The effects of exchange rate volatility on sectoral exports evidence from Sweden, UK, and Germany

Agiomirgianakis, G. , Serenis, D. and Tsounis, N.

The Effects of Exchange Rate Volatility on Sectoral Exports Evidence from Sweden, U.K. and Germany [1][2]

Dimitris Serenis
Assistant Professor, Adjunct Faculty, Department of International Trade, TEI of Western Macedonia, Kastoria, Greece, e-mail: dseren01@yahoo.com

Nicholas Tsounis
Professor, Department of International Trade, TEI of Western Macedonia, Kastoria, Greece.
Adjunct Faculty, Hellenic Open University, Patras, Greece
e-mail: tsounis@kastoria.teikoz.gr

Abstract: This paper examines the effect of exchange rate volatility for a set of three European countries, Germany, Sweden and the U.K. on sectoral exports for the period 1973 q1-2010 q4. In addition to the standard deviation of the moving average of the logarithm of the exchange rate a new measure capturing unexpected fluctuation of the exchange rate is examined using the Autoregressive Distributed Lags (ARDL) modeling to cointegration. The results suggest that exist a long-run cointegrating relationship between the exchange rate volatility and the level of exports for the sectors examined, in the UK and Germany but it does not have an effect on the exports of Sweden.

Keywords: exchange rate volatility, exports, sectoral trade, UK, Germany, Sweden, ARDL method

JEL codes: F41

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1. Introduction

The effect of exchange rate volatility on exports is one of the controversial issues of international economics. It is often claimed that exchange rate volatility increases risk and hampers the flow of exports. The reasoning behind this claim is that periods of high fluctuation of the exchange rate uncertainty is increased to future profits of risk-averse producers. Under this view the increase in risk leads to a reduction in exports since producers substitute sales from foreign markets to domestic. The exact opposite is also claimed, suggesting that volatility improves export flows since it offers the possibility for lager profits. Under this view high fluctuation of the exchange rate provides a chance to domestic investors to obtain larger profits from a possible overvalue of the foreign currency resulting to a switch in sales from domestic markets to foreign. This switch causes an increase of the exported volume. Additionally, it is stressed that the financial markets offer the possibility of hedging risk. Therefore, there is no relationship between exchange rate volatility and exports. This claim has been disputed by Akhtar and Hilton (1984) suggesting that forward markets fail to eliminate some if not all exchange rate risk. Finally, some researchers claim that it possible for volatility to produce different types of effects for different trade flows. In other words the effect of volatility might be different for aggregate exports when compared to sectoral and bilateral exports. Although, exchange rate volatility has been considered as one of the major shortcomings of the flexible exchange rates, due to the increase of uncertainty on exports, the empirical literature has not found decisive evidence of a negative, positive or no effect at all on exports. The existence of different sets of empirical results can be attributed a wide variety of different aspects that can be undertaken by empirical researchers, which include: various measurement issues of some variables, different samples time periods utilized as well as different economic models which are often used.

Motivated by the lack of extensive literature on disaggregated data, the purpose of this paper is to focus on the measurement of exchange rate volatility; a new measure which allows capturing the high and low values of exchange rate on disaggregated exports for three E.U. countries is proposed.

The paper is organized as follows: Section 1 and 2 provide an introduction and a brief discussion of the literature review. Section 3 presents the reduced form equilibrium export quantity model utilized in the study, Section 4 describes the method for measuring exchange rate volatility and Section 5 presents the data. The methodology for estimation of the models together with the analysis of the results and the conclusions are presented in sections 6 and 7, respectively.

2. Literature review

Empirical as well as theoretical literature has not found decisive evidence of the effects of exchange rate volatility on exports. The main focus of the early analysis for the most part centred on the models of risk aversion favouring the negative relationship hypothesis Clark (1973); Hooper and Kohlagen (1978).

In the 1980's various attempts were made in order to expand existing models by incorporating additional aspects, such as the extension of sample sizes, models, time periods as well as different measures of volatility. Akhtar and Hilton (1984) concluded that exchange rate uncertainty is detrimental to the international trade. De Grauwe (1988) suggested that high risk aversion could in fact lead to export increase. His study showed that although exchange rate unambiguously can reduce the total utility derived from exporting it could in fact lead to increased exports if the marginal utility of exporting is increased. His model incorporated the percentage change of export quantity as a measure of volatility. Peree and Steinher (1989) proposed the average absolute difference, between the previous forward rate and the current spot rate as a more complete measure of exchange rate volatility. Despite all attempts to provide more accurate estimates, the estimated method consists of the OLS methodology leading to a mixed set of results.

In the 1990's new advancements were applied to a variety of models. The consequence of the switch to new empirical techniques (VAR, GARCH-GARCH, ECM and VEC) resulted to less focus towards alternative measures of volatility. Franke (1991) suggested that a firm will exercise the option to enter a market if it is profitable. The profitability depends on the present value of expected cash flow from exporting which depends on the movements of the exchange rate and on the present value of entry and exist cost. Kroner and Lastrapes (1993) estimated the impact of exchange rate volatility on export volume and prices. His study concluded that volatility was found to have a negative effect on trade volume for only the U.S. and the U.K.. For other countries the estimated coefficients proved to be positive. Arize, while examining samples of E.U. as well as developing countries, published a series of studies that showed in some cases a negative (Arize, 1995, 1996, 1999a, Arize *et. al.* 2000) and in other cases no relationship at all Arize (1999b). Additionally Asseery and Peel (1991) and Mckenzie (1999) conclude that exchange rate volatility positively affects international trade.

In the early 2000 and onwards empirical researchers attempted to further expend the investigation on the issue. Sercu and Uppal (2003) developed a model of a stochastic general equilibrium economy. Their model estimated both positive as well as negative relationships according to the source of exchange rate volatility. More specifically they found that if the increase in the exchange rate volatility is due an increase in the degree of segmentation of commodity markets, then trade will fall with a rise in exchange rate volatility. Awokuse and Yuan (2006) applied three measures of volatility which included the variance of the spot exchange rate around the preferred trend to sectoral exports and revealed mixed effects. Bahmani-Oskooe *et.al.* (2008) investigated the impact of exchange rate volatility on bilateral export flows between the United States (U.S.) and the United Kingdom (U.K.) utilising the error correction technique. Their study is comprised of 177 commodities. Their results suggested that exchange rate volatility indicates effects for both short run and long run period which are for the most part, negative.

In an attempt to extend their examination further some researchers have also examined developing countries. Kargbo (2006) developed a model examining the exports and imports for African agricultural products while Benson and Godwin (2010) examined the effects of exchange rate volatility in the CFA (Communaute Financiere Africaine) and non-CFA countries of Africa. The impact of exchange rate volatility and exports for developing countries has also been examined by Javed and Farooq (2009) for Pakistan's exports under the vector error correction methodology. Their study suggested a relationship between volatility and exports and also that domestic economic performance is very sensitive to the exchange rate volatility in the long-run period. Shehu and Youtang (2012) examine the relationship between exchange rate volatility, trade flows and economic growth of the Sub-Saharan African countries with exclusive reference to Nigeria. Their results indicated significant effects of exchange rate volatility on trade flows and economic growth of Nigeria. Hall *et.al.* (2010) investigated the effects of real exchange-rate volatility on exports of ten emerging market economies and eleven other developing countries. Their results for the emerging market economies do not show a negative or a significant effect of exchange-rate volatility on exports.

Our study contributes to the existing literature in various aspects. First, in contrast with the studies of 1970's and 1980's which utilize the OLS methodology, our study employs the use of cointegration modeling techniques; the Autoregressive Distributed Lags (ARDL) method to co-integration is used. As a result, more accurate relationships are estimated. Second, our study examines the effects of disaggregated exports, an area for which empirical research has provided limited evidence. Finally, in addition to the commonly estimated measures, a new measure is constructed which captures the unexpected fluctuation of the exchange rate.

3. The Model

The model underling the empirical analysis is that of Golstain and Kahan (1978) which has been modified with the inclusion of the different volatility measures and also to account for seasonality effects. As in previous studies, the reduced form export function is in log-linear specification. The model can be summarised by the following equation:

$$\ln X_t = \lambda_0 + \lambda_1 \ln \left(\frac{P_X}{P_w}\right)_t + \lambda_2 \ln GDP_t + \lambda_3 V_t + \lambda_4 D_1 + \lambda_5 D_3 + \lambda_6 D_4 + \lambda_7 \mathrm{T} + \omega_t \qquad (1)$$

where X is export quantities, P_X/P_w are relative prices, GDP is real domestic GDP, V represents the two different measures of volatility, D1, D3, D4 are seasonal dummies, T is a time trend and ω is an error term

The real export value is created using the unit value method. The relative prices variable is constructed from the export price deflated by an index comprised of world export prices for each corresponding sector. The variable following the relative prices is real domestic GDP serving as a measure of competitiveness. Finally, the last variable (V), represents volatility which is measured in two ways. Firstly, as a measure of time varying exchange rate volatility, using the standard deviation of the moving average of the logarithm of real effective exchange rate. Secondly, as a measure of high and low fluctuation above the average values of volatility, utilising a dummy variable capturing high and low peak values of the real effective exchange rate for each sectoral trade flow.

4. Exchange rate volatility measurement

Exchange rate (ER) volatility is a measure that is not directly observable thus; there is no clear, right or wrong, measure of volatility. Even though some empirical researchers have examined alternative measures of volatility for the most part the literature utilizes a moving average measure of the logarithm of the exchange rate.

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

Where R is the logarithm of the nominal or real effective exchange rate, m is the number of periods, usually ranging between 4-12.

The application of such a measure has its benefits but it also has pitfalls. The main disadvantage is that it fails to capture and incorporate the potential effects of high and low peak values of the exchange rate.

High and low peak values capture the unpredictable factor which alters the exporters' behavior. Many empirical researchers have in the past commented on the importance of unexpected values of exchange rate. Akahtar and Hilton (1984) concluded that exchange rate uncertainty is detrimental to the international trade. Others have applied volatility measures which attempted to incorporate unexpected movements of the exchange rate. Some have proposed the average absolute difference between the previous forward rate and the current spot rate as a better indicator of exchange rate volatility (Peree and Steinherr *op.cit.*). Awokuse and Yuan, (*op.cit.*) applied a measure of volatility which included the variance of the spot exchange rate around the preferred trend. However, as suggested by De Grauwe (*op.cit.*) risk preferences to unpredictable movements of the exchange rate play a vital role on exporters' behaviour. As a result, it is possible for a producer to either increase or decrease exports during a period for which exchange rates take up extremely high and low values. A moving average does reduce these high and low values and therefore, in some cases of extreme fluctuation of the exchange rate proves inadequate to fully capture the effects of volatility on exports.

