ARE AGRICULTURAL EXPORTS ANY SPECIAL? EXCHANGE RATE NONLINEARITIES IN EUROPEAN EXPORTS TO THE US

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Abstract

Using aggregated EMU exports to the US as an example, VERHEYEN (2013) showed, that in the long run exports react to exchange rate changes in a nonlinear way. In this paper we test whether this holds true for agri-food exports as well. To address this question we apply a partial sum decomposition approach and the NARDL framework of SHIN et al. (2013) to the aggregated agricultural exports of eleven European countries to the US, which is currently the major trade partner of the EU in agricultural trade. Our outcomes suggest, that the exchange rate nonlinearities are even more pronounced in agricultural than in total exports. European exporters seem to benefit more from Euro depreciation, than its appreciation harm them, which we interpret as a sign of possible pricing strategies application (e.g., pricing-to-market) to European agri-food exports.

Keywords

Agricultural exports, asymmetry, exchange rate nonlinearity, export demand equation, NARDL.

1 Introduction

Although the investigation of trade determinants and trade elasticities has been playing an important role in international economic studies for many decades now, the question of possible nonlinearities in international trade stayed unaddressed till the end of 80s, when the sunk costs and hysteresis literature emerged (e.g., BALDWIN, 1990). According to the hysteresis literature, the nonlinearities in the export demand might be driven by strategic behavior of the exporters, who invest an amount of sunk costs into entering the market and try to gain or keep the market share in the destination country. Though these studies showed evidence in favor of nonlinearities, they were basically conducted using relatively simple models, which did not allow to take the time-series properties of data into account or to address nonlinearities of the underlying long-run relation between exports and exchange rates. A brief review on this literature can be found in the study of VERHEYEN (2013), who adopted the newly developed nonlinear autoregressive distributed lag approach (NARDL) of SHIN et al. (2011) to model nonlinearities not only in the short, but also in the long run in order to address the issue of the exchange rate nonlinearities in the exports of twelve EMU countries to the US. This study focused on total exports, and nonlinearities in the export demand towards appreciations and depreciations were found for many countries. Furthermore, asymmetries were found to be relevant mainly in the long-run. This let VERHEYEN conclude that neglecting nonlinearities in modelling export demand is too restrictive.

In this study, besides addressing total exports, we focus on food and agri-exports. Excessive demand for EU agri-products and the Euro appreciation against major currencies put European countries on the second position among the world top exporters. The US is the largest export market of the EU with an export share of 13 percent in total agricultural exports

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(EUROPEAN COMISSION, 2013). As around 80 percent of all agricultural EU exports are final goods (mainly spirits and liqueurs, wine and vermouth, beer, waters, dairy products, cereal, fruit and vegetable preparations and confectionery) we suppose to find a more pronounced evidence of exchange rate nonlinearities in the European agricultural exports than it was recorded for total exports. This is expected due to pricing-to-market strategies, which might be used in order to hinder the pass-through of the Euro appreciations to the domestic US prices and to protect the market shares and the exported quantities.

To test whether the evidence of exchange rate nonlinearities is indeed more pronounced in agricultural trade, we analyze agricultural exports of eleven European countries to the US over the last 25 years. We also estimate the export demand equations for total exports in order to compare the outcomes with the only study available study of this kind (VERHEYEN, 2013) and to have a reference for our conclusions regarding nonlinearities in agricultural exports. In order to allow for nonlinearities in the short and in the long run and to address the time series properties of the data (possible hidden cointegration) we apply the partial sum decomposition and the NARDL approach of SHIN et al. (2013) and the bounds testing by PESARAN et al. (2001).

The remainder of the paper is structured as follows: Section 2 describes the methodology in more detail, Section 3 introduces the data, Section 4 presents the result and the last section provides a summary.

2 Methodology

We assume that the European exports to the US can be described by the conventional demand function, which can be written, depending on the way of including of the exchange rate as:

(1) $X_t = A * R_t^{\alpha} * Y_t^{\beta}$, or

(2) $X_t = B * E_t^{\gamma} * P_t^{\delta} * Y_t^{\zeta}$,

where the European exports to the US over time period t (X_t) are determined by some constant parameter (A or B), the US demand Y, and the real exchange rate (R), which we include in the second specification as the nominal exchange rate (E) and the relative price (P), in order to separate the exchange rate and the price effect. The exponents refer to the elasticities of exports with respect to the foreign demand and the real exchange rate (or to the nominal exchange rate and the relative price in the second case).

Taking logs of the Equations 1 and 2 brings us to the following Equations 3 and 4, which represent the long-run relationship between the exports and its determinants (the lower case letters denote logs):

(3) $x_t = a + \alpha r_t + \beta y_t$

(4) $x_t = b + \gamma e_t + \delta p_t + \zeta y_t$.

