The Effects of Exchange Rate Volatility on Agricultural Trade

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(Preliminary)

Abstract:
I extend Cho, Sheldon, and McCorriston (2002) analysis of exchange rate volatility on agricultural trade from the G-10 group of countries they used to a broad sample of developed, emerging and developing nations. I first replicate their original results showing that exchange rate volatility has a large negative impact on agricultural trade between members of G-10. I further demonstrate that this effect disappears when I analyze developed country exports to all of developed, emerging, and developing trade partners. Importantly, the impact of exchange rate volatility on agricultural trade for developed exporters is small and comparable to the impact on aggregate exports. I provide some evidence that the large negative effect of exchange rate volatility on trade among G-10 members may be due to their agricultural subsides, which exhibit similar temporal variation as the their exchange rate volatility measures.

Key words: exchange rates, volatility, agricultural trade, developing countries, gravity equation.

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I. Introduction

Ever since the break down of the Bretton Woods System in the early 1970s, when previously fixed exchange rates among major currencies ware allowed to float, researches have been interested in the effects of greater exchange rate volatility on exports. There has been significant disagreement throughout the years with evidence on both positive and negative impacts of volatility on nation's exports. Most of the earlier studies (e.g. Thursby and Thursby, 1987) find large negative impacts of the exchange rate volatility on trade. Later work, on the other hand, finds both small negative (e.g. Frankel and Wei, 1993; Eichengreen and Irwin, 1995; Frankel, 1997) and positive (Klein, 1990) effects.[1] Most of the existing studies evaluate the impact of increased exchange rate volatility on aggregate trade, ignoring the potential differences of this impact across sectors (see Maskus, 1986). Cho, Sheldon, and McCorriston (2002) is an exception. Using panel data on bilateral trade and exchange rate volatility for the set of G-10 countries, they investigate the effects of long-run real exchange rate volatility on agricultural trade in comparison to other sectors.[2] They conclude that real exchange rate volatility has a significant negative effect on agricultural trade. The estimated impact on agricultural trade is much larger than the estimated impact on trade in other sectors and on aggregate trade.

This study builds on Cho, Sheldon, and McCorriston (2002) and extends their work using a broad sample of developed, emerging, and developing countries addressing the following two important issues. First, it investigates if the original results can be generalized and apply to developing country exporters, as well as they do for the original sample of G-10 trading partners. This is an important question since the negative effect of exchange rate volatility on agricultural

[1] De Grauwe and Skudelny (2000) focus on European trade flows and find statistically significant negative effects.

[2] The group of G-10 countries includes Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Switzerland, the United Kingdom, and the United States.

trade documented in Cho, Sheldon, and McCorriston (2002) is very large (compared to the effect on aggregate trade), and because a larger fraction of developing country exports, as well as GDP, are in the agricultural sector. This means that if similarly large negative effects of exchange rate volatility on agricultural trade are uncovered for developing nations, the consequences of floating exchange rates for development could be quite grim, and the role for policy intervention would become quite important.

The second issue this study investigates is the size, itself, of the effect of exchange rate volatility on agricultural trade among the G-10 countries. The magnitude of the impact on agricultural trade found by Cho, Sheldon, and McCorriston (2002) is about five to ten times the magnitude of the impact on aggregate trade. Given the set of G-10 countries that their study considers, this may be somewhat surprising as these nations have the most developed financial institutions and derivates to hedge risk (for example, in the form of exchange rate uncertainty). Additionally, all of the G-10 countries protect and promote their agriculture very heavily and as such their agricultural exports should be better insulated from both exchange rate fluctuations and volatility than agricultural exports of many other nations. To this end, I test if results similar to those in Cho, Sheldon, and McCorriston (2002) hold for trade among other developed nations not included in their original sample, and for trade among developed and developing countries, also not considered in original study.

After analyzing the data, three important conclusions emerge. First, after successfully replicating Cho, Sheldon, and McCorriston's (2002) main results using only the group of G-10 nations, I extend their original sample to include additional developed country trading partners and show that the effect of exchange rate volatility on agricultural exports declines. As I further extend the group of importers and consider the impact of exchange rate volatility on agricultural exports from developed nations to developed, emerging, and developing countries, the effect of exchange rate volatility almost completely disappears. This comes to show that Cho, Sheldon, and McCorriston's (2002) results are specific to trade among G-10 country pairs they consider and that exchange rate volatility does not affect agricultural exports more than overall exports for developed country exporters in general.

Second, I find that exchange rate volatility has a negative impact on developing country exporters' agricultural trade. This effect, however, is small and quite comparable to the effect on aggregate trade. Last, I provide some evidence that the negative impact of the exchange rate volatility estimated with data on trade only among G-10 country pairs may be due to agricultural policies in these nations – in particular, export and domestic subsidies, whose inter-temporal variation coincides with the inter-temporal variation in the exchange rate volatility for the set of G-10.

The rest of the article is organized as follows. In the next section I relate my econometric strategy. In section III and IV, I describe the data and the construction of the exchange rate volatility measures. In section V, I present and discuss the results, and the last section concludes.

II. Econometric Specification: Gravity Equation

Following Cho, Sheldon, and McCorriston (2002), I use a gravity equation to model the determinants of bilateral trade. In its basic form, the gravity equation states that exports from country *i* to country *j*, EXP_{ij}, are proportional to the product of both countries' economic mass, usually proxied by GDP_i and/or population (POP_i), and inversely proportional to the distance,

$DIST_{ij}$, between the two nations.[3] The equation is then augmented to include other factors that may create trade resistance, such as the exchange rate volatility, XV_{ij}:

$$EXP_{ij} = \frac{\alpha_0 .(GDP_i^{\alpha_1} .POP_i^{\alpha_2}).(GDP_j^{\alpha_3} .POP_j^{\alpha_4}).\varepsilon_{ij}}{DIST_{ij}^{\alpha_5} .exp(\alpha_6 XV_{ij})}, \qquad (1)$$

where ε_{ij} is an error term assumed statistically independent from the rest of the regressors, with conditional mean of 1, and the α's are the parameters to be estimated. The theoretical literature that has developed the micro-foundations of the gravity equation includes Helpman and Krugman (1985), who develop a model of imperfect competition and trade, and Deardorff (1998), who shows that the gravity equation is also consistent with the neoclassical trade theory based on factor endowments.

I log-linearize equation (1) to arrive at the estimating equation (2):

$$lnEXP_{ij} = \alpha_0 + \alpha_1 lnGDP_i + \alpha_2 lnPOP_i + \alpha_3 lnGDP_j + \alpha_4 lnPOP_j + \\ + \alpha_5 lnDIST_{ij} + \alpha_6 XV_{ij} + \varepsilon_{ij} \qquad (2).$$

Because I use a panel data on bilateral trade, equation (2) above acquires a time dimension. Additionally, to account for multilateral resistance, importer and exporter fixed effects, or dyadic (importer-exporter pair) fixed effects are usually included. Following Cho, Sheldon, and McCorriston (2002), I include dyadic fixed effects, μ_{ij}, and estimate equation (3) below by Ordinary Least Squares (OLS):

[3] Distance is a proxy for trade/transport costs.

$$lnEXP_{ijt} = \alpha_0 + \alpha_1 lnGDP_{it} + \alpha_2 lnPOP_{it} + \alpha_3 lnGDP_{jt} + \alpha_4 lnPOP_{jt} + \\ + \alpha_5 lnDIST_{ij} + \alpha_6 XV_{ijt} + \mu_{ij} + \tau_t + \varepsilon_{ijt} \quad (3),$$

where τ_t's are a full set of year dummies. Because of the dyadic fixed effects, the impact of exchange rate volatility on trade is estimated only using within-pair variation of XV_{ijt} over time.

Additional factors that may enhance or resist trade are also typically included in equation (3). The most common among factors included in the gravity equation are (dummy for) regional trade agreements, RFTA_{ijt}, the distance between the two countries, (indicators for) common language and common border, as well as colonial ties between the trading partners. I add RFTA_{ijt} as a determinant of exports in equation (3) but since this specification includes the dyadic fixed effects, μ_{ij}, and there is no variation in any of the rest of the additional factors within country-pair over time, their impacts are reduced to a fixed effect and absorbed in μ_{ij} in the present framework.[4]

III. Data

The bilateral trade data comes from Feenstra (1996), and Feenstra, Romalis, and Schott (2002). The data is disaggregated (four-digit Standard Industrial Trade Classification, SITC revision 3) times series of bilateral trade between the 87 countries included in the study.[5] See Table 1 for the countries included, which represent a broad sample of developed, emerging and developing economies as classified by the International Monetary Fund (IMF). In particular, in addition to

[4] See Table 2 for information on the Free Trade Agreements (RFTA_{ijt}) for the countries in the sample.

[5] Both trade and GDP are in current U.S. dollars.

Cho, Sheldon, and McCorriston's (2002) sample of G-10 countries, this study also considers another 13 advanced economies.

