Uncertainty and Export Performance: Evidence from 18 Countries

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Abstract:

We study a sample of nine developed and nine developing countries to evaluate the questions of how foreign income uncertainty and real exchange rate (RER) uncertainty impact international trade and how those impacts vary according to stage of development. RER uncertainty has a negative and significant impact on export growth for six of the nine less developed countries in our sample, while it has an insignificant effect for a majority of the developed countries. In both groups, foreign income uncertainty has a more pervasively significant (and frequently larger) influence on trade than does RER uncertainty.

Keywords: Export growth, real exchange rate uncertainty, income uncertainty, asymmetric GARCH. JEL Classifications: F40, C32

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I. Introduction

Does uncertainty matter for trade? Should countries attempting export led growth fear floating exchange rates because they are less predictable? Does uncertainty have different effects depending on the financial development or wealth of the country studied? Since foreign demand is another important determinant of exports, why do we not study the effects of foreign demand uncertainty in parallel with those of exchange rate uncertainty?

In this paper we seek to provide some answers to these questions. It is well known that theory does not uniquely pin down the sign of the exchange rate uncertainty – export relationship. It is also true that the existing empirical literature, large as it is, has not converged to a consensus. As Bacchetta and van Wincoop put it,

> "…the empirical literature examining the link between exchange rate uncertainty and trade has not found a consistent relationship." (Bacchetta and van Wincoop 2000, p. 1093).

There are several possible reasons for these non-results. First, while most of the literature focuses on the effect of exchange rate uncertainty on trade, Baum, Caglayan, and Ozkan (2004 hereafter BCO) argue that it is equally important to consider the possible effects of foreign income uncertainty on trade.[1] Second, while much of the current literature concentrates on the contemporaneous relationship between exchange rate uncertainty and international trade, the effects of uncertainty on trade may well occur with a lag. Third, much of the current literature studies rich country exchange rates, and given that these countries have well functioning derivative asset markets, their exchange rate risks can be hedged.

Here we consider a sample of nine developing and nine developed countries. We allow both foreign income and exchange rate uncertainty to help determine the evolution of export growth for each of the countries in our sample. We use multivariate Granger-causality tests to allow uncertainty to affect export growth with a lag.[2] We are interested in how uncertainty in exchange rates and income affects export growth at the national level and thus study the effect of uncertainty about the real effective exchange rate and trade weighted foreign income on aggregate exports. Our uncertainty variables are derived from preliminary GARCH modeling.[3]

Our results support the idea that real exchange rate (RER) uncertainty is more likely to influence trade for developing countries. For six of the nine less developed countries in our sample, we find significant support for the hypothesis of a negative link between RER uncertainty and export growth, with no evidence of a positive link among the remaining developing countries. In contrast, there are only two cases of a significant and negative link and five cases with no significant link between uncertainty and export growth among the developed countries in our sample.

We also find that foreign income uncertainty is an important determinant of export growth. In fact, for only three countries do we fail to find a significant relationship between income uncertainty and export growth. Compared to the effects of RER uncertainty, the differences here between rich and developing countries are less pronounced, though we do find that a majority of the developing countries exhibit a positive and significant effect compared to more mixed findings for the rich countries.

In what follows below, Section II briefly reviews the theory and some of the empirical evidence on the effects of foreign income and RER uncertainty on trade, while

Section III explains the modeling choices we make. Section IV describes the countries in the sample, the sources of our data, and our experimental design. Section V presents the results of our tests for the effect of lagged RER uncertainty and lagged foreign income uncertainty on export growth. Section VI contains our concluding remarks.

II. Exchange rate and foreign income uncertainty and trade: theory & evidence

There is little empirical or theoretical work that is interested primarily in the effects of foreign income uncertainty on foreign trade. BCO argue that this may be an important element of bias in many studies attempting to isolate a relationship between RER uncertainty and trade. They suggest that, theoretically, foreign income volatility may present a potential opportunity for market entry by domestic exporters, and thus they anticipate finding a positive relationship between trade and income volatility. Empirically, they find mixed results. Specifically, for their 149 bilateral country pairs, income uncertainty is significant in 35 cases, 19 times with a positive sign and 16 times with a negative sign.

