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## Same Currency, Different Strategies? The Role of the Exchange Rate in Shaping European Agri-Food Exports

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*This paper uses a nonlinear autoregressive distributed lag framework to assess the role that the exchange rate plays in shaping European agri-food exports after the introduction of Euro. Although the ten countries of this study share the same currency, cross-country discrepancies of exports' reactions to exchange rate changes are evident. Moreover, exchange rate changes influence exports asymmetrically especially in the long run. Euro appreciations are harmful to a lesser extent than Euro depreciations are beneficial for European agri-food exports. The magnitude of this effect is country-specific and varies considerably between individual exporting countries. Exported quantities are less affected by exchange rate fluctuations than export values.*



## 1. Introduction

The role of exchange rates in determining trade flows has been in the focus of theoretical and empirical trade studies as long as international trade has existed as an economic discipline. Exchange rate regimes, exchange rate volatility, pass-through and effects of a single currency have been the subjects empirical trade literature revolved around for a few decades. Cho et al. (2002), Clark et al. (2004), and Sheldon *et al.* (2013), among others, concentrated on the impact of exchange rate volatility on trade flows. Bahmani-Oskooee and Hegerty (2007) provided a literature overview on this topic. Other studies focused on the role of exchange rate regimes (e.g. Aristotelous, 2001; López-Córdova and Meissner, 2004). The pass-through and pricing-to-market literature addressed the role of exchange rates in situations in which the law of one price does not hold and market segmentation and differentiated products allow firms to exploit market power on some markets (e.g. Dornbusch, 1987; Krugman, 1987). Most recently, the impact of a single currency on trade and the related pass-through issues have been actively discussed in the empirical literature. Devreux *et al.* (2002), Engel and Rogers (2004), Rogers (2007) or Friberg (2003) are a few examples of studies aimed at assessing the implications of a single currency on market integration, pass-through, prices and their dispersions across countries.

Verheyen (2013a) concentrated on the aggregated export values of eleven countries of the European Monetary Union (EMU) to the US. Verheyen embedded his model in the nonlinear autoregressive distributed lag (NARDL) framework of Shin *et al.* (2014), which made his study the first attempt to account for asymmetries and nonlinearities of the exchange rate in the long and in short run. This modelling strategy allowed him to overcome the shortcomings of considering only contemporaneous asymmetric effects (as in models specified in first differences) and to diminish the risks of running a spurious regression by taking time-series properties of data into account.

Verheyen (2013a) argued that comparing trade effects across countries of the Eurozone is relevant, since these countries share one nominal rate and thus “...*might strive for a consideration of the exchange rate when taking monetary policy decisions...*” (p.66) on the ECB level, if they benefit more from the Euro appreciation (or vice versa) than the other member-countries. Indeed, the outcomes of the study suggested that exports react highly asymmetrically



to Euro appreciations and depreciations. Results also showed a large dispersion of the outcomes on the cross-country level, supporting the relevance of the topic for policy-makers.

Still, a few important issues were left unaddressed in this study. While Verheyen (2013a) emphasized the use of one nominal exchange rate across the EMU countries, the data used in his paper goes back to 1988. This made it rather complicated to discuss a truly single nominal exchange rate as the Euro was only introduced eleven years later<sup>1</sup>. Hence, results might have been driven by cross-country heterogeneities in the pre-Euro period. To avoid the ambiguity of the source of the asymmetric effects, the transition to the Euro had to be modeled explicitly by interaction terms (to compare the changes in the effects - if any - after the Euro introduction). Alternatively, one could have split the time-series into two sub-samples: before and after the Euro introduction. Furthermore, the possible reverse causality between total exports to the US (which are the main trade partner of European countries outside the Eurozone) and the exchange rate was neglected in Verheyen's study. In addition, if there are any other factors which influence the trade of all European countries in a similar way (e.g. economic crises), the error terms of individual NARDLs might be correlated and deliver inefficient estimators. Finally, Verheyen (2013a and 2013b) suggested that pricing-to-market might be a reason for an asymmetric reaction of exports to exchange rate changes, but left this argument untested. In the meantime, pricing-to-market is a very micro-founded phenomenon, which has its causes on the firm level. If it is indeed pricing-to-market strategies of individual firms that lead to an asymmetric influence of exchange rate on exports, then the policy implications suggested by Verheyen are only relevant when the exporters are influential enough to persuade the ECB to share their interests.<sup>2</sup>

An attempt to address the nonlinearity and asymmetry of exchange rates in agri-food exports was made by Fedoseeva (2014). This study focused on exports of the EMU countries to the US over 1988-2013 and reported even more pronounced asymmetries in the reactions of agricultural

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<sup>1</sup> Though the ERM imposed restrictions on its members to keep their currencies stable, it still allowed exchange rates to fluctuate within given bounds. These fluctuations, once cumulated over time, result in time series of different shapes.

<sup>2</sup> The role of lobbying and the importance of micro-foundations of political decision-making are very interesting research areas, which definitely deserve much attention. Swinnen (2010) provides some insights into the political economy of agricultural and food policies and a literature overview on this subject.

exports to different exchange rate changes, than it was found for total exports. Although this study tackled the endogeneity problem, most of the listed above issues remained unaddressed.

This paper contributes to existing studies in several ways. First, it concentrates on the period from 1999 on, when ten European countries actually introduced the Euro and thus indeed shared the same nominal exchange rate. Second, it tackles the issue of potential inefficiency of estimating individual NARDLs by applying the seemingly-unrelated regression (SUR) procedure. Third, the hypothesis of pricing-to-market as a reason for an asymmetric reaction of exports to Euro appreciations and depreciations is (indirectly) validated. Finally, asymmetric cointegration is addressed by means of bounds testing by Pesaran *et al.* (2001).

The outcomes reveal substantial asymmetries in the reaction of European agri-food exports to Euro appreciations and depreciations. Cross-country discrepancies in the reaction of exports to the exchange rate developments seem to be shaped by a heterogeneous structure of exports and (asymmetric) decisions on mark-up adjustments on the firm-level in each of the considered European countries. Asymmetries are most pronounced for large exporting countries (e.g. Germany, France, and Italy). These countries ship highly processed goods to the US and are obviously able to exploit some market power in pricing their exports by adding a mark-up over costs. Those mark-ups are used to absorb the negative effects of Euro appreciations to ensure that European goods are competitive in terms of prices on the American market. Furthermore, the mark-ups are much less adjusted during the times of a weak Euro. Thus, the exporters are able to collect additional profits during the periods of Euro depreciations. The shipped quantities to the US market are generally less affected by Euro fluctuations due to the application of local currency price stabilization strategies. Still, for some European countries the outcomes suggest that the structure of exports changes during the times of a strong Euro, thus pricing strategies are not the only reason behind the asymmetries of exports' reaction to exchange rate changes

The remainder of this paper is structured as follows: Section 2 introduces the model and empirical strategy, Section 3 briefly describes data. Section 4 describes and discusses the outcomes and Section 5 summarizes and makes some concluding remarks.



## 2. Model and Empirical Strategy

As a starting point of this study, let us assume that exports can be described by a reduced-form function<sup>3</sup>:

$$X_t = A * E_t^\gamma * P_t^\delta * Y_t^\beta \quad (1)$$

where  $X_t$  are the European exports to the US at time  $t$ , which are determined by some constant parameter  $A$ , the nominal exchange rate ( $E$ ), relative prices ( $P$ ) and the US demand  $Y$ . Eq. 1 can be rewritten in a log-log form (lower case letters  $x$ ,  $e$ ,  $p$  and  $y$  denote logs of variables) as:

$$x_t = a + \gamma e_t + \delta p_t + \beta y_t \quad (2)$$

Eq. 2 represents the long-run relationship between exports and its determinants. In this representation, the impact of the nominal exchange rate on exports is assumed to be symmetric.

In order to distinguish between the effects of a currency appreciation and depreciation, the partial sum decomposition approach (Schorderet, 2001) is applied. The effects of small currency fluctuations are isolated by using a two-threshold decomposition to account for hysteresis effects (e.g. Fedoseeva, 2014). The exchange rate decomposition takes the following form, where  $e_t$  is the logarithm of the nominal exchange rate,  $e_0$  is the value of the exchange rate at the time  $t_0$ , and  $e_t^-$ ,  $e_t^\pm$  and  $e_t^+$  are partial sums of large negative, small and large positive changes respectively:

$$e_t = e_0 + e_t^- + e_t^\pm + e_t^+ \quad (3)$$

where

$$e_t^- = \sum_{j=1}^t \Delta e_j^- = \sum_{j=1}^t \Delta e_j I\{\Delta e_j \leq -STD\} \quad (4)$$

$$e_t^\pm = \sum_{j=1}^t \Delta e_j^\pm = \sum_{j=1}^t \Delta e_j I\{-STD < \Delta e_j < +STD\} \quad (5)$$

$$e_t^+ = \sum_{j=1}^t \Delta e_j^+ = \sum_{j=1}^t \Delta e_j I\{+STD \leq \Delta e_j\} \quad (6)$$

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<sup>3</sup> A similar form is employed in e.g. Bahmani-Oskooee (1986), Bahmani-Oskooee and Kara (2003) and Verheyen (2013a and 2013b).

