Food quality and product export performance. An empirical investigation of the EU situation

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Summary

The relationship between product quality (as indicated by unit value) and export performance, both measured in absolute (per capita) and relative terms, is investigated. Five EU countries (DE, UK, FR, ES, IT), three product categories (cheese, meat preparations and wine), three export destinations (intra EU, extra EU and world) and two time periods (1995-1999 and 2000-201) are analysed. The estimation results show that the connection between quality and export performance is positive for Italy, Spain and France but depends on the product category (but not on the period), and differs (but not in all cases) according to the export destination. While the signs of the estimated slope coefficients are stable, the obtained statistical significance levels for these parameters depend on the measure used (relative or absolute) and on the estimation method (OLS or GLS). The main implication arising from this analysis is that it may be justified to introduce 'marketing of high-quality products' as a new academic discipline, teaching students and professionals in it and thus to contribute to the enhancement of EU agribusiness competitiveness in increasingly liberalised markets.

KEYWORDS: Food quality, international trade, EU.

1. Introduction

Food quality has become an increasingly important topic during the last decades. In developed countries, driven by aging populations and growing diet-related health concerns, consumer demand now seems to shift towards higher quality, more natural and healthier food (Regmi, 2001). Given today's globalised markets, it can be assumed that – in line with rising consumption – international trade of quality food products (QFPs) is increasing.

Yet, the concept of food quality is elusive. Overall, quality may be seen as an abstract construct, multidimensional in nature. More specifically, in the literature, at least four different quality definitions are discussed. It is either referred to as "excellence or superiority", as "value", as "conforming to specifications" or as "meeting or exceeding customer expectations" (Verdú Jover et al., 2004; Reeves and Bednar, 1994). The first approach defines quality as 'best in class', judged on some to-be-specified criteria. The "value" approach is an economic one (higher monetary value reflects higher quality), while the "conforming to specifications" is a technological one (a quality product is a product which fulfils some pre-defined technical standards however low they may be). The fourth approach defines quality from the point of view of the final consumer: as long as s/he is happy with it, it is a quality product. Either way, in order to measure quality objectively, a generally accepted reference system is necessary, otherwise "the term quality is very subjective and means very little" (Satin, 2002). Ninni et al. (2006) state that the quality difference between competing products can be easily analysed for measurable characteristics such as reliability, durability, various indicators of performance and health and safety. However, it becomes more subjective when it refers to intangible characteristics such as design, taste and flavour. Here the boundaries of vertical and horizontal differentiation are blurred. Obviously, the intangible characteristics are of particular importance for food products. Therefore, for these products, it may perhaps be most useful to accept them having different qualities rather than one quality.

Despite its increasing importance, and probably partly due to the difficulties of objectively defining quality, not much research has been done so far on the particularities of the international trade of QFPs. Thus, for example, it is unclear whether the nature of the international trade of QFPs is similar or potentially structurally different as compared to the one of low or average-quality food products. Since many QFPs may be more perishable, more sensitive to external influences (e.g., temperature, vibration, light etc.) and often of higher (monetary) value, more demanding logistics and insurance issues may affect the international trade of these products, potentially resulting in different export patterns.

The objectives of the following analysis are threefold. First, to review the recent literature dealing with international trade in QFPs. Second, to generate empirical insights into the export patterns (levels and destinations) of food products, depending on their quality level. Third, based on the obtained results, to derive at conclusions of what this could potentially mean for agribusiness management and/or policy making.

This paper's structure is as follows. After the introduction, section two reviews the previous literature related to the topic. Section three describes the procedure of the empirical investigation. Section four discusses the obtained results. Section five concludes by summarising and pointing at some implications which arise from the findings. Annex A provides a technical treatment on the generalised least squares estimation method used in this study.

2. Previous studies

The literature on the relationships between quality and trade performance is sparse. The few existing studies have in common that they investigate inter-country quality competition in the sense that they try to find out whether a country's exports of certain products have higher quality vis-à-vis other countries producing similar goods.

Aiginger (1997) suggested a method of how to use unit values (UV) in order to discriminate between price and quality competition in international markets, using the case of German exports of industrial goods. Gelhar and Pick (2002) applied Aiginger's framework to US food trade flows and found that almost 40% of US food exports could be characterised as dominated by quality competition. For imports, the share amounts to 60%. However, the results for bilateral trade flows are much lower, which points to problems involved when using unit values and net trade figures of economic aggregates. Ninni et al. (2006) explore the role of quality of Italian food products in international markets. They regress relative market shares of the Italian products in the import market of several different countries on a quality indicator based on UVs and other variables. The obtained results suggest that "the quality image of Italian goods offers protection for some traditional products, but that this protection is not strong enough to counteract price competition" (p. 2).