With that in mind this study will examine two sets of estimated equations. The first contains the standard deviation of the moving average of the logarithm of the real effective exchange rate as a measure of volatility (V1) and the second contains a dummy variable capturing only high and low values of the exchange rate (V2).

In order to derive the second measure of volatility the average value of the exchange rate is calculated. The usage of a dummy variable captures only the values for which the exchange rate fluctuates above and below a percentage of the average value. Since we don't know for each country which values are perceived as high or low points we examine various cases for which the exchange rate increases above and below different certain thresholds ranging from 4%-7%.

5. Data description

The data selected in this study includes three E.U. countries Germany, Sweden and the U.K. and two sectors, beverages and tobacco and chemicals. Quarterly data are employed to explore the relationship between exports and exchange rate volatility that cover the period 1973: q1 to 2010: q4. All the values and unit values of the sectoral exports are obtained from the Organization for Economic Co-operation and Development (OECD) while the GDP figures are derived from Eurostat and real effective exchange rates are derived from International Financial Statistics (IFS).

The selection of the exporting sector for each of these countries is not an easy choice. We have identified a list of their main exporting sectors and have selected two sectors that each country exports. All three countries in our sample export beverages and tobacco as well as chemicals. Another criterion for the selection of these export sectors is the percentage of the countries' total exports. In order to derive comparable estimates we have selected two sectors which correspond to similar percentage of the total trade for each of the selected countries. More specifically for the year 2012 exports of beverages and tobacco account 5% for Germany and Sweden and 6% for the U.K. of their total exported amount. Chemicals account 16% for Germany, 18% for the U.K. and 12% for Sweden for the year 2012.

Graphical representations depicting the behavior of each data variable are presented in appendix 1 and the descriptive statistics are presented in appendix 2. Due to differences in the scale of the variables all of the values in the graphs are expressed in logarithms. The last part of the appendix 1 presents the standard volatility measure (moving average) in comparison with the new measure (dummy variable capturing high and low points of the exchange rate). As it is evident the standard deviation of moving average of the log exchange rate is the same for each country and sector. However, since differences as to what is perceived, high and low points might exist among sectors, measure 2 of the exchange rate, varies for each sector with in a country. From a detailed examination of the different volatility measures graphs the following observations can be made: first, as it was expected, measure 1 is smoother and with less fluctuation than measure 2, second, a comparison of volatility measure 1, for each country reveals similar high and low points, to these estimated, with measure 2 among the selected countries, third, for the most part, volatility measure 2 follows the same pattern with measure 1. Finally, as one would expect the numeric values of measure 2, since they represent high and low peaks, are much higher than measure 1.

6. Estimating methodology and results

Before examining the existence of a long-run relationship (co-integration) between the variables we must analyse first, the order of integration of the variables considered. This analysis is usually done using the ADF (Dickey, Fuller, 1981) or the P-P (Phillips, Perron, 1988) unit root test. The criticism for these tests that they have a low power in distinguishing unit root and a near unit root process when the span of the data is not long enough does not apply in our case because the sample sets have about thirty years quarterly data. The P-P unit root test was used to test the series for stationarity.

The values of the P-P test are presented in Table 1. The bandwidth length is four lags; both a trend and intercept were used in the test equation and the critical values were determined using the Bartlett Kernel estimation method.

Table 1: Phillips-Peron unit root test results

Chemicals				Beverages and tobacco			
Country and series	Level	First difference	Second difference	Country and series	Level	First difference	Second difference
U.K.				U.K.			

lnVEX	-6.1490*	-19.075*	-44.713*	lnVEX	-9.6177*	-25.109*	-36.818*
lnGDP	-6.1206*	-15.373*	-20.243*	lnGDP	-6.1206*	-25.109*	-36.818*
V1	-10.563*	-26.470*	-46.946*	V1	-10.563*	-26.470*	-46.946*
lnP	-2.8361	-11.408*	-27.786*	lnP	-2.8110	-12.60063*	-12.624*
Sweden							
lnVEX	-4.5759*	-17.041*	-31.056*	lnVEX	-3.0593	-16.990*	-37.937*
lnGDP	-12.161*	-44.171*	-70.162*	lnGDP	-12.161*	-44.171*	-70.162*
V1	-9.8580*	-24.097*	-43.607*	V1	-9.8580*	-24.097*	-43.607*
lnP	-0.4307	-10.784*	-24.256*	lnP	-1.5277	-13.534*	-28.911*
Germany							
lnVEX	-3.6300*	-11.956*	-25.473*	lnVEX	-6.4250*	-23.203*	-40.110*
lnGDP	-5.2463*	-10.473*	-18.864*	lnGDP	-5.2463*	-10.473*	-18.864*
V1	-11.468*	-26.732*	-50.117*	V1	-11.468*	-26.732*	-50.117*
lnP	-2.9186	-12.249*	-27.372*	lnP	-3.2443	-12.310*	-28.576*

Note: All tests are performed using the 5% level of significance; Vex is the logarithm of export quantity, GDP represents the logarithm of the real gross domestic product, V1 is volatility measured as the moving average of the standard deviation of the exchange rate and P is the logarithm of relative prices of each country to the world price. All tests are performed to a maximum of three lags. The null hypothesis of a unit root is tested against the alternative. The asterisk denotes significance at least at 5% level.

Source: authors' calculations

From Table 1 it is seen that the lnP series for all sectors, all countries and the lnVEX series for the beverages and tobacco sector in Sweden and for the Chemicals sector in Germany are I(1) while the remaining variables are I(0). As one would expect, the null hypothesis of a unit root is rejected for volatility when measured as the moving average, partly due to the fact that it is already differenced. When there are I(1) variables, the maximum likelihood approach of Johansen and Juselius (1990) can be used (among others, Dritsaki *et.al*, 2013). However, the requirement is that all the variables are I(1). In our case the system contains variables with different orders of integration and therefore, the Autoregressive Distributed Lag modeling (ARDL) suggested by Pesaran *et. al.* (1999, 2001) will be used. The ARDL method can be applied on a time series data irrespective of whether the variables are I(0) or I(1) (Pesaran and Pesaran, 1997), it generally provides unbiased estimates of the long-run model and validates the t-statistics even when some of the regressors are endogenous (Laurenceson and Chai, 2003). However, it is necessary to check that the variables are not I(2) because, in this case, ARDL would produce spurious results (Oteng-Abayie et.al., 2006).

Following Perasan et.al. (1999, 2001) the ARDL representation of equation (1) is:

$$\Delta lnX_t = a_0 + \vartheta lnX_{t-1} + \sum_{i=1}^{\mu} \theta_i G_{i,t-1} + \sum_{j=1}^{p} a_j \Delta lnX_{t-j} + \sum_{i=1}^{\mu}\sum_{j=0}^{p} \beta_{ij} \Delta G_{i,t-j} + \tau T + \delta_1 D1 + \delta_3 D3 + \delta_4 D4 + \omega_t \quad (3)$$

where Δ is the first-difference operator, X is export quantities, G=(lnP, lnGDP, V1) is the vector with the explanatory variables; P is the relative prices, GDP real domestic GDP, V1 represents the first measure of exchange rate volatility, D1, D3, D4 are seasonal dummies, T time trend, ω is a white noise error term, μ=3 is the number of explanatory variable, ϑ, θ_i are the coefficients that represent the long-run relationship, α_j, β_{ij} are the coefficients that represent the short-run dynamics of the model and p is the number of lag length. For the examination of the exchange rate volatility on exports using the second measure, in equation (3) the dummy variable V2 described in section 4 was included; in this case G=(lnP, lnGDP).

The ARDL method to co-integration requires the following steps:

Step 1: Equation (3) is estimated after establishing that all the variables are either I(0) or I(1) and not I(2). The lag order of the ARDL was determined using the appropriate lag selection criterion. In the literatute three criteria are alternatively used: the Akaike Information Criterion (AIC), the Schwarz Bayesian Criterion (SBC) or the Hannan-Quinn (HQ) criterion. In our case, the SBC was used as it is a consistent model selector (Perasan et.el. (2001)). The smaller the value of the SBC the better the result. 8(μ+1) were estimated for each country and for each sector for each of the two versions of the volatility measure[3].

Step 2: After finding, in Step 1, the order of the ARDL model a test was conducted that the errors in equation (3) are serially independent. This is required by the ARDL bounds testing methodology (see Step 4) (*ibid*). The Lagrange Multiplier (LM) test was used to test the null hypothesis that the errors in equation (3) are serially independent against the alternative that there are autoregressive or moving average relationships in the errors.

Step 3: When a model has autoregressive (AR) terms it will be stationary (i.e. dynamically stable) when the inverse roots of the AR polynomials lie strictly inside the unit circle. In our case, after finding the AR order of the ARDL model, in step 1, the plot of the inverse roots of the AR polynomial was made.

Step 4: From equation (3) a test for the existence of long-run relationship was made. This is called the 'bounds testing' approach to co-integration and it is associated to the hypothesis testing $H_0\colon \vartheta = \theta_1 = \cdots = \theta_i = 0$; i is the number of explanatory variables i.e. the long-run relationship does not exist against the alternative $H_1\colon \vartheta \neq \theta_1 \neq \cdots \neq \theta_i \neq 0$ i.e. the long-run relationship exists. This hypothesis is tested by the use of the F-statistic. However, the distribution of the F-statistic is non-standard and the critical values are available in Perasan et.al. (2001). If the computed F-statistics is higher than the appropriate upper bound of the critical value, the null hypothesis of no-cointegration is rejected and the alternative is adopted. If it is bellow the appropriate

[3] In total 27,648 regressions were estimated.

lower bound, the null hypothesis cannot be rejected and if it lies within the lower and upper bounds, the result is inconclusive. In our case, a Wald test was computed in the E-views programme and the F-statistic was compare to that given by the appropriate upper bound critical value.

Step 5: Assuming that the bound test in step 5 is conclusive and there is a cointegrating relationship, the coefficient and its statistical significance of the Error Correction Term (ECT) can be found by estimating:

$$\Delta lnX_t = a_0 + \sum_{j=1}^{p} a_j \Delta lnX_{t-j} + \sum_{i=1}^{\mu}\sum_{j=0}^{p} \beta_{ij}\Delta G_{i,t-j} + eECT_{t-1} + \omega_t \ (4);$$

The coefficient of the error correction term, *e*, should be negative and statistically significant meaning that there is a co-integration between the dependent and the explanatory variables. The value of this coefficient shows the percentage change of any disequilibrium between the dependent and the explanatory variables is corrected within one period (one quarter).