STD stands for a one standard deviation of an exchange rate change, which serves as a threshold level in this specification and  $\Delta$  refers to a first difference.

Substituting  $e_t$  in Eq. 3 by Eq. 2 we obtain a long-run equation for export demand, where the impact of the exchange rate is allowed to vary depending on the sign and magnitude of exchange rate changes.

$$x_t = c + \gamma_1 e_t^- + \gamma_2 e_t^\pm + \gamma_3 e_t^+ + \delta p_t + \beta y_t \quad (7)$$

The dynamic NARDL model takes the following form:

$$\Delta x_t = a_0 + a_1(x_{t-1} - a_2 e_{t-1}^- - a_3 e_{t-1}^\pm - a_4 e_{t-1}^+ - a_5 p_{t-1} - a_6 y_{t-1}) + \sum_{\tau=0} \eta_\tau \Delta e_{t-\tau}^- + \sum_{\tau=0} \theta_\tau \Delta e_{t-\tau}^\pm + \sum_{\tau=0} \iota_\tau \Delta e_{t-\tau}^+ + \sum_{\tau=0} \kappa_\tau \Delta p_{t-\tau} + \sum_{\tau=0} \lambda_\tau \Delta y_{t-\tau} + \sum_{\omega=1} \mu_\omega \Delta x_{t-\omega} + u_t \quad (8)$$

NARDLs are estimated separately for each exporting country to allow for an individual lag structure, which is selected by means of the Schwarz criterion. Since the specified equations are estimated by means of ordinary least squares using Eviews, Eq. 8 will be assessed as:

$$\Delta x_t = a_0 + a_1 x_{t-1} - b_2 e_{t-1}^- - b_3 e_{t-1}^\pm - b_4 e_{t-1}^+ - b_5 p_{t-1} - b_6 y_{t-1} + \sum_{\tau=0} \eta_\tau \Delta e_{t-\tau}^- + \sum_{\tau=0} \theta_\tau \Delta e_{t-\tau}^\pm + \sum_{\tau=0} \iota_\tau \Delta e_{t-\tau}^+ + \sum_{\tau=0} \kappa_\tau \Delta p_{t-\tau} + \sum_{\tau=0} \lambda_\tau \Delta y_{t-\tau} + \sum_{\omega=1} \mu_\omega \Delta x_{t-\omega} + u_t \quad (9)$$

so that, e.g.,  $b_2$  coefficient includes not only the elasticity of the exchange rate variable, but also the speed of adjustment  $a_1$  ( $b_2 = a_1 * a_2$ ). Thus, in order to assess the long-run exchange rate elasticities, the obtained coefficient referring to the exchange rate variable has to be divided by the coefficient of the lagged export variable:

$$a_2 = -\frac{b_2}{a_1}, \quad a_3 = -\frac{b_3}{a_1}, \quad \text{and} \quad a_4 = -\frac{b_4}{a_1} \quad (10)$$

Standard errors and significance levels for these recalculated estimators can be obtained by means of the Delta method. In order to test whether the outcomes are spurious, the bounds testing approach by Pesaran *et al.* (2001) is used. Bounds testing relies on results of a Wald-test, applied to the lagged level variables of the NARDL. If the F-statistics is outside the critical bounds, inference about the long-run relationship of the level variables can be drawn. Two sets of asymptotic critical values which provide critical value bounds for all classifications of the regressors into I(1), I(0) or mutually cointegrated, are tabulated in Pesaran *et al.* (2001).



Moreover, the cointegration test by Banerjee *et al.* (1988) is applied, with relevant critical value bounds for the t-statistics (related to the coefficient of the lagged dependent variable in levels) taken from Pesaran *et al.* (2001).

Although the country-pair NARDLs account for time-series properties of each individual model, there is a drawback of this specification. Individual time-series models do not take into account potential correlation of the error terms across the models. Since European countries are largely interconnected, there might be some factors which affect exports of these countries in a similar way, but are not addressed by the presented specification. If this is the case, this information is captured by the residuals and causes efficient estimators. Sticking to a panel framework would be the most straightforward solution to this problem. Unfortunately, to the best of my knowledge, there is no elegant way to nest individual NARDLs in a panel setting (and still be able to deal with asymmetric cointegration issues). Instead, the SUR approach by Zellner (1962) is used, once the appropriate lag structure of each model is chosen within individual NARDLs.

### 3. Data

This study covers the period from January 1999 till December 2013. All the data are monthly. Ten exporting countries are included in the sample: Austria (AT), Belgium (BE), Germany (DE), Spain (ES), Finland (FI), France (FR), Ireland (IE), Italy (IT), the Netherlands (NL), and Portugal (PT). Those countries introduced the Euro as official currency in 1999. The destination country is the US, which is one of the main trade partners of European countries in agri-food trade. Figure 1 depicts the development of European agri-food exports to the US over time.

[Figure 1 around here]

Table 1 summarizes information about the variables which are used in the empirical part of this study.

[Table 1 around here]

Figure 2 plots the development of the original exchange rate series (EUR/USD) versus its partial sums.

[Figure 2 around here]





#### 4. Empirical Results and Discussion

Table 2 shows the results of a formal symmetry testing. Complete outcomes of the NARDL-models coefficients are provided in the Appendix A.

[Table 2 around here]

The symmetry between all the three exchange rate coefficients was rejected at the 1% level for eight countries in the sample. It was only for Spain and Ireland that the symmetry of the estimates could not be rejected. The outcomes for Austria suggest no relation between the exchange rate and exports, as all the coefficients are statistically insignificant.

The asymmetry is especially noticeable between the coefficients of large appreciations and depreciations. In most of the cases, the symmetry of the coefficients, related to the outer ( $b_2$  and  $b_4$ ) and the inner ( $b_3$ ) regimes, could not be rejected. In most of the cases, coefficients related to the inner regime are only marginally significant, which is to be expected due to hysteresis. However, the inner regime variable does not have much variation in itself (See Figure 2), which might be the reason for some surprisingly large coefficients, as e.g. for Finland.

Since the cointegration testing (Table 3) rejected the absence of a long-run relationship between the level variables in all of the estimated models, we now turn to a discussion of the main results.

[Table 3 around here]

A comparison of coefficients related to large appreciations and depreciations (Table 4) is straightforward: the coefficients referring to depreciations are much higher in absolute terms than those referring to appreciations, and are more often statistically significant.<sup>4</sup>

[Table 4 around here]

Coefficients related to Euro depreciations vary between -0.672 and -1.140. This implies that a 1 % depreciation of the Euro results in a 0.672 % increase of Belgian exports, while Spanish exports rise by 1.140 % in the long run. The coefficients related to appreciations are lower in absolute terms and vary from -0.282 to -1.050, implying that a 1 % Euro appreciation decreases German agri-food exports by 0.282 %, while Spanish exports drop by 1.050 %. Spain seems to be a country which benefits the most from Euro depreciations and suffers the most from its appreciation. Figure 3 depicts the impact of a 1 % Euro appreciation (depreciation) on exports.

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<sup>4</sup> The only exception from this pattern are Austria, where none of the exchange rate coefficients are significant, and Ireland, where the coefficients are very close in absolute terms and symmetry is not rejected.



[Figure 3 around here]

The SUR-results are reported in Appendix C. Apart from minor changes in the magnitude of coefficients, few estimates turned to be significant, compared to the outcomes of individual NARDL models. For the case of France, the coefficient for large appreciations became significant at the 10 % level and for Ireland the coefficient related to Euro depreciations became significant as well. Besides that, a few changes in significance levels were found for coefficients, referring to the inner regime. That was the case for France, Italy and Portugal. In the case of Germany, the inner regime coefficient turned out to be no longer significant.

Germany, Spain, France, Italy and the Netherlands are the largest European exporters of agri-food products to the US. For most of these countries, a strong effect of the exchange rate on exports was found. Moreover, this impact of exchange rate changes is highly asymmetric (for all countries but Spain). While countries benefit from Euro depreciations in a relatively similar way, the impact of Euro appreciations is less uniform. While the elasticity is above one for Spain, it is only around 0.3 for Germany. Since this discrepancy might be driven by certain preferences for European goods in the American market, a more detailed overview of the structure of agri-food European exports is provided in Figure 4.