Data on GDP come from the World Bank's World Development Indicators (2002). Information on geographical area and location as well as dummies indicating contiguity, common language, and colonial ties come from the CIA's World Factbook. Bilateral distance is computed using the great circle distance algorithm provided by Andrew Gray (2001). Information on regional free-trade agreements (RFTA) comes from Teneryro (2007), and it was originally collected by Frankel (1997) and the World Trade Organization (WTO). Finally, data on monthly bilateral exchange rates are from the IMF's *International Financial Statistics*. Table 3 presents summary statistics. Note, that agricultural exports are about 18 percent of total exports for the entire sample of countries, while they are only about 13 percent of total exports for the G-10 group. This highlights the importance of agricultural exports for emerging and developing nations. The last two rows of the Table 2 present summary statistics for the two main exchange rate volatility measures that I use throughout my analysis – the short and long-run exchange rate volatility, $\mathrm{XV}_{ijt}^{\mathrm{SR}}$ and $\mathrm{XV}_{ijt}^{\mathrm{LR}}$, which I define in the next section.

IV. Measuring Exchange Rate Volatility

While a variety of exchange rate volatility measures have been used in the literature, there is still no consensus on which measure is most appropriate (see Clark, Tamirisa, and Wei, 2004). The disagreement is partly due to the fact that there is no generally accepted theory of the impact of exchange rate volatility on firm behavior. Additionally, what type of volatility measure is used depends on a number of other factors such as the level of aggregation of the trade flows (bilateral vs. multilateral), and the time horizon (short-run vs. long-run). Because analyzing bilateral trade data provides more insights into the impacts of exchange rate volatility on trade, I use such data and consider the effects of bilateral exchange rata volatility on trade across different country pairs over time. Most often, the volatility measure used incorporates some variant of the standard deviation of the annual or monthly exchange rate (see, for example, Cho, Sheldon, McCorriston, 2002; Clark, Tamirisa, and Wei, 2004; Frankel and Wei, 1993; Rose, 2000; Tenreyro, 2007). I use the most common short-run and long-run measures (and econometric set-ups) utilized in the literature recently (see Clark, Tamirisa, and Wei, 2004; Tenreyro, 2007). In particular, I measure the short-run exchange rate volatility between countries *i* and *j* in year *t*, $\mathrm{XV}_{ijt}^{\mathrm{SR}}$, as the standard deviation of the first difference of (the natural logarithm of) the monthly exchange rate between the two countries, $\mathrm{X}_{ijt,m}$, over one-year period:

$$\mathrm{XV}_{ijt}^{\mathrm{SR}} = \mathrm{St.\,Dev.}[ln\mathrm{X}_{ijt,m} - ln\mathrm{X}_{ijt,m\text{-}1}], \quad m = 1, 2, ..., 12. \quad (4)$$

Additionally, the long-run exchange rate volatility between countries *i* and *j* in year *t*, $\mathrm{XV}_{ijt}^{\mathrm{LR}}$, is measured as the standard deviation of the first difference of (the natural logarithm of) the monthly exchange rate between the two countries, $\mathrm{X}_{ijt,m}$, over five-year period ending the year prior to year *t*:

$$\mathrm{XV}_{ijt}^{\mathrm{LR}} = \mathrm{St.\,Dev.}[ln\mathrm{X}_{ijt,m,k} - ln\mathrm{X}_{ijt,m\text{-}1,k}], \quad m = 1, 2, ..., 12; \quad k = t-1, ..., t-5. \quad (5)$$

I adopted the econometric framework in (3) to both of these measures following Rose (2000), Clark, Tamirisa, and Wei (2004), and Teneryro (2007). In particular, I estimate (3) with $\mathrm{XV}_{ijt}^{\mathrm{SR}}$ as a proxy for the short-run exchange rate volatility, using trade data for each year *t* from 1970 to 1997. Additionally, I estimate (3) with $\mathrm{XV}_{ijt}^{\mathrm{LR}}$ as a proxy for the medium to long-run exchange rate volatility, using trade data for years 1975, 1980, 1985, 1990, and 1995, with $\mathrm{XV}_{ijt}^{\mathrm{LR}}$ computed over the five years preceding the year the estimation.

To check for robustness, I also calculate two other long-run exchange rate volatility measures: the real exchange rate volatility measure, RXV_{ijt}^{LR}; and a measure which reflects previous experience with the highs and the lows of the exchange rate, $MaxMinXV_{ijt}^{\mathrm{LR}}$. To compute RXV_{ijt}^{LR}, I use information on consumer prices (Consumer Price Indices) supplied by the IMF's *International Financial Statistics*, in order to adjust the nominal exchange rates, $\mathrm{X}_{ijt}^{\mathrm{LR}}$ and transform them into real exchange rates, RX_{ijt}^{LR}.[6] I then use equation (5) above substituting the real exchange rates, RX_{ijt}^{LR} for the nominal rates $\mathrm{X}_{ijt}^{\mathrm{LR}}$, to calculate the real exchange rate volatility, RXV_{ijt}^{LR}. The second measure, $MaxMinXV_{ijt}^{\mathrm{LR}}$, is based on the difference between the maximum and the minimum exchange rates during the five years preceding the year of the estimation:

$$MaxMinXV_{ijt}^{\mathrm{LR}} = (Max\mathrm{X}_{ijt,m,k} - Min\mathrm{X}_{ijt,m,k}) / Min\mathrm{X}_{ijt,m,k}, \quad m = 1, 2, ..., 12; \quad k = t-1, ..., t-5. \quad (6)$$

V. Results and Discussion

V.1 Results

I first present the results for the long-run exchange rate volatility measure $\mathrm{XV}_{ijt}^{\mathrm{LR}}$, as this measure is closer in spirit to the one used in Cho, Sheldon, and McCorriston (2002) and comparisons may

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[6] There are a number of countries which do not have information on the price level for some years earlier in the sample. China is the only country which has no information on prices whatsoever, so it is entirely excluded from the sample when I use the real exchange rate volatility in the robustness checks.

be more appropriate. Additionally, the long run volatility is more likely to impact trade and the impact is more likely to be larger than the effect of short-run volatility because the costs of hedging uncertainly beyond the one-year horizon are fairly high. I start by estimating equation (3) with the sample of G-10 countries used by Cho, Sheldon, and McCorriston (2002) using the long-run econometric set-up and the long-run measure of exchange rate volatility XV_{ijt}^{LR}, as described in the previous section. Note that the econometric set-up and the long-run measure of exchange rate volatility that Cho, Sheldon, and McCorriston (2002) use is somewhat different than those I employ. For example, Cho, Sheldon, and McCorriston's (2002) version of the gravity equation features (the logarithm of) total bilateral trade, $ln(EXP_{ij} + EXP_{ji})$, as dependent variable instead of (the logarithm of) one-way exports, $\ln(EXP_{ij})$, used in this analysis. I use one-way trade (exports) because of my main objective – to capture the potentially different effects of exchange rate volatility on developed versus developing exporters. Additionally, Cho, Sheldon, and McCorriston's (2002) use (the logarithm of) the product of the two trading partners GDP's $, ln(GDP_{it} .GDP_{jt})$, and population, $ln(\mathrm{POP}_{it} .POP_{jt})$, instead of having them enter separately as controls. Because having those terms enter as a product instead of separately forces them to have the same estimated coefficient, which may not hold true in my analysis of developing exporters later on, I enter both GDP and both population terms separately.

Despite the slight differences in our approaches, I am successful in replicating Cho, Sheldon, and McCorriston's (2002) main result that agricultural exports are much more sensitive to the long-run exchange rate volatility, than are overall exports. Panel B of Table 4 presents the results from equation (3) estimated with data from G-10 countries using overall exports and exports from four major industries as delineated in Cho, Sheldon, and McCorriston (2002). For comparison, Panel A of Table 4 reports the main estimates of Cho, Sheldon, and McCorriston

(2002), who find that long-run exchange rate volatility has a small negative effect on total exports and ten times larger negative impact on agricultural trade among G-10 countries.[7] Using the long-run set-up of equation (3) and only employing data from the G-10 group of countries, I find that long-run exchange rate volatility does not affect overall exports, the estimated coefficient is small and positive and not statistically significant. On the other hand, the effect of long-run exchange rate volatility on agricultural exports is estimated to be large, negative and statistically significant, confirming Cho, Sheldon, and McCorriston's (2002) findings for G-10 countries. Note that the magnitude of the estimated coefficients here and in Cho, Sheldon, and McCorriston (2002) are not strictly comparable because of the different measures for long-run exchange rate volatility used. In particular, note that mean and standard deviation of XV_{ijt}^{LR} is lower than the mean the standard deviation of s_{ijt}, the measure used in Cho, Sheldon, and McCorriston (2002).[8]

Next, I extend the sample of G-10 countries, and re-estimate equation (3) for the group of 23 developed nations detailed in Table 1. The results shown in Panel c of Table 4 are not too dissimilar from Cho, Sheldon, and McCorriston's (2002) estimates but while the impact of the exchange rate volatility on agricultural trade is still fairly large, negative and statistically significant, it is now no longer statistically different from the its negative impact on overall trade. It appears therefore that Cho, Sheldon, and McCorriston's (2002) results may be specific to the sample of G-10 country pairs that they have considered.