No previous studies (to my knowledge), however, have addressed the issue of intra-country product export performance. That is, whether a country tends to specialise in exporting QFPs or rather in low and/or average products among the whole range of highly differentiated products it manufactures. In other words, within a nearly defined product category (e.g., cheese), is a country a high-quality exporter (which indicates that the country's high quality products are internationally appreciated and sought after) or that the country is rather a low or average/quality exporter (implying that its QFPs are more regionally preferred but that international demand for them is weak).

3. Procedure

The general research approach is an inductive, empirical investigation. That is, international trade data are analysed econometrically and conclusions are drawn from the findings.

The operationalisation of the variables under consideration is as follows. First, food quality (within a homogeneous product category) is measured by price (i.e., unit value as a price proxy). In other words, it is assumed that among similar products quality is positively related to price. Thus, the above mentioned "value" approach is adopted here for defining quality. Second, trade performance is assessed by per capita exports and by relative export shares.

3.1 Measuring quality

As price proxies, UVs (in € per kg) are used, obtained by dividing export values by export quantities. UVs are known to be imperfect price indicators (King, 1993; Shiells, 1991; Holmes, 1973). Their main problem is related to the fact that an observed change in the unit value may not necessarily be a result of an underlying price change, but may simply reflect a change in the composition of the goods within the class of exports under consideration. Another problem relates to invoicing practices. The existence of a lag between the time of contract and the delivery of goods can result in differences between the contract value (i.e., the real price) and the UV calculated from customs declaration when a good is actually delivered, in cases where the exchange rate changes in between. However, the magnitude of these measurement problems is not clear. For instance, while Shiells (1991) finds that for US trade data import UVs are good import price proxy, Holmes (1973) shows for Canada that domestic UVs (national production values divided by output quantity) do not well represent industrial selling prices obtained by means of manufacturer surveys.

Despite these shortcomings, UVs have been suggested and used as an indicator of quality content (Aiginger, 1997; Gehlhar and Pick, 2002). Since the UV is output per units of input (material measured in kilograms), for homogenous and comparable goods the value can indicate differences in quality if unit production costs can be assumed to be equal across the considered countries. However, the UV will also reflect differences in costs and thus high UVs can indicate relative high product quality and/or relative high unit costs. In order to distinguish between these two cases, Aiginger (1997) suggests looking at the net trade position of the good (aggregate) under consideration. If within a country a good's UV is high and the good's net trade position is positive, cross-country UV differences must then be due to superior quality. However, if a good's UV is high but the corresponding net trade postition is negative, this indicates a cost disadvantage. One problem with this approach is that it requires aggregate data (e.g., 'cars', 'cheese', or 'ice cream') or trade data on commodities (i.e., homogenous, undifferentiated goods) such as 'meat of sheep, frozen', 'flat fish, fresh or chilled', etc. in order to be able to calculate net trade positions. For highly disaggregated data of certain agricultural products (e.g., Gorgonzola cheese, Bordeaux red wine, etc.) no such trade balance can be calculated (because no other countries produces such goods and thus no imports can exist). Thus, in general, the higher the level of disaggregation, the more accurate UVs may be as price proxies, but the more difficult it is to determine whether high UVs reflect high quality or high production costs. Yet, if exports of products with high UVs are comparatively high, then this may nonetheless be an indicator of quality (due to an apparent international willingness to pay relative high prices for goods with many close substitutes).

UVs are calculated in absolute terms, and in relative terms (RUV) as symmetrised and normalised deviations from a category's mean unit value. That is,

$$\mathrm{UV}^{k}_{cpt} = \text{Export value}_{cpt} \text{ (in €)} / \text{Export quantity}_{cpt} \text{ (in kg)} \qquad (1)$$

$$\mathrm{RUV}^{k}_{cpt} = \left(\left(\mathrm{UV}^{k}_{cpt} \Big/ \frac{1}{n_{ck}} \sum_{p=1}^{n_{ck}} \mathrm{UV}^{k}_{cpt} \right) - 1 \Bigg/ \left(\mathrm{UV}^{k}_{cpt} \Big/ \frac{1}{n_{ck}} \sum_{p=1}^{n_{ck}} \mathrm{UV}^{k}_{cpt} \right) + 1 \right) * 100 \qquad (2)$$

where k refers to the category (i.e., cheese, wine or meat products, see below), c to the country, p to a particular product within k (e.g., Roquefort cheese), t to the period (1995-1999 or 2000-2005, see below) and nck is the number of products in a particular category for a certain country. Note that the range of RUV is [–100; 100], where positive (negative) values indicate above (below) average UVs.

3.2 Measuring export performance

Trade performance is assessed by per capita exports and by relative export shares. The latter measure is a modified version of Balassa's index of revealed comparative advantage. It is defined as the deviation from the expected export share of a product within a product category, again symmetrised and normalised as suggested by Laursen (1998).