Step 6: Once the model is obtained in Step 2, the long-run impact of the explanatory variables to the dependent variable is calculated using the expression (Bardsen (1989)):

$$\hat{\gamma}_i = -\frac{\hat{\theta}_i}{\hat{\vartheta}} \ (5);$$

where $\hat{\theta}_i$ and $\hat{\vartheta}$ are the estimated long-run coefficients in equation (3). The $\hat{\gamma}_i$s show how the dependent variable, in our case the logarithm of exports, responds in the long-run to any change in the explanatory variables *i.e.* the logarithm of relative prices, real GDP and most importantly exchange rate volatility. However, the $\hat{\gamma}_i$s provide a single value to quantify the long-run effect and they do not provide any information about the degree of variability associated to them (Gonzalez-Gomez *et.al.*, 2011). Further, confidence intervals for each coefficient cannot be constructed using traditional statistical inference because they do not follow the normal distribution since they are calculated as the division of two normal variables. Following Efron and Tibshirani (1998) the bootstrap method, which is a non-parametric method, can be used in order to calculate empirically confidence intervals without assuming a specific distribution of the γ_is. The calculation of the confidence intervals for each $\hat{\gamma}_i$ was made with the use of the STATA programme for 95% level of statistical significance. If the zero is contained in the interval then the effect of the explanatory variable will not be statistically significant.

The results are presented in Table 2; dependent variable is export quantity (VEX). The order of the ARDL model, the F-statistic for the LM test of serial correlation, the F-statistic Wald bound test, the long-run impact of the explanatory variables to the dependent variable $\hat{\gamma}_i$, the coefficient of the error correction term, *e*, and the confidence intervals of the $\hat{\gamma}_i$s calculated using the bootstrap method. All regression results and the test for dynamic stability are presented in Appendix 3.

Table 2: ARDL results for the effects of ER volatility (measure 1 and 2) on exports

Country, Sector	ARDL order	Regressor, coefficient	$\hat{\gamma}_i$	F-statistic, Wald bound test	F-statistic, LM test	$\hat{e}$	confidence intervals for $\hat{\gamma}_i$	Dynamic stability
UK-Beverages and Tobacco ER volatility measure 1	(1,0,6,2)	ln VEX(-1): -0.562* ln P(-1): 0.324* ln GDP(-1): 0.036 V1(-1): -0.247*	lnP: -0,577* lnGDP: 0,064 V1: -0.440	11.02*	2.43	-0.289*	**[-0.738 -0.415]** [-0.825 0.951] **[-1.750 -0.173]**	yes
UK-Beverages and Tobacco ER volatility measure 2	(1,0,6)	ln VEX(-1): -0.547* ln P(-1): 0.275* ln GDP(-1): -0.003 V2: -0.007	lnP: 0.503* lnGDP: -0.005	16.80*	2.22	-0.295*	**[0.046 1.003]** [-3.446 0.791]	yes
UK-Chemicals ER volatility measure 1	(3,0,6,6)	ln VEX(-1): -0.392* ln P(-1): -0.001 ln GDP(-1): 0.414* V1(-1): -0,591*	lnP: -0.003 lnGDP: 1.056* V1: -1.508*	8.97*	1.53	-0.325*	[-0.178 0.171] **[0.037 2.077]** **[-11.826 -0.802]**	yes
UK-Chemicals ER volatility measure 2	(3,0,6)	ln VEX(-1): -0.460* ln P(-1): -0.023 ln GDP(-1): 0.444* V2: 0.025*	lnP: -0.050 lnGDP: 0.965*	12.21*	0.94	-0.362*	[-2.016 1.063] **[0.508 2.226]**	yes
Germany-Beverages and Tobacco ER volatility measure 1	(1,0,4,0)	ln VEX(-1): -0.910* ln P(-1): -0.309* ln GDP(-1): -1.528* V1(-1): -6.504*	lnP: -0,340* lnGDP: -1.679* V1: -7,147*	5.84*	0.97	-0.530*	**[-1.144 -0.108]** **[-4.210 -0.023]** **[-6.547 -8.028]**	yes
Germany-Beverages and Tobacco ER volatility measure 2	(1,4,4)	ln VEX(-1): -0.946* ln P(-1): -0.156 ln GDP(-1): -1.301* V2: -0.042	lnP: -0.165 lnGDP: -1.375*	8.12*	0.19	-0.675*	[-0.492 0.135] **[-3.646 -0.741]**	yes
Germany-Chemicals ER volatility measure 1	(1,0,2,4)	ln VEX(-1): -0.353* ln P(-1): -0.057 ln GDP(-1): -0.569 V1(-1): -9.351	lnP: -0.161 lnGDP: -1.610 V1: -26.461	5.13*	2.04	-0.245*	[-0.616 0.180] [-3.876 0.346] [-66.860 7.996]	yes

Germany-Chemicals ER volatility measure 2	(1,0,2)	ln VEX(-1): -0.404* ln P(-1): -0.074 ln GDP(-1): -0.608 V2: -0.017	lnP: -0.183 lnGDP: -1.506*	5.93*	0.71	-0.291*	[-0.651 0.084] **[-7.269 -0.010]**	yes
Sweden-Beverages and Tobacco ER volatility measure 1	(1,6,2,4)	ln VEX(-1): -0.519* ln P(-1): 0.386* ln GDP(-1): 0.293 V1(-1): 8.674	lnP: 0.744 lnGDP: 0.565 V1: 16.705	5.44*	2.12	-0.493*	[-1.224 2.862] [-8.110 6.311] [-132.209 103.571]	yes
Sweden - Beverages and Tobacco ER volatility measure 2	(5,6,4)	ln VEX(-1): -0.613* ln P(-1): 0.464* ln GDP(-1): -0.051 V2: -0.009	lnP: 0.757 lnGDP: -0.083	6.14*	1.39	-0.567*	[-2.351 1.918] [-3.039 3.497]	yes
Sweden - Chemicals ER volatility measure 1	(1,4,2,0)	ln VEX(-1): -0.289* ln P(-1): 0.022 ln GDP(-1): -0.825* V1(-1): -1.262	lnP: 0.076 lnGDP: -2.854* V1: -4.368	5.12*	1.43	-0.283*	[-0.175 0.269] **[-5.431 -1.258]** [-12.806 7.038]	yes
Sweden - Chemicals ER volatility measure 2	(1,0,2)	ln VEX(-1): -0.268* ln P(-1): 0.013 ln GDP(-1): -0.858 V2: 0.001	lnP: 0.049 lnGDP: -3.201	6.03*	1.05	-0.220*	[-2.043 1.571] [-27.110 12.324]	yes

Notes: The asterisk denotes at least 5% level of statistical significance. Confidence intervals indicating statistically significant long-run coefficients ($\hat{\gamma}_i$s) are presented in bold. The plot of the inverse roots of the AR polynomials for examining the dynamic stability of the respective ARDL model are presented in Appendix 3.

Source: authors' calculations; regression results and diagnostic statistics were obtained using Eviews 7.2, confidence intervals were calculated using StataSE 12.

The lag order of the ARDL model is presented in column 2 of Table 2. It was determined using the SBC selection criterion. The F-statistic of the Wald 'bound' test of co-integration is presented in column 5 of the same Table. As it can be seen, the F-statistic is higher than the upper bound critical value (5.119 and 5.872 for the ER volatility measure 1 and the ER volatility measure 2 model, respectively) indicating a long-run relationship between exports (ln VEX) and the explanatory variables (ln P, ln GDP and V1). Further, the LM test was used to test the null hypothesis that the errors in equation (3) are serially independent against the alternative that there are autoregressive or moving average relationships in the errors. The F-statistic from the LM test is presented in column 6. Serial correlation is not detected in all cases.

The results from the examination of the effects of exchange rate volatility (measure 1 and 2) on exports are shown in Table 2, above. The fourth column, shows the long-run impact of the exchange rate on the dependent variable; the asterisk indicates a statistically significant coefficient at 5% level. The results show that the effects of exchange rate volatility on sectoral exports are mixed. They indicate that exchange rate volatility has no effects on the exports of Sweden, while it affects the exports of the UK in the sectors examined and the sector of Beverages and Tobacco in Germany. In all cases, where the long-run coefficients are statistically significant, as it is shown by the bootstrap confidence intervals, they have a negative sign, indicating a negative effect of ER volatility on exports: a one percent increase in ER volatility will lead to a decrease in the volume of exports ranging from 0.440% for the case of the sector of beverages and tobacco in the UK to 7.147% for the case of the same sector in Germany.

The relative price variable for the sectors of beverages and tobacco in the UK and Germany is negatively related with the export volume and it has a larger value in the UK in relation to Germany. Both the relative price variable and the ER volatility are not statistically significant for both sectors in Sweden, indicating that in the long-run these variables do not affect the volume of sectors.

The GDP variable, in the cases that it is statistically significant, presents a more mixed effect than relative prices. The estimated coefficient ranges from -2.854 to 1.056 showing that it may affect export volume either positively or negatively.

The coefficients of the error correction term were estimated using equation (4) and they are shown in the seventh column of Table 2. They are negative and highly statistically significant for all cases indicating that there is a co-integration between the dependent and the explanatory variables. The value of this coefficient shows the percentage change of any disequilibrium between the dependent and the explanatory variables that it is corrected within one period (one quarter). The coefficient of the error correction term (in absolute value) ranges from approximately 0.30 in the U.K. and Sweden (both sectors), to a high of 0.675 in Germany for beverages and tobacco when measure 2 of ER volatility is used. This results shows that any disequilibrium between the exports and the explanatory variables is corrected in less than a year. For the most part, the error correction term (in absolute value) seems to be larger for the cases where measure 2 is used, compared to the cases where measure 1 is used for each corresponding sector. This indicates that for measure 1 any deviation in exports resulting from the selected variables take longer time to fine tune back to its long run equilibrium when compared with the results of measure 2.

The results of this article add to the literature in several ways. First, there is a limited amount of empirical studies concentrating on the effects of volatility on exports for sectorial exports. Second, in addition to the ambiguity as to samples, time periods and variables there is also an ambiguity with regard to the exchange rate volatility measure. Third, in addition to the common measure of volatility we calculated a new measure capturing fluctuations between 4% - 7% of the average value of the exchange rate and in order to estimate the effect of high exchange rate fluctuations from volatility to exports.