Early theoretical work on the effects of exchange rate uncertainty includes Ethier (1973) who finds that the level of trade is unrelated to exchange rate risk when forward rates are taken as exogenous. On the other hand, Vianne and de Vries (1992) show that exchange rate risk can be passed on to the forward rate, and thus the effect on trade can be ambiguous. Recently, Bacchetta and van Wincoop (2000) use a general equilibrium framework that allows for deviations from purchasing power parity to analyze the question of whether exchange rate stability associated with a fixed exchange rate regime necessarily implies an increase in trade. The authors find that the level of trade is not

dependent on the exchange rate regime but depends on preferences and the policy rules followed by monetary authorities.[4]

Mirroring the theoretical work, the empirical literature on exchange rate uncertainty and trade does not present a clear picture either, though not from lack of trying a variety of approaches. McKenzie (1999) surveys 32 empirical papers of which 12 use effective exchanges rates and 20 use bilateral rates. Additionally, twelve use nominal exchange rates, sixteen use real exchange rates, and four use both. As for methods of creating an uncertainty variable, six papers use a conditional variance (ARCH/GARCH) approach, while fifteen others use a moving standard deviation.[5] About the only unifying theme in the studies is that 29 of the 32 deal exclusively with rich countries.

McKenzie (1999) also surveys the results found in these 32 papers. There are a total of 785 exchange rate uncertainty coefficients estimated, of which 522 (66%) are insignificant, 191 (24%) are negative and significant and 72 (10%) are positive and significant.[6] As of the turn of the century then, there is no convincing case that exchange rate uncertainty affects trade one way or the other.

In their recent paper discussed above, BCO also analyze the affects of exchange rate uncertainty on bilateral trade using a Poisson lag structure and an estimated exchange rate uncertainty variable based on an aggregation of estimated daily data. Their method is interesting in that it allows the effects of exchange rate uncertainty to be non-contemporaneous. BCO find mixed results for a total of 149 bilateral relationships; there are 37 significant coefficients of which 29 are positive.

III. Our modeling choices

As indicated by the initial questions we posed, this paper is interested in the effects of uncertainty on trade at the national level. For that reason we use the real effective exchange rate as our RER variable. Since we are interested in whether any relationship between uncertainty and trade is dependent on the level of a country's development, we select a sample of both industrialized and developing countries.[7]

The other choice that must be made is whether to model uncertainty with a moving standard deviation or via a parametric conditional variance model. Here we choose to model both exchange rate and foreign income uncertainty by estimating conditional variance equations for both series and then including several lags of those estimated variances as regressors in our trade equation.[8]

Even though it is more commonly employed in the literature, we do not use a moving standard deviation measure for the following reasons. (1) It provides no measure of whether its movements are significant. That is, with a moving standard deviation method there is no way to test the null hypothesis of no significant time varying uncertainty. (2) It does not distinguish between predictable and unpredictable variation in exchange rates or income, while the conditional variance measure is based on the unpredictable component. (3) It can easily make the volatility measure show an incorrect level of persistence either by including too many lags (tending toward exaggerating persistence) or too few (tending toward understating persistence). (4) With a conditional variance model we can allow positive and negative shocks to have differing effects on the volatility measure in a way that the moving standard deviation variable cannot.

As we will discuss below, we find significant GARCH effects for every country considered in our sample both for income and the RER. Furthermore, we frequently find significant evidence of asymmetry in the effects of positive and negative shocks.

IV. Sample and Experimental Design

The 18 countries in our sample are Argentina, Australia, Brazil, Canada, Denmark, India, Japan, Mexico, Norway, Peru, South Africa, South Korea, Sweden, Switzerland, Thailand, Turkey, the UK, and the US. Half of these countries are rich, industrialized nations and half are middle income developing countries. Our full sample consists of monthly data from January 1973 through May 2003.

A. Data

As noted in the introduction, we are interested in the macroeconomic consequences of exchange rate volatility on trade, which we measure as total merchandise exports. For that reason, we do not consider bilateral RERs but rather multilateral, trade-weighted RERs. Our source for these real effective exchange rates is J.P.Morgan.[9] The remaining data are obtained from the IMF's IFS CD-ROM. To measure foreign income, we use the same trade based weights employed in formulating the RER and construct a weighted average of industrial production.[10] We use real merchandise exports measured in the local currency, where nominal export values are deflated using that country's CPI. We now consider several econometric issues that must be resolved before we can present estimates from our analysis.

B. The econometric specification

Any multivariate time series analysis must address the degree of integration of the series under study. We conducted standard unit root tests, including the Augmented Dickey-Fuller test, hereafter ADF (Said and Fuller 1984), and the Kwiatkowski, Phillips, Schmidt, and Shin test, hereafter KPSS (Kwiatkowski et al. 1992), on each of our variables. The results of the tests, which are available upon request, indicate the presence of a unit root for every series, especially foreign income and exports.

