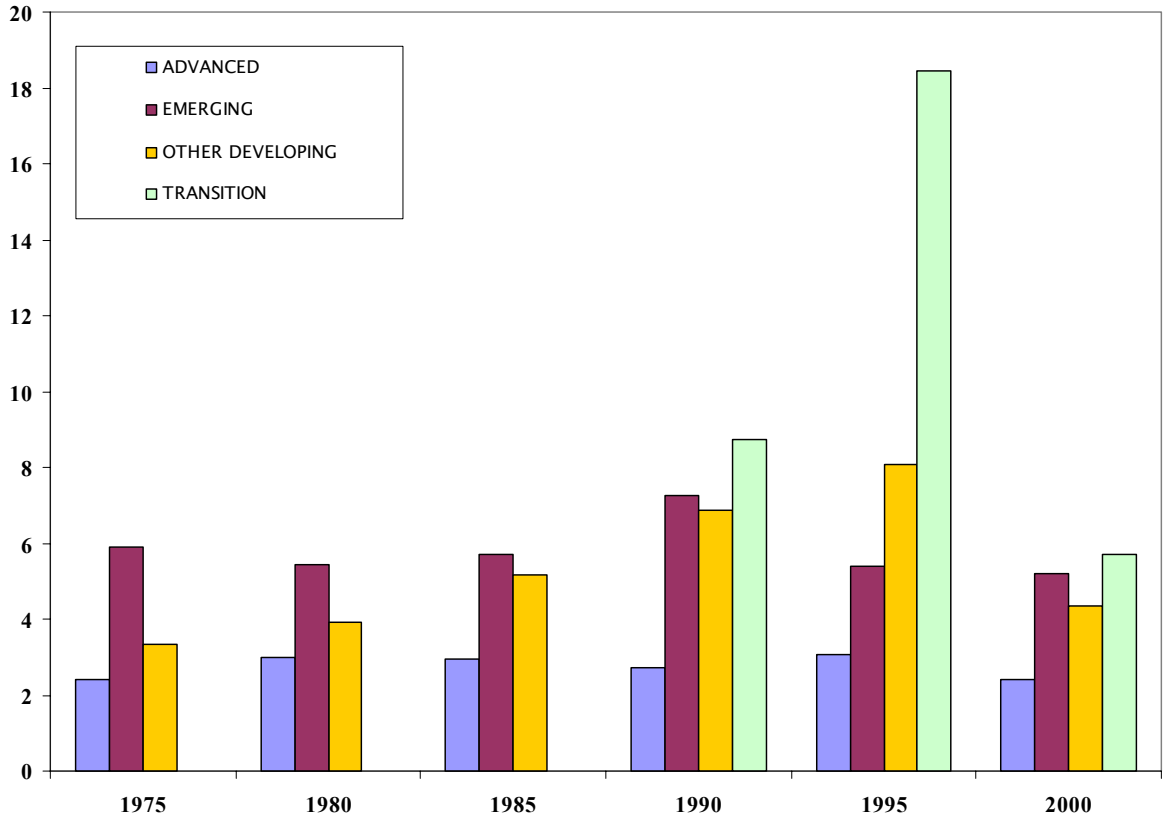


Figure 3.7 Long-Run Effective Conditional Volatility of the Real Exchange Rate by Major Country Groups

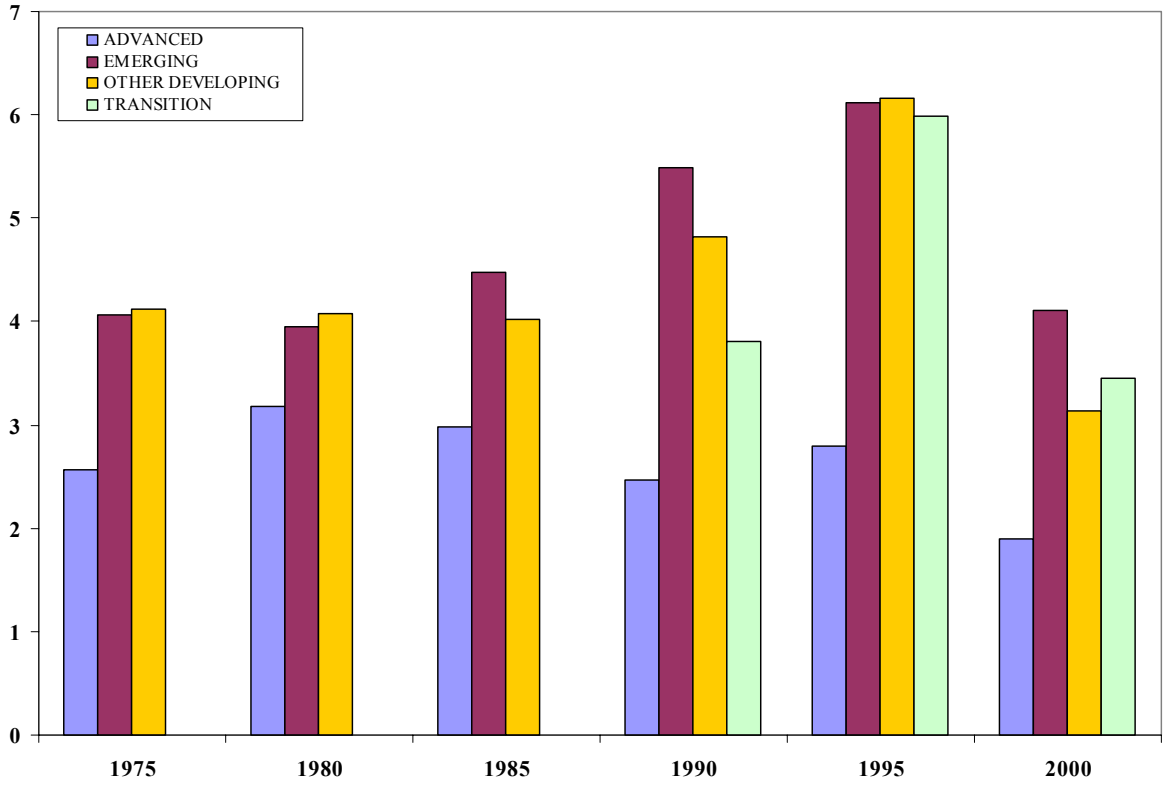


Figure 3.8 Long-Run Effective Volatility of the Real Exchange Rate in the G-7 Countries

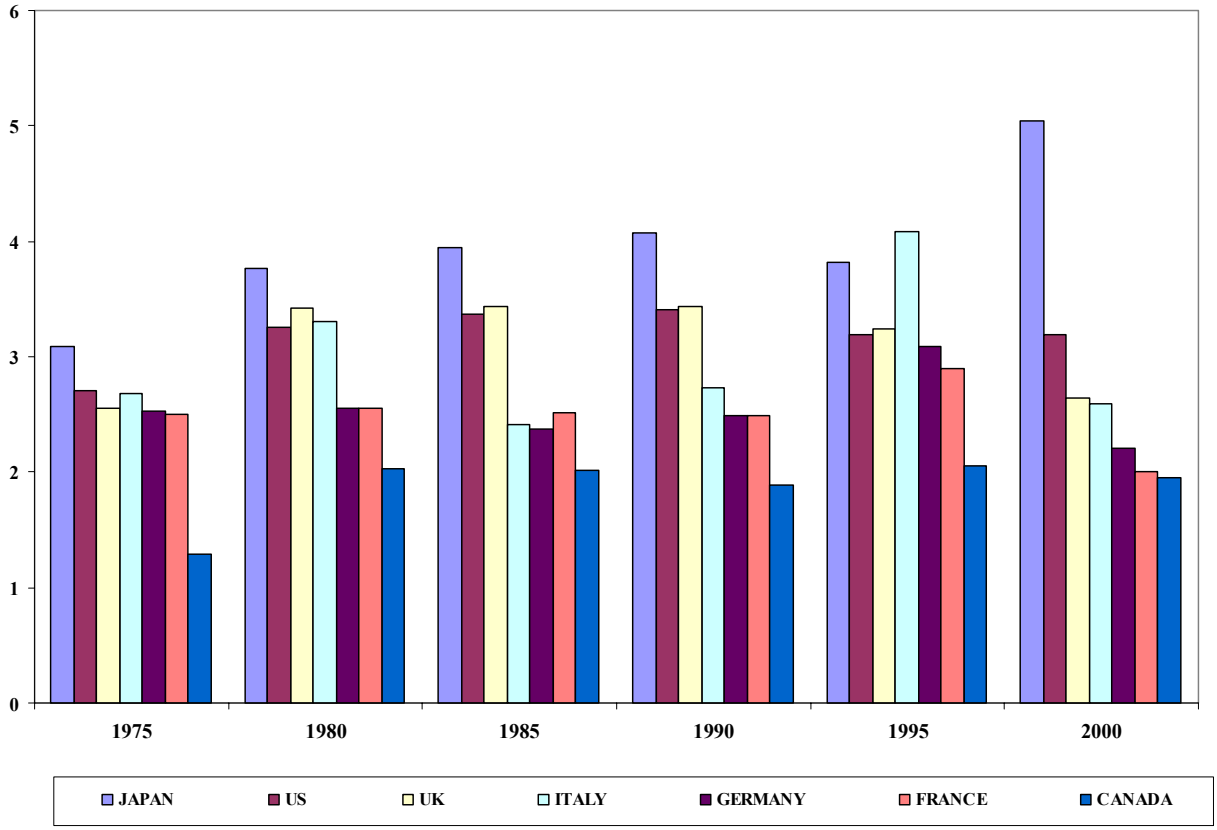
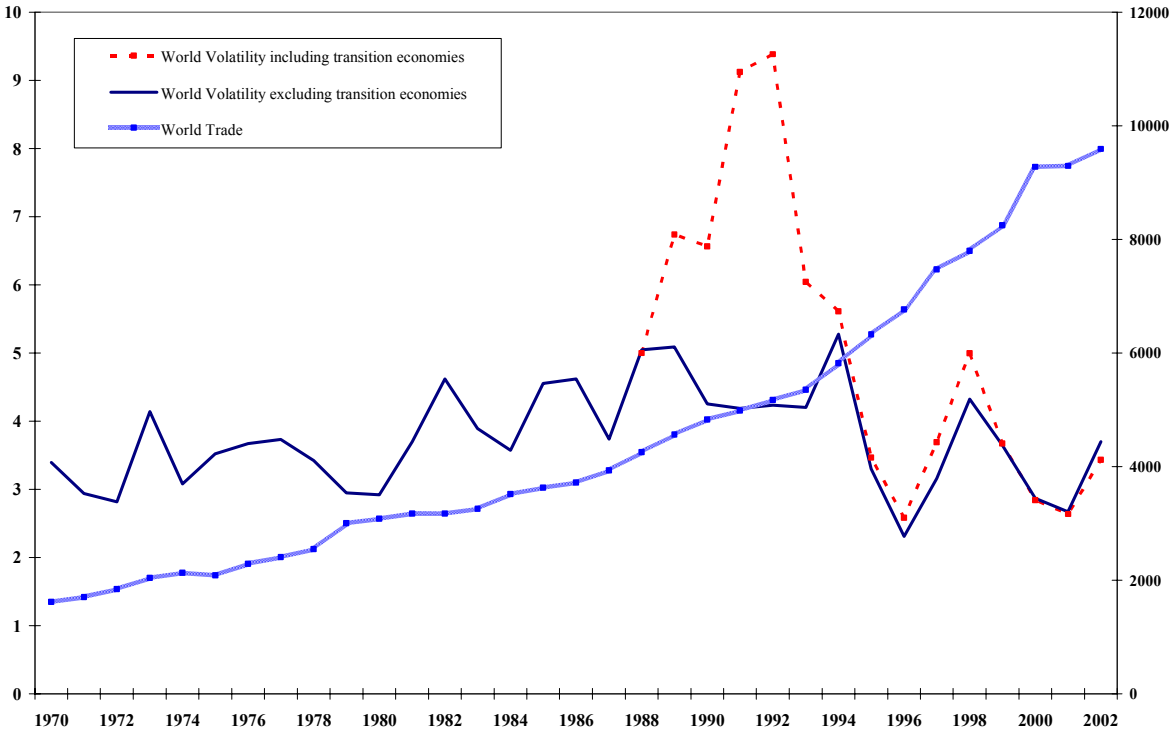