7. Conclusions and policy implications

In this study the relationship between exports and exchange rate volatility has been examined for two different sectors and three E.U. countries. Our empirical methodology relied upon the theory of cointegration, error correction representation of the cointegrated variables and different volatility measurements. The results can be summarized in four major findings. First, the empirical effects of exchange rate volatility on sectoral exports are mixed. The results also indicate that exchange rate volatility has no effects on the sectors examined for Sweden but it does affect the sectors of beverages and tobacco and chemicals in the UK and the sector of beverages and tobacco in Germany. This finding suggests differences among the various sectors and countries. Second, there is an impact of both the relative price ratio and real income on exports. Third, the study suggests for some countries and some sectors high values of the exchange rate fluctuation produce a significant effect on exports. Lastly, based on the results, we can conclude that exchange rate volatility for the most part does have a negative relationship on the sector of chemicals, in the UK and Germany. From a policy perspective, our results are important. They suggest that policy makers should consider the effects of exchange rate volatility when applying economic policy. More specifically, policy actions should be taken to reduce unexpected fluctuation of the exchange rate. Another issue that has to be considered is the amount of the total financial gain, in case of the existence of such a gain. If the amount of the potential gain is fairly low, it might not be worthwhile to impose such a policy. The effects of a volatility reducing policy will require the examination of a wide variety of sectors and products. Specification for such a policy is beyond the scope of this paper and will be addressed in future work.

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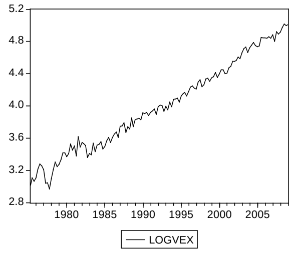
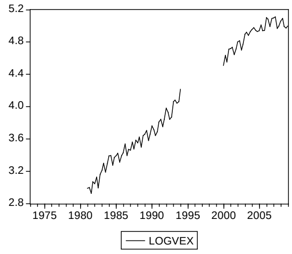
APPENDIX 1

Chemicals volume of exports

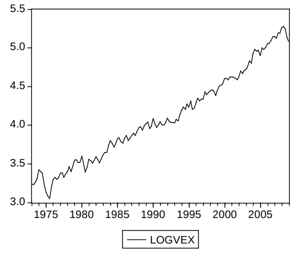
U.K.



Sweden

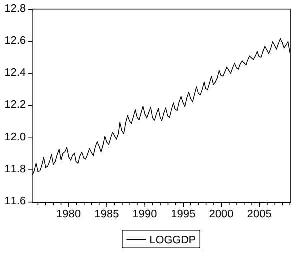


Germany

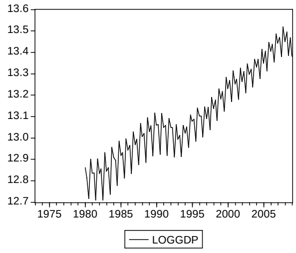


Chemicals GDP

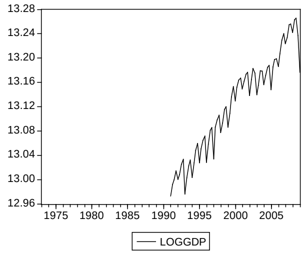
U.K.



Sweden

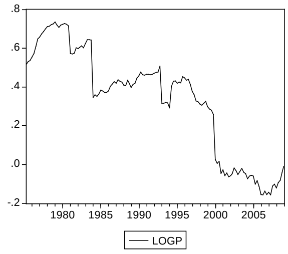


Germany



Chemicals P (relative prices)

U.K.



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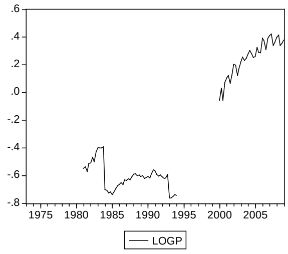

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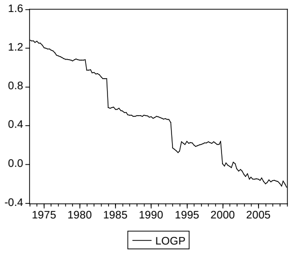
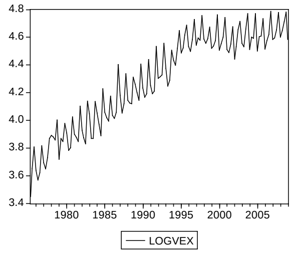


Beverages and tobacco Volume of exports

U.K.



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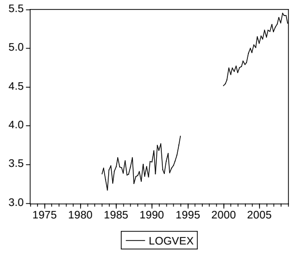

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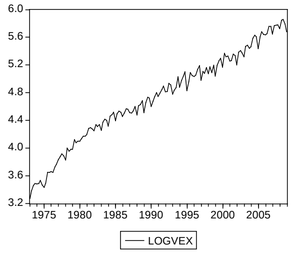
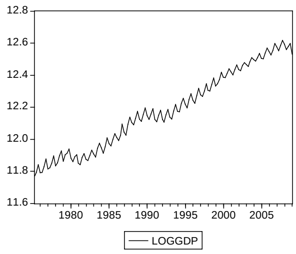


Beverages and tobacco GDP

U.K.



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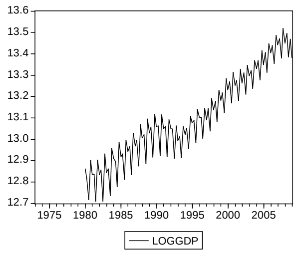

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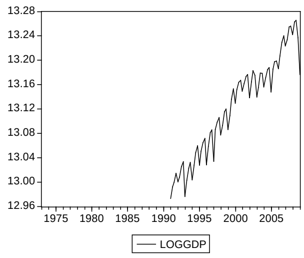
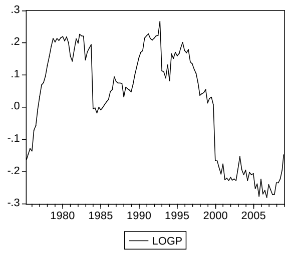


Beverages and tobacco P (relative prices)

U.K.



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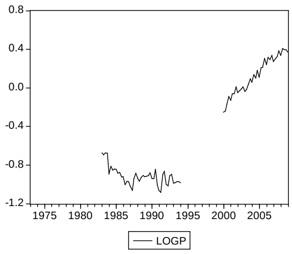

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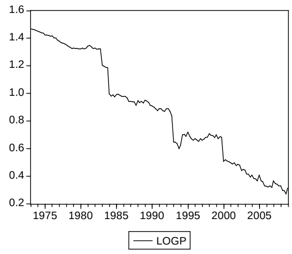
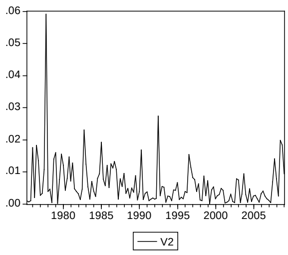
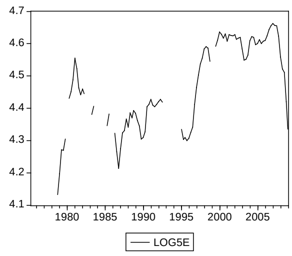


Volatility measures

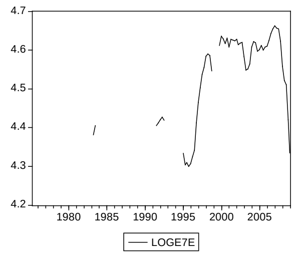
UK measure 1



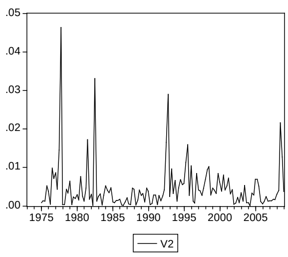
U.K. measure 2 chemicals



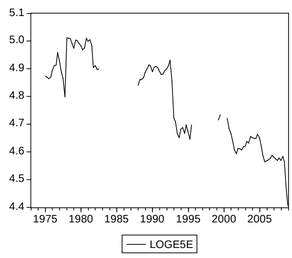
UK measure 2 beverages & tobacco



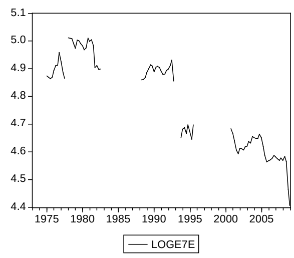
Sweden measure 1



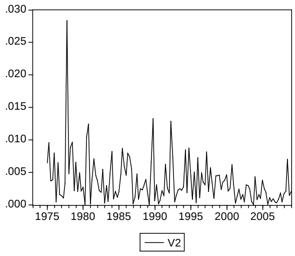
Sweden measure 2 chemicals

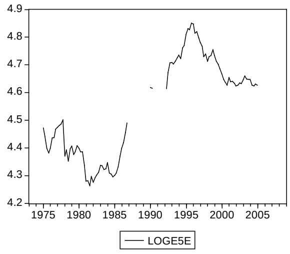


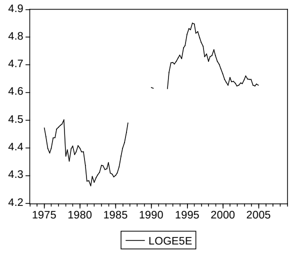
Sweden beverages & tobacco measure 2



Germany measure 1 | Germany chemicals measure 2 | Germany measure 2 beverages & tobacco







Note: All values are in linear form; logvex represents the logarithm of real exports, logp represents the logarithm of relative prices, V2 represents the logarithm of volatility under measure 1, loge5e, e7e represents the logarithm of volatility when exchange rate rises above below 4% and 7% the average value.
Source: authors' calculations

APPENDIX 2

Descriptive statistics UK (all values except volume of exports)

Series: V2		Series: LOGGDP	
Mean	0.006216	Mean	12.18104
Median	0.004055	Median	12.16435
Maximum	0.059092	Maximum	12.61697
Minimum	6.76E-05	Minimum	11.77144
Std. Dev.	0.007051	Std. Dev.	0.248399

Series: LOGE5E		Series: LOGE7E	
Mean	4.470500	Mean	4.531683
Median	4.459816	Median	4.585013
Maximum	4.662250	Maximum	4.662250
Minimum	4.132789	Minimum	4.300008
Std. Dev.	0.133314	Std. Dev.	0.113266

Descriptive statistics Sweden (all values except volume of exports)

Series: V2		Series: LOGGDP	
Mean	0.004629	Mean	13.10493
Median	0.003063	Median	13.07767
Maximum	0.046312	Maximum	13.51872
Minimum	9.15E-05	Minimum	12.71014
Std. Dev.	0.006123	Std. Dev.	0.203807