To address the nonlinearity of the US export demand with respect to the exchange rate, we apply the nonlinear autoregressive distributed lag (NARDL) model by SHIN et al. (2013), which allows us to address nonlinearities not only in the short, but also in the long run, by applying the partial sum decomposition approach to the exchange rate. Here we stick to a two-threshold decomposition case, which allows us not only to distinguish between appreciations and depreciations of the exchange rate, but also to separate small from large exchange rate changes, as it was often suggested empirically that exporters behavior might be a subject to hysteresis and the exporter might not react the same way on exchange rate changes of different magnitude (e.g., BALDWIN, 1988; BELKE et al., 2013). The exchange rate decomposition will take then the following form for the real exchange rate:

(5) $r_t = r_0 + r_t^{-} + r_t^{\pm} + r_t^{+}$

and analogously for the nominal exchange rate:

(6) $e_t = e_0 + e_t^{-} + e_t^{\pm} + e_t^{+}$.

Unlike SHIN et al. (2013) or VERHEYEN (2013) we decompose not the original series, but the log of the exchange rate here, which allows us to interpret the exchange rate coefficients as elasticities. Instead of using various quantiles, we fix the threshold levels at the level of one positive and negative standard deviation, as it allows us to show how the export reaction change within the range of standard fluctuations of exchange rates and outside of it.

Our real exchange rate series is than being decomposed as:

(7) $r_t^- = \sum_{j=1}^{t} \Delta r_j^- = \sum_{j=1}^{t} \Delta r_j I\{\Delta r_j \leq -STD\}$;

(8) $r_t^\pm = \sum_{j=1}^{t} \Delta r_j^\pm = \sum_{j=1}^{t} \Delta r_j I\{-STD < \Delta r_j < +STD\}$;

(9) $r_t^+ = \sum_{j=1}^{t} \Delta r_j^+ = \sum_{j=1}^{t} \Delta r_j I\{+STD \leq \Delta r_j\}$.

The decomposition of the nominal exchange rate is done analogously and the export Equations 3-4 can now be rewritten as:

(10) $x_t = a + \alpha_1 r_t^- + \alpha_2 r_t^\pm + \alpha_3 r_t^+ + \beta y_t$,

(11) $x_t = b + \gamma_1 e_t^- + \gamma_2 e_t^\pm + \gamma_3 e_t^+ + \delta p_t + \zeta y_t$.

In this representation we still have the original exchange rate series, which is now substituted by three partial sum decompositions, which allows us for testing the long-run relation between the positive, negative and small changes of the exchange rate and exports in the long run. The only observation that we lose due to the decomposition will be captured by the constant. The same holds true for the nominal exchange rate partial sum decomposition.

As we deal with variables, which often behave nonstationary, such long-run representation might be spurious, once we do not take its time-series properties into account. On the other hand, standard testing methods might be not applicable, as we decompose the original variable. Using NARDL allows us to take into account the possible hidden cointegration between the positive and negative components of the underlying variables (GRANGER and YOON, 2002) and test for the presence of a long-run relationship between variables irrespective of their order of integration by means of the bound testing approach by PESARAN et al. (2001), which allows us to skip the pretesting of the data time-series properties here. NARDL also allows us to test for the symmetry in the long and in the short run, as well as to address the question whether some important adjustments are taking place also in the short run.

The NARDL model for the export demand Equation (10) can be written as:

(12) $\Delta x_t = a_0 + a_1\left(x_{t-1} - a_2 r_{t-1}^- - a_3 r_{t-1}^\pm - a_4 r_{t-1}^+ - a_5 y_{t-1}\right) + \sum_{\tau=0} \eta_\tau \Delta r_{t-\tau}^- +$
$+ \sum_{\tau=0} \theta_\tau \Delta r_{t-\tau}^\pm + \sum_{\tau=0} \iota_\tau \Delta r_{t-\tau}^+ + \sum_{\tau=0} \kappa_\tau \Delta y_{t-\tau} + \sum_{\omega=1} \lambda_\omega \Delta x_{t-\omega} + u_t$.

The NARDL representation for the model with nominal exchange rate is constructed analogously:

(13) $\Delta x_t = b_0 + b_1\left(x_{t-1} - b_2 e_{t-1}^- - b_3 e_{t-1}^\pm - b_4 e_{t-1}^+ - b_5 y_{t-1} - b_6 p_{t-1}\right) +$
$+ \sum_{\tau=0} \mu_\tau \Delta e_{t-\tau}^- \sum_{\tau=0} \nu_\tau \Delta e_{t-\tau}^\pm + \sum_{\tau=0} \xi_\tau \Delta e_{t-\tau}^+ + \sum_{\tau=0} o_\tau \Delta y_{t-\tau} + \sum_{\tau=0} \pi_\tau \Delta p_{t-\tau} +$
$+ \sum_{\omega=1} \rho_\omega \Delta x_{t-\omega} + u_t$.