Heterogeneous local currency price stabilization strategies can be the reason for asymmetric reactions of exports to exchange rate changes, whereby these asymmetries might differ across countries. Local currency price stabilization implies that the exporters adjust their mark-ups as the exchange rate fluctuates in order to avoid major shifts in the price paid (and hence in quantities purchased) in the American market in US Dollars. This might only be done for products which are not homogeneous in their nature and for which no uniform world market price exists. Since more than 70 % of European agri-food exports to the US are final goods (European Commission 2013), this assumption is plausible.

Some hints regarding strategic pricing and even asymmetric price adjustments towards different types of shocks can be found in empirical studies. Bugamelli and Tedeschi (2008) test the asymmetries of pricing-to-market for France, Germany, Italy, the Netherlands and Spain and conclude that the pass-through is highly incomplete for sales to advanced economies but rather complete in emerging and developing economies. They also find evidence in favour of asymmetries of pricing-to-market. Bussière (2013) tests the symmetry of the exchange rate pass-



through (to prices) for G7 countries and states that symmetry of pass-through is a rather strong assumption, especially for exports.

Gil-Pareja (2000) shows that for “most French and Dutch products, export prices are adjusted to offset the effect of appreciations of the exporter's currency to a greater extent than they are adjusted to offset the effect of depreciations” (p. 17). Berman et al. (2012) use French firm-level data and analyse the impact of firm's productivity on pricing-to-market. They conclude that heterogeneous pricing-to-market of high-performance firms, which absorb the exchange rate movements by their mark-ups, might be the reason for a weak impact of exchange rates on exports. Verheyen (2013a) also suggested that pricing-to-market might cause asymmetric export reactions to exchange rate changes.

The outcomes of this study are in line with the pricing-to-market literature cited above. More pronounced asymmetric reactions were obtained for countries exporting high-quality goods which are valued for their specific origin and for the reputation of brand (e.g. French or Italian cheese, sugar confectionery products or coffee roasted in Germany). Since the mark-up adjustment takes place on the level of individual producers (exporters) the degree of these adjustments may vary considerably from case to case (see e.g. Martin and Rodriguez 2004; Berman et al. 2012). This might well explain the cross-country differences, which are noticeable even in the aggregated data. Proving this point completely would require conducting a pricing-to-market analysis for all the individual exporters and all the individual products shipped from the ten sample countries to the US. Such a study might well be very insightful, since empirical studies so far were rather skewed towards certain countries and goods and mostly employed aggregated industry-averaged data. However, since testing for pricing-to-market behaviour is per se a large task, which is not in the focus of this study, I follow an indirect way to test the local currency price stabilization hypothesis.

If local currency price stabilization is applied on some markets, physical quantities of exports should not fluctuate as much as export values when the exchange rate fluctuates, due to mark-up adjustments. This can be tested by estimating Eq. 9 using exported quantities as dependent variables. If the reactions of quantities are smaller in absolute terms than the reaction of export values, that might be interpreted as evidence in favour of mark-up adjustments and strategic pricing. Additionally, cointegration relationships might not prevail in the equations with

quantities as explanatory variables. Furthermore, the explanatory power of the models with quantities on the left-hand side is expected to be lower, since exchange rates do not influence quantities as much as they influence values of exports in the presence of local currency price stabilization. Table 5 reports the long-run elasticities of export quantities with respect to exchange rate changes. The complete NARDL results are summarized in Appendix D.

[Table 5 around here]

Cointegration tests could not reject the hypothesis of no long-run relationship between the level variables for the cases of Belgium and France, hence, the outcomes have to be treated with caution for these countries. In seven out of ten cases formal symmetry between all the exchange rate variables was rejected (exceptions are Spain, France and Ireland).<sup>5</sup> The elasticities of export quantities with respect to exchange rate changes are substantially lower in absolute terms than those of export values. This is especially true for large depreciations. Since exported quantities react more weakly to depreciations than export values, it should be the export prices which are adjusted during Euro depreciations. This finding is in line with local currency price stabilization strategies of the exporters, who are able to exert market power on their markets. Further hints at local currency price stabilization can be found during Euro appreciations as well. The outcomes for Austria, Belgium, Finland, France and Ireland suggest that export quantities are not affected by large appreciations. For Spain, Italy and the Netherlands, the impact of Euro appreciations is lower in absolute terms on export quantities than on export values. This is in line with findings of Gil-Pareja (2000) and conclusions of Verheyen (2013a), as in the case of Euro appreciations for these countries it might be mark-ups which are squeezed to avoid losing market shares in such an important market as the US. Still, as the outcomes for Germany and Portugal suggest, there might be more behind the asymmetric reaction of exports to exchange rate changes than pricing-to-market strategies. Positive coefficients, related to Euro appreciations for Germany and Portugal suggest that the exported quantities actually rise in times of a strong Euro. Thus, besides local currency price stabilization mechanisms, a change in the structure of exports might take place. However, testing this argument requires much more disaggregated data.

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<sup>5</sup> The outcomes of cointegration and symmetry testing are reported in Appendices E-F.

## 5. Conclusion

This study aimed to empirically assess the role which the exchange rate plays in shaping European agri-food exports. Ten European countries which adopted Euro as a single currency in 1999 were included in the analysis. The US – the most important trading partners of European exporters in agri-food trade – were chosen as destination country.

In order to account for possible asymmetric effects of the exchange rate on exports in the short and in the long run, the partial sum decomposition was applied to separate effects of Euro appreciations and depreciations and the NARDL framework was used to account for cointegration. The two-threshold decomposition of the exchange rate variable was conducted to model hysteresis effects. Finally, a SUR procedure was implemented to gain efficiency and avoid correlation in the error terms of individual NARDLs due to the influence of some not controlled factors.

The outcomes suggested that: a) the exchange rate influences exports; b) this impact is asymmetric and exports react differently to Euro appreciations and depreciations; c) Euro appreciations are less harmful than Euro depreciations are beneficial for exports of European countries; d) the magnitude of this effect is country-specific and varies considerably between individual exporting countries; e) quantities shipped are much less affected (if any) by exchange rate fluctuations; f) strategic pricing might well be one of the reasons for these asymmetries, but not the only one; and g) taking the possible correlation of error terms across the models into consideration does not alter the outcomes much.

Strategic pricing, especially in the form of local currency price stabilisation, is argued to be one of the main reasons for the asymmetric reactions of exports to Euro appreciations and depreciations. It might well be the cause of cross-country variations as well. The structure of agri-food exports is highly diverse and varies substantially across considered countries. This might well be the reason behind discrepancies in exports' reactions to appreciations and depreciations. Since mark-up adjustment decisions are made on the micro level, the outcomes we obtain for aggregated agri-food exports are also some estimated averages, resulting from the aggregation of the individual exporter's decisions regarding concrete products in each particular European country. The overview of empirical literature showed that strategic pricing is widely applied by European exporters. In addition, pricing-to-market might be asymmetric itself (see



e.g. Bugamelli and Tedeschi, 2008, or Bussière, 2013). The extent to which pricing-to-market can be used to mitigate the exchange rate fluctuations depends on the ability of each individual producer (exporter) to charge a mark-up above its marginal costs. Thus, the degree to which local currency price stabilisation is applied heavily relies on the possibility to exploit market power on a particular market. This would allow the exporting firm to smooth the currency fluctuations and, thus, protect market shares and keep the exported quantities unchanged during Euro appreciations, and extract additional profits and/or increase exports during the periods of Euro depreciations. European countries (most of the countries in the sample) seem to benefit substantially more from Euro depreciations than they suffer from Euro appreciations, which is much in line with the finding of literature on pass-through and pricing-to-market and gives hints at market power exerted by European exporters in the US market. Thus, not the common currency, but variety and quality of the European products seem to be the major factors which influence the pricing of exported goods, export reactions to exchange rate changes and shape agri-food exports.

Concerning further research, including additional importing markets to the analysis could be considered. This would allow testing whether price adjustments differ across destination countries (in the sense of classic pricing-to-market of Krugman (1987)). Employing more disaggregated data on agri-food exports could answer the question whether exchange rate fluctuations lead to changes in the structure of agri-food exports of European countries. Moreover, embedding the analysis in a cross-sector framework could help to assess how pricing strategies vary between different sectors.