To further investigate this hypothesis and to compare the effects of long-run exchange

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[7] See Table 2 in Cho, Sheldon, and McCorriston (2002) or Panel A of Table4,where I have reproduced their main estimates for easier comparison.

[8] See Table 3 here and Figures 1, 2, and 3 in Cho, Sheldon, and McCorriston (2002).

rate volatility on developed vs. emerging vs. developing country exporters, I estimate equation (3) splitting the overall sample of countries into 3 groups – developed, emerging, and developing exporters (see Table 1). In particular, the sample of developed exporters includes only developed exporters, but any nation (developed, emerging, or developing) can be an importer. The results by country exporter are presented Table 5. Panel A shows the estimates for developed exporters. This sample is different from the sample in Panel C of Table 4 because it allows the importing countries to be not only developed but also emerging and developing. The estimates now are markedly different from any of the previous coefficients in Table 4. The impact of XV_{ijt}^{LR} on overall exports (as well as Machinery, Chemicals, and Other Manufacturing) is smaller than before, still negative and statistically significant. However, the effect of XV_{ijt}^{LR} on agricultural trade while negative is very small and not statistically significant. This reinforces the conclusions that Cho, Sheldon, and McCorriston's (2002) results are specific to the sample of G-10 country pairs they have considered and that long-run exchange rate volatility does not affect agricultural exports more than overall exports for developed country exporters. In fact, the estimates in Panel A of Table 5 show that the impact of XV_{ijt}^{LR} on agricultural exports is not statistically significantly different from 0, while the impact on overall exports negative and statistically different from 0 at the 1 percent level.

The impacts of XV_{ijt}^{LR} for emerging country exporters are very similar – exchange rate volatility affects overall trade (as well as Machinery, Chemicals, and Other Manufacturing) adversely, but it has no statistically or economically significant impact on agricultural trade. The estimates for developing country exporters, on the other hand, are different – XV_{ijt}^{LR} affects both overall and agricultural trade negatively and the estimated coefficients for the two are statistically significant and almost identical in magnitude. This finding is consistent with the idea that agricultural producers and exporters in developing countries may have limited access to financial institutions and limited hedging opportunities compared to agricultural producers and exporters from developed nations.

I next discuss the results from equation (3) using the short-run exchange rate volatility measure, XV_{ijt}^{SR}. The estimates are presented in Tables 6 and 7 and they mirror the results obtained with the long-run measure of exchange rate volatility. I first estimate equation (3) with the sample of G-10 countries used by Cho, Sheldon, and McCorriston (2002). The results are fairly similar to both Cho, Sheldon, and McCorriston's (2002) estimates and the estimates with the long-run exchange rate volatility measure in Table 4. Using the short-run volatility measure, XV_{ijt}^{SR}, in Panel A of Table 6, I am again able to successfully replicate Cho, Sheldon, and McCorriston's (2002) main result, which states that exchange rate volatility affects agricultural trade much more than it affects overall trade. Note, however, that, as expected, the impact of short-run volatility on agricultural trade is much smaller than the impact of long-run volatility. The coefficient on XV_{ijt}^{LR} in Panel B of Table 4 is - 11.71 (- 4.00), while the coefficient on XV_{ijt}^{SR} in Panel A of Table 6 is - 2.66 (- 3.25) – almost three times smaller. These coefficients can be meaningfully compared because the two volatility measures that I have computed have very similar (means and) standard deviations, which implies that a one standard deviation increase in XV_{ijt}^{LR} would have more than three times larger impact than a one standard deviation increase in XV_{ijt}^{SR}. This finding is consistent with the idea that long run volatility is more likely to impact trade and the long-run volatility impact is more likely to be larger than the effect of short-run volatility because the costs of hedging uncertainly beyond the one-year horizon are fairly high.

When I extend the initial sample of G-10 country pairs, to all developed country pairs in Panel B, the impact of XV_{ijt}^{SR} on agricultural trade is still larger than the impact on overall trade, but they are now both negative and no longer statistically significantly different from one another. In Table 7, I again, investigate the effects of this time short-run exchange rate volatility by exporting country development status. Three important conclusions emerge from these estimates. First, the effect of short-run volatility is the same for both overall and agricultural trade for each group of exporters – developed, emerging and developing. Second, not only is the impact of XV_{ijt}^{SR} the same for both over and agricultural trade, but it is also very similar across country exporter types, i.e. the effect of XV_{ijt}^{SR} on overall and agricultural trade is the same for the group of developed exporters and for the group of developing exporters, and the magnitude of this impact is fairly similar across the two groups, as well. Third, for developing exporters, the magnitude of the impact of the short-run volatility is considerably smaller, than the magnitude of impact of the long-run volatility – the estimate in Panel C of Table 7, - 0.43 (- 3.08), is less than half the estimate in Panel C of Table 5, - 1.05 (- 2.83). This finding is again consistent with the idea that short-run uncertainly is easier and less expensive to hedge than long-run uncertainty.

Overall, both the long-run and the short-run volatility results support the conclusion that exchange rate volatility has a particularly adverse impact on agricultural trade only when G-10 country pairs are considered. Once the sample is enlarged, the results disappear. In particular, when I analyze exports from developed nations to other developed, emerging, or developing countries, the impact of exchange rate volatility on agricultural trade becomes smaller than the impact on overall trade, or completely disappears, both economically and statistically. What then brings about such a large negative impact when only G-10 country pairs are considered? I return to this question, once I report the results from a number of robustness checks in the following section.

V.2 Robustness Checks

As I previously discussed, using real exchange rates is preferable on theoretical grounds although it is the nominal exchange rates that policy makers (monetary authority) can directly affect. In practice, the bilateral real exchange rate follows the bilateral nominal exchange rate fairly closely for developed country pairs because the price level for such nations changes very slowly. For developing countries, however, the price level may change rather quickly and drastically, and so the real exchange rate may not necessarily track the nominal one. As such, one would expect that the impact of the real exchange volatility, RXV_{ijt}^{LR}, would be fairly similar to the impact of the nominal rate volatility, $\mathrm{XV}_{ijt}^{\mathrm{LR}}$, at least for the for the set of G-10 countries. In Panel A of Table 8, I report estimates for regression (3) using the long-run specification for overall and agricultural trade in the group of G-10 countries. The results are very similar to those reported in Panel B of Table 4, where I use the nominal exchange rate volatility, $\mathrm{XV}_{ijt}^{\mathrm{LR}}$, and to the results in Cho, Sheldon, and McCorriston's (2002).[9] The real rate volatility, RXV_{ijt}^{LR}, doe not affect overall exports but has a large negative impact on agricultural exports for group of G-10 countries.

Further, I estimate (3) with overall and agricultural trade for developed and developing

[9] Cho, Sheldon, and McCorriston's (2002) use the real exchange rate volatility measure, so these results may be even more closely comparable with theirs. However, as I already discussed, because the price level changes slowly in the group of G-10 countries, in practice, the real rate moves in a lockstep with the nominal rate.

country exporters. The results parallel the results with the nominal rate volatility reported in Table 5. The real exchange rate volatility, RXV_{ijt}^{LR}, has a small negative impact on overall exports for developed exporters and even smaller and not statistically significant effect for developing countries. Additionally, there is a small impact on agricultural exports for either developed or developing nations, but again the coefficients are not precisely estimated. All of the estimates using the real exchange rate volatility, RXV_{ijt}^{LR}, are fairly similar to those using the nominal rate volatility and lead to the same conclusions reached before – exchange rate volatility has a large negative impact on agricultural trade only when the group of G-10 countries is considered, and it has a small effect, comparable to the effect on overall trade, when all developed, or developing exporters are considered.

I perform an additional robustness check using another volatility measure, $MaxMinXV_{ijt}^{LR}$, which takes into account the previous highs and lows of the nominal exchange rate, XV_{ijt}^{LR}. The results are presented in Panel B of Table 8. The results when using $MaxMinXV_{ijt}^{LR}$ as a measure of nominal exchange rate volatility indicate that volatility does affect overall and agricultural trade when only the group pf G-10 pairs is considered, and it does not affect either overall, or agricultural trade when all developed or developing exporters are analyzed. These estimates therefore also support the conclusion that there is something special about the group of G-10 countries trading with each other that gives rise to such a negative impact of the exchange rate volatility on agricultural trade. This is what I set out to investigate in the next section.

V.3 Exchange Rate Volatility and G-10.

As already noted, it is somewhat puzzling that G-10 agricultural exports are so sensitive to exchange rate volatility given that G-10 exporters are most likely to be able to hedge exchange rate uncertainty. As shown in the previous sections, the negative effect for developed exporters shrinks and in some specifications even disappears when all countries (developed, emerging, and developing) are included in the set of importers. Still, why is the negative effect present when one considers trade amongst G-10 countries alone? There are a number of similarities among that set of nations, and probably the most relevant is their agricultural policies. The countries in the European Community (Belgium, France, Germany, Italy, the Netherlands, Switzerland, and the United Kingdom), Canada, Japan , and the United States have common agricultural policies, both domestic and trade policies alike.[10] It is therefore possible that their domestic or trade-oriented agricultural policies are correlated with the exchange rate volatility measure and potentially produces a spurious negative correlation detected for agricultural exports among G-10 countries.