Figure 4.1 Effective Volatility of the Real Exchange Rate and World Trade



Note: World trade is measured as the average of the volume of world exports and imports in billions of 1995 US dollars (right) scale. Volatility is measures as the unweighted average of the volatility of the real exchange rate of the countries in the sample. The dashed line above includes the volatility of the transition economies starting in1988.

Figure 4.2 Effective Volatility of the Real Exchange Rate and Trade: Major Country Groups

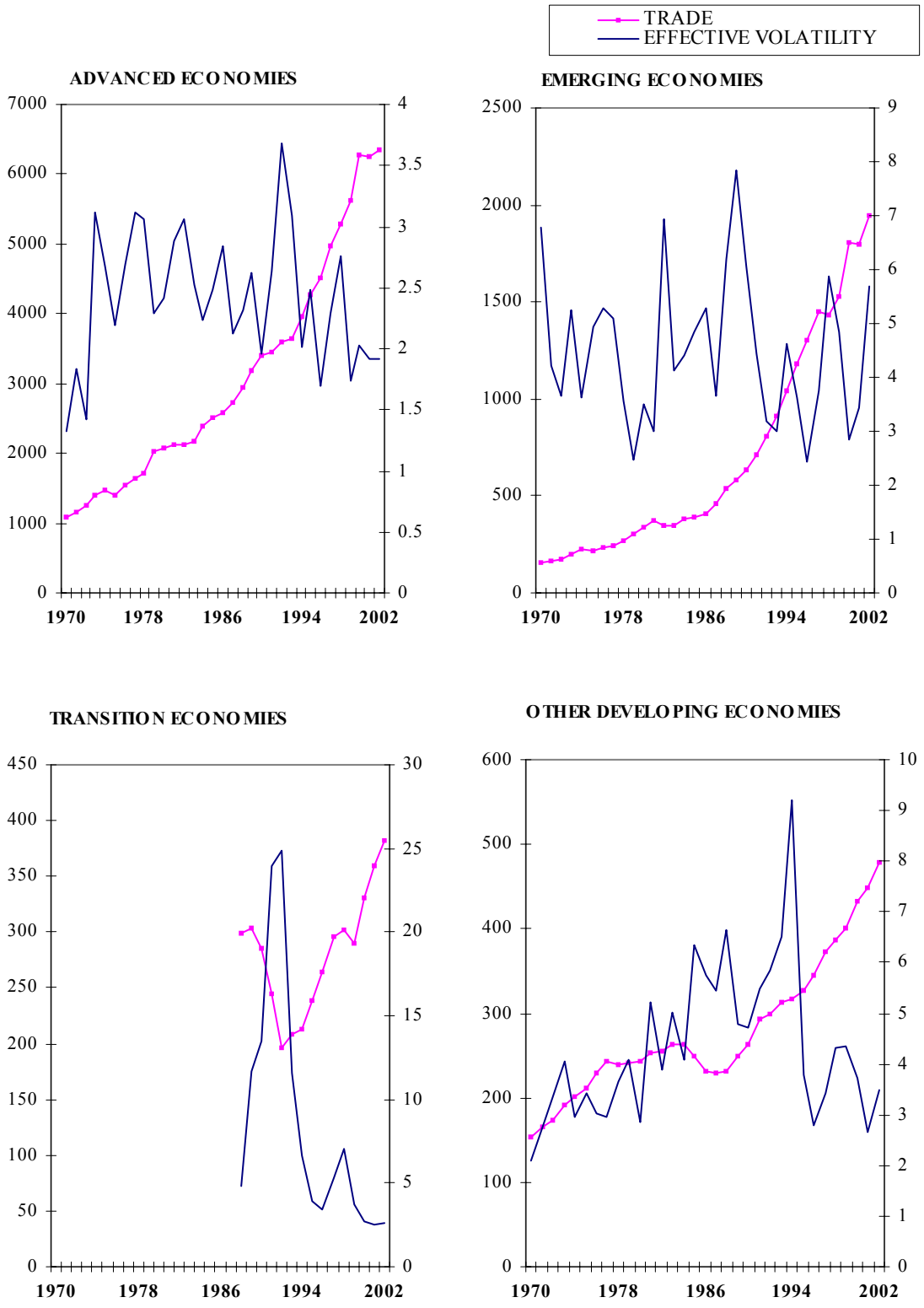


Figure 4.3 Effective Volatility of the Real Exchange Rate and Trade: Developing Countries by Region