Series: LOGE5E		Series: LOGE7E	
Mean	4.777256	Mean	4.779850
Median	4.817590	Median	4.861044
Maximum	5.012307	Maximum	5.012307
Minimum	4.406788	Minimum	4.406788
Std. Dev.	0.156885	Std. Dev.	0.163184

Descriptive statistics Germany (all values except volume of exports)

Series: LOGGDP | Series: LOGP | Series: V2

Mean	13.12242	Mean	0.468620	Mean	0.003593
Median	13.13843	Median	0.484832	Median	0.002483
Maximum	13.26539	Maximum	1.284883	Maximum	0.028331
Minimum	12.97317	Minimum	-0.233180	Minimum	2.44E-05
Std. Dev.	0.080892	Std. Dev.	0.477421	Std. Dev.	0.003579

Series: LOGE5E

Mean	4.547706
Median	4.618708
Maximum	4.850114
Minimum	4.263648
Std. Dev.	0.177316

Descriptive statistics volume of exports beverages and tobacco

U.K.		**Sweden**	
Series: LOGVEX		Series: LOGVEX	
Mean	4.292089	Mean	4.171772
Median	4.355885	Median	3.715171
Maximum	4.787492	Maximum	5.450394
Minimum	3.449195	Minimum	3.173193
Std. Dev.	0.340174	Std. Dev.	0.801333

Germany		**U.K.**	
Series: VEXLOG		Series: LOGP	
Mean	4.725895	Mean	0.020067
Median	4.777996	Median	0.059518
Maximum	5.855292	Maximum	0.266530
Minimum	3.267509	Minimum	-0.280214
Std. Dev.	0.665521	Std. Dev.	0.169091

Sweden		**Germany**	
Series: LOGP		Series: LOGP	
Mean	-0.444282	Mean	0.875033
Median	-0.753506	Median	0.889043
Maximum	0.407049	Maximum	1.466659
Minimum	-1.083838	Minimum	0.271166
Std. Dev.	0.542237	Std. Dev.	0.377190

Descriptive statistics volume of exports for chemicals

U.K.		**Sweden**	
Series: LOGVEX		Series: LOGVEX	
Mean	3.998085	Mean	4.093118
Median	3.957381	Median	3.856773
Maximum	5.016447	Maximum	5.111988
Minimum	2.968032	Minimum	2.925958
Std. Dev.	0.560239	Std. Dev.	0.724630

Germany **U.K.**

Series: LOGVEX		Series: LOGP	
Mean	4.098101	Mean	0.333625
Median	4.029696	Median	0.411360
Maximum	5.278426	Maximum	0.735382
Minimum	3.051506	Minimum	-0.158067
Std. Dev.	0.591313	Std. Dev.	0.274107

Sweden Series: LOGP		**Germany** Series: LOGP	
Mean	-0.255059	Mean	0.468620
Median	-0.510449	Median	0.484832
Maximum	0.424034	Maximum	1.284883
Minimum	-0.762314	Minimum	-0.233180
Std. Dev.	0.438469	Std. Dev.	0.477421

Note: All values are in linear form; logvex represents the logarithm of real exports, logp represents the logarithm of relative prices, V2 represents the logarithm of volatility under measure 1, loge5e, e7e represents the logarithm of volatility when exchange rate rises above below 4% and 7% the average value.
Source: authors' calculation

APPENDIX 3: ARDL regression results and dynamic stability test

UK-Beverages and Tobacco

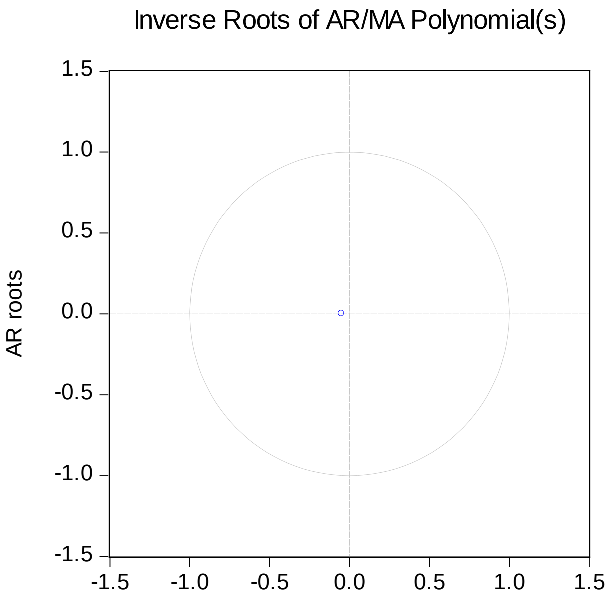
ER volatility measure 1

Dependent Variable: D(LOG(VEX))
Method: Least Squares
Sample (adjusted): 1975Q4 2009Q1
Included observations: 134 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(VEX(-1))	-0.562446	0.085803	-6.555076	0.0000
LOG(P(-1))	-0.324171	0.062391	-5.195769	0.0000
LOG(GDP(-1))	0.035517	0.221083	0.160650	0.8727
V2(-1)	-0.246601	0.098047	-2.515133	0.0133
C	1.664525	2.630393	0.632805	0.5281
D1	-0.269268	0.042020	-6.408136	0.0000
D3	-0.086464	0.058595	-1.475631	0.1428
D4	-0.052652	0.040250	-1.308116	0.1935
@TREND	0.005067	0.001588	3.191303	0.0018
D(LOG(VEX(-1)))	0.039196	0.086917	0.450964	0.6529
D(LOG(P))	-0.083074	0.143119	-0.580456	0.5628
D(LOG(GDP))	1.787823	0.456895	3.912987	0.0002
D(LOG(GDP(-1)))	1.442214	0.468385	3.079119	0.0026
D(LOG(GDP(-2)))	0.399810	0.468400	0.853567	0.3952
D(LOG(GDP(-3)))	0.424717	0.432264	0.982539	0.3279
D(LOG(GDP(-4)))	-0.683161	0.484862	-1.408979	0.1616
D(LOG(GDP(-5)))	0.560961	0.486689	1.152608	0.2515
D(LOG(GDP(-6)))	1.066077	0.423189	2.519148	0.0132
D(V2)	-0.613089	0.286074	-2.143113	0.0379

D(V2(-1))	1.095407	0.494977	2.213046	0.0313
D(V2(-2))	1.406110	0.557516	2.522098	0.0150

R-squared	0.879216	Mean dependent var	0.006962
Adjusted R-squared	0.857838	S.D. dependent var	0.144022
S.E. of regression	0.054303	Akaike info criterion	-2.845509
Sum squared resid	0.333211	Schwarz criterion	-2.391370
Log likelihood	211.6491	Hannan-Quinn criter.	-2.660961
F-statistic	41.12768	Durbin-Watson stat	2.042094
Prob(F-statistic)	0.000000		



UK-Beverages and Tobacco

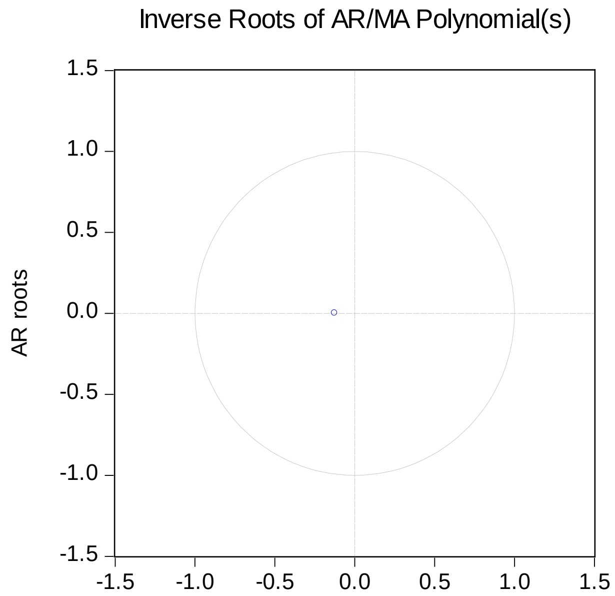
ER volatility measure 2

Dependent Variable: D(LOG(VEX))
Method: Least Squares
Sample: 1975Q2 2009Q1
Included observations: 136

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(VEX(-1))	-0.546962	0.091506	-5.977318	0.0000
LOG(P(-1))	0.274868	0.063279	4.343749	0.0000
LOG(GDP(-1))	-0.002547	0.240740	-0.010581	0.9916
V2	-0.006578	0.013300	-0.494616	0.6218
C	2.064491	2.877485	0.717464	0.4745
D1	-0.236124	0.043129	-5.474850	0.0000
D3	-0.062513	0.059852	-1.044453	0.2984
D4	-0.068985	0.040176	-1.717073	0.0886
@TREND	0.005028	0.001726	2.912812	0.0043
D(LOG(VEX(-1)))	0.017102	0.088859	0.192465	0.8477
D(LOG(P))	-0.094732	0.147890	-0.640557	0.5231
D(LOG(GDP))	1.463808	0.465091	3.147359	0.0021
D(LOG(GDP(-1)))	0.925282	0.474459	1.950184	0.0535
D(LOG(GDP(-2)))	0.052838	0.492814	0.107216	0.9148
D(LOG(GDP(-3)))	0.345704	0.459568	0.752237	0.4534
D(LOG(GDP(-4)))	-0.442553	0.490298	-0.902619	0.3686
D(LOG(GDP(-5)))	1.016320	0.485505	2.093325	0.0385

D(LOG(GDP(-6)))	0.856060	0.436220	1.962450	0.0521

R-squared	0.862456	Mean dependent var	0.007354
Adjusted R-squared	0.842641	S.D. dependent var	0.144464
S.E. of regression	0.057307	Akaike info criterion	-2.758054
Sum squared resid	0.387522	Schwarz criterion	-2.372556
Log likelihood	205.5477	Hannan-Quinn criter.	-2.601398
F-statistic	43.52402	Durbin-Watson stat	2.019819
Prob(F-statistic)	0.000000		