To investigate this scenario, I first test if any particular agricultural product or group of products is responsible for the negative impact of exchange rate volatility on total agricultural exports, I use disaggregated export data and implement regression equation (3) for the group of G-10 countries using the benchmark long-run nominal exchange rate volatility measure, $\mathrm{XV}_{ijt}^{\mathrm{LR}}$. Table 9 presents the results by agricultural sub-industry/product. It reports the estimated coefficient of $\mathrm{XV}_{ijt}^{\mathrm{LR}}$ on the particular agricultural product exports for G-10 country pairs, and additionally for developed and developing exporters. The bench mark impact of $\mathrm{XV}_{ijt}^{\mathrm{LR}}$ on total

[10] Countries from the European Community have a set of common agricultural policies – the Common Agricultural Plan (CAP).

agricultural exports for G-10 pairs is - 11.71 (4.00). The estimates in Table 9 reveal that there are 6 agricultural products whose exports are much more sensitive (the coefficient is economically large and statistically significant) to the nominal rate volatility than are total agricultural exports. In particular, those products are live animals, cereals, sugar, raw hides, pulp, and crude fertilizers. Additionally, cereals, which include wheat, rice, barley, and maize, are by far the most important contributor to the negative impact because their weight in the total value of agricultural exports is the largest of all 6 products.

I next show that export subsidies, especially for cereals, in the United States and the European Community are positively correlated with the exchange rate volatility measures for the U.S. dollar and all the European currencies considered in this analysis. These export subsidies, took the form of export bonuses through the Export Enhancement Program (EEP) in the United States and export restitution payments in the European Community. In particular, the EEP was started in 1985 after several years of declining U.S. agricultural exports due to a strong dollar, high commodity loan rates, global recession, and export subsidies of the European Community, which helped competing products establish presence in traditional U.S. markets.[11] Targeted to specific markets outside the European Community, more than 75 percent of the total EEP spending was on wheat export bonuses.[12] [13] According to the Economic Research Service (ERS) at the United States Department of Agriculture (USDA) after the start of the EEP in 1985, the European Community export restitutions for wheat grew from $365 million to $1.8 billion in 1988. It is unclear, however, if E.C. restitutions were targeted to specific markets to counter

[11] The United States had previously discontinued a long-standing agricultural export subsidy program in 1973.

[12] Five countries Algeria, Egypt, Former Soviet Union, Morocco, and the People's Republic of China account for 75 percent of all EEP export bonuses (see GAO Report # 94-79).

[13] The targeted markets were ones where U.S. competitors, the E.C. in particular, heavily subsidized their exports.

EEP bonuses (see Haley, 1989).

The rise in these targeted export subsidies for the U.S. and the E.C. exporters would have lead to channeling U.S. and E.C. agricultural exports away from the U.S. and E.C. markets and towards the targeted markets, i.e. those targeted export subsidies would have lead to a decrease in agricultural exports from the U.S. and E.C. to the U.S. and E.C. markets. Thus, if bilateral exchange rate volatility for the U.S. and E.C. currencies has a negative impact on exports and it is positively correlated with the targeted export subsidies, it is quite plausible that the impact of the exchange rate volatility for exports among the group of G-10 is exaggerated because the analysis does not adequately account for the variation in the targeted agricultural export subsidies for those exporters over time.

Although data on export subsidies for the E.C. countries is not readily available, I use limited data on measures of producer subsidy equivalent (PSE) from the ERS and OECD, as well as data on EEP payments form Government Accountability Office (GAO) report 94-79 to show that there is some evidence that points towards a positive correlation between the nominal exchange rate volatility and export-oriented subsidies in the U.S. and the E.C. countries.

First, I provide evidence that the volatility of the nominal bilateral exchange rates between the U.S. dollar and the rest of the G-10 currencies is positively correlated with the agricultural EEP payments in the U.S. As Cho, Sheldon, and McCorriston's (2002) main result was shown to hold using both the long and the short-run nominal volatility measure, I use the short-run set-up first because provides more time series data for testing. I perform the following regression:

$$XV_{US,jt}^{\mathrm{SR}} = \beta_0 + \beta_1 EEP_{US,t} + \mu_{ij} + \tau_t + \varepsilon_{ijt} \qquad (7),$$

where $EEP_{US,t}$ is the U.S. EEP payments (adjusted for inflation) for year *t*, *t* = 1970, …, 1997, and *j* is a trading partner from the set of the remaining G-10 countries. Additionally, I estimate the same equation for the long-run U.S. bilateral nominal volatility $\mathrm{XV}_{US,jt}^{\mathrm{LR}}$, but omitting the time dummies as there are only 5 cross-sections for t = 1975, 1980, 1985, 1990, 1995. The results are presented in Table 10. The estimate of β_1 is positive and statistically significant in each case, confirming the EEP payments are positively correlated with the nominal exchange rate volatility measures.

Further, I estimate the following regression equation

$$XV_{EC,jt}^{\mathrm{SR}} = \gamma_0 + \gamma_1 PSE_{EC,t} + \mu_{ij} + \tau_t + \varepsilon_{ijt} \qquad (8),$$

with data on volatility of bilateral exchange rates between E.C. countries and their G-10 trading partners (*j* is again, a trading partner from the set of the remaining G-10 countries); $PSE_{EC,t}$ is a measure of overall producer subsidy equivalent (PSE) for E.C. exporters. I use $PSE_{EC,t}$ because precise measures for export subsidies for E.C. countries are not available – the PSE estimates are constructed by the ERS and are available for all G-10 countries but Switzerland from 1982 to 1992. The estimate of γ_1 presented in Panel A of Table 10 is positive and statistically significant, indicating that the inter-temporal variation of trade and domestic subsidies (as captured by producer subsidy equivalents) in E.C. countries is similar to the inter-temporal variation of the exchange rate volatility measure. Further, I correlate $PSE_{EC,t}$ for E.C. countries to a measure which captures trade subsidies for wheat in the European Community. There exists a strong positive correlation between the two (simple OLS regression of $PSE_{EC,t}$ on the E.C. Wheat Trade Subsidy is reported) indicating that some of the variation in $PSE_{EC,t}$ is indeed driven by trade subsidies given to E.C. wheat exporters.

Because precise data on agricultural trade subsidies for most G-10 countries is not available, I use producer subsidy equivalent measures (PSE) for all countries to check if similar positive inter-temporal correlation between their bilateral exchange rate volatility measure and a measure of agricultural producer's support (PSE) exists when all G-10 countries are considered. The estimate, reported in the last column of Panel A of Table 10, shows a strong negative inter-temporal correlation which must be driven by G-10 members other than E.C. whose trade and domestic agricultural policies are strongly negatively correlated with their exchange rate volatility measures.

Finally, to check if the effect of exchange rate volatility on agricultural trade among G-10 trading partners can be due to domestic and export agricultural trade subsidies, I include the producer subsidy equivalent as a control variable in the export equation (3). Because I have limited data on PSE_{it}, I first estimate equation (3) for the sample years and G-10 countries which have information on PSE_{it}. The estimates for overall and agricultural exports are presented in the first and third column of Panel B of Table 10. The results are very similar to the estimates from the full sample. I then add PSE_{it} as a control variable on the right hand side of equation (3). There is almost no change for the aggregate exports estimates, however, the impact of exchange rate volatility on agricultural trade declines to about half of its original size and it is no longer statistically significantly different from 0. This provides some evidence that the effects of exchange rate volatility on agricultural exports for G-10 country pairs may be spurious driven by the inter-temporal correlation between the exchange rate volatility measure and the agricultural subsidies in G-10 countries.

VI. Conclusion

This study builds on Cho, Sheldon, and McCorriston (2002) and extends their work on exchange rate volatility and agricultural trade by incorporating a broad sample of developed, emerging, and developing countries in the analysis. Three important conclusions emerge. First, after successfully replicating Cho, Sheldon, and McCorriston's (2002) main results which states that exchange rate volatility affect agricultural trade much more than it affect aggregate trade in the group of G-10 nations, I extend their original sample to include additional developed country trading partners and show that the effect of exchange rate volatility on agricultural exports declines. As I further extend the group of importers and consider the impact of exchange rate volatility on agricultural exports from developed nations to developed, emerging, and developing countries, the effect of exchange rate volatility almost completely disappears. This comes to show that Cho, Sheldon, and McCorriston's (2002) results are specific to trade among G-10 country pairs they consider and that exchange rate volatility does not affect agricultural exports more than overall exports for developed country exporters in general.

Second, I find that exchange rate volatility has a negative impact on developing country exporters' agricultural trade. This effect, however, is small and quite comparable to the effect on aggregate trade. Last, I provide some evidence that the negative impact of the exchange rate volatility estimated with data on trade only among G-10 country pairs may be due to agricultural policies in these nations – in particular, export and domestic subsidies, whose inter-temporal variation coincides with the inter-temporal variation in the exchange rate volatility for the set of G-10.