The index of revealed comparative advantage (RXA) was defined by Balassa (1965) as a measure for "the export performance of individual industries in a particular country…" (p. 105) which can be evaluated by "… comparing the relative shares of a country in the world exports of individual commodities […] where the data have to be made comparable through appropriate 'normalisation'". Thus, the original index was constructed in a form such as

$$\mathrm{RXA}_{ct} = \left(x_{ct} / \sum_c x_{ct} \right) \Big/ \left(X_{ct} / \sum_c X_{ct} \right), \tag{3}$$

where x_{ct} stands for the exports (in €) of the food processing sector of a country c in year t, and X_{ct} stands for total country exports of country c in year t. $\Sigma\, x_{ct}$ designates total sector exports, while $\Sigma\, X_{ct}$ refers to total aggregate exports in a particular year t. The RXA, therefore, is an index of the share of a country in the international market of a particular economic sector, corrected (i.e., normalised) for the size of the country to which the sector belongs. The correction is necessary since larger countries can a priori be assumed to have larger market shares simply due to their size. Bowen (1983) showed that Balassa's RXA may also be interpreted as the deviation of actual exports, x_{ct}, from expected exports, $E(x_{ct})$, where $E(x_{ct})$ can be defined as $\Sigma\, x_{ct} * (X_{ct} / \Sigma\, X_{ct})$, assuming that all countries engage in all economic activities in equi-proportional shares.

The (theoretical) range of the RXA index is from $[0; \infty[$, with scores $\in[0; 1[$, indicating a comparative disadvantage and scores $\in]1; \infty[$ showing a comparative advantage of an economic sector of a particular country relative to the other sectors within this country. Thus, the RXA allows determining the strong and weak sectors within one country, by ranking them by descending RXA scores. Unfortunately, however, the RXA may fail to reliably indicate comparative (or competitive) advantages within the same sector relative to other countries. The main problem in cross-country comparisons is the different frequency distribution of the RXA scores in each country.[1] In addition, De Benedictis and Tamberi (2001) show that the effective upper bound of the RXA for each country is different. This upper bound is equal to world total trade divided by total trade of country c ($\Sigma\, X_{ct} / X_{ct}$), and thus is in general relative small for large and very high for small countries. Consequently, the >1 index scores can not directly be compared across differently sized countries (implying the above mentioned normalisation for country size does not work perfectly in the standard notation of the RXA). Thus, because the conventional RXA range is inconvenient for interpretation, a "symmetrisation" has been suggested by Laursen (1998), which yields a range for the RXA $\in[-1; +1]$ with values below (above) zero indicating below (above) average relative exports:[2]

$$\mathrm{SRXAct} = (\mathrm{RXA}_{ct} - 1) / (\mathrm{RXA}_{ct} + 1). \tag{4}$$

The main problem with using the RXA in the context of this research is again that it can only be applied to aggregate data or trade data on commodities (i.e., homogenous, undifferentiated goods) in order to be able to calculate 'world sector exports'. However, for highly disaggregated data of certain agricultural products (e.g., Gorgonzola cheese, Bordeaux red wine, etc.) no such sums can be calculated because these products are only produced in one single country and thus country exports equal 'world sector exports'. For this reason, a modified version of the RXA is used in the following, which is related to

[1] See Hinloopen's and Van Marrewijk's (2001) study on the empirical distribution of the Balassa Index and the problem of the incomparability of RXA scores across countries.

[2] However, it should be noted that despite symmetrisation the problem of unequal distribution and different country specific upper bounds remains.

Bowen's (1983) interpretation of the Balassa index. Here the relative export performance (REP) is assessed by the share of the exports of a particular product *p* in category (*k*) exports as deviation from the expected export share ($1/n_{ck}$, where n_{ck} is the number of *p* in *k* for a particular country *c*), assuming that preferences for all products *p* are equal. That is,

$$\mathrm{REP}_{cpt}^{k} = \left(\left(\frac{x_{cpt}^{k}}{\sum_{p=1}^{n_{ck}} x_{cpt}^{k}} \Big/ \frac{1}{n_{ck}} \right) - 1 \Bigg/ \left(\frac{x_{cpt}^{k}}{\sum_{p=1}^{n_{ck}} x_{cpt}^{k}} \Big/ \frac{1}{n_{ck}} \right) + 1 \right) * 100 \qquad (5)$$

where *t* refers to the period (1995-1999 or 2000-2005, see below). Note that the range of REP is also [–100; 100], where positive (negative) values indicate above-(below-)average relative export performance.

3.3 Data

The raw data were taken from Eurostat's COMEXT "EU25 Trade Since 1995 By CN8" database and combined with Eurostat population figures. The trade data are at the highest available level of disaggregation (8-digit level).