## References

- Aristotelous, K. (2001). 'Exchange-rate volatility, exchange-rate regime, and trade volume: Evidence from the UK–US export function (1889–1999)', *Economic Letters*, Vol. 72, pp. 87-94.
- Bahmani-Oskooee, M. (1986). 'Determinants of international trade flows: The case of developing countries', *Journal of Development Economics*, Vol. 20, pp. 107-123.
- Bahmani-Oskooee, M. and Kara, O. (2003). 'Relative responsiveness of trade flows to a change in prices and exchange rate', *International Review of Applied Economics*, Vol. 17, pp. 293-308.
- Bahmani-Oskooee, M. and Hegerty, S. W. (2007). 'Exchange rate volatility and trade flows: A review article', *Journal of Economic Studies*, Vol. 34, pp. 211-255.
- Banerjee A. J., Dolando, J. J. and Mestre, R. (1998). 'Error-correction mechanism tests for cointegration in a single equation framework', *Journal of Time-Series Analysis*, Vol. 19, pp.: 267-285.
- Berman N., Martin, P. and Mayer, T. (2012). 'How do different exporters react to exchange rate changes?', *The Quarterly Journal of Economics*, Vol. 127, pp. 437-492.
- Bugamelli M. and Tedeschi, R. (2008). 'Pricing-to-market and market structure', *Oxford Bulletin of Economics and Statistics*, Vol. 70, pp. 155-180.
- Bussière, M. (2013). 'Exchange rate pass-through to trade prices: the role of non-linearities and asymmetries', *Oxford Bulletin of Economics and Statistics*, Vol. 75, pp. 731-758.
- Cho, G., Sheldon, I. and McCorrison, S. (2002). 'Exchange rate uncertainty and agricultural trade', *American Journal of Agricultural Economics*, Vol. 84, pp. 931-942.
- Clark, P. G., Tamirisa, N. and Wei, S.-J. (2004). 'A new look at exchange rate volatility and trade flows', Occasional Paper 235, International Monetary Fund.
- Devereux, M. B., Engel, C. and Tille, C. (2003). 'Exchange rate pass-through and the welfare effects of the Euro', *International Economic Review*, Vol. 44, pp. 223-242.
- Dornbusch, R. (1987). 'Exchange rates and prices', *The American Economic Review*, Vol. 77, pp. 93-106.



Engel, C. and Rogers, J. H. (2004). 'European product market integration after the Euro', *Economic Policy*, Vol. 19, pp. 347-384.

European Commission (2013). 'Monitoring agri-trade policy. Agricultural trade in 2012: a good story to tell in a difficult year?', available at: [http://ec.europa.eu/agriculture/trade-analysis/map/index\\_en.htm](http://ec.europa.eu/agriculture/trade-analysis/map/index_en.htm). Fedoseeva, S. (2014). 'Are agri-food exports any special? Exchange rate nonlinearities in European exports to the US', *German Journal of Agricultural Economics*, Vol. 63, pp. 259-270.

Friberg, R. (2003). 'Common currency, common market?' *Journal of the European Economic Association*, Vol. 1, pp. 650-661.

Gil-Pareja, S. (2000). 'Exchange rates and European countries' export prices: an empirical test for asymmetries in pricing to market behavior', *Weltwirtschaftliches Archiv*, Vol. 136, pp. 1-23.

Grier, K. B. and Smallwood, A. D. (2007). 'Uncertainty and export performance: evidence from 18 countries', *Journal of Money, Credit and Banking*, Vol. 39, pp. 965-979.

Krugman, P. (1987). 'Pricing to market when the exchange rate changes', in Arndt, S. W., and Richardson, J. D. (eds), *Real-financial Linkages among Open Economies*. MIT Press, Cambridge, MA.

López-Córdova, J. E., and Meissner, C. M. (2003). 'Exchange-rate regimes and international trade: evidence from the classical Gold Standard era', *The American Economic Review*, Vol. 93, pp. 344-353.

Martin, L. M., and Rodriguez, D. R. (2004). 'Pricing to market at firm level', *Review of World Economics*, Vol. 140, pp. 302-320.

Pesaran, M. H, Shin, Y. and Smith, R. J. (2001). 'Bounds testing approaches to the analysis of level relationships', *Journal of Applied Econometrics*, Vol. 16, pp. 289-326.

Rogers, J. H. (2007). 'Monetary Union, price level convergence, and inflation: how close is Europe to the USA?', *Journal of Monetary Economics*, Vol. 54, pp. 785-796.

Schorderet, Y. (2001). 'Revisiting Okun's law: a hysteretic perspective', Discussion Papers, Department of Economics, University of California, San Diego, USA.



Sheldon, I., Mishra, K. S., Pick, D. and Thompson, S. R. (2013). 'Exchange rate uncertainty and US bilateral fresh fruit and fresh vegetable trade: an application of the gravity model', *Applied Economics*, Vol. 45, pp. 2067-2082.

Shin, Y., Yu, B. and Greenwood-Nimmo, M. J. (2014). 'Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework', in Horrace, W. C. and Sickles, R. C. (eds), *Festschrift in Honor of Peter Schmidt*. Springer Science & Business Media, New York.

Swinnen, J. F. M. (2010). 'The political economy of agricultural and food policies: recent contributions, new insights, and areas for further research', *Applied Economic Perspectives and Policy*, Vol. 32, 33-58.

Verheyen, F. (2013a). 'Exchange rate nonlinearities in EMU exports to the US', *Economic Modelling*, Vol. 32, pp. 66-76.

Verheyen, F. (2013b). 'The stability of German export demand equations – have German exports suffered from the strength of the Euro?', *International Economics and Economic Policy*, forthcoming.

Zellner, A. (1962). 'An efficient method of estimating seemingly unrelated regression equations and tests for aggregation bias', *Journal of the American Statistical Association*, Vol. 57, pp. 348–368.

## Tables and Figures

**Table 1. Description of variables**

| Variable  | Description                     | Source   |
|-----------|---------------------------------|--|
| $x_t$     | Exports                         | Bilateral exports (in Euro), SITC 0 "Food and live animals", seasonally adjusted (Census-12), deflated by corresponding consumer prices for food, similar to Grier and Smallwood (2007). Log |
|           |                                 | Eurostat;<br>OECD Main Economic Indicators (MEI)   |
| $e_t$     | Exchange rate                   | Nominal exchange rate, measured as units of American Dollar (USD) per one Euro. Log  |
|           |                                 | Eurostat   |
| $e_t^-$   |                                 | Partial sum of large Euro depreciations  |
|           |                                 | Own computation (Eq. 4)  |
| $e_t^\pm$ |                                 | Partial sum of small Euro fluctuations   |
|           |                                 | Own computation (Eq. 5)  |
| $e_t^+$   |                                 | Partial sum of large Euro appreciation   |
|           |                                 | Own computation (Eq. 6)  |
| $p_t$     | Relative prices                 | Consumer price indexes (CPI) of the corresponding European country divided by the American CPI, both seasonally adjusted. Log  |
|           |                                 | OECD MEI   |
| $y_t$     | Income of a destination country | US index of industrial production (2010=100), seasonally adjusted, as a proxy for income of the destination country. Chosen as available on a monthly basis. Log                             |
|           |                                 | OECD MEI   |

Source: Own presentation.



**Table 2. Symmetry testing (Eq. 9 with export values as dependent variables)**

|                         | <i>AT</i>      | <i>BE</i>      | <i>DE</i>      | <i>ES</i>    | <i>FI</i>      | <i>FR</i>     | <i>IE</i>      | <i>IT</i>    | <i>NL</i>          | <i>PT</i>       |
|-------------------------|----------------|----------------|----------------|--------------|----------------|---------------|----------------|--------------|--------------------|-----------------|
| <i>H</i> <sub>0</sub> : | <i>Austria</i> | <i>Belgium</i> | <i>Germany</i> | <i>Spain</i> | <i>Finland</i> | <i>France</i> | <i>Ireland</i> | <i>Italy</i> | <i>Netherlands</i> | <i>Portugal</i> |
| $b_2 = b_3 = b_4$       | 0.00           | 0.00           | 0.00           | 0.17         | 0.00           | 0.00          | 0.89           | 0.00         | 0.01               | 0.00            |
| $b_2 = b_4$             | 0.01           | 0.00           | 0.00           | 0.49         | 0.00           | 0.00          | 0.80           | 0.00         | 0.02               | 0.00            |
| $b_2 = b_3$             | 0.35           | 0.66           | 0.00           | 0.42         | 0.00           | 0.12          | 0.76           | 0.36         | 0.02               | 0.58            |
| $b_3 = b_4$             | 0.93           | 0.17           | 0.03           | 0.67         | 0.00           | 0.72          | 0.72           | 0.11         | 0.27               | 0.57            |

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

**Table 3. Cointegration results (Eq. 9 with export values as dependent variables)**

|   | <i>AT</i>      | <i>BE</i>      | <i>DE</i>      | <i>ES</i>    | <i>FI</i>      | <i>FR</i>     | <i>IE</i>      | <i>IT</i>    | <i>NL</i>          | <i>PT</i>       |
|---|----------------|----------------|----------------|--------------|----------------|---------------|----------------|--------------|--------------------|-----------------|
|   | <i>Austria</i> | <i>Belgium</i> | <i>Germany</i> | <i>Spain</i> | <i>Finland</i> | <i>France</i> | <i>Ireland</i> | <i>Italy</i> | <i>Netherlands</i> | <i>Portugal</i> |
| Bounds testing, Pesaran et al. (2001):              | 20.89***       | 9.38***        | 11.82***       | 5.37***      | 22.43***       | 3.80**        | 8.92***        | 7.75***      | 4.52**             | 12.98***        |
| f-stat.   |                |                |                |              |                |               |                |              |                    |                 |
| Cointegration test, Banerjee et al. (1998): t-stat. | -10.58***      | -6.91***       | -8.30***       | -5.19***     | -10.80***      | -4.19*        | -6.41***       | -6.75***     | -4.30*             | -8.46***        |

Notes: \*\*\*, \*\*, \* denote significance at the 1, 5 and 10 % level respectively according to critical values presented in Appendix B. For the Bounds testing, critical values of the most restrictive model are applied. Source: Own computations.