References

Clark, P., Tamirisa, N., Wei, S., "Exchange Rate Volatility and Trade Flows - Some New Evidence," IMF report, 2004.

Cho, G., Sheldon, I., McCorriston S., "Exchange Rate Uncertainty and Agricultural Trade," American Journal of Agricultural Economics, 84(4): 2002, 931-942.

Deardoff, A. (1998). "Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World?" in Jeffrey Frankel (ed.), The Regionalization of the World Economy. Chicago, IL: University of Chicago Press.

De Grauwe, P. and F. Skudelny (2000). "The Impact of EMU on Trade Flows," *Weltwirtschaftliches Archiv*, 136, 381-400.

Economic Research Service (ERS), United States Department of Agriculture (USDA) – *http://www.ers.usda.gov*.

Eichengreen, B. and Irwin, D.A. "Trade Blocs, Currency Blocs and the Reorientation of Trade in the 1930s." *Journal of International Economics*, 38 (1995): 1-24.

Feenstra, Robert, "U.S. Imports 1972-1994: Data and Concordances." NBER W. P. #5515, 1996.

Feenstra, Robert, Romalis, John, and Peter Schott, "U.S. Imports, Exports, and Tariff Data, 1989-2001," NBER W. P. #9387, 2002.

Frankel, J. (1997), Regional Trading Blocs in the World Economic System. Washington, DC: Institute for International Economics.

Frankel, J. and S. Wei (1993). "Trade Blocs and Currency Blocs," NBER Working Paper No. 4335.

Goldberg, P., Knetter, M., "Causes and Consequencesof the Export Enhancement Program for Wheat." NBER working paper # 5359, 1995.

Government Accountability Office (GAO) Report # 94-79 – *http://www.gao.gov*.

Gray, A. (2001). http://argray.fateback.com/dist/formula.html.

Helpman, E. and P. Krugman (1985). Market Structure and Foreign Trade. Cambridge, MA: MIT Press.

Hooper, P. and Kohlhagen, S.W. "The Effect of Exchange Rate Uncertainty on the Prices and Volume of International Trade." *Journal of International Economics*, 8 (1978): 483-511.

Klein, M.W., 1990. “Sectoral Effects of Exchange Rate Volatility on United States Exports.” *Journal of International Money and Finance*, 9 (1990): 299-308.

Langley, S.V., Guigale, M., Meyers, W.H. and Hallahan, C. “International Financial Volatility and Agricultural Commodity Trade: A Primer.” *American Journal of Agricultural Economics*, 82 (2000): 695-700.

Maskus, K. “Exchange Rate Risk and US Trade: A Sectoral Analysis.” *Federal Reserve Bank of Kansas Economic Review*, 3 (1986): 16-28.

Pick, D.H. “Exchange Rate Risk and US Agricultural Trade Flows.” *American Journal of Agricultural Economics*, 72 (1990): 694-700.

Tenreyro, Silvana, “On the Trade Impact of Nominal Exchange Rate Volatility,” forthcoming Journal of Development Economics, 2007.

Thursby, J.G. and Thursby, M.C. “Bilateral Trade Flows, the Linder Hypothesis and Exchange Rate Risk.” *Review of Economics and Statistics*, 69 (1987): 488-495.

Table 1. Country List. Countries in the group of G-10 are marked with an asterisk (*).

Developed Economies	Emerging Economies	Developing Economies
Australia	Argentina	Algeria
Austria	Brazil	Benin
Belgium *	Chile	Bolivia
Canada *	China (Mainland)	Burkina-Faso
Denmark	Colombia	Burundi
Finland	Ecuador	Cameroon
France *	Hong Kong	Central African Republic
Germany *	Hungary	Chad
Greece	Indonesia	Congo (Dem. Rep.)
Iceland	Korea (South)	Congo (Rep.)
Ireland	Malaysia	Costa Rica
Israel	Mexico	Cote d'Ivoire
Italy *	Panama	Dominican Republic
Japan *	Peru	Egypt
Netherlands *	Philippines	El Salvador
New Zealand	Singapore	Gabon
Norway	South Africa	Gambia
Portugal	Thailand	Ghana
Spain	Turkey	Guatemala
Sweden	Uruguay	Guyana
Switzerland *	Venezuela	Haiti
United Kingdom *		Honduras
United States *		India
		Jamaica
		Madagascar
		Malawi
		Mali
		Malta
		Mauritania
		Morocco
		Nepal
		Niger
		Nigeria
		Pakistan
		Paraguay
		Saudi Arabia
		Senegal
		Sri Lanka
		Suriname
		Syria
		Togo
		Zambia
		Zimbabwe

Table 2. List of Regional Free-Trade Agreements (RFTA) for the sample of countries in Table 1, 1970-1997.

EU		**Andean Community**	
Austria	1995 -	Bolivia	1992 -
Belgium	1967 -	Colombia	1992 -
Denmark	1973 -	Ecuador	1992 -
Finland	1995 -	Venezuela	1992 -
France	1967 -		
Germany	1967 -	**Caricom (Caribbean Community)**	
Greece	1981 -	Jamaica	1968 -
Ireland	1973 -	Dominica	1968 -
Italy	1967 -	Guyana	1995 -
Netherlands	1967 -	Suriname	1995 -
Portugal	1986 -		
Spain	1986 -	**Mercosur (Mercado Comun del Sur)**	
Sweden	1995 -	Argentina	1991 -
United Kingdom	1973 -	Brazil	1991 -
		Paraguay	1991 -
EFTA(European Free Trade Association)		Uruguay	1991 -
Austria	1960 – 1995	Bolivia	1996 -
Denmark	1960 – 1972		
Norway	1960 -	**Australia-New Zealand CER**	
Portugal	1960 – 1985	Australia	1983 -
Sweden	1960 – 1995	New Zealand	1983 -
Switzerland	1960 -		
Iceland	1970 -	**Customs Union of West African States**	
Finland	1986 – 1995	Benin	1994 -
UK	1960 – 1972	Burkina Faso	1994 -
		Cote d'Ivoire	1994 -
EEA(European Economic Area)		Mali	1994 -
Iceland	1994 -	Niger	1994 -
Norway	1994 -	Senegal	1994 -
Austria	1994 -	Togo	1994 -
Finland	1994 -		
Sweden	1994 -	**Israel/US**	
EU	1994 -	Israel	1985 -
		US	1985 -
NAFTA			
Canada	1989 -	**Israel/EU**	
Mexico	1994 -	Israel	1996 -
US	1989 -	EU	1996 -
Group of Three		**Israel/EFTA**	
Colombia	1995 -	Israel	1993 -
Mexico	1995 -	EFTA	1993 -
Venezuela	1995 -		
		Israel/Canada	
		Israel	1997 -
		Canada	1997 -

Table 3. Summary Statistics.

Variable	All Country pairs		G-10 country pairs	
	Mean	St. Dev.	Mean	St. Dev.
EXP_{ijt}^{TOTAL} (Million $)	451	2,965	10,356	16,268
$EXP_{ijt}^{AGRICULTURE}$ (Million $)	81	463	1,370	2,432
GDP_{it}^{EXP} (Million $)	256,949	769,599	1,097,799	1,537,468
GDP_{it}^{IMP} (Million)	251,390	767,694	1,097,799	1,537,468
POP_{it}^{EXP} (Million)	57	160	66	67
POP_{it}^{IMP} (Million)	51	148	66	67
RFTA_{ijt}	0.07	0.25	0.34	0.47
$\text{XV}_{ijt}^{\text{SR}}$	0.034	0.064	0.019	0.011
$\text{XV}_{ijt}^{\text{LR}}$	0.049	0.064	0.021	0.008
N	23,809		450	

Table 4. Effects of long-run exchange rate volatility on exports – comparison across Cho, Sheldon, McCorriston (2002) results and estimates from an expanded set of developed countries.

Panel A: Cho, Sheldon, McCorriston (2002) benchmark results (G-10 country pairs). Dependent variable is $log(EXP_{ijt} + EXP_{jit})$.

	Total	Machinery	Chemicals	Other Manufacturing	Agricultural
$log(GDP_{it}^{EXP} GDP_{it}^{IMP})$	1.10***	1.24***	1.02***	0.76***	0.01
	(25.1)	(21.6)	(14.4)	(11.7)	(0.04)
$log(\mathrm{POP}_{it}^{EXP} \mathrm{POP}_{it}^{IMP})$	- 1.17***	- 0.03	- 1.80***	- 1.08***	- 1.60***
	(- 7.48)	(- 0.83)	(- 7.29)	(- 4.66)	(- 3.83)
s_{ijt}	- 0.10***	- 0.05***	- 0.05	- 0.18***	- 0.58***
	(- 2.69)	(3.77)	(- 0.64)	(- 2.72)	(- 13.9)
R^2	0.99	0.99	0.98	0.98	0.98
N	990	990	990	990	990

Panel B: Estimates from equation (3), Cho, Sheldon, McCorriston (2002) sample of G-10 countries. Dependent variable is $log(EXP_{ijt})$.