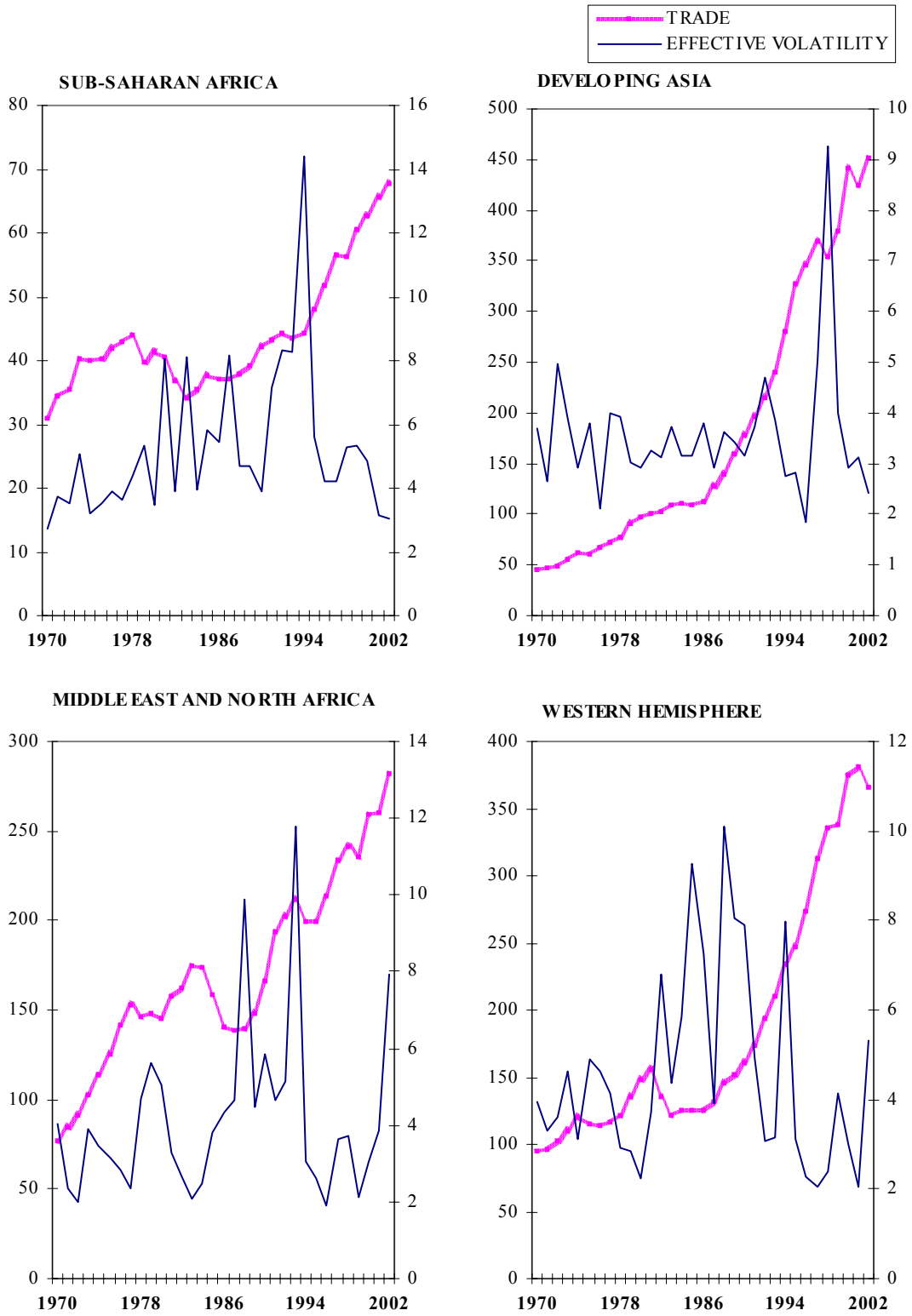
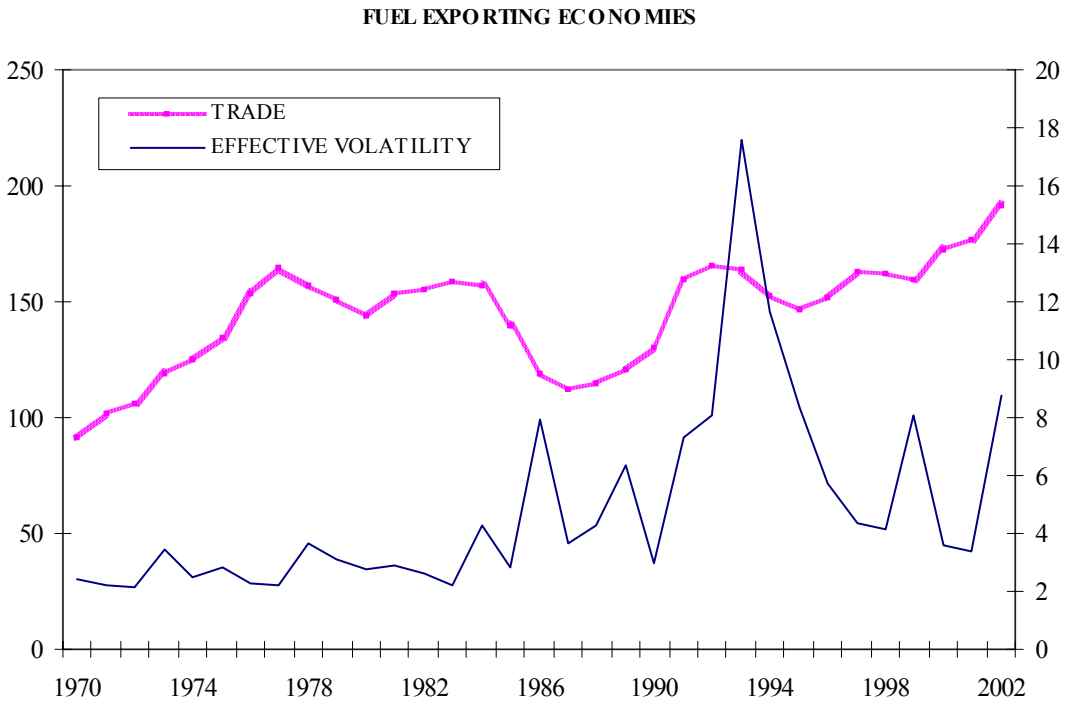
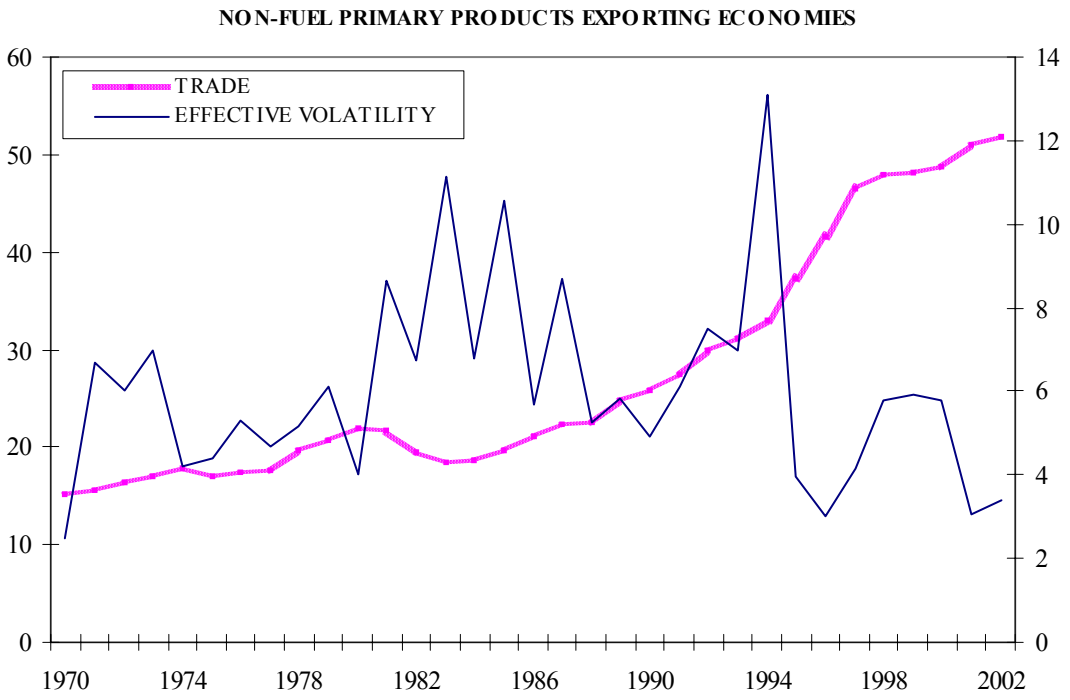


Figure 4.4 Effective Volatility of the Real Exchange Rate and Trade: Developing Countries by Type of Export





Appendix Table III.1. List of Countries in Major Country Groupings

Advanced Economies	Transition Economies	Emerging Economies	ROW
Australia	Albania	Argentina	Afghanistan, I.S. of
Austria	Armenia	Brazil	Algeria
Belgium	Azerbaijan	Chile	Angola
Canada	Belarus	China,P.R.: Mainland	Antigua and Barbuda
Cyprus	Bulgaria	China,P.R.:Hong Kong	Aruba
Denmark	Croatia	Colombia	Bahamas, The
Finland	Czech Republic	Ecuador	Bahrain, Kingdom of
France	Czechoslovakia	Indonesia	Bangladesh
Germany	Estonia	Korea	Barbados
Greece	Georgia	Malaysia	Belize
Iceland	Hungary	Mexico	Benin
Ireland	Kazakhstan	Panama	Bolivia
Israel	Kyrgyz Republic	Peru	Burkina Faso
Italy	Latvia	Philippines	Burundi
Japan	Lithuania	Singapore	Cambodia
Luxembourg	Macedonia, FYR	South Africa	Cameroon
Netherlands	Moldova	Thailand	Cape Verde
New Zealand	Mongolia	Turkey	Central African Rep.
Norway	Poland	Uruguay	Chad
Portugal	Romania	Venezuela, Rep. Bol.	China,P.R.:Macao
Spain	Russia		Congo, Dem. Rep. of
Sweden	Slovak Republic		Congo, Republic of
Switzerland	Slovenia		Costa Rica
United Kingdom	Ukraine		Côte d'Ivoire
United States	Yugoslavia, SFR		Djibouti
			Dominica
			Dominican Republic
			Egypt
			El Salvador
			Equatorial Guinea
			Ethiopia
			Fiji
			Gabon
			Gambia, The
			Ghana

Appendix Table III.1. List of Countries in Major Country Groupings

Advanced Economies	Transition Economies	Emerging Economies	ROW
			Grenada
			Guatemala
			Guiana, French
			Guinea-Bissau
			Guyana
			Haiti
			Honduras
			India
			Iran, I.R. of
			Iraq
			Jamaica
			Jordan
			Kenya
			Kuwait
			Lao People's Dem.Rep
			Lebanon
			Liberia
			Libya
			Madagascar
			Malawi
			Maldives
			Mali
			Malta
			Martinique
			Mauritania
			Mauritius
			Morocco
			Mozambique
			Myanmar
			Nepal
			Netherlands Antilles
			Nicaragua
			Niger
			Nigeria
			Oman

Appendix Table III.1. List of Countries in Major Country Groupings

Advanced Economies	Transition Economies	Emerging Economies	ROW
			Pakistan
			Papua New Guinea
			Paraguay
			Qatar
			Rwanda
			Réunion
			Samoa
			Saudi Arabia
			Senegal
			Seychelles
			Sierra Leone
			Solomon Islands
			Sri Lanka
			St. Kitts and Nevis
			St. Lucia
			St. Vincent & Grens.
			Sudan
			Suriname
			Syrian Arab Republic
			Tanzania
			Togo
			Tonga
			Trinidad and Tobago
			Tunisia
			Uganda
			Vanuatu
			Vietnam
			Yemen Arab Rep.
			Yemen, P.D. Rep.
			Yemen, Republic of
			Zambia
			Zimbabwe

