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Exchange Rate Volatility and Foreign Trade: The case for Cyprus and Croatia

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Abstract

This paper examines the effect of exchange rate volatility for a set of two countries, Croatia and Cyprus on sectoral exports during the period of 1990: q1-2012:q1. It is claimed by some researchers that exchange rate volatility causes a reduction on the overall level of trade. Empirical researchers often utilize the standard deviation of the moving average of the logarithm of the exchange rate as a measure of exchange rate fluctuation. In this study we propose a new measure for volatility. Overall our results have suggested significant negative effects from volatility on exports for one country in our sample.

1.1 Introduction

The relationship between exchange rate volatility and export flows has been studied in a large number of theoretical and empirical papers. The main notion suggested by some theoretical models, is that a rise in exchange rate volatility increases uncertainty of profits on contracts denominated in foreign currency and force risk averse agents redirect their activity to the lower risk home market. Other models suggest that higher

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levels of exchange rate movements offer greater opportunity for profit and therefore might lead to an increase on exports. Alternatively some researchers have suggested since it is possible to offset potential unexpected movements of the exchange rate by investing at the forward market causing producers to be unaffected by movements of the exchange rate. These different ranges of results have been supported by a large variety of empirical studies causing the effects of exchange rate volatility on exports to be one of the most controversial topics of international trade.

This paper aims to model the effects of exchange rate volatility for two countries for which empirical evidence is both limited and ambiguous and to utilize a new measure of volatility which captures unexpected movements of the exchange rate.

The remainder of this paper will be organized as follows: First, the existing literature is analyzed; second, various measurement issues of exchange rate volatility are discussed; third, the data are presented; fourth, the methodological framework is also discussed; fifth, the results of the utilized statistical tests, the estimated equations and an analysis of the main empirical findings are discussed. Finally the last section addresses the issue of policy implications, and presents a brief summary as well as the main collusions.

2.1 Literature review

The literature on the issue is quite large. Both theoretical as well as empirical studies provide ambiguous effects of volatility on exports. An extensive review of both theoretical and empirical literature is well surveyed in Makenzie, 1999. However in this section the main arguments are survived with an emphasis on key aspects pertaining to this study. Early empirical work, utilizing the OLS methodology, favored the negative hypothesis Clark, 1973 as well as an insignificant relationship between export quantity and volatility Hooper and Kohlagen, 1978. Hoper and Kohlhagen, 1978 investigated bilateral and multilateral trade among developed countries using the standard error of nominal exchange rate fluctuations as their volatility measure.

In the 1980's the empirical evidence continues to be mixed and often differ with samples and estimation methods. Therefore, there is no consistent pattern when the same method is applied to different countries. While many suggest that the exchange rate uncertainties does depress trade Thursby and Thursby, 1987 others provide evidence that exchange rate uncertainties affect international trade positively Mckenzie and Brooks, 1997. In an attempt to explain these different ranges of results some researchers have turned to the measure of exchange rate volatility. Cushman, 1983 used the moving average of the real exchange rate as his volatility measure and found a negative relationship between volatility and exports. In his 1988 study, Cushman added the absolute difference between spot, forward and current rates as an alternative measure of volatility and found mixed effects of volatility on exports. Akahtar and Hilton, 1984 concluded that exchange rate uncertainty is detrimental to the international trade. De Grauwe, 1988 captured the ambiguity of the debate by modelling a producer who must decide between selling in the domestic or the foreign market. By providing some basic assumptions his model assumes that the only source affecting the exporter's behaviour is the local currency price of exports as well as his risk preferences. In his model exchange rate is measured as the percentage change of export quantity as a measure of volatility. Following De Grauwe's study Peree and Steinher, 1989 proposed the average absolute difference between the previous forward rate and the current spot rate as better indictor of exchange rate volatility to bilateral exports.

Even though new empirical statistical techniques are applied in the 1990's ambiguity of the estimated relationships continues to dominate the empirical literature. Several authors used the ARCH-GARCH method in order to model and measure exchange rate volatility Kroner and Lastrapes, 1993; Pozo, 1991. Others

follow the VAR and VECM methodology allowing them to examine and model the properties of the samples such as unit roots and cointegration Arize, 1995. Asseery and Peel, 1991 emphasized the importance of examining the characteristics of the data being used and examined for stationarity as well as seasonality. Chowdhury, 1993 investigated the impact of exchange rate trade volatility on trade flows for the G-7 countries utilizing an error correction model. His study found exchange rate volatility measure as an eight period moving sample standard deviation of the growth rate of the real exchange rate and found a significant negative impact. Despite all these developments the traditional measure of exchange rate still remains the moving average of the standard deviation.