The finding of a unit root in the real exchange rate is more controversial than for our other variables. In fact, a number of authors have argued that the unit root finding may be spurious because of possible non-linear effects. A number of non-linear models are available, including the exponential smooth transition autoregressive model (ESTAR), which has been used by several researchers to analyze the RER (e.g. Taylor, Peel ,and Sarno 2001, and Baum, Barkoulas, and Caglayan, 2001).[11] We thus consider an ESTAR process as an alternative to a unit root for the RER. For the log of the RER, r_t, the ESTAR(p) model is given as follows (see Teräsvirta 1994 for precise details):

$$r_t = \phi_{1,0} + \sum_{j=1}^{p} \phi_{1,j} r_{t-j} + (\phi_{2,0} + \sum_{j=1}^{p} \phi_{2,j} r_{t-j})(1 - \exp[\gamma (r_{t-d} - c)^2]) + \varepsilon_t . \qquad (1)$$

Here $\phi_{j,k}$ denotes the j^{th} autoregressive coefficient in the k^{th} regime, c is the threshold parameter, often thought of as the equilibrium value of the log of the real exchange rate, and γ is the parameter that determines the extent of non-linearity.

We test all our RER series for nonlinearity using the procedure outlined by Teräsvirta (1994) in conjunction with the tests of Kapetanois et al. (2003).[12] In using the non-linear tests a maximum value for d must be selected. Following Baum, Barkoulas,

and Caglayan (2001) we set the maximum value to 12. Details of the tests, which are available upon request, indicate that the linearity hypothesis is rejected for Australia and for all the less developed countries except India. For these nine cases, we model the RER as a stationary non-linear ESTAR process. For the other nine cases, where all the series are I(1), we checked each country to see whether or not the RER, foreign income and exports showed evidence of co-integration. Using the Johansen estimation and testing algorithm (Johansen, 1991), we found cointegration only for the US, and we thus include an error correction term in the US regressions reported below.

C. Generating the uncertainty measures

Given that we plan to base our measures of RER and foreign income uncertainty on a GARCH modeling framework, it is important to determine the extent to which GARCH effects exist in these series before proceeding further. Given our testing above, we begin by fitting either an autoregressive or non-linear model (whenever appropriate) for the RER and an AR(p) model for the growth rate of foreign income.[13]

It is plausible that positive shocks affect predictability differently than negative shocks, especially in the case of the RER. To this end, we allow for possible asymmetry in the conditional variance equation by using the threshold GARCH model of Glosten, Jaganathan, and Runkle (1993). For example, the T-GARCH(1,1) model for the conditional variance of the RER can be written as follows:

$$h_{rer_t} = \kappa_{rer} + \alpha_{rer}\varepsilon_{rer_{t-1}}^{2} + \lambda_{rer}\varepsilon_{rer_{t-1}}^{2} I_{\{\varepsilon_{rer_{t-1}}<0\}} + \beta_{rer} h_{rer_{t-1}}, \qquad (2)$$

where h_{rer_t} is the conditional variance of ε_{rer_t}, the residuals affiliated with the equation for the RER, and $I_{\{\varepsilon_{RER_{t-1}}<0\}}$ is the indicator function, which takes on the value one when

there is a negative shock to the RER process and zero otherwise. A test for asymmetry can be conducted via a simple t-test or likelihood ratio test.

We choose an initial GARCH model base by examining the correlogram of the squared residuals. We then fit a few simple GARCH models and test for the joint significance of the GARCH parameters. To summarize our findings on GARCH effects, all 18 countries show significant GARCH effects in their RER and foreign income variable data at the 5% level or better.[14] In 12 of the countries, there is significant evidence of asymmetric GARCH effects in the RER at the 5% level. The general pattern in these cases is that positive residuals raise uncertainty more than do negative residuals. That is, when the RER is more appreciated than expected, future RERs are less predictable than when the RER is less appreciated than expected. We also find significant evidence of asymmetry in six of the foreign income variables.[15]

D. The experimental design

Given the above results, we are now in a position to describe exactly how we will test for the effects of uncertainty on trade. Our baseline reduced form specification regresses the growth of exports on its own lags, along with lags of RER growth, foreign income growth, RER uncertainty and foreign income uncertainty.[16] To account for potential time varying volatility in the export growth equation, we also model the conditional variance of exports as a potentially asymmetric GARCH process. Our baseline model is given by,

$$\Delta x_t = c_x + \sum_{i=1}^{p} (\phi_{1i} \Delta x_{t-i} + \phi_{2i} \Delta y^*_{t-i} + \phi_{3i} \Delta r_{t-i} + \phi_{4i} h_{rer_{t-i}} + \phi_{5i} h_{y^*_{t-i}}) + \varepsilon_{x_t}$$

$$E(\varepsilon_{x_t}{}^2 \mid \Omega_t) = h_{x_t} \qquad (3)$$

$$h_{x_t} = \kappa_x + \sum_{i=1}^{p} \alpha_{xi} \varepsilon_{xt-i}{}^2 + \gamma_x \varepsilon_{x_{t-1}}{}^2 I_{\{\varepsilon_{xt-1}<0\}} + \sum_{i=1}^{q} \beta_{xi} h_{xt-i},$$

where Ω_t denotes the available information set, r_t denotes the log of the RER, y_t^* and x_t denote the log of foreign income and exports respectively, and the rest of the notation is as above. As discussed below, p is allowed to vary up to a maximum value of 12.[17]