UK-Chemicals
ER volatility measure 1

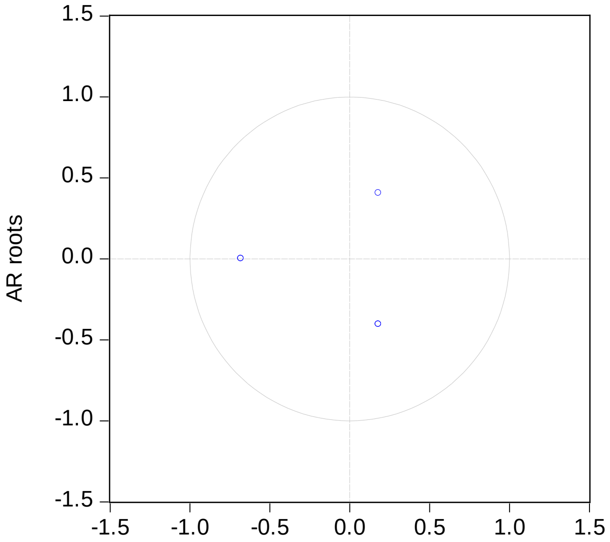
Dependent Variable: D(LOG(VEX))
Method: Least Squares
Sample (adjusted): 1976Q4 2009Q1
Included observations: 130 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(VEX(-1))	-0.391811	0.087495	-4.478090	0.0000
LOG(P(-1))	-0.001431	0.039272	-0.036443	0.9710
LOG(GDP(-1))	0.413969	0.171861	2.408751	0.0178
V1(-1)	-0.590651	0.277931	2.125175	0.0360
C	-3.742909	1.955390	-1.914149	0.0584
D1	0.001456	0.036311	0.040100	0.9681
D3	0.000587	0.047434	0.012381	0.9901
D4	0.075196	0.035934	2.092623	0.0388
@TREND	0.003313	0.001332	2.488143	0.0144
D(LOG(VEX(-1)))	-0.073593	0.098715	-0.745515	0.4577
D(LOG(VEX(-2)))	0.151220	0.099431	1.520855	0.1314
D(LOG(VEX(-3)))	-0.041906	0.094270	-0.444532	0.6576
D(LOG(P))	-0.032809	0.098731	-0.332305	0.7403
D(LOG(GDP))	-0.166399	0.368640	-0.451387	0.6527
D(LOG(GDP(-1)))	-0.265009	0.392413	-0.675333	0.5010
D(LOG(GDP(-2)))	0.078470	0.390987	0.200697	0.8413
D(LOG(GDP(-3)))	-0.831654	0.365060	-2.278128	0.0248
D(LOG(GDP(-4)))	-0.979407	0.423702	-2.311548	0.0228
D(LOG(GDP(-5)))	-0.916089	0.427138	-2.144713	0.0343
D(LOG(GDP(-6)))	-0.524594	0.393139	-1.334373	0.1850

D(V1)	-1.218772	0.650203	-1.874448	0.0637
D(V1(-1))	-0.982701	0.385866	-2.546739	0.0124
D(V1(-2))	-0.705966	0.304078	-2.321655	0.0222
D(V1(-3))	-0.690833	0.346621	-1.993048	0.0489
D(V1(-4))	-0.562182	0.273421	-2.056105	0.0423
D(V1(-5))	-0.421000	0.138776	-3.033659	0.0031
D(V1(-6))	-0.300461	0.109363	-2.747383	0.0071

R-squared	0.655029	Mean dependent var	0.013264
Adjusted R-squared	0.567950	S.D. dependent var	0.065160
S.E. of regression	0.042830	Akaike info criterion	-3.280583
Sum squared resid	0.188943	Schwarz criterion	-2.685018
Log likelihood	240.2379	Hannan-Quinn criter.	-3.038585
F-statistic	7.522163	Durbin-Watson stat	2.065225
Prob(F-statistic)	0.000000		

Inverse Roots of AR/MA Polynomial(s)



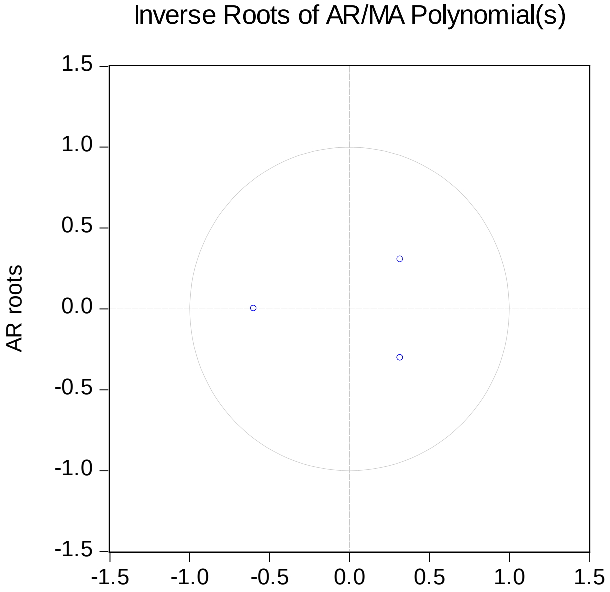
UK-Chemicals
ER volatility measure 2

Dependent Variable: D(LOG(VEX))
Method: Least Squares
Sample (adjusted): 1976Q2 2009Q1
Included observations: 132 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(VEX(-1))	-0.459960	0.088882	-5.174946	0.0000
LOG(P(-1))	-0.029472	0.041292	-0.713745	0.4769
LOG(GDP(-1))	0.443590	0.176762	2.509527	0.0135
V2	0.025278	0.010977	2.302716	0.0231
C	-3.852323	2.039216	-1.889119	0.0615
D1	0.033754	0.035849	0.941571	0.3484
D3	0.050864	0.046130	1.102629	0.2726
D4	0.088785	0.035069	2.531760	0.0127
@TREND	0.003488	0.001387	2.515133	0.0133
D(LOG(VEX(-1)))	0.012865	0.094685	0.135873	0.8922
D(LOG(VEX(-2)))	0.174323	0.093856	1.857357	0.0659
D(LOG(VEX(-3)))	-0.057674	0.088298	-0.653179	0.5150
D(LOG(P))	-0.011869	0.098330	-0.120703	0.9041

D(LOG(GDP))	0.121445	0.364808	0.332902	0.7398
D(LOG(GDP(-1)))	-0.004760	0.387606	-0.012279	0.9902
D(LOG(GDP(-2)))	-0.101482	0.395630	-0.256507	0.7980
D(LOG(GDP(-3)))	-0.916342	0.366457	-2.500547	0.0138
D(LOG(GDP(-4)))	-1.155766	0.418672	-2.760556	0.0067
D(LOG(GDP(-5)))	-1.006317	0.410679	-2.450372	0.0158
D(LOG(GDP(-6)))	-0.684857	0.382768	-1.789220	0.0763

R-squared	0.608248	Mean dependent var	0.014376
Adjusted R-squared	0.541790	S.D. dependent var	0.065350
S.E. of regression	0.044236	Akaike info criterion	-3.259834
Sum squared resid	0.219163	Schwarz criterion	-2.823046
Log likelihood	235.1491	Hannan-Quinn criter.	-3.082344
F-statistic	9.152380	Durbin-Watson stat	1.935291
Prob(F-statistic)	0.000000		



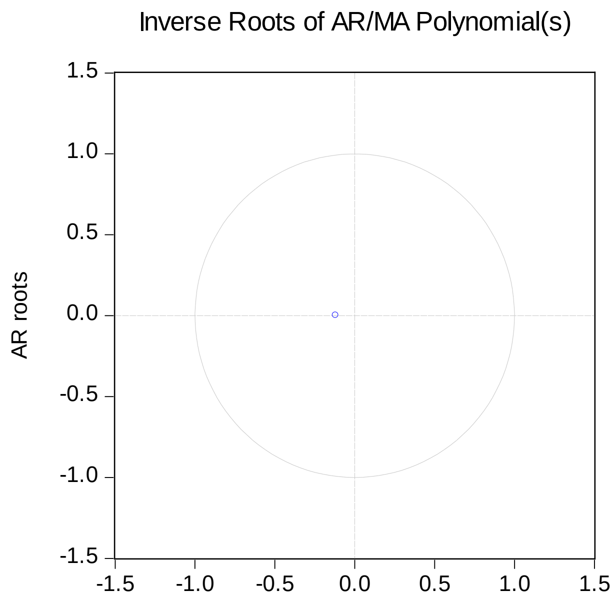
Germany-Beverages and Tobacco
ER volatility measure 1

Dependent Variable: D(LOG(VEX))
Method: Least Squares
Sample (adjusted): 1992Q2 2009Q1
Included observations: 68 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(VEX(-1))	-0.909940	0.174375	-5.218299	0.0000
LOG(P(-1))	-0.308902	0.136296	-2.266408	0.0277
LOG(GDP(-1))	-1.527824	0.617822	-2.472921	0.0168
V1(-1)	-6.503554	3.194252	-2.036018	0.0463
C	23.13143	8.151082	2.837835	0.0065
D1	-0.113541	0.049338	-2.301284	0.0255
D3	-0.070200	0.055411	-1.266894	0.2109
D4	0.002408	0.044784	0.053777	0.9573
@TREND	0.017335	0.004056	4.273760	0.0001
D(LOG(VEX(-1)))	-0.014029	0.132971	-0.105505	0.9164
D(LOG(P))	-0.372156	0.191131	-1.947127	0.0570
D(LOG(GDP))	1.073953	0.619958	1.732299	0.0893

D(LOG(GDP(-1)))	2.082992	0.812424	2.563922	0.0133
D(LOG(GDP(-2)))	2.600066	0.934331	2.782810	0.0075
D(LOG(GDP(-3)))	2.169152	0.946728	2.291210	0.0261
D(LOG(GDP(-4)))	1.280952	0.818233	1.565509	0.1236
D(V1)	5.399677	3.170489	1.703106	0.0946

R-squared	0.825620	Mean dependent var	0.012809
Adjusted R-squared	0.770912	S.D. dependent var	0.101205
S.E. of regression	0.048440	Akaike info criterion	-3.004673
Sum squared resid	0.119667	Schwarz criterion	-2.449796
Log likelihood	119.1589	Hannan-Quinn criter.	-2.784814
F-statistic	15.09154	Durbin-Watson stat	2.002226
Prob(F-statistic)	0.000000		