The export data (€ values and kg quantities) are factored in four dimensions. First, reporters: the five largest EU countries (DE, ES, GB, FR and IT) were selected. Second, as destination area three different locations were chosen: within the EU-15, outside the EU-15 and world (i.e., the sum of the former two). Third, three product categories (cheese, meat preparations and wine) were selected. Each category contains a large number of individual products. The maximum types of products for each category is: cheese 66, meat preparations 54 and wine 70.[3] However, the actual number of types included into the analysis depends on the individual country (see next paragraph). The categories were selected based on their importance to the EU food industry (meat, beverages and dairy products are the three most important sub-sectors as measured by their shares in total sector value added, see Lienhardt (2004)). The fourth dimension is time. The years 1995 to 2005 were included into the analysis. Since the used trade data are volatile, the 11-years were averaged over two periods (1995-99 and 2000-05). The first covers the period before the Euro introduction as a general currency, the second the period after its introduction. Overall, some 26,804 observations were used in the analysis. For the UK, the wine category was not analysed because the country is not a significant wine producer. For Spain, no (or only a few) wine export quantities for the second period were available, thus only period-one exports could be included into the analysis. Despite these few missing values, the dataset covers a whole target population rather than being of sample nature. This needs to be kept in mind when interpreting the statistical significance (i.e., deviations from zero larger than those to be expected due to sampling error) of the estimation results later in this paper.

Data preparation involved the removal of re-export data and of outliers.[4] Unfortunately, the raw data also included export flows of products which could not have been produced in a certain country (e.g., Navarra red wines in German exports, or Gorgonzola cheese in French exports). These re-exports were removed from the original data set where possible.

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[3] The covered product codes are: cheese: 4061010–4069099; meat preparations: 16010010–16029099 and wine: 22041011–22042199. The exact description of the individual products can be found on the internet through the Eurostat Comext database or be obtained on request by the author.

[4] Only two product types (16022011 and 16022019: preparations of goose or duck liver) were removed in the meat preparations category. In almost all countries, these products displayed extremely high unit values and very low export performance, thus making them very influential outliers.

However, for many products (e.g., processed cheese, uncooked sausages, etc.) where the production is not restricted to a certain geographical area, no potentially existing re-exports could be eliminated. Table 1 lists the actual number of products included in the empirical analysis for each category and country (the n_{ck}) [Table 1 around here].

3.4 Estimation methods

The relationship between export performance and food quality was estimated using regression analysis. First, ordinary least squares (OLS) estimators of the slope coefficients were obtained separately for each country and product category, controlling for a potential period effect. Second, all data were pooled and feasible generalised least squares (GLS, which allows for heteroscedasticity across and correlation between different panels, see Cameron and Trivedi, 2005) was used to estimate the (nested) fixed effect of food quality on export performance, controlling for country, product category and time. A more detailed description of the GLS estimation procedure is provided in Appendix A.

4. Results

The estimation results are displayed in Figures 1 to 10 (OLS) and in Tables 2 and 3 (GLS). Overall, it emerges that the direction (and the significance) of the relationship between food product quality and its export performance is not systematic but depends on the country, the product category and the export destination. However, the direction (i.e., the sign of the slope coefficient) is in most cases independent of the measurement approach (per capita or relative), yet the significance levels are not.

In the OLS estimations, export performance (per capita and relative) was regressed on unit values (absolute and relative) and a dummy variable was included in all cases (except for wine in Spain), in order to control for a potential period effect. However, in no case the dummy coefficient turned out to be significant at least at the 95% confidence.

4.1 Country-specific results

In Germany (Figures 1 and 2), for all investigated product categories and export destinations, the relationship between product quality and export performance is negative. The slope coefficient is statistically significant (at least at the 95% confidence level) for total and intra-EU per capita cheese exports and in addition for wine exports to all three export destinations using relative export performance measurement. There does not seem to be a major difference between the intra- and extra-EU situation, except for perhaps the case of meat preparations where the slope coefficient seems to be slightly larger than for intra and total exports. Overall, it appears that Germany exports relatively very few high-quality food products, where high quality is meant relative to the other products in the respective categories [Figures 1 and 2 around here].

In Italy (Figures 3 and 4), the situation is almost completely different as compared to the one of Germany. The estimated slope coefficients are positive for cheese and meat preparations and negative for wine to all export destinations. Here the significance levels depend on the applied measurement approach: in the case of per capita exports the slope coefficients are statistically significant (at least at the 95% confidence level) for cheese and meat preparations to all destinations but not for wine. In the case of relative measurement, they are significant for cheese extra-EU exports and for wine exports to all destinations. Overall, it appears therefore that Italy is predominantly a quality exporter, except for wine [Figures 3 and 4 around here].