V. Results

We wish to determine the possible effects of foreign income and exchange rate uncertainty over time. Following Grier and Perry (1998), we employ a testing framework (that in our case is multivariate) that allows lags of our uncertainty measures to enter the trade equation. We conduct several sets of tests using one, four, eight, and twelve lags.

To determine the effects of exchange rate and foreign income uncertainty on trade, we calculate the test statistics associated with the null hypothesis that the relevant uncertainty measures do not belong in the trade equation.[18] Referring to equation (3), the null hypothesis that RER uncertainty does not affect export growth can be tested by means of a partial F-test with the null hypothesis, $\phi_{41}=...=\phi_{4p}=0$, while the same hypothesis for foreign income volatility can be tested with a similar restriction for the coefficients, ϕ_{5i}, $i=1,...,p$. This approach allows us to isolate both short term and long term effects of uncertainty on export growth.

A priori, we place no restrictions on the expected signs for the volatility terms. In fact, it is plausible that the short term effects of RER uncertainty may be negligible or

even positive, whereas the long run effects are negative as agents adjust trade contracts. Finally, to quantify the importance of the two uncertainty variables, we calculated the equilibrium effect of a one standard deviation increase in each uncertainty variable on export growth. In particular, the long run effect of RER uncertainty is calculated as

$$\textit{Long Run Effect} = \frac{\sum_{i=1}^{p} \phi_{4,i}}{(1 - \sum_{i=1}^{p} \phi_{1,i})} \sigma_{h_{rer}}, \qquad (4)$$

where $\sigma_{h_{rer}}$ denotes the unconditional standard deviation of the uncertainty measure associated with the RER, and where the remaining variables are defined as in equation (3). The long run effects of the income uncertainty variable are calculated in an analogous manner, where ϕ_{5i} replaces ϕ_{4i}, and where $\sigma_{h_{y^*}}$ the unconditional standard deviation of the growth of foreign income, replaces $\sigma_{h_{rer}}$ in equation (4).

Our results are presented in Tables I and II. Given that we have four different lag lengths for each type of uncertainty, two different types of uncertainty, and eighteen countries, it seems advisable to provide a summary for the reader. The first version of this summary appears in Table III. The columns indicate whether the effect of RER uncertainty on exports is positive, negative, mixed or insignificant, while the rows provide the same breakdown for the effect of income growth uncertainty.[19]

We find six countries where RER uncertainty unambiguously has a significantly negative effect on export growth (Argentina, Brazil, Denmark, India, Mexico, South Africa), two where it has a positive effect (Japan, Sweden), two where the effect changes sign depending on the lag length examined (Norway, Peru) and eight where the effect is never significant (Australia, Canada, South Korea, Switzerland, Thailand, Turkey, UK,

USA). Note that five of the six countries with a significant negative effect are developing countries, while five of the eight with no effect are rich countries.

Turning to the trade effect of income growth uncertainty we find six countries where the effect is unambiguously significantly positive (Argentina, Denmark, India, South Korea, Thailand, Turkey), where five of these six countries are developing ones. There are four countries with a negative effect of income uncertainty on trade (Brazil, Mexico, Switzerland, USA) and five countries where the effect changes sign (Canada, Japan, Norway, Sweden, UK). There are also three countries where foreign income volatility has no affect on export growth (Australia, South Africa, Peru).

In sum, for 10 of the 18 countries there is evidence of a significant effect of RER uncertainty on export growth and for 15 nations there is a significant effect of income growth uncertainty on export growth.

The equilibrium effect of our uncertainty variables, which is depicted in bold type below the test statistics and p-values in Tables I and II, sheds further light on their relative importance in determining the evolution of exports. We have estimated a total of 72 different models. Regardless of significance, the absolute value of the equilibrium effect of income uncertainty exceeds that of RER uncertainty 38 times versus 34 times where the reverse is true. If we only consider the less developed countries, the difference is slightly more pronounced. Of the estimated 36 models for the less developed countries, the equilibrium effect of income uncertainty exceeds that of RER uncertainty 20 times in absolute value, or about 56% of the time.