Germany-Beverages and Tobacco
ER volatility measure 2

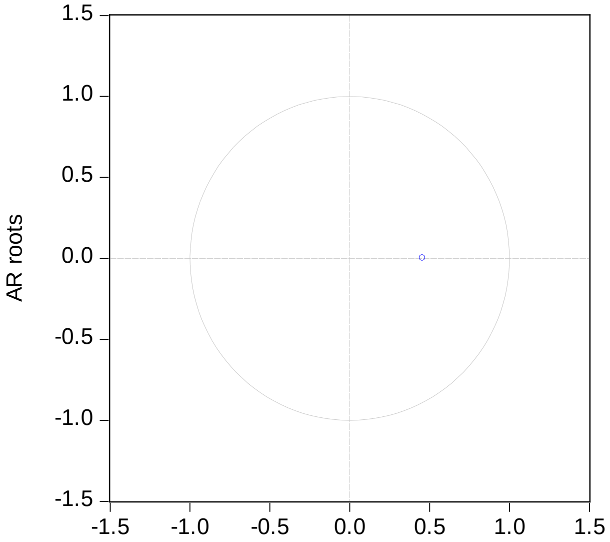
Dependent Variable: D(LOG(VEX))
Method: Least Squares
Sample (adjusted): 1992Q2 2009Q1
Included observations: 68 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(VEX(-1))	-0.946410	0.177725	-5.325130	0.0000
LOG(P(-1))	-0.156136	0.148468	-1.051644	0.2982
LOG(GDP(-1))	-1.301040	0.637856	-2.039708	0.0469
V2	-0.041671	0.024402	-1.707656	0.0942
C	20.33125	8.227095	2.471255	0.0171
D1	-0.134382	0.046363	-2.898468	0.0056
D3	-0.063048	0.052085	-1.210475	0.2320
D4	0.009099	0.041407	0.219757	0.8270
@TREND	0.017208	0.004033	4.266424	0.0001
D(LOG(VEX(-1)))	-0.043735	0.130162	-0.336001	0.7383
D(LOG(P))	-0.193890	0.172021	-1.127131	0.2653
D(LOG(P(-1)))	-0.054636	0.173425	-0.315043	0.7541
D(LOG(P(-2)))	0.235573	0.172957	1.362032	0.1795
D(LOG(P(-3)))	-0.307442	0.176910	-1.737846	0.0887

D(LOG(P(-4)))	-0.273444	0.183736	-1.488246	0.1432
D(LOG(GDP))	0.683339	0.603721	1.131880	0.2633
D(LOG(GDP(-1)))	2.063796	0.818285	2.522098	0.0150
D(LOG(GDP(-2)))	2.527306	0.915471	2.760661	0.0081
D(LOG(GDP(-3)))	2.208916	0.898300	2.458995	0.0176
D(LOG(GDP(-4)))	1.123825	0.788956	1.424446	0.1608

R-squared	0.852758	Mean dependent var	0.012809
Adjusted R-squared	0.794475	S.D. dependent var	0.101205
S.E. of regression	0.045881	Akaike info criterion	-3.085599
Sum squared resid	0.101044	Schwarz criterion	-2.432803
Log likelihood	124.9104	Hannan-Quinn criter.	-2.826941
F-statistic	14.63129	Durbin-Watson stat	1.942948
Prob(F-statistic)	0.000000		

Inverse Roots of AR/MA Polynomial(s)



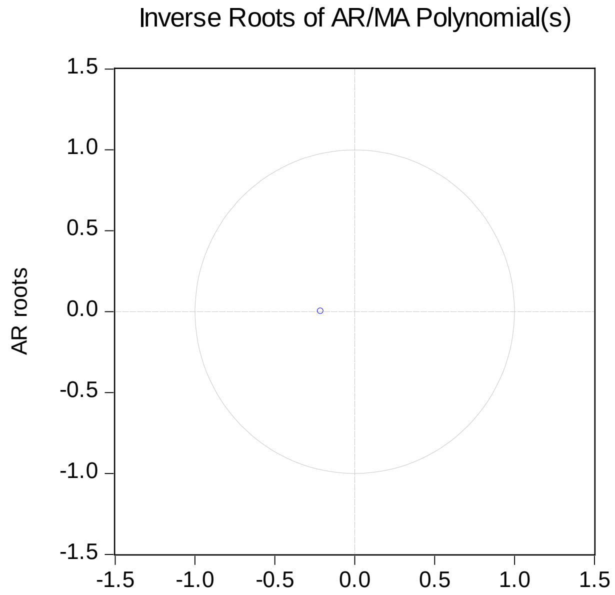
Germany -Chemicals
ER volatility measure 1

Dependent Variable: D(LOG(VEX))
Method: Least Squares
Sample (adjusted): 1991Q4 2009Q1
Included observations: 70 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(VEX(-1))	-0.353397	0.092333	-3.827407	0.0004
LOG(P(-1))	-0.056834	0.062104	-0.915134	0.3644
LOG(GDP(-1))	-0.569086	0.340047	-1.673551	0.1003
V1(-1)	-9.351303	5.273125	-1.773389	0.0821
C	8.241168	4.368950	1.886304	0.0650
D1	0.108220	0.018620	5.812007	0.0000
D3	0.024983	0.027964	0.893387	0.3758
D4	0.026279	0.025665	1.023937	0.3107
@TREND	0.007692	0.002557	3.007908	0.0041
D(LOG(VEX(-1)))	-0.090194	0.119413	-0.755308	0.4535
D(LOG(P))	-0.156445	0.096718	-1.617547	0.1119
D(LOG(GDP))	2.292490	0.382340	5.995944	0.0000
D(LOG(GDP(-1)))	0.640710	0.522956	1.225169	0.2261

D(LOG(GDP(-2)))	1.450172	0.474797	3.054300	0.0036
D(V1)	0.443948	1.866041	0.237909	0.8129
D(V1(-1))	8.455483	3.913677	2.160496	0.0355
D(V1(-2))	8.734560	3.190085	2.738034	0.0085
D(V1(-3))	4.584013	2.551956	1.796274	0.0784
D(V1(-4))	1.248613	1.727854	0.722638	0.4732

R-squared	0.708271	Mean dependent var	0.015504
Adjusted R-squared	0.605308	S.D. dependent var	0.047813
S.E. of regression	0.030038	Akaike info criterion	-3.946489
Sum squared resid	0.046018	Schwarz criterion	-3.336183
Log likelihood	157.1271	Hannan-Quinn criter.	-3.704068
F-statistic	6.878893	Durbin-Watson stat	2.202078
Prob(F-statistic)	0.000000		



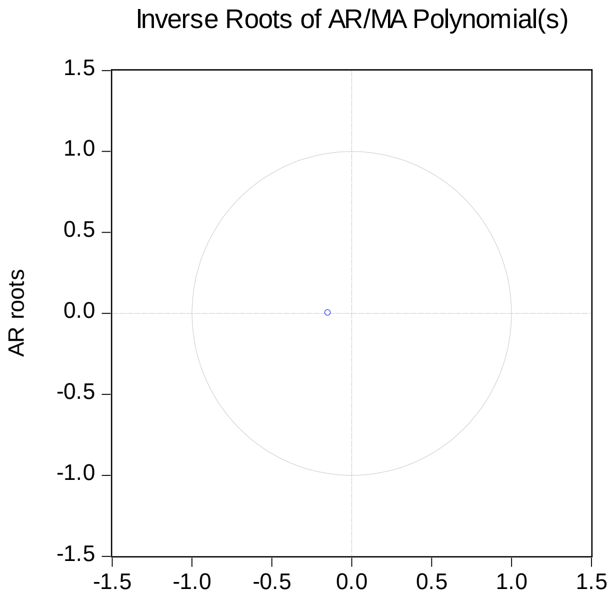
Germany -Chemicals
ER volatility measure 2

Dependent Variable: D(LOG(VEX))
Method: Least Squares
Sample (adjusted): 1991Q4 2009Q1
Included observations: 70 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(VEX(-1))	-0.403915	0.101481	-3.980202	0.0002
LOG(P(-1))	-0.073487	0.057137	-1.286140	0.2037
LOG(GDP(-1))	-0.608498	0.353115	-1.723227	0.0904
V2	-0.017085	0.014260	-1.198077	0.2359
C	8.848823	4.502504	1.965311	0.0543
D1	0.109229	0.019047	5.734753	0.0000
D3	0.028132	0.028160	0.998982	0.3221
D4	0.028281	0.025502	1.108981	0.2722
@TREND	0.008840	0.002573	3.435104	0.0011
D(LOG(VEX(-1)))	-0.027218	0.122932	-0.221405	0.8256
D(LOG(P))	-0.119567	0.092038	-1.299102	0.1992
D(LOG(GDP))	2.304567	0.379420	6.073928	0.0000
D(LOG(GDP(-1)))	0.782225	0.523049	1.495511	0.1404

D(LOG(GDP(-2)))	1.574768	0.467444	3.368889	0.0014

R-squared	0.660793	Mean dependent var	0.015504
Adjusted R-squared	0.582048	S.D. dependent var	0.047813
S.E. of regression	0.030911	Akaike info criterion	-3.938559
Sum squared resid	0.053507	Schwarz criterion	-3.488860
Log likelihood	151.8496	Hannan-Quinn criter.	-3.759933
F-statistic	8.391607	Durbin-Watson stat	2.085470
Prob(F-statistic)	0.000000		



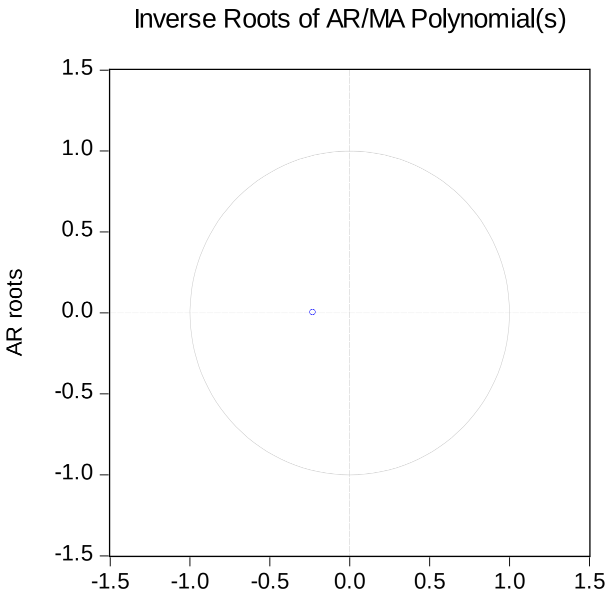
Sweden-Beverages and Tobacco
ER volatility measure 1

Dependent Variable: D(LOG(VEX))
Method: Least Squares
Date: 09/11/13 Time: 08:54
Sample (adjusted): 1984Q4 2009Q1
Included observations: 68 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(VEX(-1))	-0.519261	0.140526	-3.695125	0.0006
LOG(P(-1))	0.386281	0.151242	2.554058	0.0143
LOG(GDP(-1))	0.292581	0.416045	0.703242	0.4857
V1(-1)	8.674492	5.152418	1.683577	0.0995
C	-2.108414	5.368020	-0.392773	0.6964
D1	-0.007878	0.162684	-0.048426	0.9616
D3	-0.024318	0.093672	-0.259613	0.7964
D4	0.239536	0.148781	1.609994	0.1147
@TREND	0.005789	0.002540	2.279275	0.0277
D(LOG(VEX(-1)))	-0.040329	0.145535	-0.277111	0.7830
D(LOG(P))	-0.779916	0.193939	-4.021456	0.0002
D(LOG(P(-1)))	-0.705841	0.253600	-2.783278	0.0080
D(LOG(P(-2)))	-0.492843	0.254485	-1.936625	0.0594
D(LOG(P(-3)))	-0.638689	0.225956	-2.826607	0.0071
D(LOG(P(-4)))	-0.167683	0.207695	-0.807352	0.4239
D(LOG(P(-5)))	-0.398995	0.205166	-1.944739	0.0584
D(LOG(P(-6)))	-0.566486	0.202022	-2.804081	0.0075
D(LOG(GDP))	2.000417	0.525011	3.810238	0.0004