Appendix Table III.2. List of Countries in Regional Groups of Developing Countries and by Source of Export Earnings

Sub Saharan Africa 1/	Developing Asia	Middle East and Turkey	Western Hemisphere	Fuel Exporters	Nonfuel Primary Product Exporters
Angola	Afghanistan, I.S. of	Bahrain, Kingdom of	Antigua and Barbuda	Algeria	Afghanistan, I.S. of
Benin	Bangladesh	Egypt	Argentina	Angola	Bolivia
Burkina Faso	Cambodia	Iran, I.R. of	Bahamas, The	Bahrain, Kingdom of	Burkina Faso
Burundi	Fiji	Iraq	Barbados	Congo, Republic of	Burundi
Cameroon	Indonesia	Jordan	Belize	Equatorial Guinea	Chad
Cape Verde	Lao People's Dem.Rep	Kuwait	Bolivia	Gabon	Chile
Central African Rep.	Malaysia	Lebanon	Brazil	Iran, I.R. of	Congo, Dem. Rep. of
Chad	Maldives	Libya	Chile	Iraq	Côte d'Ivoire
Congo, Dem. Rep. of	Myanmar	Malta	Colombia	Kuwait	Ethiopia
Congo, Republic of	Nepal	Oman	Costa Rica	Libya	Ghana
Côte d'Ivoire	Pakistan	Qatar	Dominica	Nigeria	Guinea-Bissau
Djibouti	Papua New Guinea	Saudi Arabia	Dominican Republic	Oman	Guyana
Equatorial Guinea	Philippines	Syrian Arab Republic	Ecuador	Qatar	Liberia
Ethiopia	Samoa	Turkey	El Salvador	Saudi Arabia	Malawi
Gabon	Solomon Islands	Yemen Arab Rep.	Grenada	Venezuela, Rep. Bol.	Mali
Gambia, The	Sri Lanka	Yemen, P.D. Rep.	Guatemala	Yemen, Republic of	Mauritania
Ghana	Thailand	Yemen, Republic of	Guyana		Niger
Guinea-Bissau	Tonga		Haiti		Papua New Guinea
Kenya	Vanuatu		Honduras		Rwanda
Liberia	Vietnam		Jamaica		Sierra Leone
Madagascar			Mexico		Solomon Islands
Malawi			Netherlands Antilles		Togo
Mali			Nicaragua		Uganda
Mauritania			Panama		Zambia
Mauritius			Paraguay		Zimbabwe
Mozambique			Peru		
Niger			St. Kitts and Nevis		
Rwanda			St. Lucia		
Senegal			St. Vincent & Grens.		
Seychelles			Suriname		
Sierra Leone			Trinidad and Tobago		
Sudan			Uruguay		
Tanzania			Venezuela, Rep. Bol.		
Togo					
Uganda					
Zambia					
Zimbabwe					

1/ Excludes Nigeria and South Africa.

Appendix Table III.3. List of Countries in the Real Parallel Exchange Rate Dataset

Advanced Economies	Transition Economies	Emerging Economies	ROW
Australia	Belarus	Argentina	Afghanistan, I.S. of
Austria	Bulgaria	Brazil	Algeria
Belgium	Czech Republic	Chile	Bangladesh
Canada	Estonia	China,P.R.: Mainland	Benin
Cyprus	Hungary	China,P.R.:Hong Kong	Bolivia
Denmark	Latvia	Colombia	Burundi
Finland	Lithuania	Ecuador	Congo, Dem. Rep. of
France	Poland	Indonesia	Costa Rica
Germany	Romania	Korea	Dominican Republic
Greece	Russia	Malaysia	Egypt
Iceland	Ukraine	Mexico	El Salvador
Ireland	Yugoslavia, SFR	Peru	Ethiopia
Israel		Philippines	Gambia, The
Italy		Singapore	Ghana
Japan		South Africa	Guatemala
Netherlands		Thailand	Guyana
New Zealand		Turkey	Haiti
Norway		Uruguay	Honduras
Portugal		Venezuela, Rep. Bol.	India
Spain			Iran, I.R. of
Sweden			Iraq
Switzerland			Jamaica
United Kingdom			Jordan
United States			Kenya
			Kuwait
			Lao People's Dem.Rep
			Lebanon
			Liberia
			Libya
			Madagascar
			Malawi
			Malta
			Mauritania
			Mauritius
			Morocco

Appendix Table III.3. List of Countries in the Real Parallel Exchange Rate Dataset

Advanced Economies	Transition Economies	Emerging Economies	ROW
			Myanmar
			Nepal
			Nicaragua
			Nigeria
			Pakistan
			Paraguay
			Saudi Arabia
			Sierra Leone
			Sri Lanka
			Suriname
			Syrian Arab Republic
			Tanzania
			Tunisia
			Uganda
			Vietnam
			Zambia
			Zimbabwe

Appendix Table III.4. Short-Run Effective Volatility of Real I.F.S Exchange Rate: Smaller Sample of Major Country Groups

Year	G-7	Advanced Economies	Transition Economies	Emerging Market Economies	Rest Countries of the World
1970	1.39	1.17	1.56	6.15	1.82
1971	1.75	1.93	6.34	1.99	2.33
1972	1.76	1.63	2.41	4.17	3.68
1973	2.84	2.73	3.26	6.82	4.17
1974	2.26	2.35	3.05	3.89	3.08
1975	1.71	1.77	1.94	4.89	3.21
1976	2.38	2.25	2.42	4.70	2.86
1977	1.98	2.40	1.86	4.97	2.74
1978	2.41	2.20	3.21	2.81	3.47
1979	1.94	1.78	2.31	2.18	4.12
1980	2.01	1.84	5.83	2.71	2.73
1981	2.28	2.23	3.89	3.01	5.47
1982	2.67	2.61	4.33	6.46	4.04
1983	1.97	2.05	3.34	3.65	5.68
1984	1.79	1.96	3.61	3.84	4.16
1985	2.47	2.38	4.23	4.24	7.52
1986	2.49	2.39	4.48	4.49	6.61
1987	1.96	1.90	6.49	3.03	5.75
1988	1.96	1.90	4.60	5.27	8.56
1989	2.12	2.19	11.71	7.37	5.18
1990	2.10	1.81	13.55	4.68	5.04
1991	2.03	2.03	22.04	3.45	4.89
1992	3.02	2.84	27.35	2.78	5.17
1993	2.49	2.41	6.52	2.48	6.29
1994	1.73	1.62	7.23	3.60	7.22
1995	2.66	2.23	4.53	3.54	3.15
1996	1.33	1.33	3.56	1.87	2.25
1997	2.16	2.00	5.78	3.55	3.19
1998	2.55	2.29	8.43	5.02	3.74
1970-1980	2.04	2.01	3.11	4.11	3.11
1981-1990	2.18	2.14	6.83	4.62	5.87
1991-1998	2.25	2.09	8.83	3.29	4.47
1970-1998	2.14	2.08	7.46	4.04	4.55

Appendix Table III.5. Short-Run Effective Volatility of Real Parallel Exchange Rate: Smaller Sample of Major Country Groups

Year	G-7	Advanced Economies	Transition Economies	Emerging Market Economies	Rest Countries of the World
1970	2.27	1.88	4.87	8.47	4.15
1971	2.01	2.43	5.58	4.75	4.93
1972	2.32	2.27	3.97	4.98	5.57
1973	4.02	4.06	4.48	7.51	6.95
1974	6.00	6.18	6.71	5.74	8.10
1975	2.78	4.14	4.81	4.87	6.57
1976	3.95	4.26	5.58	7.15	6.01
1977	2.90	3.83	6.83	6.31	6.49
1978	4.29	4.58	7.88	4.54	6.44
1979	3.34	3.59	9.47	3.17	6.96
1980	3.37	3.55	9.86	4.14	8.50
1981	4.39	4.83	7.32	6.28	10.01
1982	4.24	4.67	7.13	9.61	9.65
1983	3.71	4.70	6.59	9.42	7.87
1984	3.88	4.49	7.82	6.60	7.67
1985	3.58	3.69	8.30	8.14	10.15
1986	3.53	3.72	10.67	6.60	8.52
1987	2.89	2.94	7.53	7.52	9.09
1988	2.78	2.79	8.48	7.27	12.42
1989	3.17	3.35	16.16	9.64	8.47
1990	2.83	2.71	13.76	10.88	6.32
1991	2.71	2.91	10.16	4.92	6.71
1992	3.64	3.66	15.18	4.84	6.40
1993	3.71	4.65	8.15	3.94	6.80
1994	2.09	1.89	6.04	4.43	6.33
1995	3.13	2.74	6.23	3.57	4.49
1996	1.89	1.83	4.57	2.50	3.58
1997	2.63	2.51	8.57	3.87	4.79
1998	3.03	2.70	6.96	5.26	3.98
1970-1980	3.39	3.71	6.85	5.59	6.50
1981-1990	3.50	3.79	9.99	8.22	9.02
1991-1998	2.86	2.86	7.86	4.17	5.37
1970-1998	3.28	3.49	8.23	6.08	7.02

Appendix Table III.6. Correspondence Between the Official/IMF and Natural Regime Classification 1970-2001

NATURAL CLASSIFICATION /2	OFFICIAL IMF CLASSIFICATION /1				
	Peg	Limited Flexibility	Managed Floating	Freely Floating	Total
Peg	84.29	8.17	5	2.54	100
	53.53	46.61	8.48	5.18	35.33
Limited Flexibility	34.86	8.82	35.84	20.48	100
	16.13	36.65	44.28	30.42	25.74
Managed Floating	55.1	1.23	24.6	19.07	100
	22.58	4.52	26.92	25.08	22.8
Freely Floating	12.58	16.98	1.26	69.18	100
	1.01	12.22	0.27	17.8	4.46
Freely Falling	32.21	0	35.82	31.97	100
	6.75	0	20.05	21.52	11.67
Total	55.64	6.2	20.84	17.33	100
	100	100	100	100	100

Note: The *first* entry in every cell is the *row* percentage, while the *second* is the *column* percentage.
1/ Based on the IMF's annual publication *Exchange Arrangements and Exchange Restrictions*
2/ Based on Reinhart and Rogoff (2003)
The above statistics are derived for a sample of 150 countries.