These results coupled with those that deal with statistical significance presented above, suggest that foreign income uncertainty is quite possibly more important for the

evolution of exports than RER uncertainty, even for the less developed countries in our sample.

In Table IV we take a further step in refining the results by resolving the mixed cases. To do so, we have taken as definitive the sign of the summed coefficients from the longest significant lag length. That is to say, we are taking the sign of the long run effect as definitive. With this refinement, there are now eight countries where RER risk lowers exports (Norway and Peru are now added), with the same two positive and eight insignificant cases as before. In the case of income risk, there are now eight countries where the effect is positive (Canada and Norway) and seven where the effect is negative (Japan, Sweden, and the UK are added), with the same three insignificant cases.

Finally in Table V we summarize the results from Table IV by country group. As can be seen, there is a clear difference between how RER uncertainty influences trade in the rich countries, where it is insignificant for a majority of the nations, and in the developing countries, where it is significantly negative for two-thirds of them, with no occurrences of a positive link.[20]

The case of income uncertainty does not show as strong a difference between the two groups, though the rich countries are split evenly between positive and negative effects, while a majority of the developing countries show a positive effect.

In summary, we find two robust results. First income growth uncertainty is an extremely important determinant of export growth. Its effects, which have been largely ignored in the literature, can dominate the effects of RER uncertainty on exports. Second, a negative link between RER uncertainty and export growth is found much more often among the less developed countries in our sample. The negative link between RER

uncertainty and export growth has been obtained for at least two reasons: (1) we devote half our sample to middle income developing countries, and (2) we allow for lags in the relationship. If we had only studied the nine rich countries, our results would look like much of the rest of the literature, a couple positive, a couple negative, but most insignificant. By contrast a two-thirds majority of the nine developing countries display the intuitively appealing negative relationship. It is important to note that even in these cases, allowing for lags in the relationship is crucial. For example, in Table I, there is evidence of a negative link between RER uncertainty and trade for six developing countries. For all but one country (India), we find that a significant link is detected when eight or twelve lags of RER uncertainty are included. This finding is consistent with BCO (2004), who find that the effects (when they are found) are most pronounced with roughly a one year lag.

VI. Conclusions

Our paper contributes to the literature on the relationship between uncertainty and trade in several important ways. The existing literature generally focuses on the effects of exchange rate uncertainty for a set of homogeneous countries. In contrast, we consider a group of both developed and less developed countries and apply a common methodology in analyzing export growth. In addition, we analyze the impact of foreign income uncertainty in determining export growth. We also document very strong evidence of time varying conditional volatility in both the RER process and the measure of foreign income we consider. To allow for the possibility that positive shocks affect the conditional variance of foreign income or the RER differently than do negative shocks,

we model the conditional variance using a threshold GARCH model. We also test for nonlinearity in the RERs and model it with an ESTAR model where appropriate. Finally, we use a series of multivariate Granger-causality tests to determine the role of lagged values of uncertainty on trade. This is important since it is likely that agents face impediments in rapidly altering the level of export contracts following a change in the perception of uncertainty about important determinants of export demand.

Our evidence is generally supportive of the assertion that negative effects of RER uncertainty are more likely in less developed countries. We find evidence that exchange rate uncertainty negatively impacts export growth for six of the nine countries from our less developed country sub-sample with no evidence of a positive link. In contrast, the results among nine developed countries are mixed, with a majority showing no significant effect.

The results also suggest that foreign income volatility is an important component of export growth, with significant results for all but three countries in our sample. Interestingly, we generally show a positive and significant link between foreign income volatility and export growth among the less developed countries. The results for foreign income volatility are generally quite strong. The equilibrium effects can dominate those of RER uncertainty. This suggests that this variable may be an important determinant of trade that has been excluded from much of the existing literature.

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NOTES:

1. Beyond the intrinsic interest in the relationship, incorrectly excluding income uncertainty from the trade equation may bias the coefficient on exchange rate uncertainty.
2. Grier and Perry (1998) model the effect of inflation uncertainty on average inflation with a lag, using a similar technique in their tests to the methodology employed here.
3. Our findings suggest that there is very strong evidence of GARCH dynamics for both the real exchange rate and foreign income variable we employ. Furthermore, in a number of instances, we find evidence that positive exchange rate shocks affect volatility differently than negative shocks as in the threshold GARCH specification of Glosten, Jaganathan, and Runkle (1993).
4. See McKenzie (1999) for a more comprehensive review of this literature.
5. The other papers use relatively idiosyncratic uncertainty measures. No more than three of the remaining eleven studies employ the same type of measure.
6. These numbers are based on calculations we made from McKenzie's Table 2.
7. While the macro level of modeling is well established in the literature, studying both rich and developing countries and looking for differences is, to our knowledge, unique to this paper.
8. It should be noted that BCO describe a third way to generate uncertainty measures that we cannot use due to data limitations with daily data in our sample of developing countries.
9. These data are available at http://www2.jpmorgan.com/MarketDataInd/Forex/currIndex.html.