**Table 4. Long-run elasticities of agri-food export values to the US with respect to exchange rates (Eq. 10)**

|       | <i>AT</i>      | <i>BE</i>      | <i>DE</i>      | <i>ES</i>    | <i>FI</i>      | <i>FR</i>     | <i>IE</i>      | <i>IT</i>    | <i>NL</i>          | <i>PT</i>       |
|-------|----------------|----------------|----------------|--------------|----------------|---------------|----------------|--------------|--------------------|-----------------|
|       | <i>Austria</i> | <i>Belgium</i> | <i>Germany</i> | <i>Spain</i> | <i>Finland</i> | <i>France</i> | <i>Ireland</i> | <i>Italy</i> | <i>Netherlands</i> | <i>Portugal</i> |
| $a_2$ | 0.079          | -0.672 ***     | -0.939 ***     | -1.140 ***   | -0.089         | -0.970 ***    | -0.643         | -0.748 ***   | -1.071 ***         | -1.069 ***      |
|       | (0.451)        | (0.227)        | (0.106)        | (0.181)      | (0.472)        | (0.179)       | (0.443)        | (0.102)      | (0.265)            | (0.260)         |
| $a_3$ | 0.584          | -0.800 ***     | 0.266          | 0.863 *      | -3.049 ***     | -0.333        | -0.360         | -0.636 ***   | -0.121             | -0.696          |
|       | (0.576)        | (0.248)        | (0.216)        | (0.373)      | (0.611)        | (0.388)       | (0.690)        | (0.141)      | (0.513)            | (0.762)         |
| $a_4$ | 0.526          | -0.391 *       | -0.282 **      | -1.050 ***   | -0.717         | -0.202        | -0.679 *       | -0.415 ***   | -0.615 ***         | -0.268          |
|       | (0.439)        | (0.202)        | (0.275)        | (0.175)      | (0.475)        | (0.173)       | (0.353)        | (0.073)      | (0.219)            | (0.183)         |

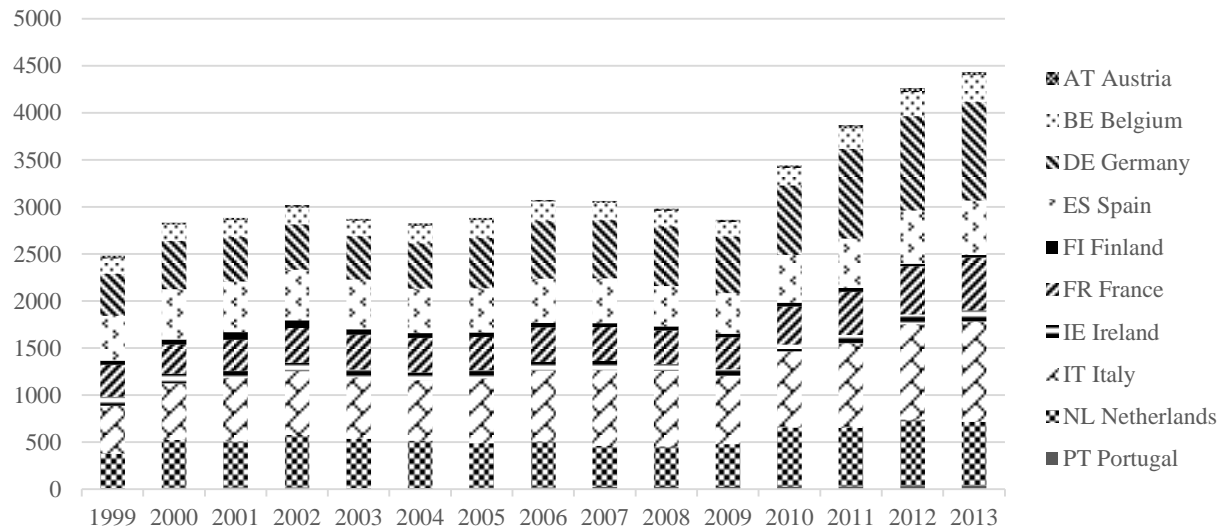


Notes:  $a_2$ ,  $a_3$  and  $a_4$  stand for the coefficients referring to  $e^-$ ,  $e^\pm$  and  $e^+$  respectively. Delta method standard errors are in parentheses. \*\*\*, \*\* and \* refer to significance at the 1, 5, 10 % level. Source: Own computations.

**Table 5. Long-run elasticities of agri-food export quantities to the US with respect to exchange rates (Eq. 10)**

|       | <i>AT</i>        | <i>BE</i>         | <i>DE</i>             | <i>ES</i>             | <i>FI</i>            | <i>FR</i>           | <i>IE</i>         | <i>IT</i>             | <i>NL</i>             | <i>PT</i>            |
|-------|------------------|-------------------|-----------------------|-----------------------|----------------------|---------------------|-------------------|-----------------------|-----------------------|----------------------|
|       | <i>Austria</i>   | <i>Belgium</i>    | <i>Germany</i>        | <i>Spain</i>          | <i>Finland</i>       | <i>France</i>       | <i>Ireland</i>    | <i>Italy</i>          | <i>Netherlands</i>    | <i>Portugal</i>      |
| $a_2$ | 0.501<br>(0.599) | -1.229<br>(0.800) | -0.786 ***<br>(0.203) | -0.734 ***<br>(0.177) | 1.104<br>(1.826)     | -0.884 *<br>(0.491) | -0.227<br>(0.649) | -0.553 ***<br>(0.133) | -0.834 ***<br>(0.149) | -0.147<br>(0.365)    |
| $a_3$ | 0.096<br>(0.593) | -2.248<br>(1.399) | 0.063<br>(0.310)      | -1.276 ***<br>(0.392) | -5.241 **<br>(2.053) | -0.181<br>(1.234)   | -1.648<br>(1.104) | -0.449 *<br>(0.261)   | -0.041<br>(0.298)     | -0.222<br>(1.427)    |
| $a_4$ | 0.690<br>(0.739) | 0.019<br>(0.614)  | 0.477 **<br>(0.203)   | -0.680 ***<br>(0.175) | 0.961<br>(1.949)     | -0.037<br>(0.544)   | -0.451<br>(0.490) | -0.284 **<br>(0.113)  | -0.445 ***<br>(0.116) | 0.758 ***<br>(0.225) |

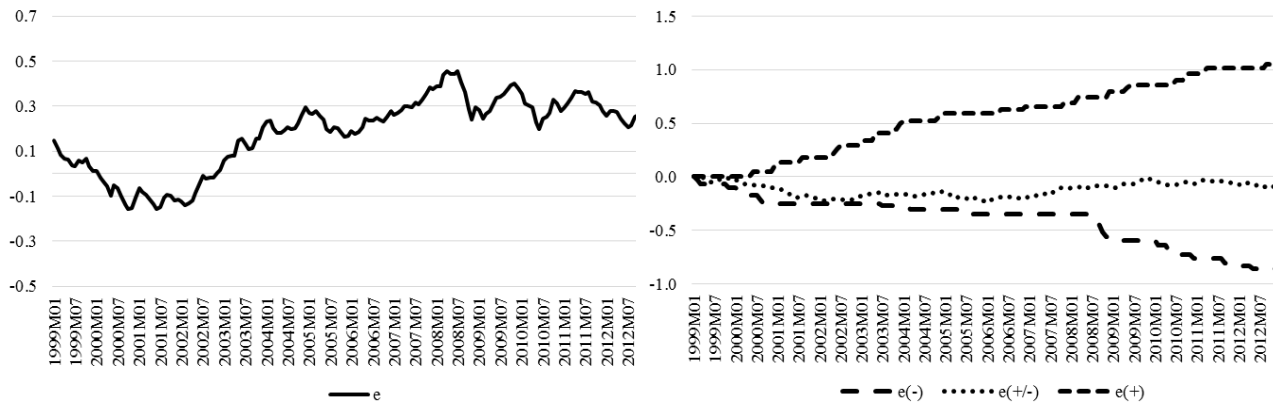
Notes:  $a_2$ ,  $a_3$  and  $a_4$  stand for the coefficients referring to  $e^-$ ,  $e^\pm$  and  $e^+$  respectively. Delta method standard errors are in parentheses. \*\*\*, \*\* and \* refer to significance at the 1, 5, 10 % level. Source: Own computations.