The appropriate lag structure is chosen according to the Schwarz criterion. When autocorrelation is still present in the chosen specification we add the lags of the first difference of the dependent variable in order to overcome the problem. In any case we consider a maximum lag length of 12 as we are using the monthly data.

As the estimation of NARDL with OLS delivers only the product of the exchange rate estimates and the coefficient of the lagged export demand, we recalculate the long-run elasticities as follows:

(14) $rer^- = -\frac{a_2}{a_1}$; $rer^\pm = -\frac{a_3}{a_1}$; $rer^+ = -\frac{a_4}{a_1}$

(15) $er^- = -\frac{b_2}{b_1}$; $er^\pm = -\frac{b_3}{b_1}$; $er^+ = -\frac{b_4}{b_1}$.

The standard errors and significance levels of the recalculated coefficients are assessed using the Delta method. In order to make sure that the significance levels are appropriate, we conduct the Bounds testing by PESARAN et al. (2001) to make sure that there is the long-run relationship between our parameters. This is done by testing the H_0 of $\mathrm{a}_1 = \mathrm{a}_2 = \mathrm{a}_3 = \mathrm{a}_4 = \mathrm{a}_5 = 0$ in the Equation 12 and H_0 of $b_1 = b_2 = b_3 = b_4 = b_5 = b_6 = 0$ in the Equation 13 and comparing the test statistics with the critical values tabulated by PESARAN et al. (2001). The symmetry is tested by means of a Wald test.

The rejection of the H_0 of symmetry will be considered a prove of a nonlinear reaction of exports to appreciations and depreciations. As there might be not much variation in the inner regime we suppose to face difficulties proving hysteresis in the sense of VERHEYEN (2013), who stated that hysteresis can be indicated by a stronger reaction on large than on small exchange rate changes. Still, we suppose to see nonlinearity in the response of the export demand to exchange rate changes of different magnitude.

In general, we expect positive values for the estimates of the foreign demand (y), as it should stimulate exports, and the negative coefficients for the relative prices (p). As theory suggests an inverse relationship between the exchange rate and exports, we also expect negative signs of the exchange rate coefficients.

3 Data

Our nominal export series are taken from the Eurostat and consist of bilateral total and agricultural exports from 11 European countries[2] to the US measured in Euro. For the analysis we use all currently available data, which limits our sample to the period from January 1988 to August 2013. For two countries in the sample (Austria and Finland) the export series are only available from January 1995 on, so the sample is adjusted for these two countries accordingly. For the total exports we use the total exports according to SITC classification. Our agricultural exports are limited to Standard International Trade Classification (SITC) group 0 “Food and live animals”, which include, e.g. meat and preparations, dairy products, cereals and preparations, fruits and vegetables, coffee, sugar and confectionery. In order to deseasonalise nominal exports we apply the Census-12 procedure. As no price series are available, we use consumer price indexes (CPI) as a measure of relative prices, which is calculated as the CPI of the corresponding European country divided by the US series. The US demand is represented in our data by the index of industrial production (IIP), as it is available on a monthly basis, contrary to GDP data, which is only available quarterly. The IIP and the CPI are collected from the OECD Main Economic Indicators database and are already seasonally adjusted.