   Recent empirical studies have confirmed that exchange rate volatility has a negative effect on exports, especially for developing economies Arize, 2000; Dognalar, 2002. However, in addition to the literature which suggests a negative Javed and Faroog, 2009 relationship there are studies that have suggested a positive Sheny and Youtang, 2012 or no effects at all Hondroyiannis, Swamy, Tavlas and Ulan, 2010. The literature however for the most part continues to overlook additional measures of volatility. Awokuse and Yuan, 2006 tried to apply three measures of volatility which included the variance of the spot exchange rate around the preferred trend to sectorial exports and revealed mixed effects.

      Over all three conclusions can be drawn from the literature. First, some studies relay mainly on the OLS methodology which proves to be inadequate to cope and account with some of the statistical properties that the samples often may contain, such as unit roots and cointegration. As a result, inadequate estimates might be obtained. Second, the empirical research has provided limited or no evidence of the effects of exchange rate volatility on exports for Croatia and Cyprus. Thirdly, for the most part the empirical research uses the standard deviation of the moving average of the logarithm of the exchange rate as a measure of exchange rate volatility.

3.1 The Model

   The model underling the empirical analysis is that of Golstain and Kahan, 1976 which has been extended in such a way to account for volatility as well as seasonality effects. The model can be summarized by the equation 1.1

$$log(X) = \lambda_0 + \lambda_1 * log(PX/Pw) + \lambda_2 * log(GDP) + \lambda_3 + \lambda_4 * (V) + \lambda_5 * D1 + \lambda_6 * D3 + \lambda_7 * D4 + \lambda_8 * log(T) + \omega \quad (1.1)$$

Where:
- X is real exports,
- PX/Pw the relative prices,
- GDP real world GDP,
- V volatility (defined as the standard deviation of the moving average of the logarithm of real exchange rate), as well as a dummy capturing high and low peak values of the real effective exchange rate
- D1, D3, D4 seasonal dummies
- T time trend
- ω an error term

   The real export value is created using the unit value method. The first explanatory variable is relative prices and it is constructed by the division of the export price of each sector to an index comprised of world export prices for each corresponding sector. The second right hand variable is real world GDP, the third right hand variable is volatility which is measured in two ways. Firstly, as a measure of time varying exchange rate volatility, we use the standard deviation of the moving average of the logarithm of real effective exchange rate. Secondly, we utilize a dummy variable capturing the amount of times which the exchange rate moves above and below the average value of the real effective exchange rate for each sectoral trade flow. Our

estimation of each of the reduced from export equations for each country will be consistent with the vector error correction methodology (V.E.C.M.) and will impose the restriction of three endogenous variables and five exogenous.

3.2 Exchange rate volatility measurement

One of the most fundamental issues of the topic in question is volatility measure. Exchange rate volatility is a measure that is not directly observable thus; there is no clear, right or wrong, measure of volatility. Most empirical studies have utilized the standard deviation of the moving average of the logarithm of the exchange rate.

$$V_{t+m} = [\frac{1}{m} \sum_{i=1}^{m} (R_{t+i-1} - R_{t+i-2})^2]^{\frac{1}{2}}$$

Were:

R is the nominal or real effective exchange rate

M is the number of periods which usually ranges between 4-12

The main criticism for the application of the standard deviation of the moving average of the logarithm of the exchange rate, is that it fails to capture the potential effects of high and low peak values of the exchange rate. According to some economic models these high and low values refer to the unpredictable factor which affects exports. Our investigation will be comprised of two measures of volatility. The first is the standard deviation of the moving average of the logarithm of real effective exchange rate while the second, is comprised of a dummy variable capturing the unexpected variation of the exchange rate. This dummy variable is constructed in the flowing way. First, the values of the exchange rate are divided with its average value in an attempt to capture the amount of times where each variable exceeds the average value. With the use of a dummy variable we capture only the previously calculated values which correspond to the cases for which the exchange rate falls above and below 5%-7% of its average value. This calculation is to determine the amount of times that the exchange rate moves above and below its average value as a measure of unexpected fluctuation. However, since for each country different values above and below the average value (of the exchange rate) affect exporter's behaviour; various cases are examined for which the exchange rate fluctuates above and below its average value from 5% to 30%. Since these ranges might be different for each country; therefore, only the first significant cases obtained irrespective of the percentage used will be reported. In the event that none of these results have statistical significance, the cases for which the exchange rate variable is closest to statistical significance will are reported.