10. We obtained seasonally adjusted industrial production for every country for which data was available from the IMF. We have data for the G-7 countries and the remaining euro-zone countries except Ireland and Portugal. In addition, we have IP data for Israel, Mexico, Norway, and South Korea. We re-calculate the weights of JP Morgan using these 18 countries, which constitute the vast majority of world output.
11. We considered a variety of specifications for the mean equation of the RER, especially for the less developed countries in our sample. In particular, we considered the inclusion of currency crises dummies and electoral dummies with largely robust results compared to the linear specification.
12. The tests of Kapetanios et al. (2003) allow one to test the hypothesis that r_t is a unit root, against the alternative that the process is a globally stationary non-linear process. Both tests for linearity use a Taylor series approximation of the transition function about $\gamma=0$. The tests of Kapetanios et al. use a Dickey-Fuller regression where Δr_t is regressed on r_{t-d}^3 and augmented terms. The test is carried out by a zero restriction on the coefficient of r_{t-d}^3. See Terasvirta (1994) and Kapetnios et al. (2003) for additional details.
13. In the ESTAR case, we do this via a two-step procedure that produces consistent estimates. See Lundbergh and Terasvirta (1999) and Chan and McAleer (2002) for details related to the two step STAR-GARCH estimator.
14. We do not report specific results here in order to save space. Full results are available from the authors upon request.
15. The alert reader will notice that we do not present stationarity tests for our conditional variance based uncertainty measures, which we assume are stationary. Standard unit

root tests produce very strong evidence against a unit root, but these tests are not directly applicable to generated data as pointed out by Kroner and Lastrapes (1993). However, our measures of foreign income and RER uncertainty exhibit weak persistence as measured by the autocorrelation function of these series. Further, Wright (1999) presents strong evidence that the volatilities of nominal exchange rate data are stationary.

16. In instances where the non-linear results indicate the presence of stationary non-linear dynamics, we include the level of the RER in the export growth regression rather than its difference.
17. A preferred specification would be a multivariate GARCH-M type model allowing for a fully specified time varying variance/covariance matrix. Unfortunately, since we employ a three dimensional system, and include up to 12 lags of the volatility terms in the mean equation, estimation of such a system proves to be impossible. The effect of different specifications is possibly an important avenue for future research.
18. While not reported in the text, we also find overwhelming evidence that (1) RER appreciations significantly lower export growth, while (2) foreign income growth raises export growth.
19. Positive (negative) means all the significant lag lengths have coefficients that sum to be greater (less) than zero. Mixed means there is at least one significant lag length whose coefficients sum to greater than zero and at least one whose coefficients sum to less than zero. Throughout, we have a used a 10% cutoff, noting that we have included RER uncertainty for India with one lag given that its p-value is exceptionally close to 10%.

20. These results are robust to the specification selected for the RER and do not stem from the fact that eight of nine rich country RERs are modeled as unit roots, while eight of nine developing country RERs are modeled as ESTAR processes. For example, if we use the linear model for all 18 countries we still find a majority of the developing countries show a negative and significant effect of RER uncertainty, while a majority of the rich countries show no significant effect.