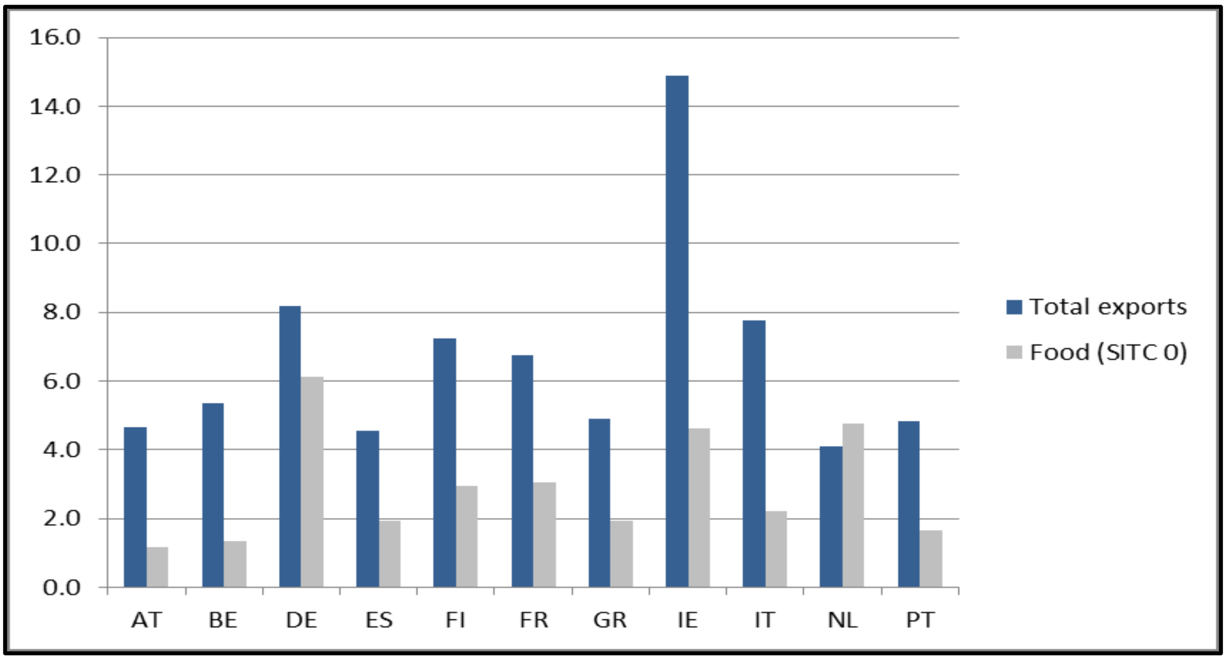
The nominal exchange rates measured as units of the American Dollar (USD) per 1 Euro is obtained from Eurostat. In order to adjust the exchange rates for the period before the introduction of the Euro, we use the official conversion rates to obtain the bilateral exchange rate series. In order to obtain the real exchange rates the bilateral nominal exchange rate series are multiplied with the relative price measures. Thus, the increase of the exchange rate series corresponds to Euro appreciation. The descriptive statistics of nominal and the real exchange rate series in levels as well as of the first differences of the exchange rates in logs are reported in Appendix 1. Figure 1 provides some overview of the relevance of the US for the exports of the considered European countries.

The US is one of the most relevant trade partners of the European countries and the main importer of European agricultural products in recent years. For many EMU countries the US is the major export destination outside of the Eurozone (VERHEYEN, 2013). Even though the EU expansion and the introduction of the Euro led to some shifts in the US importance as a

2 Those countries are: Austria (AT), Belgium (BE), Germany (DE), Spain (ES), Finland (FI), France (FR), Greece (GR), Ireland (IE), Italy (IT), Netherlands (NL), and Portugal (PT).

trade partner due to increasing trade with other European destinations, the proportions presented in Figure 1 stay relatively stable over time.

Figure 1: Exports of the US relative to all country's exports (average of values 1988-2012, %)



Source: Own representation, based on data from Eurostat (1988-2012)

In the following section we proceed with the outcomes of the estimated models. As nonlinearities in the export reactions on exchange rate changes were not in the focus of the empirical literature, we compare our outcomes for total exports with those of VERHEYEN (2013), and then compare our results with the outcomes obtained for agricultural exports to see whether some differences/similarities can be found there.

4 Results

4.1 Total exports

The outcomes for total exports[3] we have obtained are very much in line with those by VERHEYEN (2013), despite the fact that our sample is somewhat larger, the exchange rates enter the equations in logs and the threshold levels are not similar. The chosen lag structure and the explanatory power of the models are comparable in most of the cases. Adjusted R-squared takes the value of around 0.391 on average, with values on the country level ranging from 0.286 to 0.529. Our adjusted R-squared are somewhat smaller than those of VERHEYEN for the equations for Belgium, Germany, Netherlands, Portugal and Spain, but somewhat higher for Austria, France, Greece, Ireland and Italy. This holds for both specifications (with nominal and real exchange rates).

The evidence in favor of the presence of a long-run level relationship is also quite strong. The only models for which we could not reject the H_0 of no cointegration were the ones for Austria, Netherlands and Ireland (only for the model with the nominal exchange rate). Estimated coefficients mostly carry the expected signs and show that the US income, proxied by the industrial production index, positively and over proportionally affects the European exports to the US, while inflation in Europe affects it negatively. To save space Table 1

[3] Due to space limitation, the outcomes of the estimated NARDL models were skipped here, as well as in the outcomes, related to agricultural exports. Still, I discuss the quality of the NARDL models in order to validate the presented long-run coefficients. Full results are available upon request.