The situation in France (Figures 5 and 6) is the exact mirror image to the one in Italy: a negative quality-performance relationship for cheese and meat preparations and a positive one for wine. For intra-EU per capita exports of meat preparations there seems to be a slight positive relationship. However, when measured in relative terms, the relationship comes out as slightly negative. As for the significance levels, both measurement approaches yield significant (95% confidence level) slope coefficients for extra-EU exports of meat preparations and wine exports to all destinations. Overall, France seems therefore

to be a quality exporter of wine only. In the other product categories, export performance is highest for low- and average-quality products [Figures 5 and 6 around here].
In Spain (Figures 7 and 8), the results are less uniform. There appears to be a difference in the direction of the quality-performance relationship between the intra- and extra-EU export situation for cheese and meat preparations. For cheese, the relationship is negative for the total (but slightly positive in per capita terms) and intra-EU situation, but positive for extra-EU exports. For meat preparations, the situation is almost vice versa: a positive relationship for the total and intra-EU situation, and a neutral (or only slightly positive one) for extra-EU exports. For wine, the slope coefficients are (except for the relative measurement of the intra-EU situation) positive in all cases. As for statistical significance levels, only the per capita coefficients for extra-EU cheese exports and total and intra-EU wine exports exceed the 95% confidence-level threshold. Overall, Spain clearly seems to be a high-quality wine exporter, a high-quality exporter of meat products and a high-quality exporter of cheese to extra-EU destinations [Figures 7 and 8 around here].
The UK situation (Figures 9 and 10) finally, is also different according to the export destination. For cheese, the estimated slope coefficients are negative or only slightly positive for total and intra-EU exports, but definitely positive for extra-EU exports. For meat preparation, the situation is vice versa: a positive relationship for total and intra-EU exports and a negative one for extra-EU exports. However, none of the coefficients turned out to be statistically significant (again 95% confidence level). Thus, the UK appears to be a high-quality exporter for cheese to extra-EU countries and for meat preparations to intra-EU countries only [Figures 9 and 10 around here].

4.2 Results from the pooled estimation

As the previous section has shown, there does not seem to be a systematic relationship between product quality and export performance. The signs of the estimated slope coefficients vary widely across countries and sometimes even across export destinations. The only exception is perhaps for meat-preparations exports to extra-EU destinations, where the slope coefficients are mostly negative. Thus, regressions run on the overall (i.e., pooled) dataset can be expected to not perform well. Nonetheless, the results from these GLS estimations are reported in Tables 2 and 3.

For the absolute (per capita) measurement approach (Table 2), the tests for fixed effects show that there are significant differences between the included factors (country, category and period). This implies that the absolute level of per capita exports is significantly different across all three factors which makes the pooling of the data problematic. As a result, the estimates for the included covariates (here unit value) may be biased. From the fixed-effect parameter estimates it can be seen that relative to the reference category Italy, France has (across all included product categories and the two periods) the highest per capita exports, followed by the UK, Spain and Germany. As compared to the reference category wine, the per capita exports of meat products are (across all countries and the two periods) the smallest, followed by cheese. Given a total dataset size of 744 observations, the differences between the two included periods turn also out to be statistically highly significant. The absolute level of per capita exports is higher in the latter period, which can perhaps be explained by inflation-induced increases (neither export nor unit values were deflated) or the trade-enhancing effect of the common market from 1999 onwards. The overall effect of quality (unit value) comes out as being positive for all three analysed export destinations, however it is only statistically significant (95% confidence level) for extra-EU exports (but the estimate may not be reliable as argued above). All variance components were estimated as statistically highly significant. There seems to be a considerable difference between the error variance of the first and the second period, implying that heteroscedasticity may be present in the data. Residual autocorrelation also seems to be present. Thus, on statistical grounds, the use of feasible GLS seems to be justified. The overall fit of the model is not very high, as can be seen from the comparatively high values of the information criteria restricted –2 log likelihood, AIC and BIC (see Appendix A for a theoretical discussion of these measures) [Table 2 around here].

For the relative measurement approach (see Table 3), only the results from the final estimated model are reported. Since deviations from means are used in the relative measures, differences in levels across countries or periods are no longer present in the data. However, there is still a significant difference in levels between the analysed product categories. Relative to wine, meat products seems to be structurally exported least (although the difference is only statistically significant for total and intra-EU exports). Given these differences in levels, the unit-value slope coefficient were estimated in nested form, i.e., as category-specific. The results show that for cheese exports, the slope coefficient is negative for all export destinations (but it is not statistically significant). For meat preparations, the unit-value slope coefficient is negative for total and extra-EU exports but positive for intra-EU exports. It is highly significant (and largest in magnitude) for extra-EU export only. For wine, the situation is exactly vice versa as compared to the one of meat preparations: positive unit-value slope coefficient for total and extra-EU exports, but a negative one for intra-EU ones. However, none of these coefficients is statistically significant at the 95% confidence level. As for the estimated variance components, the degree of heteroscedasticity seems to be less severe, but autocorrelation is still present across the two panels. All information criteria statistics have comparatively high values which indicates that overall model fit is low [Table 3 around here].