Table 1
Effects of Exchange Rate Uncertainty on Export Growth

	Lags			
	1	4	8	12
Argentina	0.4718	1.1146	0.8908	1.8047
	[0.4926]	[0.3495]	[0.5244]	[0.0470]
	-0.0055	**-0.0017**	**-0.0044**	**-0.0162**
Australia	0.0057	1.5574	0.6950	0.9394
	[0.9397]	[0.1861]	[0.6959]	[0.5805]
	-0.0002	**-0.0028**	**-0.0021**	**-0.0028**
Brazil	1.1119	1.3222	0.6580	1.8723
	[0.2924]	[0.2615]	[0.7283]	[0.0378]
	0.0043	**0.0051**	**0.0032**	**-0.0006**
Canada	0.9682	1.2480	1.2717	1.1832
	[0.3258]	[0.2904]	[0.2577]	[0.2946]
	0.0024	**0.0044**	**0.0034**	**0.0012**
Denmark	0.2992	1.3238	3.2653	4.0562
	[0.5847]	[0.2638]	[0.0014]	[0.0000]
	-0.0011	**-0.0013**	**-0.0020**	**-0.0030**
India	2.6902	0.3265	0.2306	0.6924
	[0.1019]	[0.8601]	[0.9851]	[0.7586]
	-0.0060	**-0.0007**	**-0.0016**	**-0.0051**
Japan	0.0904	2.4541	1.1291	1.4717
	[0.7638]	[0.0457]	[0.3432]	[0.1340]
	-0.0005	**0.0034**	**0.0011**	**0.0032**
Korea	0.1324	0.3281	1.0167	0.7200
	[0.7162]	[0.8590]	[0.4232]	[0.7316]
	-0.0013	**0.0010**	**0.0012**	**0.0022**
Mexico	0.6309	0.2881	0.1624	17.3202
	[0.4276]	[0.8856]	[0.9954]	[0.0000]
	-0.0045	**-0.0022**	**-0.0021**	**-0.0088**
Norway	1.3910	5.3076	4.3868	5.5252
	[0.2390]	[0.0004]	[0.0000]	[0.0000]
	-0.0068	**0.0051**	**0.0038**	**-0.0028**
Peru	1.8428	0.7289	1.7779	2.0201
	[0.1755]	[0.5728]	[0.0808]	[0.0226]
	-0.0079	**-0.0032**	**0.0015**	**-0.0014**
South Africa	0.0693	0.5778	1.9417	1.4941
	[0.7926]	[0.6790]	[0.0536]	[0.1255]
	0.0011	**-0.0019**	**-0.0027**	**-0.0024**
Sweden	3.2173	3.4119	3.0792	2.0199
	[0.0737]	[0.0094]	[0.0024]	[0.0226]
	0.0043	**0.0037**	**0.0044**	**0.0027**
Switzerland	0.0784	0.3804	0.5805	0.3282
	[0.7797]	[0.8226]	[0.7939]	[0.9838]
	-0.0005	**-0.0013**	**-0.0014**	**-0.0011**

Table 1a (cont)
Effects of Exchange Rate Uncertainty on Export Growth

	Lags 1	4	8	12
Thailand	0.1768	1.8223	1.2813	1.1745
	[0.6744]	[0.1241]	[0.2525]	[0.3009]
	-0.0017	**0.0049**	**0.0007**	**-0.0016**
Turkey	0.0430	0.7831	1.1840	0.8949
	[0.8359]	[0.5368]	[0.3081]	[0.5526]
	0.0013	**0.0063**	**0.0070**	**0.0061**
UK	0.7226	0.6885	0.2233	1.3900
	[0.3959]	[0.6003]	[0.9866]	[0.1697]
	-0.0018	**-0.0005**	**-0.0001**	**-0.0019**
USA	1.1761	0.8861	1.1092	0.7949
	[0.5727]	[0.4724]	[0.3566]	[0.6557]
	-0.0014	**0.0006**	**-0.0003**	**-0.0005**

Notes: The first number in each row denotes the test statistic associated with the null hypothesis that as a group the conditional volatility coefficients are zero in the export equation. The number in brackets is the associated probability value based on the F-version of the Wald test. The number in bold type beneath the p-values is the equilibrium effect on export growth of a one standard deviation increase in the conditional variance of the RER variable (see equation 4).

Table 2
Effects of Income Uncertainty on Export Growth

	Lags 1	4	8	12
Argentina	0.0173	1.1979	2.4212	1.7736
	[0.8956]	[0.3115]	[0.0150]	[0.0521]
	0.0010	**0.0036**	**0.0163**	**0.0200**
Australia	0.3774	0.9668	1.2686	1.1626
	[0.5395]	[0.4262]	[0.2607]	[0.3119]
	-0.0011	**0.0021**	**0.0035**	**0.0036**
Brazil	5.7519	0.2672	0.8249	0.8156
	[0.0170]	[0.8990]	[0.5811]	[0.6343]
	-0.0071	**-0.0035**	**0.0003**	**0.0031**
Canada	1.0462	2.2801	2.8128	2.0573
	[0.3071]	[0.0605]	[0.0051]	[0.0198]
	-0.0021	**0.0008**	**-0.0005**	**0.0001**
Denmark	2.4983	2.3649	1.7894	5.3708
	[0.1149]	[0.0528]	[0.0785]	[0.0000]
	0.0038	**0.0023**	**0.0007**	**0.0046**
India	0.3224	2.1515	2.0106	1.4938
	[0.5705]	[0.0742]	[0.0488]	[0.1255]
	0.0021	**0.0052**	**0.0039**	**0.0043**
Japan	9.3743	4.1772	2.2315	2.1476
	[0.0024]	[0.0026]	[0.0251]	[0.0143]
	-0.0052	**0.0017**	**-0.0034**	**-0.0020**
Korea	0.2817	2.1011	2.3776	1.4635
	[0.5960]	[0.0804]	[0.0169]	[0.1373]
	0.0019	**0.0072**	**0.0148**	**0.0088**
Mexico	0.0236	0.3692	1.2047	81.0862
	[0.8781]	[0.8306]	[0.2957]	[0.0000]
	-0.0010	**0.0048**	**0.0029**	**-0.0041**
Norway	1.0855	4.8496	3.4976	5.4950
	[0.2982]	[0.0008]	[0.0007]	[0.0000]
	0.0041	**-0.0020**	**0.0033**	**0.0168**
Peru	0.8097	0.9685	0.5863	0.6246
	[0.3688]	[0.4249]	[0.7890]	[0.8208]
	-0.0073	**-0.0028**	**-0.0027**	**-0.0022**
South Africa	0.3249	0.3368	0.3133	0.4333
	[0.5690]	[0.8531]	[0.9608]	[0.9494]
	0.0022	**0.0033**	**0.0002**	**0.0012**
Sweden	6.4083	5.8088	3.1612	3.1414
	[0.0118]	[0.0002]	[0.0019]	[0.0003]
	0.0047	**0.0035**	**-0.0023**	**-0.0036**
Switzerland	0.3253	3.7545	1.4085	1.4080
	[0.5688]	[0.0053]	[0.1920]	[0.1612]
	0.0010	**-0.0007**	**0.0002**	**0.0003**