reports only the recalculated long-run export demand elasticities with respect to exchange rates.
The outcomes suggest that exchange rates affect European exports. As the values of the coefficient of the nominal and real exchange rates are quite close and mostly significant, while the relative prices are significant in 4 out of 11 cases only, we conclude as VERHEYEN (2013), that it is indeed the nominal exchange rate that influences the export demand. Although we also conclude that depreciations affect the export demand much more than appreciations, in our outcomes the magnitude of the cumulated depreciations are always larger in absolute values than for depreciations. For most of the models irrespective of the specification the depreciation coefficients are highly significant and support the idea, that the EU countries benefit more from the Euro depreciations than suffer from the reduction in the US export demand, once the Euro appreciates. We were not able to find any robust evidence in favor of hysteresis, apart from France, Greece, Italy and Spain. Table 2 provides an overview of a symmetry testing.
Symmetry between all the exchange rate coefficients is rejected for 7 (8) out of 11 cases for the models with real (nominal) exchange rates as explanatory variables. The most pronounced and robust evidence for nonlinearities is found for Austria and Belgium, where the hypothesis of the equality of long-run coefficients of the exchange rates is rejected for both models and for all of the exchange rate coefficients' combinations. In other countries the evidence is somewhat weaker, but still very pronounced. Symmetry between the two outer regimes – appreciations and depreciations – was rejected for all the countries but Finland, France and Ireland, where we conclude, that the magnitude of the reaction of the exports does not depend on the direction or magnitude of the exchange rate change.

4.2 Agricultural exports

The overall fit of the models, which focus on agricultural exports, is somewhat higher than for the models with total exports as dependent variable. Adjusted R-squared takes the value of around 0.405 on average, with the values on the country level ranging from 0.291 to 0.471. The evidence in favor of cointegration in the equations is even more pronounced than in the models with total exports. The bound testing suggests that there is a long-run relationship between the level variables in all models.
Most of the coefficients of the estimated NARDL models have the expected sign. The export demand for food products, when significant, enters the equations for all the countries but Portugal with a positive sign. In most of the cases US industrial production affects the exports over proportionally, thus export demand seems to be income elastic in the cases of Belgium, Greece, Ireland, Italy and Spain. As for Portugal, there might be some substitution effect taking place, as with increasing demand from the American side less products of the Portuguese origin are imported, while the neighboring south European countries might act as providers of those goods. For Austria, Finland, Germany and Netherlands, the US wealth factor seems to play no decisive role in determination of the export demand. Furthermore, relative prices are of less importance for the exports determination for agricultural than for the total exports. More than fifty percent of the coefficients are not statistically significant.
Similarly to the case of the total exports, the nominal exchange rate itself seems to be more important than the inflation factor, as the coefficients of the nominal and real exchange rate in the different model specifications do not differ much. For the agricultural exports the exchange rate seems also to be more important than the US income factor: while only half of the industrial production indices are statistically significant, exchange rate coefficients (especially the ones capturing depreciations) are often highly statistically significant. The only robust exclusion is Austria, where neither for the nominal nor for real exchange rate specifications any of the exchange rate coefficients are significant. Finland, France, Greece, Netherlands, Portugal and Spain seem to benefit the most from the Euro depreciations. In the

Table 1: Summary of the long-run exchange rate coefficients (total exports)

	AT	BE	DE	ES	FI	FR	GR	IE	IT	NL	PT
A. Real exchange rates											
rer^-	-0.658** (0.305)	-0.715*** (0.253)	-0.812*** (0.151)	-0.654*** (0.208)	-0.423* (0.250)	-0.960*** (0.090)	-1.300*** (0.248)	-2.234*** (0.839)	-0.691*** (0.116)	-0.215 (0.318)	-0.918*** (0.348)
$rer^\pm$	-2.130*** (0.551)	-2.602*** (0.452)	-0.770*** (0.231)	-0.087 (0.387)	-1.214*** (0.348)	-0.765*** (0.141)	-0.028 (0.608)	-1.879* (1.127)	-0.231 (0.165)	-1.330** (0.577)	-0.961* (0.498)
rer^+	0.083 (0.273)	-0.198 (0.194)	-0.509*** (0.130)	-0.290* (0.159)	-0.309 (0.231)	-0.926*** (0.076)	-0.273** (0.121)	-1.699 (1.065)	-0.614*** (0.086)	0.440 (0.283)	-0.698*** (0.258)
B. Nominal exchange rates											
er^-	-0.524** (0.211)	-0.727** (0.301)	-0.770*** (0.121)	-0.548*** (0.144)	-0.457 (0.286)	-0.959*** (0.097)	-0.813*** (0.296)	-1.914*** (0.697)	-0.710*** (0.091)	-0.405 (0.351)	-0.815*** (0.291)
$er^\pm$	-1.698*** (0.348)	-2.087*** (0.423)	-0.778*** (0.170)	-0.393* (0.207)	-1.047*** (0.349)	-0.900*** (0.141)	-0.153 (0.400)	-2.003* (1.020)	-0.467*** (0.127)	-1.211** (0.585)	-1.290*** (0.384)
er^+	0.172 (0.205)	-0.040 (0.261)	-0.590*** (0.131)	0.046 (0.113)	-0.371 (0.316)	-0.838*** (0.101)	0.084 (0.233)	-1.074* (0.636)	-0.627*** (0.072)	0.168 (0.316)	-0.590*** (0.213)