6. Conclusions

This paper has investigated the relationship between product quality (as indicated by UV) and export performance, both measured in absolute (per capita) and relative terms. The estimation results show that the connection between quality and export performance clearly depends on the product category and country (but not on the period) and differs, but not in all cases, according to the export destination. While the signs of the estimated slope coefficients are stable, the obtained statistical significance levels depend on the used measures (relative or absolute) and estimation methods (OLS or GLS).

Overall, it emerges that in Italy export performance is positively related to product quality (i.e., exports of higher-quality products are relatively higher) for cheese and meat preparations, but not for wine. In France, the situation is exactly vice versa: a negative relation for cheese and meat preparations but a positive one for wine. In Spain, relative export performance rises with quality for meat products and wine, but decreased for cheese (however, it increases for extra-EU exports). In the UK, for both analysed product categories, meat preparations and cheese, the slopes are only slightly positive, indicating that export performance is roughly the same for all quality levels (although there are differences between the intra and extra-EU export situation). Finally, in Germany, there is a negative connection for all three product categories, implying that high-quality products only play a minor role in the country's exports.

The findings from this analysis suggest that while there does not seem to be a systematic relationship between food quality and export performance high-quality products clearly play a considerable role in the food exports of at least some countries (here Italy, France and Spain). This underlines the point that it is justified, and even necessary, to give special attention to this sort of trade. One possibility to do this, for instance, could be the introduction of specialised courses in 'marketing of quality products'. Today, a few other highly specialised post-graduated management courses already exist (e.g., Essec Business School in Paris offers an MBA in Luxury Brand Management while the University of South Australia offers a Master of Wine Marketing), which may serve as a model. Another possibility would be to offer specialised short courses (or other training programmes) to already practicing agribusiness professionals. Given that the issue seems to be of relevance for several EU countries, an integrated, pan-European teaching/training programme and thus the pooling of the expertises from different countries may perhaps be most useful. In any case, such specialised capacity-building initiatives for current and/or future agribusiness leaders can clearly be expected to contribute positively to the enhancement of the competitiveness of EU food companies, which operate in increasingly liberalised markets.

Future research may investigate why some countries in some product categories perform better in exporting high-quality products than others. One possible reason could be that exports simply reflect production proficiency, i.e., that countries which produce relative more high-quality food products also export more of these. However, this hypothesis needs empirical confirmation.

Appendix A

Given the special nature of the data (i.e., a short unbalanced panel, or, more accurately, a nested cross-section with one repeated measurement), a general linear model (GLM) was fitted for estimating the slope coefficient of product quality with regard to product export performance. Formally, the GLM (i.e., a fixed-effects specification which is assumed to be linear in parameters; Verbeke and Molenberghs (1997)) can be specified as

$$y_{ckt} = \mu + \phi_c + \phi_k + \phi_t + \sum_l \left(\gamma^l_{(c,k,t)} \cdot x^l_{ckt} \right) + \varepsilon_{ckt} \quad . \tag{A.1}$$

μ is the overall (grand) mean (a fixed parameter, equivalent to the usual intercept); $\phi_{..}$ the fixed main-effect parameter for the three categorical predictors (i.e., 'factors') country (c = 1, …, C), category (k = 1,…, K) and time period (t = 1,…, T_{ck}); $\gamma^l_{(c,k,t)}$ the fixed parameters of l included (non-stochastic) covariates x^l_{ckt} (l = 1,…, L); and ε_{ckt} the random error (disturbance) of y_{ckt}. (In this case, $C = 5$, $K = 3$ and $T_{ck} \in [1, 2]$, depending on the country and category; and L can potentially be high, since nested effects were considered.) In the given specification, product categories (level one) are nested in countries (level two), and covariate parameters $\gamma^l_{(c,k,t)}$ are allowed to vary by included factor, i.e., across countries, categories or periods. (If the parameter is estimated and presented as not factor-specific, then it represents the overall mean effect across all countries, categories and periods, i.e., γ^l.) In this way, eq. (A.1) can also be seen as a two-level hierarchical linear model (HLM) (Cameron and Trivedi, 2005).