4.1 The Data

This study will examine the effects of volatility for two countries, Cyprus and Croatia. All the data are derived from Eurostat with the exception of GDP and real effective exchange rate figures which are derived from the IFS (International Financial Statistics). All the data are collected quarterly and extend from 1990: q1-2012:q1.

5.1 Empirical results

This section presents the empirical results. The augmented Dickey Fuller unit root tests have been

preformed for all the data series. The results of the unit root tests are presented in table 1

Table 1. Augmented Dickey Fuller unit root test results

Country	Variables			
	X	**GDP**	**P**	**V2**
Cyprus	I(1)	I(0)	I(1)	I(0)
Croatia	I(1)	I(0)	I(1)	I(0)

All tests are performed using the 5% level of significance*Vex the export quantity, GDP represents the real gross domestic product, V2 volatility and P is the relative prices of the each country to the world price *All tests are performed to a maximum of three lags using the Akaike info criterion

The unit root test was used to evaluate the hypothesis that each individual variable is stationary against the alternative, that the individual series is non stationary of order n and allow us to determining the order of integration. The tests indicate that the null hypothesis of stationarity can be rejected at the 5% level of significance for X and P for the first differences. For the most part volatility is not integrated partly do to the fact that it is already differenced. We therefore conclude that all the results of the unit root tests indicate that most of the countries in our sample contain at least one unit root.

For each country an error correction model for exports is developed. However, prior to developing such a model, the long run relationship among the variables included in this equation is tested. The cointegration procedure developed by Johansen and Juselious is employed to test the log run relationship of equation 1.1. The results are summarized in tables 2-3 and suggest that the null hypothesis of zero cointegration (Ho: r=0) is rejected for the most part by both the trace as well as the maximum eigen value (λmax) statistics for all the cases examined here indicating that at all of the trade flows contain at least one or more conintegrating relationship as well as a long run effect.

Table 2. Johansen's maximum likelihood test results (R = number of cointegrating vectors) for export equation using the volatility measure 1

country	Trace Statistic				Max-Eigen Statistic			
	r=0 r=1	r<=1 r=2	r<=2 r=3	r<=3 r=4	r=0 r=1	r<=1 r=2	r<=2 r=3	r<=3 r=4
Croatia	64.71757	31.44172	6.615813	1.322193	33.27585	24.82591	5.293620	1.322193
Cyprus	67.63259	37.03843	15.59582	0.075852	30.59416	21.44261	15.51996	0.075852
Critical values 5%	47.21	29.68	15.41	3.76	27.07	20.97	14.07	3.76

 * Measure 1 refers to the standard deviation of the logarithm of real effective exchange rate.

Table 3. Johansen's maximum likelihood test results (R = number of cointegrating vectors) using volatility measure 2 when exchange rate rise above and below the average value

country	Trace Statistic				Max-Eigen Statistic			
	r=0 r=1	r<=1 r=2	r<=2 r=3	r<=3 r=4	r=0 r=1	r<=1 r=2	r<=2 r=3	r<=3 r=4
Croatia	64.31465	32.83121	9.976837	0.227957	31.48344	22.85437	9.748880	0.227957
Cyprus	71.31165	28.56352	8.704828	0.056904	42.74812	19.85870	8.647924	0.056904
Critical values 5%	47.21	29.68	15.41	3.76	27.07	20.97	14.07	3.76

* Volatility represents the number of times for which the values of 7% for Croatia and 3% for Cyprus are above and below the average

value of the exchange rate

5.2 Error correction model

It is evident from the previously presented tests (table 1) all of the variables in our equation contain at least one unit root of order no higher than one. The next step is to estimate each export flow equation for the cases examined here using the two volatility measures. Recognizing however, that the type of cointegration tests are very sensitive to the underlining model specification, for example the number of lags as well as the treatment of some of the variables endogenous or exogenous variables it, is assumed that all the I(1) variables contain at least one cointegrating vector (since each trade flow contains at least one cointegrating relationship). With all these in mind it is evident that a vector error correction model can be applied in all of the cases examined here. The results for each volatility measure are presented in tables 4-5.