Notes: Delta method standard errors are in parentheses. ***, ** and * refer to significance at the 1, 5 and 10 percent level. Source: Own computations.

Table 2: Symmetry testing summary (total exports)

Reg	AT	BE	DE	ES	FI	FR	GR	IE	IT	NL	PT
A. Real exchange rates											
$a_2 = a_3 = a_4$	0.020	0.000	0.001	0.006	0.133	0.243	0.000	0.367	0.000	0.033	0.199
$a_2 = a_3$	0.047	0.004	0.865	0.146	0.064	0.155	0.113	0.807	0.000	0.092	0.949
$a_3 = a_4$	0.018	0.001	0.358	0.625	0.049	0.267	0.721	0.926	0.232	0.029	0.949
$a_2 = a_4$	0.005	0.000	0.000	0.005	0.226	0.399	0.000	0.402	0.000	0.011	0.093
B. Nominal exchange rates											
$b_2 = b_3 = b_4$	0.004	0.003	0.051	0.000	0.329	0.477	0.000	0.280	0.044	0.047	0.070
$b_2 = b_3$	0.039	0.015	0.966	0.460	0.171	0.669	0.105	0.949	0.066	0.178	0.257
$b_3 = b_4$	0.010	0.003	0.408	0.053	0.139	0.710	0.569	0.546	0.264	0.040	0.092
$b_2 = b_4$	0.001	0.001	0.019	0.000	0.512	0.241	0.000	0.111	0.107	0.031	0.076

Notes: Wald test results of equality of the coefficients are reported (p-values). Source: Own computations.

meantime, those are in general also the countries who suffer the most of the Euro appreciations. Still, Euro appreciations do not seem to harm the export demand much.
The coefficients for Euro depreciations are often considerably higher in absolute terms than the ones for appreciations. Table 3 reports the long-run elasticities of food exports with respect to exchange rate changes.
There might be some plausible reasons for such asymmetric reactions of the exports: as European countries export a lot of processed products to the US, some of those products might have gained reputation on the American market, so that the US consumers do not switch away from European goods as their local price in US Dollars rise, and consume more, once the Dollar price falls. It could also be the case, that the European food exporters, who perceive the US market as strategically important and invested at some point a lot into entering the market, use some pricing strategies (e.g., pricing-to-market) in order to partially offset the Euro appreciations and smooth fluctuations in shipped quantities, by reducing the markup they set on marginal costs. Then the total food imports of the European goods by the US do not change much, as the Euro appreciates, which results in a modest number of significant coefficients referring to a Euro appreciation. Strategic pricing might be a plausible explanation behind the nonlinearity of the export volumes' reactions towards Euro appreciations and depreciations, as empirical literature often found evidence of a pricing-to-market policy of European exporters, especially in their trade with the US (e.g., KNETTER 1989, 1997; FALK and FALK, 2000; GLAUBEN and LOY, 2003; STAHN, 2007).
The evidence for hysteresis is also more pronounced for agricultural exports which support the sunk costs hypothesis and suggest that strategic pricing might really take place on some markets. For the food product group the evidence in support to the hysteresis hypothesis is found for Belgium, France, Greece, Italy, Portugal and Spain.
Table 4 provides the outcomes of the symmetry testing for the food export demand. The equality of all the long-run exchange rate coefficients is rejected in ten out of eleven cases in both model specifications. Thus, Ireland is the only country, for which the symmetry of the export's reaction on exchange rate changes of different direction and magnitude could not be rejected. In general, asymmetry between the appreciations and depreciations is more pronounced, than between those and the inner regime. The evidence in favor of nonlinearities is larger for the food exports equations compared to the equations with total exports as dependent variable. This suggests that assuming linearity and symmetry in export demand functions, as it has been often done in the literature, might be too restrictive, especially for agri-food exports.