**Figure 1. Bilateral nominal exports from the EU countries to US, million Euro**

Source: Own presentation with data from Eurostat.



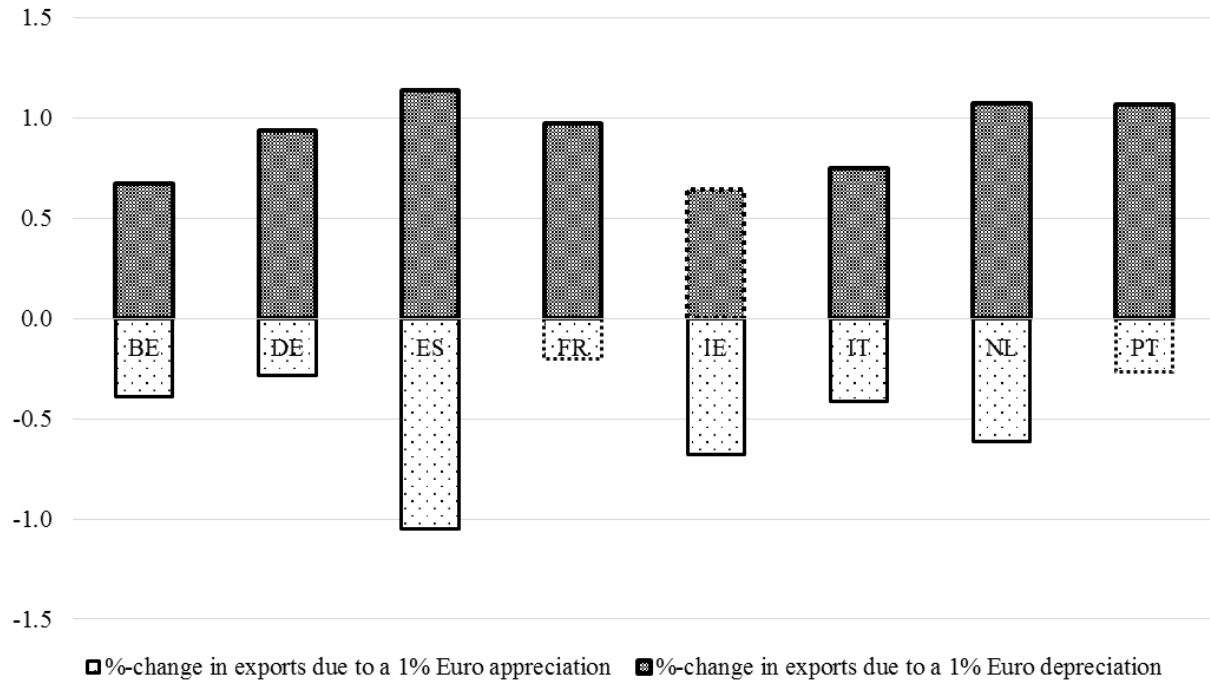
**Figure 2. Exchange rate (log) and partial sum decomposition**



Source: Own presentation.

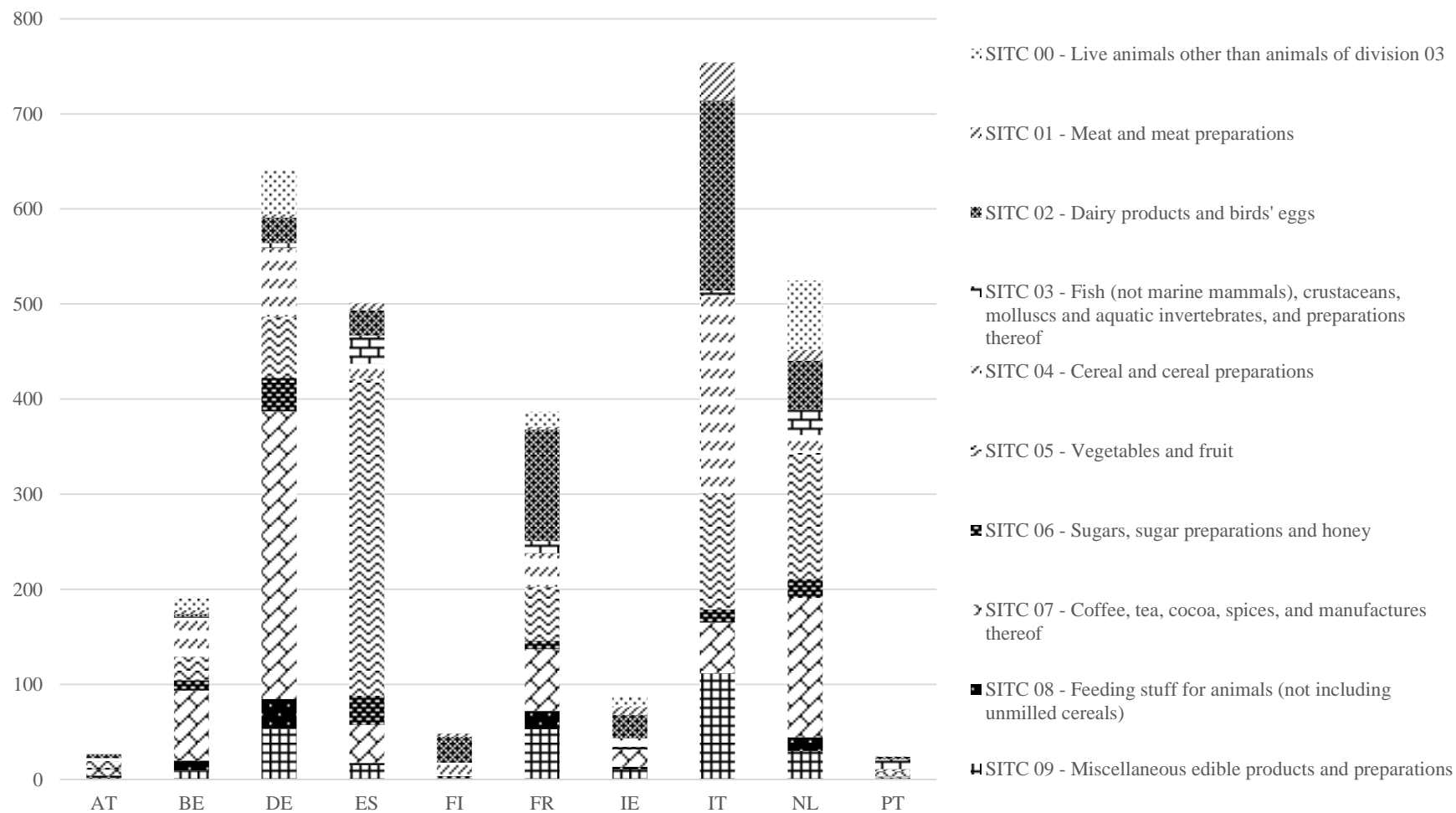


**Figure 3. Changes in European agri-food exports to the US due to a 1% appreciation (depreciation) of Euro**



Notes: Dotted areas refer to statistically insignificant coefficients. Austria and Finland are omitted from the figure as no significant effects due to Euro appreciations or depreciations on exports were found. Long-run elasticities are depicted. Source: Own presentation.

**Figure 4. Structure of European agri-food exports to the US (average over 1999-2013, Million Euro, SITC 2 digits)**



Source: Own presentation with data from Eurostat.