Table 4. Vector error correction model v2

country	LAG	VEX	C	GDP	P	V2	ECT	statistics
Croatia	0						-0.036945 (-1.62847)	**R2**=0.987844 **DW**=1.933930 **Serial corl** **F[4, 53]**= 0.065368 **ARCH F[4,53]**= 0.152366
	1	-0.656810 (-3.49147)		1.588291 (1.5378)				
	2	-0.357009 (-1.66449)		2.073104 (1.7625)				
Cyprus	0		3.045043 (2.97921)				-0.567525 (-3.05583)	**R2**=0.958465 **DW**=1.972213 **Serial corl** **F[4, 62]**= 0.084122 **ARCH F[4,62]**= 0.278987
	3	-0.399481 (-2.61946)			0.636290 (1.65435)			
	4	0.248653 (1.60873)						

Table 5. Vector error correction model measure 2

country	LAG	VEX	C	GDP	P	V2	ECT	statistics
Croatia	0					-0.058712 (-1.88491)	-0.134662 (-1.56350)	**R2**=0.990470 **DW**=1.901788 **Serial corl** **F[6, 52]**= 0.072494 **ARCH F[6,52]**= 0.546579
	1	-0.427730 (-2.03563)						
	5				1.196605 (1.61326)			
Cypru	0		3.445445				-0.546615	**R2**=0.958191

s	(2.95377)		(-3.01061)	DW=1.973619 **Serial corl F[4, 62]=** 0.129560 **ARCH F[4,62]=** 0.259093
2	-0.228687 (-1.39501)			
3	-0.425635 (-2.80278)	0.621905 (1.61221)		
4	0.233731 (1.50188)			

*For all of the tables vex is the export quantity, GDP represents the real domestic gross domestic product, V2 volatility, ECT represents the error correction term, C the constant and P is the relative prices of the each country to the world price. * For table 4 V2 is defined as the simple standard deviation of the log effective exchange rate and 4 lags were used for Croatia and Cyprus * For table 5 volatility represents the number of times for which the values of 7% for Croatia and 3% for Cyprus are above and below the average value of the exchange rate using 6 lags for Croatia and 4 lags for Cyprus. * T statistics are in parenthesis.

Considering the regressand results of tables 4-5 the empirical results suggest that the statistical fit or each model to the data is satisfactory as indicated by the values of R^2. Moreover the statistical appropriateness of all the equations fulfils the conditions of non serial corelation (for both the serial correlation LM test as well as the ARCH test) joint significance of all the dependent variables (using the Wald test) and is supported by all of the diagnostic tests. Additionally the error correction term is statistically significant and displays the appropriate negative sign.

The results of the estimated equations signify that dynamics of the equations show for the most part that changes in real income (GDP) and relative prices both have significant effects on exports. As suggested by the Wald test results a short run effect is indicated in addition to the long run effect. A closer examination of the focus variable, volatility, reveals that none of the cases examined here utilizing a moving average measure of volatility was proven to be significant. However, for the cases for which the alternative measure of volatility has been used the results appear to have more statistical significant cases. The results therefore suggest that (for the second measure) there is one significant case for Croatia and with a negative coefficient.

The results of this study add to the literature in several ways. First, as we pointed out in the beginning our investigation of the literature has uncovered limited empirical work concentrating on the effects of volatility on exports for Croatia and Cyprus. Second, we have concentrated on an important issue often overlooked by empirical research, the exchange rate measure. In this study (in addition to the common measure) a new measure of exchange rate was developed which accounts for these unexpected fluctuations in the exchange rate.

6.1 Summary conclusion and policy implications

In this study we have taken explicit account of nonstationarity and have applied a multivariate cointegration error correction model for two countries and two different measures of volatility. Each model satisfies several commonly utilized econometric tests in the analysis of time-series data such as cointegration and unit roots. Our empirical analysis suggests that although exchange rate volatility when measured as the simple standard deviation of the log effective exchange has no effect on the level of exports for both Croatia and Cyprus. However, when an alternative measure is used there is an indication of a stronger effect from movements of the exchange rate to the level of exports. As a result a negative statistical significant relationship is estimated for Croatia. From a policy prospective our results are important. They suggest that policy makers should consider volatility for some but not all countries when applying economic policy. More specifically, policy actions reducing unexpected fluctuation of the exchange rate, for one of our sample countries, will increase the exported amount. The actual reduction from such a policy is beyond the scope of this paper and will be addressed in future work.

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