5 Summary

In this paper we concentrated on the relationship between the exports of food and agricultural products and exchange rates and tested if this relationship is linear, using a newly developed methodology of SHIN et al (2013), which allowed us to model the exchange rate's nonlinearities in export demand equations not only in the short, but also in the long run. Furthermore, we compared our outcomes for food and agri-products with aggregated total exports, and showed that assuming linearity of the export's reaction on the exchange rates is very restrictive in both cases.
The results of the analysis, which was carried out using monthly data on exports from 11 European countries to the US during the period 1988-2013, show, that exports react differently on appreciations and depreciations of the Euro. Even though the outcomes differ a lot between countries, they suggest that European exports benefit more from Euro depreciations, than the Euro appreciations harm them. This result is even more pronounced when agricultural exports are considered. We were able to reject the symmetry hypotheses between all the exchange rates regimes in ninety one percent of cases for agricultural exports and found support of the hysteresis hypothesis in half of the cases.

Table 3: Summary of the long-run exchange rate coefficients (agricultural exports)

	AT	BE	DE	ES	FI	FR	GR	IE	IT	NL	PT
A. Real exchange rates											
rer^{-}	-0.332 (0.468)	-0.771*** (0.258)	-0.600* (0.330)	-1.146*** (0.158)	-0.900** (0.414)	-0.839*** (0.229)	-1.094*** (0.299)	-0.849*** (0.265)	-0.710*** (0.089)	-1.146*** (0.216)	-1.360*** (0.518)
$rer^{\pm}$	1.108 (0.820)	-0.011 (0.487)	0.779 (0.517)	-0.779*** (0.288)	-3.649*** (0.578)	-0.771** (0.357)	-0.598 (0.744)	-0.898** (0.450)	-0.103 (0.124)	-1.647*** (0.390)	-1.174 (0.855)
rer^{+}	-0.042 (0.414)	-0.312 (0.191)	0.16 (0.279)	-0.790*** (0.121)	-0.879** (0.383)	-0.269 (0.190)	-0.168 (0.145)	-0.608*** (0.230)	-0.028 (0.065)	-0.388** (0.185)	-0.392 (0.388)
B. Nominal exchange rates											
er^{-}	-0.127 (0.410)	-0.626*** (0.107)	-0.704** (0.342)	-1.093*** (0.156)	-1.083** (0.538)	-1.917*** (0.285)	-0.713*** (0.249)	-0.585 (0.391)	-0.684*** (0.085)	-1.168*** (0.217)	-0.879*** (0.329)
$er^{\pm}$	0.836 (0.707)	-0.468*** (0.163)	0.835* (0.486)	-1.017*** (0.224)	-3.653*** (0.656)	-0.579 (0.356)	-0.650* (0.337)	-1.200** (0.600)	-0.189 (0.119)	-1.248*** (0.364)	-0.176 (0.473)
er^{+}	0.607 (0.407)	-0.083 (0.092)	-0.160 (0.382)	-0.605*** (0.121)	-1.396** (0.595)	-0.249 (0.271)	0.269 (0.196)	-0.418 (0.304)	-0.025 (0.066)	-0.335* (0.188)	0.102 (0.243)

Notes: Delta method standard errors are in parentheses. ***, ** and * refer to significance at the 1, 5 and 10 percent level. Source: Own computations.

Table 4: Symmetry testing summary (agricultural exports)

	AT	BE	DE	ES	FI	FR	GR	IE	IT	NL	PT
A. Real exchange rates											
$a_2 = a_3 = a_4$	0.087	0.006	0.000	0.000	0.001	0.000	0.000	0.224	0.000	0.000	0.001
$a_2 = a_3$	0.140	0.114	0.018	0.201	0.000	0.845	0.113	0.917	0.000	0.227	0.864
$a_3 = a_4$	0.260	0.512	0.225	0.971	0.000	0.182	0.721	0.585	0.596	0.008	0.450
$a_2 = a_4$	0.148	0.002	0.000	0.000	0.897	0.000	0.000	0.094	0.000	0.000	0.001
B. Nominal exchange rates											
$b_2 = b_3 = b_4$	0.010	0.000	0.004	0.000	0.005	0.003	0.000	0.298	0.000	0.000	0.000
$b_2 = b_3$	0.240	0.333	0.021	0.740	0.002	0.078	0.849	0.430	0.000	0.817	0.154
$b_3 = b_4$	0.788	0.027	0.153	0.084	0.010	0.446	0.011	0.293	0.232	0.011	0.557
$b_2 = b_4$	0.005	0.000	0.013	0.000	0.216	0.002	0.000	0.305	0.000	0.000	0.000

Notes: Wald test results of equality of the coefficients are reported (p-values). Source: Own computations.