Appendix Table III.7. Distribution of Exchange Rate Regimes Across Country Groups 1970-2001

Country Groups	OFFICIAL IMF CLASSIFICATION /1				
	Peg	Limited Flexibility	Managed Floating	Freely Floating	Total
Advanced	32.32	25.46	13.72	28.5	100
	11.31	87.33	13.27	33.08	19.82
Emerging	39.52	0.63	43.97	15.87	100
	11.5	1.81	35.33	15.31	16.47
Transition	35.06	0	34.32	30.63	100
	4.39	0	11.86	12.71	7.09
Developing	72.84	1.11	14.32	11.73	100
	72.81	10.86	39.54	38.9	56.62
Total	56.64	5.78	20.5	17.08	100
	100	100	100	100	100

Note: The *first* entry in every cell is the *row* percentage, while the *second* is the *column* percentage.
1/ Based on the IMF's annual publication *Exchange Arrangements and Exchange Restrictions*
The above statistics are derived for a sample of 150 countries.

Appendix Table III.8. Distribution of Exchange Rate Regimes Across Country Groups 1970-2001

Country Groups	NATURAL CLASSIFICATION /1					
	Peg	Limited Flexibility	Managed Floating	Freely Floating	Freely Falling	Total
Advanced	26.82	40.63	17.71	11.98	2.86	100
	15.16	33.3	16.31	57.14	5.14	20.65
Emerging	26.41	24.84	24.53	2.97	21.25	100
	12.44	16.97	18.82	11.8	31.78	17.21
Transition	13.81	25	19.03	3.73	38.43	100
	2.72	7.15	6.12	6.21	24.07	7.21
Developing	46.35	19.53	23.98	1.96	8.17	100
	69.68	42.58	58.75	24.84	39.02	54.93
Total	36.54	25.19	22.43	4.33	11.51	100
	100	100	100	100	100	100

Note: The *first* entry in every cell is the *row* percentage, while the *second* is the *column* percentage.
1/ Based on Reinhart and Rogoff(2003)
The above statistics are derived for a sample of 150 countries.

Appendix Table IV.1. Summary Statistics and Correlations

A . Summary Statistics of Main Variables for Aggregate Trade Data

Full Sample :

Variable	Code in Dataset	Num of Obs	Mean	Std. Dev.	Min	Max
L-R Official Real Vol	vol_lor	26395	0.066	0.076	0.003	1.405
L-R Official Nominal Vol	vol_lon	37254	0.062	0.081	0	0.979
L-R Parallel Real Vol	vol_lpr	11844	0.090	0.074	0.007	0.684
L-R Parallel Nominal Vol	vol_lpn	16302	0.089	0.073	0	0.596
S-R Official Real Vol	vol_sor	26444	0.046	0.065	0.001	0.836
S-R Official Nominal Vol	vol_son	37416	0.041	0.069	0	0.900
S-R Parallel Real Vol	vol_spr	12575	0.073	0.075	0.000	0.664
S-R Parallel Nominal Vol	vol_spn	16753	0.073	0.069	0	0.561
Log of Bilateral Trade	ltrade	37443	9.983	3.541	-16.090	20.890
Log of Real GDP Product	lrgdp	37593	47.973	2.765	36.128	58.356
Log of Real Per Capita GDP Product	lrgdppc	37593	16.047	1.662	9.160	20.850

Sample for Regressions :

Variable	Code in Dataset	Num of Obs	Mean	Std. Dev.	Min	Max
L-R Official Real Vol	vol_lor	16303	0.043	0.028	0.003	0.293
L-R Official Nominal Vol	vol_lon	16303	0.039	0.031	0	0.271
L-R Parallel Real Vol	vol_lpr	6988	0.066	0.054	0.007	0.541
L-R Parallel Nominal Vol	vol_lpn	6988	0.063	0.052	0	0.517
S-R Official Real Vol	vol_sor	16149	0.034	0.025	0.002	0.254
S-R Official Nominal Vol	vol_son	16303	0.028	0.027	0	0.267
S-R Parallel Real Vol	vol_spr	7190	0.052	0.039	0.000	0.393
S-R Parallel Nominal Vol	vol_spn	7229	0.049	0.040	0	0.387
Conditional Vol	cvol	16303	0.047	0.021	0.003	0.191
Log of Bilateral Trade	ltrade	16238	10.458	3.573	-8.076	20.890
Log of Real GDP Product	lrgdp	16303	48.296	2.852	37.368	58.356
Log of Real Per Capita GDP Product	lrgdppc	16303	16.264	1.733	9.160	20.850

B. Correlation Matrix of Main Variables for Aggregate Trade Data

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1)	L-R Official Real Vol	1.00											
(2)	L-R Official Nominal Vol	0.96	1.00										
(3)	L-R Parallel Real Vol	0.44	0.52	1.00									
(4)	L-R Parallel Nominal Vol	0.42	0.51	0.99	1.00								
(5)	S-R Official Real Vol	0.38	0.40	0.37	0.36	1.00							
(6)	S-R Official Nominal Vol	0.35	0.40	0.38	0.37	0.97	1.00						
(7)	S-R Parallel Real Vol	0.15	0.12	0.24	0.24	0.31	0.27	1.00					
(8)	S-R Parallel Nominal Vol	0.12	0.10	0.21	0.21	0.29	0.25	0.99	1.00				
(9)	Log of Bilateral Trade	-0.32	-0.28	-0.31	-0.31	-0.19	-0.13	-0.22	-0.20	1.00			
(10)	Log of Real GDP Product	-0.20	-0.17	-0.23	-0.23	-0.08	-0.04	-0.16	-0.14	0.76	1.00		
(11)	Log of Real Per Capita GDP Product	-0.35	-0.27	-0.34	-0.33	-0.19	-0.11	-0.30	-0.26	0.61	0.44	1.00	
(12)	Conditional Vol	0.56	0.57	0.33	0.32	0.32	0.31	0.09	0.07	-0.35	-0.22	-0.36	1.00

C . Summary Statistics of Main Variables for Disaggregate Trade Data

	Num of Obs	Mean	Std. Dev.	Min	Max
Log Imports of Differentiated Goods (Real Value)	4667	10.54	3.23	-2.62	17.84
Log Imports of Homogeneous Goods (Real Value)	4473	9.29	3.08	-4.05	17.08
Log Total Imports (Real Value)	9140	9.93	3.22	-4.05	17.84

	1975	1980	1985	1990	1995	2000
Total Imports of Differentiated Goods (million real US dollars)	187	290	300	538	788	946
Total Imports of Homogeneous Goods (million real US dollars)	70	138	114	148	165	185
Share of Differentiated Products in Total Trade	0.73	0.68	0.72	0.78	0.83	0.84

Appendix Table IV.2. The Role of Exchange Rate Volatility in Trade: Main Results

Variable	Country FE + Time FE	Country Pair FE + Time FE	Time-Varying Country Effects	Country FE + Time FE with Full Sample	Time-Varying Country Effects with Full Sample
	(1)	(2)	(3)	(4)	(5)
Long-Run Volatility of Real Official Exchange Rate	-2.37 (0.67)	-2.40 (0.47)	2.89 (1.78)	-1.16 (0.22)	-1.17 (0.83)
Dummy for Common Currency Union	1.35 (0.14)	0.25 (0.38)	1.43 (0.14)	1.35 (0.12)	1.30 (0.12)
Log of Real GDP Product	0.20 (0.13)	0.49 (0.10)	0.83 (0.19)	0.10 (0.11)	0.06 (0.27)
Log of Real Per Capita GDP Product	-0.06 (0.12)	-0.25 (0.09)	0.07 (0.22)	0.00 (0.10)	0.83 (0.28)
Log of Distance	-1.52 (0.02)		-1.54 (0.02)	-1.50 (0.02)	-1.50 (0.02)
Common Language Dummy	0.25 (0.05)		0.26 (0.05)	0.36 (0.04)	0.36 (0.04)
Common Border Dummy	-0.12 (0.10)		-0.11 (0.10)	0.36 (0.08)	0.35 (0.08)
Number of Landlocked Countries in the Country Pair	0.11 (0.50)		-1.37 (0.39)	0.28 (0.32)	-0.22 (0.47)
Number of Island Countries in the Country Pair	2.54 (0.36)		0.86 (0.77)	2.12 (0.27)	-0.11 (0.4)
Log of Area Product	0.52 (0.08)		-0.03 (0.18)	0.56 (0.07)	0.16 (0.14)
Dummy for Same Colonizer after 1945	0.70 (0.07)		0.72 (0.07)	0.59 (0.06)	0.61 (0.06)
Dummy for Both Currently Being Colonies	0.31 (0.47)	0.21 (0.98)	-1.12 (0.16)	0.59 (0.44)	-1.05 (0.14)
Dummy for Common Nation	0.83 (0.57)		2.33 (0.37)	0.57 (0.53)	2.29 (0.33)
Dummy for Being Colonizer and Colony to Each Other	1.46 (0.07)		1.45 (0.07)	1.31 (0.06)	1.29 (0.06)
Dummy for Common FTA Membership	0.28 (0.08)	0.25 (0.10)	0.27 (0.08)	0.39 (0.06)	0.40 (0.07)
Dummy for One in WTO	0.26 (0.12)	0.10 (0.10)	1.80 (0.55)	0.22 (0.09)	2.03 (0.49)
Dummy for Both in WTO	0.43 (0.14)	0.22 (0.10)	3.52 (1.10)	0.41 (0.11)	4.01 (0.97)
Dummy for GSP	0.63 (0.03)	0.45 (0.09)	0.59 (0.03)	0.71 (0.03)	0.67 (0.03)
Time Fixed Effects	Yes	Yes	No	Yes	No
Country Fixed Effects	Yes	No	No	Yes	No
Country Pair Fixed Effects	No	Yes	No	No	No
Time-Varying Country Effects	No	No	Yes	No	Yes
Number of Observations	16238	16238	16238	26267	26267
R-squared	0.79	0.49	0.81	0.75	0.77
RMSE	1.64		1.60	1.76	1.71