**Appendix A. NARDL outcomes (Eq. 9 with export values as dependent variables)**

|                     | <i>AT</i>      |     | <i>BE</i>      |     | <i>DE</i>      |     | <i>ES</i>    |     | <i>FI</i>      |     | <i>FR</i>     |     | <i>IE</i>      |     | <i>IT</i>    |     | <i>NL</i>          |     | <i>PT</i>       |     |
|---------------------|----------------|-----|----------------|-----|----------------|-----|--------------|-----|----------------|-----|---------------|-----|----------------|-----|--------------|-----|--------------------|-----|-----------------|-----|
|                     | <i>Austria</i> |     | <i>Belgium</i> |     | <i>Germany</i> |     | <i>Spain</i> |     | <i>Finland</i> |     | <i>France</i> |     | <i>Ireland</i> |     | <i>Italy</i> |     | <i>Netherlands</i> |     | <i>Portugal</i> |     |
| Const.              | 10.607         | *** | 4.390          | *** | 7.786          | *** | 9.098        | *** | 22.719         | *** | 4.979         | *** | 0.883          |     | 9.087        | *** | 5.664              | *** | 8.909           | *** |
| $x_{t-1}$           | -0.823         | *** | -0.662         | *** | -0.739         | *** | -0.586       | *** | -0.935         | *** | -0.462        | *** | -0.634         | *** | -0.752       | *** | -0.373             | *** | -0.769          | *** |
| $e_{t-1}^-$         | 0.065          |     | -0.445         | **  | -0.693         | *** | -0.668       | *** | -0.083         |     | -0.448        | *** | -0.407         |     | -0.562       | *** | -0.399             | *** | -0.882          | *** |
| $e_{t-1}^\pm$       | 0.480          |     | -0.530         | *** | 0.196          |     | -0.506       | **  | -2.849         | *** | -0.154        |     | -0.228         |     | -0.478       |     | -0.045             |     | -0.536          |     |
| $e_{t-1}^+$         | 0.433          |     | -0.259         | *   | -0.208         | *   | -0.615       | *** | -0.670         |     | -0.093        | *** | -0.430         | *   | -0.311       | *** | -0.229             | **  | -0.206          |     |
| $p_{t-1}$           | 7.910          |     | 3.354          | *** | -0.329         |     | -0.495       |     | -0.357         |     | 1.862         | **  | -1.574         |     | -1.488       | *   | 0.321              |     | -3.647          | *   |
| $y_{t-1}$           | 0.245          |     | 1.405          | *** | 1.126          | *** | 0.268        |     | -1.835         | *** | 0.606         | **  | 1.983          | *** | 0.944        | *** | 0.182              |     | 0.432           |     |
| $\Delta e_t^-$      | -1.796         |     | -0.714         |     | -0.883         | **  | -0.356       |     | -1.859         |     | -0.762        |     | -2.409         |     | -0.105       |     | -1.023             |     | 0.223           |     |
| $\Delta e_t^\pm$    | 1.651          |     | -1.316         |     | 0.003          |     | -0.332       |     | 0.656          | *   | 0.929         | *   | -2.161         |     | -0.106       |     | -0.029             |     | -0.121          |     |
| $\Delta e_t^+$      | -1.613         |     | -1.032         |     | -0.342         |     | -0.388       |     | -2.104         | **  | 0.714         |     | 0.108          |     | -0.116       |     | 0.853              |     | -2.530          | *   |
| $\Delta p_t$        | 6.065          |     | 1.459          |     | -1.053         |     | -0.500       |     | 2.218          |     | -1.919        |     | -3.857         |     | 0.385        |     | 0.959              |     | -2.616          |     |
| $\Delta y_t$        | 1.942          |     | 1.998          |     | 2.415          | **  | 2.045        |     | -4.906         |     | 1.663         |     | 2.418          |     | 0.438        |     | 4.222              | *** | -0.262          |     |
| $\Delta x_{t-1}$    |                |     | -0.110         |     |                |     | -0.192       | *   |                |     | -0.438        | *** | -0.109         |     | -0.174       | **  | -0.342             | *** |                 |     |
| $\Delta x_{t-2}$    |                |     |                |     |                |     | 0.122        |     |                |     | -0.230        | *** |                |     |              |     | -0.146             |     |                 |     |
| $\Delta x_{t-3}$    |                |     |                |     |                |     | 0.105        |     |                |     | 0.025         |     |                |     |              |     | 0.040              |     |                 |     |
| $\Delta x_{t-4}$    |                |     |                |     |                |     |              |     |                |     |               |     |                |     |              |     | -0.182             | *   |                 |     |
| $\Delta x_{t-5}$    |                |     |                |     |                |     |              |     |                |     |               |     |                |     |              |     | -0.055             |     |                 |     |
| R <sup>2</sup>      | 0.43           |     | 0.38           |     | 0.38           |     | 0.42         |     | 0.48           |     | 0.51          |     | 0.39           |     | 0.48         |     | 0.41               |     | 0.41            |     |
| Adj. R <sup>2</sup> | 0.39           |     | 0.33           |     | 0.33           |     | 0.37         |     | 0.45           |     | 0.47          |     | 0.34           |     | 0.44         |     | 0.35               |     | 0.37            |     |
| LM-Corr.            | 0.33           |     | 0.06           |     | 0.31           |     | 0.10         |     | 0.20           |     | 0.01          |     | 0.03           |     | 0.12         |     | 0.06               |     | 0.39            |     |
| R-Reset             | 0.25           |     | 0.44           |     | 0.12           |     | 0.24         |     | 0.18           |     | 0.02          |     | 0.03           |     | 0.06         |     | 0.12               |     | 0.09            |     |

Notes: \*\*\*, \*\* and \* denote significance at the 1, 5 and 10 % error term (White robust standard errors). LM-Corr. refers to LM serial correlation test, R-Reset stands for Ramsey-Reset test, in both cases p-values are reported. Source: Own computations.

## Appendix B. Critical values for cointegration tests

|  | 10%                |                    | 5%                 |                    | 1%                 |                    |
|--|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
|  | <i>Lower bound</i> | <i>Upper bound</i> | <i>Lower bound</i> | <i>Upper bound</i> | <i>Lower bound</i> | <i>Upper bound</i> |
| <i>Asymptotic critical value bounds for the F-statistics</i> |                    |                    |                    |                    |                    |                    |
| Case II: Restricted intercept and no trend                   |                    |                    |                    |                    |                    |                    |
| <i>k=4</i>   | 2.20               | 3.09               | 2.56               | 3.49               | 3.29               | 4.37               |
| <i>k=6</i>   | 1.99               | 2.94               | 2.27               | 3.28               | 2.88               | 3.99               |
| Case III: Unrestricted intercept and no trend                |                    |                    |                    |                    |                    |                    |
| <i>k=4</i>   | 2.45               | 3.52               | 2.86               | 4.01               | 3.74               | 5.06               |
| <i>k=6</i>   | 2.12               | 3.23               | 2.45               | 3.61               | 3.15               | 4.43               |
| <i>Asymptotic critical value bounds of the t-statistics</i>  |                    |                    |                    |                    |                    |                    |
| Case III: Unrestricted intercept and no trend                |                    |                    |                    |                    |                    |                    |
| <i>k=4</i>   | -2.57              | -3.66              | -2.86              | -3.99              | -3.43              | -4.60              |
| <i>k=6</i>   | -2.57              | -4.04              | -2.86              | -4.38              | -3.43              | -4.99              |

Notes: Critical values from Pesaran et al. (2001). *k* refers to a number of level variables.

### Appendix C. SUR outcomes (Eq. 9 with export values as dependent variables)

|                  | <i>AT</i>      | <i>BE</i>      | <i>DE</i>      | <i>ES</i>    | <i>FI</i>      | <i>FR</i>     | <i>IE</i>      | <i>IT</i>    | <i>NL</i>          | <i>PT</i>       |
|------------------|----------------|----------------|----------------|--------------|----------------|---------------|----------------|--------------|--------------------|-----------------|
|                  | <i>Austria</i> | <i>Belgium</i> | <i>Germany</i> | <i>Spain</i> | <i>Finland</i> | <i>France</i> | <i>Ireland</i> | <i>Italy</i> | <i>Netherlands</i> | <i>Portugal</i> |
| Const.           | 10.809 ***     | 4.321 ***      | 8.080 ***      | 9.149 ***    | 22.142 ***     | 5.536 ***     | 0.531          | 9.068 ***    | 6.131 ***          | 9.021 ***       |
| $x_{t-1}$        | -0.843 ***     | -0.647 ***     | -0.755 ***     | -0.596 ***   | -0.909 ***     | -0.506 ***    | -0.641 ***     | -0.746 ***   | -0.413 ***         | -0.784 ***      |
| $e_{t-1}^-$      | -0.088         | -0.416 **      | -0.738 ***     | -0.706 ***   | -0.134         | -0.507 ***    | -0.571 *       | -0.578 ***   | -0.443 ***         | -0.855 ***      |
| $e_{t-1}^\pm$    | 0.183          | -0.487 **      | 0.130          | -0.546 ***   | -2.332 ***     | -0.268 *      | -0.294         | -0.535 ***   | -0.095             | -0.950 **       |
| $e_{t-1}^+$      | 0.329          | -0.243 *       | -0.263 **      | -0.658 ***   | -0.500         | -0.137 *      | -0.523 **      | -0.324 ***   | -0.251 ***         | -0.182          |
| $p_{t-1}$        | 6.988 ***      | 3.390 ***      | -0.750         | 0.020        | -0.459         | 1.580 *       | -1.033         | -1.778 ***   | 0.326              | -5.007 *        |
| $y_{t-1}$        | 0.259          | 1.368 ***      | 1.129 ***      | 0.295        | -1.786 ***     | 0.648 ***     | 2.076 ***      | 0.923 ***    | 0.230              | 0.442           |
| $\Delta e_t^-$   | -1.919         | -0.587         | -0.867 **      | -0.502       | -1.775         | -0.832        | -2.489 *       | -0.069       | -1.017 *           | 0.359           |
| $\Delta e_t^\pm$ | 1.910          | -1.238         | 0.077          | -0.251       | 0.193          | 1.062 *       | -2.064         | -0.054       | -0.087             | -0.022          |
| $\Delta e_t^+$   | -1.451         | -1.030 *       | -0.324         | -0.397       | -2.417         | 0.738         | 0.032          | -0.103       | 0.854 *            | -2.276 **       |
| $\Delta p_t$     | 6.247          | 3.341          | -1.139         | -0.550       | 2.474          | -2.221        | -4.090         | 0.571        | 1.172              | -2.246          |
| $\Delta y_t$     | 2.233          | 1.756          | 2.556 **       | 1.923        | -5.010         | 1.731 *       | 2.892          | 0.449        | 4.247 ***          | -0.150          |
| $\Delta x_{t-1}$ |                | -0.884         |                | -0.148       |                | -0.394 ***    | -0.099         | -0.143 **    | -0.308 ***         |                 |
| $\Delta x_{t-2}$ |                |                |                | 0.102        |                | -0.294 ***    |                |              | -0.109             |                 |
| $\Delta x_{t-3}$ |                |                |                | 0.064        |                | -0.017        |                |              | 0.038              |                 |
| $\Delta x_{t-4}$ |                |                |                |              |                |               |                |              | -0.128 *           |                 |
| $\Delta x_{t-5}$ |                |                |                |              |                |               |                |              | -0.010             |                 |
| “R-sq”           | 0.44           | 0.38           | 0.38           | 0.42         | 0.49           | 0.53          | 0.39           | 0.48         | 0.41               | 0.42            |