Table 2a (cont)
Effects of Income Uncertainty on Export Growth

	Lags 1	4	8	12
Thailand	0.8723	0.8956	1.2567	1.7748
	[0.3510]	[0.4667]	[0.2657]	[0.0519]
	-0.0036	**0.0029**	**0.0030**	**0.0051**
Turkey	0.0515	0.6400	1.1768	4.0922
	[0.8206]	[0.6343]	[0.3126]	[0.0000]
	-0.0006	**-0.0011**	**-0.0010**	**0.0022**
UK	4.1161	1.9613	1.2518	1.5906
	[0.0432]	[0.1001]	[0.2683]	[0.0936]
	0.0035	**0.0024**	**0.0043**	**-0.0014**
USA	5.1318	1.6284	1.1108	1.4370
	[0.0241]	[0.1667]	[0.3555]	[0.1484]
	-0.0034	**0.0003**	**0.0009**	**0.0033**

Notes: The first number in each row denotes the test statistic associated with the null hypothesis that as a group the conditional volatility coefficients are zero in the export equation. The number in brackets is the associated probability value based on the F-version of the Wald test. The number in bold type beneath the p-values is the equilibrium effect on export growth of a one standard deviation increase in the conditional variance of the foreign income variable (see equation 4).

Table III
Effects of Uncertainty on Export Growth

Effects of Income Uncertainty On Export Growth	*Effects of RER Uncertainty on Export Growth* POSITIVE	NEGATIVE	MIXED	NOT SIG
POSITIVE		Argentina Denmark India		South Korea Thailand Turkey
NEGATIVE		Brazil Mexico		Switzerland USA
MIXED	Japan Sweden		Norway	Canada UK
NOT SIG		South Africa	Peru	Australia

Notes: The description of the various headings can be found in footnote number 19. For example, "positive" refers to cases where, for at least one lag, the sum of the estimated coefficients is greater than zero, and there are no cases where a significant negative effect is found.

Table IV
Effects of Uncertainty on Export Growth
Taking the Long Run Sign as Definitive for Mixed Cases

Effects of Income Uncertainty on Export Growth		*Effects of RER Uncertainty on Export Growth* POSITIVE	NEGATIVE	NOT SIG
	POSITIVE		Argentina Denmark India Norway	Canada South Korea Thailand Turkey
	NEGATIVE	Japan Sweden	Brazil Mexico	Switzerland UK USA
	NOT SIG		Peru South Africa	Australia

Notes: In Table IV, we take a definitive stand on the effects of uncertainty in cases where mixed results are found in Table III. In particular, to capture long run effects, we choose the longest lag associated with statistically significant results and record the sign of the aggregated coefficients.

Table V
Effects of Uncertainty on Export Growth
Grouping by Development Status

	Results for RER Uncertainty				*Results for Income Uncertainty*		
	POSTIVE	NEGATIVE	NOT SIG		POSITIVE	NEGATIVE	NOT SIG
RICH	2	2	5	**RICH**	3	5	1
POOR	0	6	3	**POOR**	5	2	2
TOTAL	2	8	8	**TOTAL**	8	7	3

Notes: The results here are based on the results in Table IV. We track the number of occurrences of positive, negative, and insignificant effects of uncertainty on export growth as reported in Table IV for both developed and less developed countries.