Appendix Table IV.3. Alternative Measures of Volatility: Short-Run, Parallel Market, Nominal and Conditional

Variable	LR & SR, Official, Real	LR, Official & Parallel, Real	LR & SR, Official & Parallel, Real	LR, Official, Nominal	Conditional, Official, Real
	(1)	(2)	(3)	(4)	(5)
L-R Official Real Vol	-3.86 (0.88)	-1.86 (0.98)	-3.92 (1.30)		
(S-R Official Real Vol) - (L-R Official Real Vol)	-1.87 (0.71)		-2.72 (1.04)		
(L-R Parallel Real Vol) - (L-R Official Real Vol)		-1.55 (0.60)	-1.20 (0.63)		
(S-R Parallel Real Vol) - (S-R Official Real Vol)			-0.55 (0.73)		
L-R Official Nominal Vol				-2.60 (0.60)	
Volatility Conditional upon Historical Information					-2.20 (0.92)
Dummy for Common Currency Union	1.37 (0.14)			1.30 (0.14)	1.41 (0.14)
Log of Real GDP Product	0.18 (0.13)	0.21 (0.19)	0.21 (0.19)	0.22 (0.13)	0.18 (0.13)
Log of Real Per Capita GDP Product	-0.05 (0.12)	1.04 (0.21)	1.03 (0.21)	-0.09 (0.12)	-0.04 (0.12)
Log of Distance	-1.51 (0.02)	-1.40 (0.03)	-1.39 (0.03)	-1.51 (0.02)	-1.52 (0.02)
Common Language Dummy	0.25 (0.05)	0.30 (0.06)	0.30 (0.06)	0.25 (0.05)	0.25 (0.05)
Common Border Dummy	-0.12 (0.09)	-0.26 (0.12)	-0.22 (0.12)	-0.12 (0.10)	-0.12 (0.10)
Number of Landlocked Countries in the Country Pair	-3.12 (0.56)	-3.06 (0.69)	-3.33 (0.55)	-0.01 (0.50)	0.10 (0.50)
Number of Island Countries in the Country Pair	0.56 (0.54)	-3.08 (0.72)	-5.11 (1.11)	2.51 (0.36)	2.58 (0.36)
Log of Area Product	0.53 (0.09)	0.27 (0.10)	0.23 (0.12)	0.50 (0.08)	0.52 (0.08)
Dummy for Same Colonizer after 1945	0.68 (0.07)	0.70 (0.11)	0.70 (0.11)	0.70 (0.07)	0.70 (0.07)
Dummy for Both Currently Being Colonies	0.31 (0.48)	-0.81 (0.16)	-0.82 (0.16)	0.28 (0.46)	0.29 (0.47)
Dummy for Common Nation	0.80 (0.58)			0.91 (0.57)	0.84 (0.57)
Dummy for Being Colonizer and Colony to Each Other	1.44 (0.07)	1.01 (0.09)	1.00 (0.09)	1.45 (0.07)	1.46 (0.07)
Dummy for Common FTA Membership	0.27 (0.08)	-0.49 (0.11)	-0.50 (0.11)	0.28 (0.08)	0.28 (0.08)
Dummy for One in WTO	0.27 (0.12)	-0.14 (0.18)	-0.18 (0.18)	0.26 (0.12)	0.29 (0.12)
Dummy for Both in WTO	0.43 (0.14)	-0.15 (0.22)	-0.18 (0.22)	0.43 (0.14)	0.49 (0.14)
Dummy for GSP	0.63 (0.03)	0.59 (0.04)	0.60 (0.04)	0.63 (0.03)	0.63 (0.03)
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
Country Fixed Feffects	Yes	Yes	Yes	Yes	Yes
Number of Observations	16085	6988	6949	16238	16238
R-squared	0.79	0.82	0.83	0.79	0.79
RMSE	1.64	1.44	1.44	1.64	1.65

Appendix Table IV.4. Country-Pair Fixed Effects

Variable	LR & SR, Official, Real	LR, Official & Parallel, Real	LR & SR, Official & Parallel, Real	LR, Official, Nominal	Conditional, Official, Real
	(1)	(2)	(3)	(4)	(5)
L-R Official Real Vol	-4.84 (0.61)	-1.43 (0.60)	-4.72 (0.76)		
(S-R Official Real Vol) - (L-R Official Real Vol)	-2.97 (0.44)		-4.15 (0.55)		
(L-R Parallel Real Vol) - (L-R Official Real Vol)		-0.94 (0.34)	-0.42 (0.34)		
(S-R Parallel Real Vol) - (S-R Official Real Vol)			-1.14 (0.41)		
L-R Official Nominal Vol				-2.51 (0.43)	
Volatility Conditional upon Historical Information					-4.12 (0.70)
Dummy for Common Currency Union	0.22 (0.38)			0.20 (0.38)	0.28 (0.38)
Log of Real GDP Product	0.50 (0.10)	0.61 (0.13)	0.65 (0.13)	0.51 (0.10)	0.50 (0.10)
Log of Real Per Capita GDP Product	-0.25 (0.09)	0.52 (0.14)	0.47 (0.13)	-0.27 (0.09)	-0.24 (0.09)
Dummy for Both Currently Being Colonies	0.17 (0.98)			0.15 (0.98)	0.16 (0.98)
Dummy for Common FTA Membership	0.25 (0.10)	0.29 (0.13)	0.33 (0.13)	0.26 (0.10)	0.24 (0.10)
Dummy for One in WTO	0.10 (0.10)	-0.24 (0.13)	-0.25 (0.13)	0.10 (0.10)	0.13 (0.10)
Dummy for Both in WTO	0.24 (0.10)	-0.20 (0.14)	-0.20 (0.14)	0.22 (0.10)	0.29 (0.10)
Dummy for GSP	0.43 (0.10)	0.03 (0.14)	0.00 (0.14)	0.45 (0.09)	0.46 (0.09)
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
Country Pair Fixed Effects	Yes	Yes	Yes	Yes	Yes
Number of Observations	16085	6988	6949	16238	16238
R-squared	0.49	0.69	0.69	0.48	0.49

Appendix Table IV.5. Time-Varying Country Effects

Variable	LR & SR, Official, Real	LR, Official & Parallel, Real	LR & SR, Official & Parallel, Real	LR, Official, Real & Effective Real	Conditional, Official, Real
	(1)	(2)	(3)	(4)	(5)
L-R Official Real Vol	5.99 (2.14)	3.34 (3.25)	7.52 (3.89)	3.64 (1.58)	
(S-R Official Real Vol) - (L-R Official Real Vol)	4.19 (1.88)		6.70 (3.24)		
(L-R Parallel Real Vol) - (L-R Official Real Vol)		-2.01 (2.69)	-2.20 (2.71)		
(S-R Parallel Real Vol) - (S-R Official Real Vol)			-1.55 (2.80)		
Sum of Effective L-R Official Real Vol of Country Pairs				-6.20 (1.52)	
Volatility Conditional upon Historical Infomation					0.97 (1.50)
Dummy for Common Currency Union	1.42 (0.14)			1.49 (0.15)	1.36 (0.14)
Log of Real GDP Product	0.81 (0.18)	0.97 (0.09)	0.99 (0.09)	0.24 (0.14)	0.72 (0.17)
Log of Real Per Capita GDP Product	0.12 (0.22)	0.69 (0.09)	0.83 (0.13)	-0.08 (0.12)	0.19 (0.21)
Log of Distance	-1.54 (0.02)	-1.42 (0.03)	-1.43 (0.03)	-1.53 (0.03)	-1.53 (0.02)
Common Language Dummy	0.27 (0.05)	0.30 (0.06)	0.31 (0.06)	0.26 (0.05)	0.25 (0.05)
Common Border Dummy	-0.11 (0.09)	-0.22 (0.12)	-0.17 (0.12)	-0.13 (0.09)	-0.12 (0.10)
Number of Landlocked Countries in the Country Pair	-1.27 (0.39)	-0.19 (0.25)	-0.75 (0.29)	-2.97 (0.59)	-1.26 (0.39)
Number of Island Countries in the Country Pair	0.97 (0.75)	1.16 (0.26)	0.77 (0.26)	0.52 (0.52)	1.02 (0.76)
Log of Area Product	0.01 (0.18)	-0.20 (0.04)	-0.21 (0.04)	0.52 (0.08)	0.10 (0.16)
Dummy for Same Colonizer after 1945	0.71 (0.07)	0.72 (0.11)	0.70 (0.11)	0.73 (0.07)	0.72 (0.07)
Dummy for Both Currently Being Colonies	-1.14 (0.16)	-0.75 (0.18)	-0.70 (0.19)	0.00 (0.57)	-1.11 (0.16)
Dummy for Common Nation	2.42 (0.38)			1.21 (0.66)	2.33 (0.37)
Dummy for Being Colonizer and Colony to Each Other	1.45 (0.07)	1.00 (0.09)	1.00 (0.09)	1.47 (0.07)	1.45 (0.07)
Dummy for Common FTA Membership	0.26 (0.08)	-0.57 (0.11)	-0.56 (0.11)	0.30 (0.08)	0.26 (0.08)
Dummy for One in WTO	1.78 (0.54)	0.64 (0.35)	0.10 (0.41)	0.26 (0.13)	1.78 (0.55)
Dummy for Both in WTO	3.49 (1.06)	1.40 (0.64)	0.38 (0.75)	0.41 (0.15)	3.46 (1.09)
Dummy for GSP	0.58 (0.03)	0.57 (0.04)	0.56 (0.04)	0.65 (0.03)	0.59 (0.03)
Time Fixed Effects	No	No	No	Yes	No
Country Fixed Effects	No	No	No	Yes	No
Time-Varying Country Effects	Yes	Yes	Yes	No	Yes
Number of Observations	16085	6988	6949	15157	16238
R-squared	0.81	0.83	0.84	0.79	0.81
RMSE	1.59	1.43	1.42	1.62	1.60