Notes: \*\*\*, \*\* and \* denote significance at the 1, 5 and 10 % error term. Source: Own computations.



### Appendix D. NARDL outcomes (Eq. 9 with export quantities as dependent variables)

|                     | <i>AT</i>      | <i>BE</i>      | <i>DE</i>      | <i>ES</i>    | <i>FI</i>      | <i>FR</i>     | <i>IE</i>      | <i>IT</i>    | <i>NL</i>          | <i>PT</i>       |
|---------------------|----------------|----------------|----------------|--------------|----------------|---------------|----------------|--------------|--------------------|-----------------|
|                     | <i>Austria</i> | <i>Belgium</i> | <i>Germany</i> | <i>Spain</i> | <i>Finland</i> | <i>France</i> | <i>Ireland</i> | <i>Italy</i> | <i>Netherlands</i> | <i>Portugal</i> |
| Const.              | 4.452 **       | -0.258         | 6.005 **       | 8.739 ***    | 32.933 ***     | 1.233         | -0.467         | 4.933 ***    | 7.551 ***          | 2.454           |
| $x_{t-1}$           | -0.750 ***     | -0.333 **      | -0.999 ***     | -0.756 ***   | -0.972 ***     | -0.503 **     | -0.488 ***     | -0.674 ***   | -0.659 ***         | -0.549 ***      |
| $e_{t-1}^-$         | 0.072          | -0.409         | -0.786 ***     | -0.554 ***   | 1.073          | -0.445        | -0.111         | -0.373 ***   | -0.55 ***          | -0.081          |
| $e_{t-1}^\pm$       | 0.517          | -0.749 **      | 0.063          | -0.964 ***   | -5.094 **      | -0.091        | -0.804         | -0.303       | -0.027             | 0.122           |
| $e_{t-1}^+$         | 0.376          | 0.006          | 0.477 **       | -0.514 ***   | 0.934          | -0.019        | -0.220         | -0.191 **    | -0.293 ***         | 0.416 ***       |
| $p_{t-1}$           | 6.582 **       | 1.260          | 5.626 ***      | -1.477       | 15.882 *       | 3.682         | -2.225         | -0.553       | 0.451              | -0.899          |
| $y_{t-1}$           | 0.447          | 0.778          | 1.140 **       | 0.110        | -5.167 **      | 0.909         | 1.156 **       | 0.767 ***    | 0.048              | 0.488           |
| $\Delta e_t^-$      | -0.146         | -2.88 *        | -1.809         | 0.448        | 0.062          | -1.224        | -3.051 *       | 0.558        | -0.497             | 1.007           |
| $\Delta e_t^\pm$    | 1.071          | -2.561 *       | 2.728 *        | -0.590       | 2.048          | 2.106         | -0.680         | -0.251       | -0.856             | 1.085           |
| $\Delta e_t^+$      | -2.306         | -0.789         | 1.395          | 0.176        | -6.867         | 3.470         | -0.045         | -0.500       | 0.296              | -2.236 *        |
| $\Delta p_t$        | 5.466          | -3.775         | 3.506          | -1.704       | 44.101         | 7.765         | -4.909         | 0.891        | -0.320             | 1.552           |
| $\Delta y_t$        | 1.963          | 0.894          | 0.083          | 3.029 *      | -11.318        | 0.573         | 1.654          | 1.761        | 2.619 **           | -2.327          |
| $\Delta x_{t-1}$    |                | -0.395 ***     |                |              |                | -0.324        | -0.211 ***     |              | -0.147             |                 |
| $\Delta x_{t-2}$    |                | -0.405 ***     |                |              |                | -0.299 *      |                |              | -0.112             |                 |
| $\Delta x_{t-3}$    |                | -0.321 ***     |                |              |                | -0.120        |                |              | 0.016              |                 |
| $\Delta x_{t-4}$    |                |                |                |              |                |               |                |              | -0.136 *           |                 |
| $\Delta x_{t-5}$    |                |                |                |              |                |               |                |              | -0.086             |                 |
| R <sup>2</sup>      | 0.38           | 0.44           | 0.51           | 0.39         | 0.50           | 0.46          | 0.37           | 0.33         | 0.44               | 0.30            |
| Adj. R <sup>2</sup> | 0.34           | 0.39           | 0.48           | 0.34         | 0.47           | 0.42          | 0.32           | 0.28         | 0.38               | 0.25            |
| LM-Corr.            | 0.92           | 0.44           | 0.40           | 0.17         | 0.34           | 0.01          | 0.11           | 0.06         | 0.05               | 0.18            |
| R-Reset             | 0.25           | 0.01           | 0.52           | 0.15         | 0.22           | 0.11          | 0.02           | 0.74         | 0.79               | 0.44            |

Notes: \*\*\*, \*\* and \* denote significance at the 1, 5 and 10 % error term (White robust standard errors). LM-Corr. refers to LM serial correlation test, R-Reset stands for Ramsey-Reset test, in both cases p-values are reported. Source: Own computations.

**Appendix E. Symmetry testing (Eq. 9 with export quantities as dependent variables).**

|                   | AT      | BE      | DE      | ES    | FI      | FR     | IE      | IT    | NL          | PT       |
|-------------------|---------|---------|---------|-------|---------|--------|---------|-------|-------------|----------|
| $H_0:$            | Austria | Belgium | Germany | Spain | Finland | France | Ireland | Italy | Netherlands | Portugal |
| $b_2 = b_3 = b_4$ | 0.01    | 0.03    | 0.00    | 0.19  | 0.00    | 0.16   | 0.48    | 0.00  | 0.00        | 0.00     |
| $b_2 = b_4$       | 0.06    | 0.02    | 0.00    | 0.68  | 0.82    | 0.06   | 0.34    | 0.00  | 0.00        | 0.01     |
| $b_2 = b_3$       | 0.40    | 0.38    | 0.01    | 0.12  | 0.00    | 0.58   | 0.30    | 0.61  | 0.00        | 0.77     |
| $b_3 = b_4$       | 0.83    | 0.05    | 0.24    | 0.18  | 0.01    | 0.90   | 0.36    | 0.51  | 0.13        | 0.72     |

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

### Appendix F. Cointegration results (Eq. 9 with export quantities as dependent variables)

|  | <i>AT</i>      | <i>BE</i>      | <i>DE</i>      | <i>ES</i>    | <i>FI</i>      | <i>FR</i>     | <i>IE</i>      | <i>IT</i>    | <i>NL</i>          | <i>PT</i>       |
|--|----------------|----------------|----------------|--------------|----------------|---------------|----------------|--------------|--------------------|-----------------|
|  | <i>Austria</i> | <i>Belgium</i> | <i>Germany</i> | <i>Spain</i> | <i>Finland</i> | <i>France</i> | <i>Ireland</i> | <i>Italy</i> | <i>Netherlands</i> | <i>Portugal</i> |
| Bounds testing, Pesaran <i>et al.</i> (2001): f-stat.      | 31.77***       | 1.47           | 22.15***       | 9.59***      | 2.50***        | 1.33          | 6.24***        | 14.07***     | 5.55***            | 4.82***         |
| Cointegration test, Banerjee <i>et al.</i> (1998): t-stat. | -12.07***      | -2.03          | -10.81***      | -7.18***     | -11.38***      | -2.28         | -5.94***       | -8.53***     | -5.19***           | -5.15***        |

*Notes:* \*\*\*, \*\*, \* denote significance at the 1, 5 and 10 % level respectively according to critical values presented in Appendix B. For the Bounds testing, critical values of the most restrictive model are applied. *Source:* Own computations.