	Total	Machinery	Chemicals	Other Manufacturing	Agricultural
$log(GDP_{it}^{EXP})$	0.33***	0.26**	0.28***	- 0.08	- 4.48***
	(4.20)	(2.56)	(3.29)	(- 0.78)	(- 5.26)
$log(GDP_{jt}^{IMP})$	0.78***	0.74***	0.49***	0.87***	0.78***
	(11.40)	(7.38)	(5.83)	(9.57)	(7.19)
$log(\mathrm{POP}_{it}^{EXP})$	- 2.55***	1.55**	- 1.96***	- 2.80***	- 4.06***
	(- 5.58)	(2.15)	(- 2.77)	(- 4.32)	(- 7.71)
$log(\mathrm{POP}_{jt}^{IMP})$	- 0.35	- 0.76	- 0.30	- 0.82	1.12**
	(- 0.82)	(- 1.25)	(0.58)	(- 1.61)	(2.18)
RFTA_{ijt}	0.28***	- 0.22	0.23**	0.38***	0.31***
	(3.33)	(- 1.42)	(2.56)	(4.53)	(3.17)
$\mathrm{XV}_{ijt}^{\mathrm{LR}}$	2.26	2.02	- 0.58	7.08**	- 11.71***
	(0.92)	(0.63)	(- 0.17)	(2.10)	(- 4.00)
R^2	0.99	0.98	0.98	0.97	0.99
N	450	450	450	450	450

Panel C: Estimates from equation (3), all developed countries. Dependent variable is $log(EXP_{ijt})$.

	Total	Machinery	Chemicals	Other Manufacturing	Agricultural
$log(GDP_{it}^{EXP})$	0.51***	0.48***	0.53***	0.23**	- 1.12
	(5.72)	(4.53)	(4.27)	(1.96)	(- 1.00)
$log(GDP_{jt}^{IMP})$	0.76***	0.98***	0.68***	0.97***	0.63***
	(10.00)	(8.17)	(5.61)	(11.64)	(6.16)
$log(\mathrm{POP}_{it}^{EXP})$	- 1.14***	3.58***	- 1.13**	- 0.11	- 2.09***
	(- 2.99)	(11.20)	(- 2.29)	(- 0.31)	(- 4.57)
$log(\mathrm{POP}_{jt}^{IMP})$	0.02	- 0.69	0.14	0.67	0.03
	(0.08)	(- 1.64)	(0.33)	(1.57)	(0.06)
RFTA_{ijt}	0.18***	0.09	0.07	0.19***	0.34***
	(4.75)	(1.55)	(1.27)	(4.07)	(7.05)
$\mathrm{XV}_{ijt}^{\mathrm{LR}}$	- 3.16**	- 4.25*	- 1.46	- 2.17	- 5.17***
	(- 2.04)	(1.77)	(- 0.64)	(- 1.19)	(- 2.86)
R^2	0.97	0.98	0.98	0.97	0.97
N	2,523	2,453	2,427	2,491	2,512

Note: t-stats are in parenthesis. $^{***}\leq$ 1 percent, $^{***}\leq$ 5 percent, $^{*}\leq$ 10 percent. Full set of year dummies included.

Table 5. Effects of long-run exchange rate volatility on exports, equation (3). Dependent variable is $log(EXP_{ijt})$.

Panel A: Developed Exporters

	Total	Machinery	Chemicals	Other Manufacturing	Agricultural
$log(GDP_{it}^{EXP})$	0.59***	0.69***	0.26***	0.07	0.36***
	(7.58)	(7.71)	(2.88)	(0.78)	(2.97)
$log(GDP_{jt}^{IMP})$	1.00***	1.06***	0.85***	1.11***	0.94***
	(23.58)	(20.25)	(16.81)	(21.52)	(15.44)
$log(\text{POP}_{it}^{EXP})$	1.03***	2.72***	1.00***	2.28***	- 0.21
	(2.97)	(7.05)	(2.69)	(5.34)	(- 041)
$log(\text{POP}_{jt}^{IMP})$	0.33**	- 0.46**	0.23	0.02	1.49***
	(2.14)	(- 2.46)	(1.29)	(0.09)	(8.46)
RFTA_{ijt}	0.11**	- 0.04	0.15***	0.07	0.30***
	(2.44)	(- 0.60)	(2.65)	(1.31)	(5.70)
$\text{XV}_{ijt}^{\text{LR}}$	- 1.00***	- 0.92***	- 1.24***	- 1.38***	-0.40
	(- 4.39)	(- 2.81)	(3.81)	(- 4.46)	(1.20)
R^2	0.98	0.98	0.98	0.97	0.98
N	9,071	8,144	7,757	8,409	8,159

Panel B: Emerging Exporters

	Total	Machinery	Chemicals	Other Manufacturing	Agricultural
$log(GDP_{it}^{EXP})$	0.50***	0.84***	0.47***	0.21**	0.07
	(7.05)	(8.47)	(5.22)	(2.51)	(0.91)
$log(GDP_{jt}^{IMP})$	0.82***	0.81***	0.78***	0.88***	0.63***
	(11.27)	(8.08)	(7.53)	(9.17)	(7.24)
$log(\text{POP}_{it}^{EXP})$	0.81**	2.92***	2.91***	2.13***	- 1.16***
	(2.26)	(5.99)	(6.63)	(4.76)	(- 2.61)
$log(\text{POP}_{jt}^{IMP})$	1.93***	- 1.36***	0.79**	2.26***	2.71***
	(8.12)	(- 3.77)	(2.38)	(7.29)	(9.70)
RFTA_{ijt}	- 0.60***	- 0.52**	0.19	- 1.21***	0.43**
	(- 4.07)	(- 2.41)	(1.13)	(- 6.57)	(2.44)
$\text{XV}_{ijt}^{\text{LR}}$	- 0.80***	- 1.67***	- 0.86**	- 1.04***	- 0.15
	(- 2.95)	(- 3.66)	(2.33)	(- 2.89)	(- 0.45)
R^2	0.97	0.97	0.97	0.97	0.97
N	6,791	4,824	4,382	5,968	5,671

Panel C: Developing Exporters

	Total	Machinery	Chemicals	Other Manufacturing	Agricultural
$log(GDP_{it}^{EXP})$	0.31***	0.58***	- 0.32	0.21	- 0.08
	(3.45)	(2.95)	(- 1.38)	(1.61)	(- 0.93)
$log(GDP_{jt}^{IMP})$	0.67***	0.99***	0.32	0.53***	0.65***
	(6.29)	(5.02)	(1.42)	(3.49)	(5.97)
$log(\text{POP}_{it}^{EXP})$	0.03	- 0.59	4.37***	- 1.19**	1.73***
	(0.09)	(- 0.88)	(4.13)	(- 2.14)	(3.81)
$log(\text{POP}_{jt}^{IMP})$	3.27***	- 0.09	0.27	1.30***	3.21***
	(10.76)	(- 0.14)	(0.38)	(3.08)	(10.35)
RFTA_{ijt}	- 0.13	- 0.76	- 1.73***	- 0.43	- 0.26
	(- 0.61)	(- 1.23)	(- 4.51)	(- 1.24)	(- 1.33)
$\text{XV}_{ijt}^{\text{LR}}$	- 1.11***	- 1.48	- 2.33*	- 1.03*	- 1.05***
	(- 3.26)	(- 1.28)	(- 1.89)	(- 1.95)	(- 2.83)
R^2	0.98	0.98	0.98	0.97	0.97
N	7,754	2,580	2,210	5,145	6,350

Note: t-stats are in parenthesis. *** ≤ 1 percent, *** ≤ 5 percent, * ≤ 10 percent. Full set of year dummies included.

Table 6. Effects of short-run exchange rate volatility on exports – Cho, Sheldon, McCorriston (2002) sample, and an expanded sample of developed countries. Dependent variable is $log(EXP_{ijt})$.

Panel A: Estimates from equation (3), Cho, Sheldon, McCorriston (2002) sample of G-10 countries.

	Total	Machinery	Chemicals	Other Manufacturing	Agricultural
$log(GDP_{it}^{EXP})$	0.50***	0.38***	0.38***	0.15*	- 0.44***
	(6.64)	(3.29)	(4.63)	(1.76)	(- 4.00)
$log(GDP_{jt}^{IMP})$	0.76***	0.85***	0.50***	0.89***	0.68***
	(10.85)	(6.77)	(6.23)	(9.12)	(6.10)
$log(\mathrm{POP}_{it}^{EXP})$	- 2.20***	2.24***	- 1.91***	- 2.13***	- 5.08***
	(- 4.61)	(3.13)	(- 2.96)	(- 3.24)	(- 9.94)
$log(\mathrm{POP}_{jt}^{IMP})$	0.37	1.52*	0.23	- 0.15	0.87
	(0.90)	(1.88)	(0.48)	(- 0.31)	(1.65)
RFTA_{ijt}	0.27***	- 0.26***	0.23***	0.35***	0.36***
	(5.83)	(- 2.97)	(2.50)	(4.16)	(5.71)
$\mathrm{XV}_{ijt}^{\mathrm{SR}}$	0.93	1.86	- 0.05	1.57**	- 2.66***
	(1.49)	(1.21)	(- 0.06)	(2.10)	(- 3.25)
R^2	0.97	0.96	0.97	0.97	0.96
N	1,980	1,980	1,980	1,980	1,980

Panel B: Estimates from equation (3), all developed countries.