Appendix Table IV.6A. Controlling for Endogeneity of Exchange Rate Volatility: Relative Money Supply as IV [1/]

Variable	Real Exchange Rate			Nominal Exchange Rate		
	(1)	(2)	(3)	(4)	(5)	(6)
Long-Run Volatility of Real Official Exchange Rate	-22.64	-6.49	-23.82			
	(12.5)	(6.24)	(28.87)			
Long-Run Volatility of Nominal Official Exchange Rate				-25.98	-7.78	-17.92
				(14.50)	(7.52)	(21.72)
Log of Real GDP Product	0.37	0.52	0.44	0.62	0.60	0.45
	(0.2)	(0.12)	(0.41)	(0.31)	(0.16)	(0.40)
Log of Real Per Capita GDP Product	-0.25	-0.28	0.35	-0.52	-0.36	0.41
	(0.19)	(0.12)	(0.35)	(0.32)	(0.17)	(0.41)
Log of Distance	-1.52		-1.52	-1.49		-1.52
	(0.04)		(0.09)	(0.06)		(0.08)
Common Language Dummy	0.27		0.27	0.22		0.26
	(0.06)		(0.10)	(0.08)		(0.10)
Common Border Dummy	-0.08		-0.12	-0.10		-0.12
	(0.12)		(0.14)	(0.12)		(0.14)
Number of Landlocked Countries in the Country Pair	-1.41		-1.38	-1.86		-1.16
	(0.56)		(0.39)	(0.72)		(0.51)
Number of Island Countries in the Country Pair	1.76		-1.64	1.36		-0.87
	(0.70)		(2.79)	(0.91)		(1.87)
Log of Area Product	0.44		0.54	0.31		0.43
	(0.11)		(0.60)	(0.16)		(0.46)
Dummy for Same Colonizer after 1945	0.78		0.79	0.70		0.76
	(0.09)		(0.13)	(0.12)		(0.16)
Dummy for Being Colonizer and Colony to Each Other	1.33		1.33	1.32		1.31
	(0.08)		(0.08)	(0.09)		(0.08)
Dummy for Common FTA Membership	0.27	0.23	0.26	0.30	0.24	0.29
	(0.09)	(0.11)	(0.13)	(0.09)	(0.11)	(0.10)
Dummy for One in WTO	0.14	-0.02	-1.77	0.16	-0.02	-0.65
	(0.16)	(0.11)	(3.83)	(0.16)	(0.11)	(2.48)
Dummy for Both in WTO	0.11	0.12	-3.63	0.10	0.11	-1.41
	(0.29)	(0.15)	(7.69)	(0.30)	(0.16)	(5.01)
Dummy for GSP	0.66	0.44	0.63	0.65	0.43	0.63
	(0.03)	(0.11)	(0.04)	(0.03)	(0.11)	(0.03)
Time Fixed Effects	Yes	Yes	No	Yes	Yes	No
Country Fixed Effects	Yes	No	No	Yes	No	No
Country Pair Fixed Effects	No	Yes	No	No	Yes	No
Time-Varying Country Effects	No	No	Yes	No	No	Yes
Number of Observations	14343	14343	14343	14343	14343	14343
R-squared	0.77	0.48	0.80	0.76	0.46	0.80
RMSE	1.71		1.62	1.74		1.62

1/ The instrumental variable is the long-run volatility of the relative money supply, constructed similarly to Frankel and Wei (1993).

Appendix Table IV.6B. Controlling for Endogeneity of Exchange Rate Volatility: Common Anchor Dummy as IV [1/]

Variable	Real Exchange Rate			Nominal Exchange Rate		
	(1)	(2)	(3)	(4)	(5)	(6)
Long-Run Volatility of Real Official Exchange Rate	-10.62 (7.45)	29.06 (17.79)	-7.23 (7.73)			
Long-Run Volatility of Nominal Official Exchange Rate				-7.06 (4.92)	27.75 (17.17)	-4.37 (4.67)
Log of Real GDP Product	0.66 (0.20)	1.08 (0.18)	1.06 (0.12)	0.73 (0.20)	0.83 (0.21)	1.02 (0.1)
Log of Real Per Capita GDP Product	0.31 (0.26)	1.07 (0.48)	0.36 (0.16)	0.31 (0.26)	1.41 (0.69)	0.45 (0.11)
Log of Distance	-1.45 (0.04)		-1.46 (0.04)	-1.45 (0.04)		-1.46 (0.04)
Common Language Dummy	0.35 (0.07)		0.36 (0.07)	0.36 (0.07)		0.36 (0.07)
Common Border Dummy	0.24 (0.14)		0.25 (0.14)	0.24 (0.14)		0.25 (0.14)
Number of Landlocked Countries in the Country Pair	-2.19 (1.44)		-0.78 (0.47)	-2.43 (1.36)		-0.81 (0.47)
Number of Island Countries in the Country Pair	-2.39 (1.02)		0.17 (0.33)	-2.00 (0.93)		0.13 (0.32)
Log of Area Product	0.08 (0.14)		-0.17 (0.07)	0.02 (0.12)		-0.16 (0.06)
Dummy for Same Colonizer after 1945	1.00 (0.10)		1.02 (0.10)	0.99 (0.10)		1.01 (0.10)
Dummy for Being Colonizer and Colony to Each Other	0.95 (0.20)		0.95 (0.20)	0.95 (0.20)		0.94 (0.20)
Dummy for Common FTA Membership	0.81 (0.17)	0.74 (0.31)	0.69 (0.18)	0.82 (0.17)	0.77 (0.33)	0.70 (0.18)
Dummy for One in WTO	0.02 (0.16)	-0.05 (0.16)	0.70 (0.39)	0.04 (0.15)	-0.09 (0.15)	0.84 (0.34)
Dummy for Both in WTO	0.01 (0.22)	0.41 (0.29)	1.40 (0.73)	0.06 (0.20)	0.38 (0.28)	1.66 (0.63)
Dummy for GSP	0.66 (0.04)	0.20 (0.20)	0.64 (0.04)	0.66 (0.04)	0.20 (0.20)	0.64 (0.04)
Time Fixed Effects	Yes	Yes	No	Yes	Yes	No
Country Fixed Effects	Yes	No	No	Yes	No	No
Country Pair Fixed Effects	No	Yes	No	No	Yes	No
Time-Varying Country Effects	No	No	Yes	No	No	Yes
Number of Observations	8531	8531	8531	8531	8531	8531
R-squared	0.75	0.52	0.77	0.76	0.49	0.77
RMSE	1.72		1.68	1.71		1.68

1/ The instrumental variable is a common anchor dummy, constructed by Tenreyro (2003).

Appendix Table IV.6C. Controlling for Endogeneity of Exchange Rate Volatility: Propensity to Share a Common Anchor as IV [1/]

Variable	Real Exchange Rate			Nominal Exchange Rate		
	(1)	(2)	(3)	(4)	(5)	(6)
Long-Run Volatility of Real Official Exchange Rate	-46.60	-19.76	-34.99			
	(12.99)	(20.98)	(8.86)			
Long-Run Volatility of Nominal Official Exchange Rate				-32.91	-11.48	-24.65
				(8.77)	(11.44)	(6.14)
Log of Real GDP Product	1.87	1.53	1.19	2.03	1.55	1.19
	(0.37)	(0.29)	(0.09)	(0.35)	(0.29)	(0.09)
Log of Real Per Capita GDP Product	-1.89	-0.80	0.47	-1.70	-0.53	0.60
	(0.67)	(1.10)	(0.15)	(0.59)	(0.77)	(0.14)
Log of Distance	-1.18		-1.22	-1.21		-1.24
	(0.07)		(0.05)	(0.06)		(0.05)
Common Language Dummy	0.51		0.48	0.49		0.48
	(0.10)		(0.09)	(0.09)		(0.09)
Common Border Dummy	-0.17		-0.09	-0.21		-0.13
	(0.21)		(0.18)	(0.20)		(0.18)
Number of Landlocked Countries in the Country Pair	-6.01		-0.34	-4.73		-0.38
	(1.86)		(0.31)	(1.49)		(0.30)
Number of Island Countries in the Country Pair	0.36		-0.20	1.34		-0.12
	(1.55)		(0.34)	(1.42)		(0.34)
Log of Area Product	-0.37		-0.06	-0.49		-0.07
	(0.22)		(0.07)	(0.20)		(0.07)
Dummy for Same Colonizer after 1945	0.55		0.66	0.53		0.64
	(0.19)		(0.15)	(0.18)		(0.15)
Dummy for Being Colonizer and Colony to Each Other	0.80		0.89	0.81		0.87
	(0.24)		(0.21)	(0.22)		(0.20)
Dummy for Common FTA Membership	0.03	0.25	0.00	0.11	0.31	0.05
	(0.22)	(0.26)	(0.21)	(0.21)	(0.22)	(0.20)
Dummy for One in WTO	-0.75	-0.18	-1.60	-0.53	-0.07	-0.49
	(0.31)	(0.25)	(0.63)	(0.26)	(0.18)	(0.48)
Dummy for Both in WTO	-1.62	-0.53	-3.06	-1.16	-0.27	-0.87
	(0.52)	(0.58)	(1.22)	(0.40)	(0.31)	(0.91)
Dummy for GSP	0.62	-0.22	0.63	0.60	-0.27	0.61
	(0.06)	(0.32)	(0.05)	(0.05)	(0.28)	(0.05)
Time Fixed Effects	Yes	Yes	No	Yes	Yes	No
Country Fixed Effects	Yes	No	No	Yes	No	No
Country Pair Fixed Effects	No	Yes	No	No	Yes	No
Time-Varying Country Effects	No	No	Yes	No	No	Yes
Number of Observations	4801	4801	4801	4801	4801	4801
R-squared	0.73	0.44	0.81	0.76	0.49	0.81
RMSE	1.78		1.53	1.68		1.52