Equation (A.1) can be simplified to $y_{ckt} = \mathbf{x}'_{ckt}\boldsymbol{\beta}_{(c,k,t)} + \varepsilon_{ckt}$, where $\mathbf{x}'_{ckt}$ denotes a (row) vector of m inputs (factors, covariates and interactions) and $\boldsymbol{\beta}_{(c,k,t)}$ the (column) vector of corresponding parameters (including the $\phi_{..}$). Rewritten in full matrix notation, eq. (A.1) becomes

$$\mathbf{y} = \mathbf{X}\ \boldsymbol{\beta}_{(c,k,t)} + \boldsymbol{\varepsilon} \quad , \tag{A.2}$$

where $\mathbf{y}$ is a $\sum_{c=1}^{C} I_c T_c \times 1$ response vector, $\mathbf{X}$ is a $\sum_{c=1}^{C} I_c T_c \times m$ input matrix, $\boldsymbol{\beta}$ is a $m \times 1$ parameter vector, and $\boldsymbol{\varepsilon}$ is a $\sum_{c=1}^{C} I_c T_c \times 1$ disturbance vector.

Given the panel structure of the data, where the different product types are treated as subjects, $\mathrm{E}(\mathbf{y}) = \mathbf{X}\ \boldsymbol{\beta}_{(c,k,t)}$, and $\mathrm{Var}(\mathbf{y}) = \mathrm{Var}(\boldsymbol{\varepsilon})$ is assumed to be i.i.d. $N(0, \sigma^2_t)$, thus disturbances in the two panels may be contemporaneously correlated and potentially heteroscedastic (i.e., displaying non-constant variance). As a consequence, $\boldsymbol{\beta}_{(c,k,t)}$ in eq. (A.2) cannot efficiently be estimated by pooled ordinary least squares (OLS) regression. Instead, a method that takes into account autocorrelated and non-constant residual errors needs to be used. One such method is feasible generalised least squares (FGLS), where:

$$\hat{\boldsymbol{\beta}}_{\mathrm{FGLS}} = \left[\mathbf{X}'\hat{\mathbf{V}}^{-1}\mathbf{X}\right]^{-1}\mathbf{X}'\hat{\mathbf{V}}^{-1}\mathbf{y} \tag{A.3}$$

(see Cameron and Trivedi, 2005), and where implementation requires the consistent estimation of **V**, the variance-covariance matrix of disturbances $\boldsymbol{\varepsilon}$. In order to consistently estimate **V**, one usually needs to make explicit assumptions about the underlying structure of its variance components, but it is possible (and was done in this case) to treat **V** as being completely unstructured, i.e., $\begin{bmatrix} \sigma_1^2 & \sigma_{12} \\ \sigma_{21} & \sigma_2^2 \end{bmatrix}$.

The estimation of variance components can be done in different ways. Under the i.i.d. multivariate normal assumption for $\boldsymbol{\varepsilon}$, maximum likelihood estimation methods are usually employed, with two possible options: maximum likelihood (ML) or restricted maximum likelihood (REML). A weakness of the ML method is that the estimates are biased in small samples (Cameron and Trivedi, 2005). Moreover, since REML does explicitly take into account the loss of the degrees of freedom involved in estimating the fixed effects, it is the recommended option in models containing many fixed-effect parameters (Verbeke and Molenberghs, 1997). The –2 times log-likelihood of REML is (Cameron and Trivedi, 2005)

$$-2\ell_{\mathrm{REML}}(\mathbf{V}) = \ln|\mathbf{V}| + (NT-p)\ln\left(\mathbf{r}'\mathbf{V}^{-1}\mathbf{r}\right) + (NT-p)\left[1+\ln\left(\frac{2\pi}{NT-p}\right)\right] + \ln\left|\mathbf{X}'\mathbf{V}^{-1}\mathbf{X}\right|$$

(A.4)

where $\mathbf{r} = \mathbf{y} - \mathbf{X}\left[\mathbf{X}'\mathbf{V}^{-1}\mathbf{X}\right]^{-1}\mathbf{X}'\mathbf{V}^{-1}\mathbf{y}$, $|\mathbf{V}|$ denotes the determinant of **V**, *N* the number of subjects, and *p* is the rank of **X**. The variance components of **V** can be computed by maximising eq. (A.4), however in general, there are no closed-form solutions. Therefore, Newton and scoring algorithms are usually used to find the solution numerically, starting with some initial value for residual error variance σ^2. Assuming i.i.d. $N(0, \sigma^2)$, residual sum of squares from OLS regression usually yields $\hat{\sigma}^2$ to be used as starting value.

Once **V** has been estimated, original data **X** and **y** are then accordingly transformed and OLS regressions are run on the adjusted data, yielding autocorrelation and heteroscedasticity-adjusted $\hat{\boldsymbol{\beta}}_{(c,k,t)}$ and respective panel-robust standard errors. For the significance tests of the included factors, ANOVA (i.e., 'method of moments'-type) estimators, which equate quadratic sums of squares to their expectations and solve the resulting equations for the unknowns, are used. Baltagi et al. (2001) showed that ANOVA methods perform well in estimating the regression coefficients in unbalanced nested error-component regression models. Given that the dataset in this paper is unbalanced, and that I am interested in the significance of the remaining differences in the factor category (or marginal) means, Type III sums of squares are used (Hill and Lewicki, 2006).