D(LOG(GDP(-1)))	1.645996	0.545579	3.016970	0.0043
D(LOG(GDP(-2)))	1.177570	0.528650	2.227507	0.0312
D(V1)	-2.014109	2.238887	-0.899603	0.3733
D(V1(-1))	-6.491982	4.084700	-1.589341	0.1193
D(V1(-2))	-5.838000	3.721137	-1.568875	0.1240
D(V1(-3))	-5.255465	3.243563	-1.620276	0.1125
D(V1(-4))	-6.672006	2.591657	-2.574418	0.0136

R-squared	0.862254	Mean dependent var	0.018041
Adjusted R-squared	0.785373	S.D. dependent var	0.127712
S.E. of regression	0.059166	Akaike info criterion	-2.539952
Sum squared resid	0.150527	Schwarz criterion	-1.723957
Log likelihood	111.3584	Hannan-Quinn criter.	-2.216630
F-statistic	11.21540	Durbin-Watson stat	2.213683
Prob(F-statistic)	0.000000		



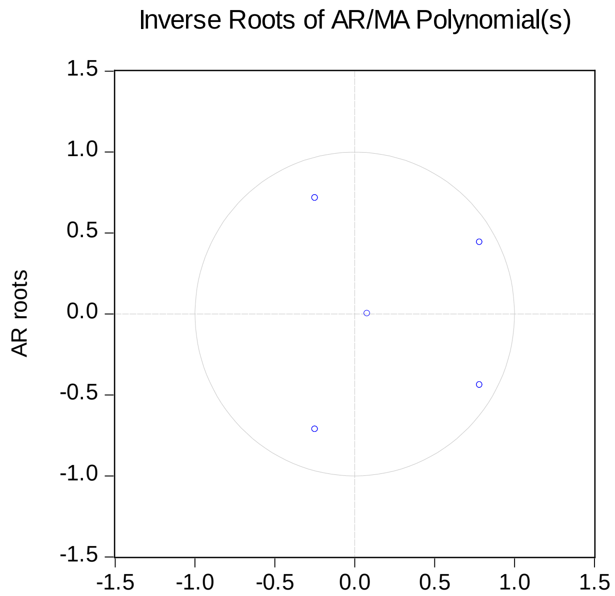
Sweden-Beverages and Tobacco
ER volatility measure 2

Dependent Variable: D(LOG(VEX))
Method: Least Squares
Date: 09/11/13 Time: 17:12
Sample (adjusted): 1984Q4 2009Q1
Included observations: 68 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(VEX(-1))	-0.612954	0.174777	-3.507066	0.0011
LOG(P(-1))	0.463128	0.150939	3.068307	0.0038
LOG(GDP(-1))	-0.051498	0.382494	-0.134637	0.8935
V2	-0.009488	0.040508	-0.234215	0.8160
C	2.719928	4.804610	0.566108	0.5743
D1	-0.129245	0.187787	-0.688254	0.4951
D3	-0.185804	0.114273	-1.625967	0.1114
D4	0.068734	0.188077	0.365454	0.7166
@TREND	0.008646	0.002835	3.050254	0.0040
D(LOG(VEX(-1)))	0.049442	0.174308	0.283646	0.7781
D(LOG(VEX(-2)))	0.237052	0.170306	1.391922	0.1713

D(LOG(VEX(-3)))	0.235251	0.162672	1.446162	0.1556
D(LOG(VEX(-4)))	0.311897	0.145535	2.143113	0.0379
D(LOG(VEX(-5)))	-0.054279	0.134514	-0.403519	0.6886
D(LOG(P))	-0.886350	0.202966	-4.366998	0.0001
D(LOG(P(-1)))	-0.967691	0.269074	-3.596368	0.0008
D(LOG(P(-2)))	-0.353303	0.289491	-1.220429	0.2291
D(LOG(P(-3)))	-0.547842	0.255079	-2.147738	0.0376
D(LOG(P(-4)))	-0.124221	0.219728	-0.565339	0.5749
D(LOG(P(-5)))	-0.316374	0.207105	-1.527605	0.1341
D(LOG(P(-6)))	-0.495117	0.185249	-2.672711	0.0107
D(LOG(GDP))	2.127484	0.564662	3.767712	0.0005
D(LOG(GDP(-1)))	1.669171	0.700133	2.384077	0.0217
D(LOG(GDP(-2)))	1.331235	0.812929	1.637578	0.1090
D(LOG(GDP(-3)))	-0.134459	0.826747	-0.162636	0.8716
D(LOG(GDP(-4)))	-1.251853	0.870513	-1.438063	0.1578

R-squared	0.862478	Mean dependent var	0.018041
Adjusted R-squared	0.780620	S.D. dependent var	0.127712
S.E. of regression	0.059818	Akaike info criterion	-2.512168
Sum squared resid	0.150282	Schwarz criterion	-1.663533
Log likelihood	111.4137	Hannan-Quinn criter.	-2.175913
F-statistic	10.53626	Durbin-Watson stat	2.122220
Prob(F-statistic)	0.000000		



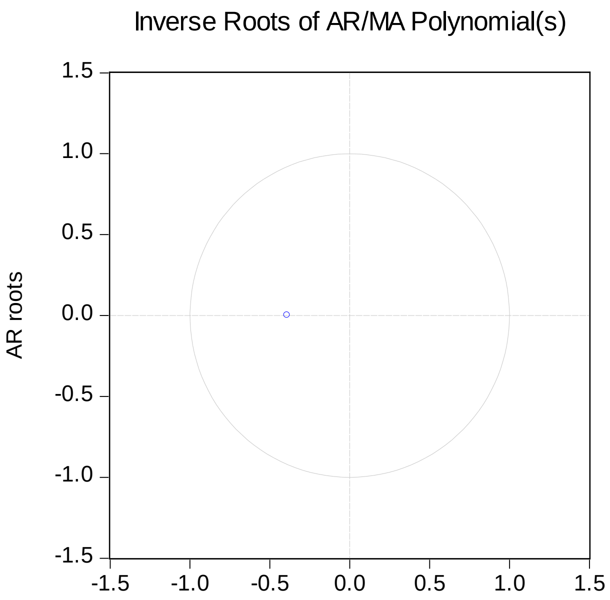
Sweden -Chemicals
ER volatility measure 1

Dependent Variable: D(LOG(VEX))
Method: Least Squares
Sample (adjusted): 1982Q2 2009Q1
Included observations: 80 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(VEX(-1))	-0.288973	0.095602	-3.022659	0.0037
LOG(P(-1))	0.021823	0.030193	0.722789	0.4726
LOG(GDP(-1))	-0.824632	0.208924	-3.947036	0.0002
V1(-1)	-1.262145	1.269107	-0.994514	0.3239
C	11.03429	2.802197	3.937727	0.0002

D1	0.176091	0.070367	2.502460	0.0150
D3	0.132674	0.047949	2.766961	0.0075
D4	0.163724	0.065416	2.502808	0.0150
@TREND	0.010008	0.002705	3.699528	0.0005
D(LOG(VEX(-1)))	-0.285116	0.113389	-2.514497	0.0146
D(LOG(P))	0.072845	0.095271	0.764608	0.4475
D(LOG(P(-1)))	-0.041209	0.098827	-0.416975	0.6782
D(LOG(P(-2)))	0.002857	0.092830	0.030772	0.9756
D(LOG(P(-3)))	0.074665	0.093605	0.797660	0.4282
D(LOG(P(-4)))	0.091124	0.089832	1.014383	0.3144
D(LOG(GDP))	0.890001	0.225868	3.940361	0.0002
D(LOG(GDP(-1)))	1.004288	0.323014	3.109113	0.0029
D(LOG(GDP(-2)))	0.446696	0.272837	1.637225	0.1067
D(V1)	-1.619563	0.847991	-1.909881	0.0609

R-squared	0.852187	Mean dependent var	0.018147
Adjusted R-squared	0.808570	S.D. dependent var	0.083183
S.E. of regression	0.036395	Akaike info criterion	-3.584941
Sum squared resid	0.080799	Schwarz criterion	-3.019209
Log likelihood	162.3976	Hannan-Quinn criter.	-3.358123
F-statistic	19.53793	Durbin-Watson stat	2.139244
Prob(F-statistic)	0.000000		



Sweden -Chemicals
ER volatility measure 2

Dependent Variable: D(LOG(VEX))
Method: Least Squares
Date: 09/11/13 Time: 17:46
Sample (adjusted): 1981Q3 2009Q1
Included observations: 66 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(VEX(-1))	-0.268499	0.106994	-2.509481	0.0152
LOG(P(-1))	0.013452	0.038650	0.348039	0.7292
LOG(GDP(-1))	-0.857586	0.278684	-3.077273	0.0033

V2	0.000771	0.000948	0.813186	0.4198
C	11.25560	3.612065	3.116114	0.0030
D1	0.167152	0.081862	2.041877	0.0463
D3	0.131812	0.047716	2.762433	0.0079
D4	0.178584	0.078312	2.280404	0.0267
@TREND	0.010315	0.003368	3.062640	0.0035
D(LOG(VEX(-1)))	-0.322120	0.123701	-2.604011	0.0120
D(LOG(P))	0.305385	0.137993	2.213046	0.0313
D(LOG(GDP))	1.016726	0.255604	3.977739	0.0002
D(LOG(GDP(-1)))	1.164262	0.386043	3.015890	0.0040
D(LOG(GDP(-2)))	0.447063	0.325363	1.374043	0.1753

R-squared	0.810008	Mean dependent var	0.016420
Adjusted R-squared	0.762509	S.D. dependent var	0.082372
S.E. of regression	0.040142	Akaike info criterion	-3.406944
Sum squared resid	0.083793	Schwarz criterion	-2.942472
Log likelihood	126.4292	Hannan-Quinn criter.	-3.223409
F-statistic	17.05347	Durbin-Watson stat	1.974485
Prob(F-statistic)	0.000000		

Inverse Roots of AR/MA Polynomial(s)