	Total	Machinery	Chemicals	Other Manufacturing	Agricultural
$log(GDP_{it}^{EXP})$	0.72***	0.74***	0.75***	0.33***	0.08
	(9.74)	(7.84)	(6.71)	(3.39)	(0.68)
$log(GDP_{jt}^{IMP})$	0.65***	0.81***	0.47***	0.82***	0.55***
	(9.61)	(8.27)	(4.59)	(10.63)	(5.25)
$log(\mathrm{POP}_{it}^{EXP})$	- 0.76***	4.27***	- 0.53*	0.33	- 1.55***
	(- 2.79)	(14.02)	(- 1.66)	(1.22)	(- 4.38)
$log(\mathrm{POP}_{jt}^{IMP})$	- 0.01	- 0.36	0.44	0.22	- 0.03
	(- 0.02)	(- 0.99)	(1.31)	(0.64)	(- 0.07)
RFTA_{ijt}	0.23***	0.17***	0.17***	0.24***	0.36***
	(7.72)	(3.97)	(3.89)	(6.18)	(8.79)
$\mathrm{XV}_{ijt}^{\mathrm{SR}}$	- 1.33***	- 2.13***	- 0.75	-0.80*	- 2.22***
	(- 3.23)	(- 2.80)	(1.12)	(- 1.65)	(- 3.71)
R^2	0.98	0.98	0.97	0.98	0.97
N	14,091	13,744	13,600	13,948	14,026

Note: t-stats are in parenthesis. *** ≤ 1 percent, *** ≤ 5 percent, * ≤ 10 percent. Full set of year dummies included.

Table 7. Effects of short-run exchange rate volatility on exports, equation (3). Dependent variable is $log(EXP_{ijt})$.

Panel A: Developed Exporters

	Total	Machinery	Chemicals	Other Manufacturing	Agricultural
$log(GDP_{it}^{EXP})$	0.61^{***}	1.00^{***}	0.50^{***}	0.11	0.33^{***}
	(8.66)	(13.08)	(6.16)	(1.35)	(3.34)
$log(GDP_{jt}^{IMP})$	0.94^{***}	0.99^{***}	0.80^{***}	1.05^{***}	0.87^{***}
	(28.20)	(24.57)	(20.17)	(27.14)	(19.39)
$log(\text{POP}_{it}^{EXP})$	1.41^{***}	3.46^{***}	1.30^{***}	2.35^{***}	0.30
	(5.12)	(11.99)	(4.92)	(7.28)	(0.86)
$log(\text{POP}_{jt}^{IMP})$	0.31^{**}	$- 0.60^{***}$	0.39^{***}	- 0.08	1.48^{***}
	(2.51)	(- 4.49)	(3.03)	(- 0.58)	(11.43)
RFTA_{ijt}	0.14^{***}	0.06	0.21^{***}	0.15^{***}	0.27^{***}
	(4.11)	(1.30)	(4.77)	(3.45)	(5.97)
$\text{XV}_{ijt}^{\text{SR}}$	$- 0.62^{***}$	$- 0.74^{***}$	$- 0.28^{***}$	$- 0.73^{***}$	$- 0.57^{***}$
	(7.15)	(- 6.10)	(- 2.64)	(- 6.93)	(- 4.14)
R^2	0.98	0.97	0.98	0.98	0.97
N	50,803	45,669	43,701	47,240	45,970

Panel B: Emerging Exporters

	Total	Machinery	Chemicals	Other Manufacturing	Agricultural
$log(GDP_{it}^{EXP})$	0.49^{***}	0.85^{***}	0.61^{***}	0.27^{***}	0.03
	(7.82)	(10.47)	(9.35)	(3.96)	(0.44)
$log(GDP_{jt}^{IMP})$	0.78^{***}	0.89^{***}	0.50^{***}	0.88^{***}	0.51^{***}
	(13.47)	(12.14)	(6.85)	(11.83)	(8.04)
$log(\text{POP}_{it}^{EXP})$	0.53^{***}	2.36^{***}	1.54^{***}	2.31^{***}	$- 1.00^{***}$
	(1.83)	(6.37)	(4.94)	(6.77)	(- 3.07)
$log(\text{POP}_{jt}^{IMP})$	2.00^{***}	$- 1.40^{***}$	0.70^{***}	1.80^{***}	2.80^{***}
	(10.82)	(- 5.00)	(2.84)	(7.87)	(14.25)
RFTA_{ijt}	$- 0.29^{***}$	$- 0.35^{**}$	0.24^{**}	$- 0.96^{***}$	0.52^{***}
	(- 2.61)	(- 2.51)	(2.04)	(7.18)	(3.88)
$\text{XV}_{ijt}^{\text{SR}}$	$- 0.69^{***}$	- 0.21	- 0.05	$- 0.55^{***}$	$- 0.59^{***}$
	(- 6.59)	(- 1.49)	(- 0.41)	(- 4.55)	(- 5.06)
R^2	0.98	0.96	0.99	0.98	0.97
N	37,329	26,265	23,995	32,879	31,380

Panel C: Developing Exporters

	Total	Machinery	Chemicals	Other Manufacturing	Agricultural
$log(GDP_{it}^{EXP})$	0.46^{***}	0.43^{***}	- 0.06	0.43^{***}	0.11^{*}
	(7.48)	(4.63)	(- 0.45)	(5.04)	(1.95)
$log(GDP_{jt}^{IMP})$	0.63^{***}	0.54^{***}	0.28^{**}	0.61^{***}	0.57^{***}
	(9.32)	(5.60)	(2.08)	(6.34)	(7.81)
$log(\text{POP}_{it}^{EXP})$	0.08	$- 0.88^{**}$	3.29^{***}	$- 0.91^{**}$	1.34^{***}
	(0.29)	(- 2.29)	(4.36)	(- 2.30)	(4.00)
$log(\text{POP}_{jt}^{IMP})$	2.51^{***}	- 0.40	1.17^{***}	0.31	2.92^{***}
	(12.22)	(- 1.16)	(2.62)	(1.12)	(13.48)
RFTA_{ijt}	0.02	$- 0.49^{*}$	$- 1.31^{***}$	- 0.31	- 0.17
	(0.12)	(- 1.86)	(- 4.08)	(- 1.44)	(- 1.06)
$\text{XV}_{ijt}^{\text{SR}}$	$- 0.31^{**}$	$- 0.68^{***}$	$- 0.79^{**}$	- 0.14	$- 0.43^{***}$
	(- 2.38)	(- 2.78)	(- 2.54)	(- 0.79)	(- 3.08)
R^2	0.96	0.96	0.97	0.96	0.96
N	43,624	14,600	12,803	29,213	35,852

Note: t-stats are in parenthesis. $^{***} \leq$ 1 percent, $^{***} \leq$ 5 percent, $^{*} \leq$ 10 percent. Full set of year dummies included.

Table 8. Robustness checks. Effects of long-run exchange rate volatility on exports, equation (3). Dependent variable is $log(EXP_{ijt})$.

Panel A: Long-run Real Exchange Rate Volatility.

	G-10 country pairs only		Developed Exporters		Developing Exporters	
	Total	Agricultural	Total	Agricultural	Total	Agricultural
$log(GDP_{it}^{EXP})$	0.31***	- 0.54***	0.59***	0.33***	0.29***	- 0.04
	(3.79)	(- 5.60)	(7.13)	(2.59)	(2.94)	(- 0.44)
$log(GDP_{jt}^{IMP})$	0.79***	0.81***	1.04***	1.01***	0.83***	0.78***
	(10.24)	(6.71)	(23.64)	(15.93)	(7.05)	(6.58)
$log(\mathrm{POP}_{it}^{EXP})$	- 2.80***	- 4.20***	0.91**	0.12	- 0.67	1.57***
	(5.61)	(- 6.91)	(2.45)	(0.22)	(- 1.55)	(2.70)
$log(\mathrm{POP}_{jt}^{IMP})$	- 0.11	1.27**	0.68***	1.80***	3.26***	3.32***
	(- 0.24)	(2.12)	(3.99)	(9.63)	(9.94)	(9.83)
RFTA_{ijt}	0.28***	0.32***	0.15***	0.36***	- 0.02	- 0.22
	(3.15)	(3.05)	(3.33)	(6.37)	(- 0.09)	(- 1.12)
RXV_{ijt}^{LR}	- 0.72	- 8.93***	- 0.74***	- 0.29	- 0.26	- 0.22
	(- 0.23)	(- 2.77)	(- 4.89)	(- 1.33)	(- 0.94)	(- 0.78)
R^2	0.99	0.99	0.89	0.87	0.88	0.88
N	378	378	7,978	7,183	6,401	5,269

Panel B: Alternative measure for Long-run Nominal Exchange Rate Volatility.