1/ The instrumental variable is propensity to share a common anchor, estimated based on Tenreyro (2003).

Appendix Table IV.7. Differentiation by Country Type [1/]

Variable	Developed & Developing Countries	
	(1)	(2)
L-R Official Real Vol	43.47 (3.54)	47.90 (3.85)
(L-R Official Real Vol) * (NS Dummy)	-45.70 (3.60)	-47.59 (3.90)
(L-R Official Real Vol) * (SS Dummy)	-46.69 (3.64)	-47.92 (4.00)
Dummy for Common Currency Union	-0.62 (0.23)	-0.60 (0.21)
(Currency Union Dummy) * (SS Dummy)	2.11 (0.27)	2.12 (0.25)
Dummy for North-South Country Pair	-0.49 (0.28)	1.11 (0.45)
Dummy for South-South Country Pair	-2.49 (0.52)	0.56 (0.87)
Time Fixed Effects	Yes	No
Country Fixed Effects	Yes	No
Time-Varying Country Effects	No	Yes
Number of Observations	16238	16238
R-squared	0.79	0.81
RMSE	1.64	1.59

1/ The estimated coefficients for standard control dummies in the baseline specification are not reported.

Appendix Table IV.8. Differentiation by Product Type (SUR)

Variable	With Country Fixed Effect		With Time-Varying Country Effect	
	Homogeneous	Differentiated	Homogeneous	Differentiated
L-R Official Real Vol	-0.59 (2.12)	-2.89 (1.66)	-2.97 (4.39)	0.98 (3.06)
Log of Real GDP Product	2.29 (0.28)	3.18 (0.22)	0.84 (0.09)	0.23 (0.12)
Log of Real Per Capita GDP Product	-2.16 (0.28)	-3.24 (0.22)	-0.79 (0.20)	0.49 (0.24)
Log of Distance	-2.06 (0.04)	-1.01 (0.03)	-2.11 (0.04)	-1.08 (0.03)
Common Language Dummy	0.05 (0.09)	0.30 (0.07)	0.04 (0.08)	0.33 (0.06)
Common Border Dummy	-0.95 (0.14)	-0.23 (0.11)	-0.99 (0.12)	-0.28 (0.08)
Number of Landlocked Countries in the Country Pair	-1.99 (0.46)	-6.41 (1.22)	1.28 (0.41)	0.62 (0.48)
Number of Island Countries in the Country Pair	-6.82 (1.59)	-12.11 (1.25)	4.68 (0.51)	-3.97 (0.63)
Log of Area Product	-2.12 (0.34)	-3.36 (0.26)	-0.29 (0.08)	-0.16 (0.11)
Dummy for Same Colonizer after 1945	0.43 (0.27)	0.35 (0.21)	0.47 (0.24)	0.26 (0.17)
Dummy for Both Currently Being Colonies	0.49 (1.16)	0.12 (0.91)	0.13 (1.05)	0.04 (0.73)
Dummy for Being Colonizer and Colony to Each Other	0.89 (0.16)	0.79 (0.12)	0.89 (0.14)	0.81 (0.10)
Dummy for Common FTA Membership	-0.34 (0.11)	0.05 (0.08)	-0.51 (0.11)	0.06 (0.08)
Dummy for One in WTO	0.67 (1.16)	1.31 (0.90)	-0.02 (0.54)	-0.12 (0.38)
Dummy for Both in WTO	0.99 (1.16)	0.96 (0.91)		
Dummy for GSP	-0.51 (0.09)	0.51 (0.07)	-0.41 (0.08)	0.55 (0.06)
Time Fixed Effects	Yes	Yes	No	No
Country Fixed Effects	Yes	Yes	No	No
Time-Varying Country Effect	No	No	Yes	Yes
Number of Observations	4370	4370	4370	4370
R-squared	0.72	0.82	0.78	0.89
RMSE	1.61	1.26	1.43	0.99

Appendix IV.9. List of Countries in the Regressions with Disaggregated Trade

ARGENTINA
AUSTRALIA
AUSTRIA
BELGIUM
BRAZIL
CANADA
CHILE
COLOMBIA
DENMARK
FINLAND
FRANCE
GERMANY
GREECE
HONG KONG
INDIA
INDONESIA
IRELAND
ITALY
JAPAN
KOREA,SOUTH(R)
MALAYSIA
MEXICO
NETHERLANDS
NEW ZEALAND
NORWAY
PERU
PHILIPPINES
PORTUGAL
SINGAPORE
SOUTH AFRICA
SPAIN
SWEDEN
SWITZERLAND
THAILAND
TURKEY
UNITED KINGDOM
UNITED STATES
CHINA
POLAND

Appendix IV.10. Classification of Products into Homogeneous and Differentiated Categories

A. Homogeneous products

SITC 4 (rev. 1)	Name
1121	Wine of fresh grapes including grape must
1124	Distilled alcoholic beverages
1222	Cigarettes
2517	Sulphate wood pulp
3214	Coal /anthracite, bituminous/
3310	Petroleum,crude & partly refined
3321	Motor spirit, gasolene and other light oils
3411	Gas, natural
5121	Hydrocarbons and their derivatives
5122	Alcohols,phenols,phenol-alcohols,glycerine
5811	Prods of condensation, polycond. & polyaddition
6411	Newsprint paper
6412	Other printing and writing paper, machine-made
6415	Machine-made paper & paperboard, simply fnshd
6516	Yarn and thread of synthetic fibres
6732	Bars and rods of iron or steel, ex wire rod
6748	Oth. coated iron or steel plates etc under 3 mm
6821	Copper and alloys, unwrought
6822	Copper and alloys of copper, worked
6841	Aluminium and aluminium alloys, unwrought
6842	Aluminium and aluminium alloys, worked
7291	Batteries and accumulators

B. Differentiated products

SITC 4 (rev. 1)	Name
2432	Lumber, sawn, planed, etc. - conifer
5417	Medicaments
5530	Perfumery & cosmetics,dentifrices etc.
5999	Chemical products and preparations,nes
6291	Rubber tyres & tubes for vehicles and aircraft
6429	Art. of paper pulp,paper or paperboard
6522	Cotton fabrics, woven, other than grey
6537	Knitted or crochd fabrics not elast nor rubberd
6554	Coated or impregnated textile fabrics & prod.
6942	Nuts, bolts, screws, rivets, washers, etc.
6952	Other tools for use in the hand or in machines

6981	Locksmiths wares
6989	Articles of base metals, nes
7114	Aircraft - incl jet propulsion - engines
7115	Internal combustion engines, not for aircraft
7143	Statistical machines-cards or tapes-
7149	Office machines, nes
7151	Machine-tools for working metals
7171	Textile machinery
7182	Printing and bookbinding machinery
7184	Construction and mining machinery, nes
7191	Heating and cooling equipment
7192	Pumps and centrifuges
7193	Mechanical handling equipment
7195	Powered-tools, nes
7196	Other non-electrical machines
7197	Ball, roller or needle-roller bearings
7199	Parts and accessories of machinery, nes
7222	Apparatus for electrical circuits
7231	Insulated wire and cable
7241	Television broadcast receivers
7242	Radio broadcast receivers
7249	Telecommunications equipment nes
7250	Domestic electrical equipment
7293	Thermionic valves and tubes, transistors, etc.
7294	Automotive electrical equipment
7295	Electrical measuring & controlling instruments
7299	Electrical machinery and apparatus, nes
7321	Passenger motor cars, other than buses
7323	Lorries and trucks, including ambulances, etc.
7328	Bodies & parts motor vehicles ex motorcycles
7331	Bicycles & other cycles, not motorized, & parts
7341	Aircraft, heavier-than-air
7349	Parts of aircraft,balloons airships
7353	Ships and boats, other than warships
8210	Furniture
8310	Travel goods,handbags & similar articles
8411	Clothing of text fabric, not knitted crocheted
8414	Clothing and accessories,knitted or crocheted
8510	Footwear
8616	Photographic & cinematographic equipment nes
8617	Medical instruments, nes
8619	Measuring,controlling & scientific instruments
8624	Photo. film etc & develpd film other than cine.
8911	Phonographs, tape & other sound recorders etc.
8912	Phonograph records,recorded tapes,oth.sound rec
8921	Books and pamphlets,printed
8942	Childrens toys, indoor games, etc.
8944	Other sporting goods