As European countries export a lot of final goods to the US, which is their most important trade partner outside of the Eurozone, it seems like European exporters apply pricing-to-market strategies in order to stay competitive on the US market and protect their market shares by partially offsetting Euro appreciations. Euro depreciations might be used in order to gain competitiveness and expand exports. Numerous empirical pricing-to-market studies support this hypothesis for the case of agri-food exports, chemical products and manufactured goods, especially vehicles. The outcomes obtained for agricultural exports suggest that pricing-to-market might play an important role in European exporters' trade decisions. The outcomes obtained for total exports might then reflect the high degree of aggregation, when heterogeneous final goods, for which pricing-to-market strategies in export pricing are expected, and the very homogeneous commodities, which are often traded at the world price level without application of any pricing strategies, are brought together. As the shares of different goods in the structure of total exports are unknown, we cannot distinguish between the export demands reactions to the exchange rate changes within different groups of goods, which would require more detailed data. Also, in order to better explain the cross-countries differences, one should consider more disaggregated agri-food product groups (e.g. milk and milk products, fruits and vegetables and their preparations)[1]. As European markets are highly interlinked, one might think of some way to nest the NARDL approach into a panel setting to include the possible third country effect[2]. As implementing of these ideas requires an independent large-scale study, at this point these suggestions left for a future research

Still, we conclude that the sign and the magnitude of the exchange rate change are very important determinants of the exports (especially agricultural) and that assuming exchange rate long-run linearity in the export demand is way too restrictive even for highly aggregated exports.

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[1] I thank the first anonymous referee for this suggestion.

[2] I am grateful to the second anonymous referee for pointing this out to me.

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Appendix 1: Exchange rates related descriptive statistics

	AT	BE	DE	ES	FI	FR	GR	IE	IT	NL	PT
A. Real exchange rates (level)											
Mean	1.247	1.276	1.316	1.108	1.268	1.330	0.944	1.226	1.168	1.271	1.140
Median	1.278	1.308	1.329	1.111	1.291	1.338	0.961	1.241	1.200	1.289	1.166
Maximum	1.559	1.594	1.673	1.575	1.572	1.728	1.513	1.684	1.618	1.561	1.594
Minimum	0.889	0.877	0.917	0.703	0.928	0.901	0.215	0.856	0.748	0.889	0.646
Std. Dev.	0.155	0.161	0.156	0.211	0.148	0.179	0.348	0.167	0.200	0.148	0.214
Observations	224	308	308	308	224	308	308	308	308	308	308
B. Nominal exchange rates (level)											
Mean	1.210	1.222	1.220	1.153	1.209	1.227	1.083	1.208	1.167	1.219	1.177
Median	1.240	1.237	1.240	1.161	1.238	1.252	1.094	1.223	1.168	1.234	1.191
Maximum	1.577	1.577	1.577	1.577	1.577	1.577	1.577	1.577	1.591	1.577	1.577
Minimum	0.853	0.853	0.853	0.830	0.853	0.853	0.541	0.853	0.812	0.853	0.853
Std. Dev.	0.168	0.152	0.152	0.178	0.169	0.154	0.245	0.154	0.186	0.152	0.161
Observations	224	308	308	308	224	308	308	308	308	308	308
C. Real exchange rates (log, first difference)											
Mean	0.000	0.000	-0.001	0.001	0.000	-0.001	0.006	0.000	0.001	0.000	0.002
Median	0.000	-0.001	0.000	0.000	0.000	0.000	0.004	0.001	0.002	0.000	0.001
Maximum	0.067	0.063	0.069	0.077	0.066	0.066	0.081	0.066	0.139	0.067	0.072
Minimum	-0.067	-0.081	-0.077	-0.080	-0.067	-0.075	-0.066	-0.079	-0.087	-0.071	-0.080
Std. Dev.	0.024	0.024	0.024	0.026	0.023	0.025	0.030	0.026	0.028	0.024	0.026
Observations	223	307	307	307	223	307	307	307	307	307	307
D. Nominal exchange rates (log, first difference)											
Mean	0.000	0.000	0.000	0.001	0.000	0.000	0.003	0.000	0.001	0.000	0.001
Median	0.001	0.000	0.000	0.001	0.001	0.001	0.003	0.001	0.002	0.001	0.001
Maximum	0.065	0.065	0.065	0.076	0.065	0.065	0.065	0.068	0.134	0.065	0.065
Minimum	-0.076	-0.076	-0.076	-0.082	-0.076	-0.076	-0.076	-0.077	-0.092	-0.076	-0.084
Std. Dev.	0.023	0.025	0.024	0.025	0.024	0.025	0.027	0.026	0.028	0.024	0.025
Observations	223	307	307	307	223	307	307	307	307	307	307

Source: Own computations.