	G-10 country pairs only		Developed Exporters		Developing Exporters	
	Total	Agricultural	Total	Agricultural	Total	Agricultural
$log(GDP_{it}^{EXP})$	0.36***	- 0.48***	0.60***	0.36***	0.37***	- 0.03
	(4.38)	(- 5.10)	(7.62)	(2.97)	(4.19)	(- 0.32)
$log(GDP_{jt}^{IMP})$	0.81***	0.77***	1.05***	0.96***	0.70***	0.67***
	(11.25)	(7.05)	(26.35)	(15.90)	(6.61)	(6.13)
$log(\mathrm{POP}_{it}^{EXP})$	- 2.34***	- 4.38***	1.08***	- 0.19	0.13	1.83***
	(5.12)	(- 8.43)	(3.09)	(- 0.37)	(0.34)	(4.04)
$log(\mathrm{POP}_{jt}^{IMP})$	- 0.14	0.80	0.31**	1.47***	3.27***	3.18***
	(- 0.34)	(1.50)	(2.00)	(8.38)	(10.74)	(10.30)
RFTA_{ijt}	0.28***	0.37***	0.12***	0.31***	- 0.16	- 0.30
	(3.27)	(3.69)	(2.68)	(5.82)	(- 0.76)	(- 1.50)
$MaxMinXV_{ijt}^{\mathrm{LR}}$	- 0.11**	- 0.13**	0.00	0.00	0.00	0.00
	(- 2.25)	(- 2.44)	(0.74)	(1.52)	(0.08)	(0.45)
R^2	0.99	0.99	0.85	0.87	0.87	0.85
N	450	450	9,062	8,151	7,731	6,331

Note: t-stats are in parenthesis. *** ≤ 1 percent, *** ≤ 5 percent, * ≤ 10 percent. Full set of year dummies included.

Table 9. Effects of long-run exchange rate volatility on agricultural exports – breakdown by agricultural products. Estimates from equation (3). Dependent variable is $log(EXP_{ijt}^{PRODUCT})$.

	G-10 pairs	G-10 pairs	Developed	Developing	G-10 pairs	Developed	Developing
	XV_{ijt}^{LR}	Weight	XV_{ijt}^{LR}	XV_{ijt}^{LR}	XV_{ijt}^{SR}	XV_{ijt}^{SR}	XV_{ijt}^{SR}
All agriculture (SITC Rev. 3)	- 11.71***	1.00	-0.40	- 1.05***	- 2.66***	- 0.57***	- 0.43***
	(- 4.00)		(1.20)	(- 2.83)	(- 3.25)	(- 4.14)	(- 3.08)
Live animals (0)	**- 29.77****	0.03	- 0.89	- 0.79	- 6.01*	- 0.15	- 1.28*
	(- 2.36)		(- 0.98)	(-0.28)	(- 1.70)	(- 0.52)	(- 1.76)
Meat and preparations (1)	- 15.07	-	-	-	- 1.14***	-	-
	(- 1.36)				(- 0.35)		
Dairy and eggs (2)	- 6.07	-	-	-	1.20	-	-
	(- 0.60)				(0.42)		
Fish (3)	- 14.93	-	-	-	- 3.72	-	-
	(- 1.40)				(- 1.32)		
Cereals (4)	**- 22.99****	0.11	- 1.16*	- 2.12	- 5.37**	- 0.32	- 0.64
	(- 2.60)		(-1.65)	(- 0.90)	(- 2.45)	(- 1.11)	(- 1.64)
Vegetables and fruit (5)	- 0.17	-	-	-	- 2.70	-	-
	(- 0.56)				(- 1.30)		
Sugar and preparations (6)	**- 35.19*****	0.02	- 0.13	- 1.35	- 1.88	0.25	- 0.22
	(- 3.66)		(- 0.17)	(- 0.49)	(- 0.73)	(0.59)	(- 0.31)
Coffee, tea, spices (7)	- 11.12	-	-	-	- 5.62**	-	-
	(- 1.15)				(- 2.26)		
Animal feed (8)	- 2.44	-	-	-	1.22	-	-
	(- 0.16)				(0.37)		
Miscellaneous edible products (9)	- 12.16	-	-	-	- 4.64**	-	-
	(- 1.60)				(- 2.07)		
Beverages (11)	6.81	-	-	-	0.98	-	-
	(0.81)				(0.55)		
Tobacco and preparations (12)	- 5.62	-	-	-	- 1.84	-	-
	(- 0.40)				(- 0.53)		
Raw hides and skins (21)	**- 28.87****	0.01	2.76	2.75	- 2.36	0.14	0.87*
	(- 2.17)		(1.22)	(1.33)	(- 0.91)	(0.19)	(1.77)
Oil seeds (22)	- 10.14	-	-	-	- 4.32	-	-
	(- 0.45)				(- 0.89)		
Crude rubber (23)	1.96	-	-	-	2.68	-	-
	(0.23)				(0.89)		
Cork and wood (24)	17.83	-	-	-	5.50	-	-
	(1.20)				(1.46)		
Pulp and waste paper (25)	**- 52.63****	0.05	- 4.15*	6.02	- 7.58	- 1.15**	0.93
	(- 2.30)		(- 1.77)	(1.51)	(- 1.44)	(- 2.46)	(0.80)
Textile fibers (26)	5.54***	-	-	-	- 0.33	-	-
	(0.78)				(- 0.14)		
Crude fertilizers (27)	**- 20.84*****	0.03	- 0.23	4.13**	- 3.27	- 0.38*	0.15
	(- 3.23)		(- 0.33)	(2.46)	(- 1.49)	(- 1.74)	(0.42)
Metalliferous ores (28)	7.66	-	-	-	3.54	-	-
	(0.74)				(1.64)		
Crude materials, n.e.s. (29)	2.50	-	-	-	- 2.67*	-	-
	(0.53)				(- 1.84)		
Animal oils and fats (41)	-16.12	-	-	-	- 2.75	-	-
	(- 1.36)				(- 0.72)		
Vegetable fats and oils (42)	36.45***	-	-	-	12.39***	-	-
	(2.82)				(2.70)		
Oils and fats, n.e.s. (43)	-7.53	-	-	-	1.25	-	-
	(- 0.52)				(0.34)		

Note: t-stats are in parenthesis. *** ≤ 1 percent, *** ≤ 5 percent, * ≤ 10 percent. Full set of year dummies included.

Table 10. Effect of export subsidies and Producer Subsidy Equivalent (PSE) on the exchange rate volatility and exports.

Panel A: Correlation between exchange rate volatility and export subsidies in the U.S. and the European Community.

Sample	U.S.	U.S.	All E.C. Exporters	E.C. Exporter	G-10
Dependent Variable	$\mathrm{XV}_{ijt}^{\mathrm{SR}}$	$\mathrm{XV}_{ijt}^{\mathrm{LR}}$	$\mathrm{XV}_{ijt}^{\mathrm{SR}}$	PSE_{it}^{EC}	$\mathrm{XV}_{ijt}^{\mathrm{SR}}$
EEP_{it}^{US}	0.027*** (7.010)	0.023** (4.460)	-	-	-
PSE_{it}	-	-	0.004*** (2.880)	-	- 0.019*** (- 3.120)
$WheatTradeSubsidy_{it}^{EC}$	-	-	-	0.004*** (23.380)	-
R^2	0.71	0.79	0.78	0.81	0.69
N	252	45	432	72	765

Panel B: Effect of Producer Subsidies (PSE_{it}) on exports among G-10 country pairs. Dependent variable is $log(EXP_{ijt})$.

	Total		Agricultural	
$log(GDP_{it}^{EXP})$	0.50*** (6.33)	0.54*** (6.12)	- 0.02 (- 0.11)	- 0.22 (- 1.19)
$log(GDP_{jt}^{IMP})$	0.77*** (9.28)	0.77*** (9.28)	0.78*** (6.63)	0.78*** (6.83)
$log(\mathrm{POP}_{it}^{EXP})$	- 4.03*** (- 6.11)	- 3.91*** (- 5.88)	4.09*** (3.87)	4.63*** (4.78)
$log(\mathrm{POP}_{jt}^{IMP})$	2.47*** (3.22)	2.47*** (3.31)	2.79** (2.53)	2.77*** (2.63)
RFTA_{ijt}	- 0.01 (- 0.13)	- 0.01 (- 0.09)	0.23*** (2.80)	0.22*** (3.94)
XV_{ijt}^{SR}	- 0.15 (- 0.20)	- 0.38 (- 0.52)	- 2.24*** (- 2.88)	- 1.17 (- 1.27)
PSE_{it}	-	- 0.003 (- 1.58)	-	0.016*** (4.20)
R^2	0.99	0.99	0.99	0.99
N	765	765	765	765

Note: t-stats are in parenthesis. *** ≤ 1 percent, *** ≤ 5 percent, * ≤ 10 percent. Full set of year dummies included.