In maximum likelihood-based FGLS regressions, conventionally only the final value of the (restricted) –2 times log-likelihood function and derived information criteria (such as the Akaike information criteria, AIC, and the Bayesian information criteria, BIC) are calculated (see Cameron and Trivedi, 2005 for a discussion), on the basis of which appropriate (nested) models are selected. However, for assessing the overall fit of a model to the underlying data, theses statistics are less useful, since they cannot be compared across different non-nested models.

7. References

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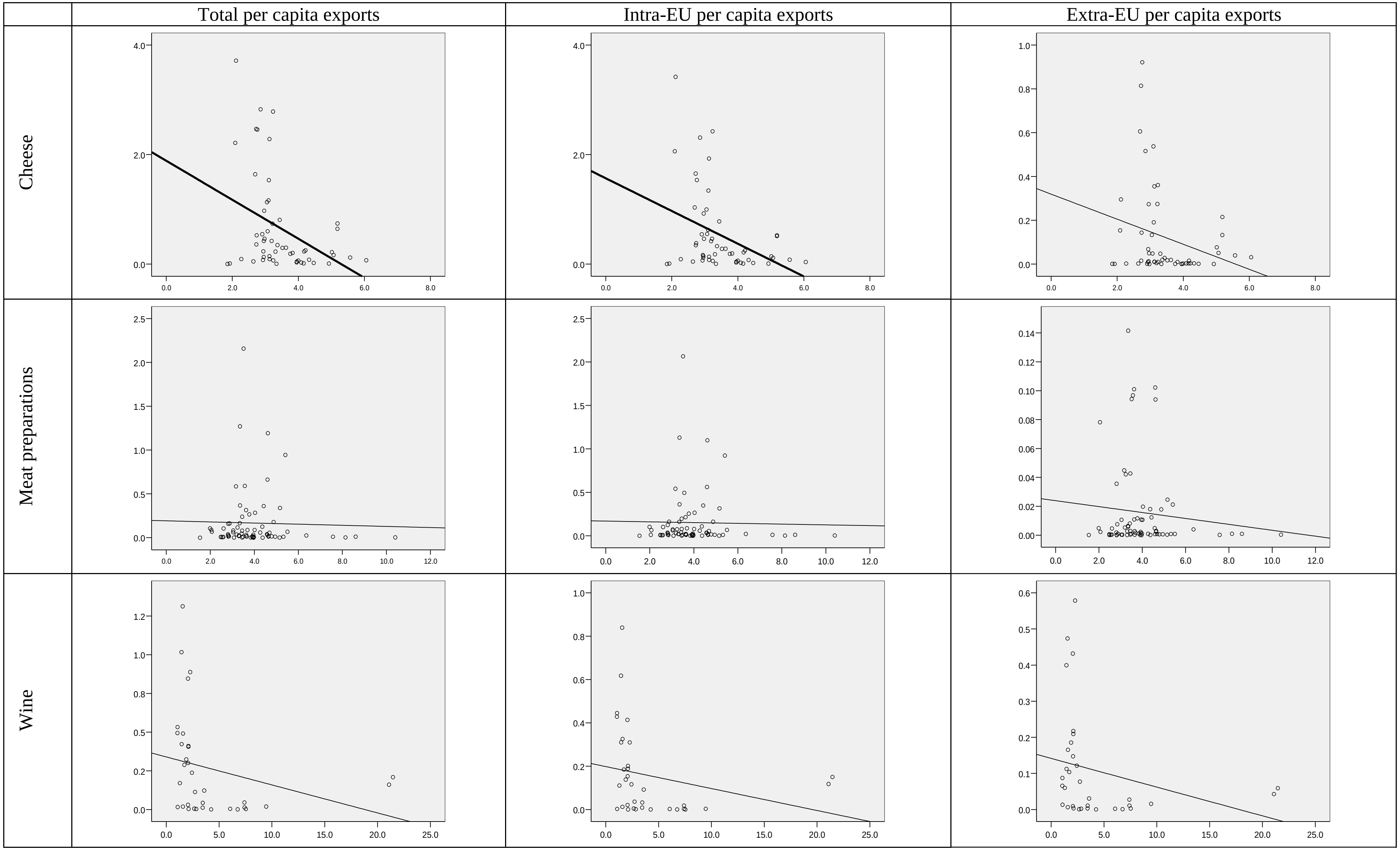
Tables and Figures

Table 1. Number of product types included in the empirical analysis for each product category and country (n_{ck})

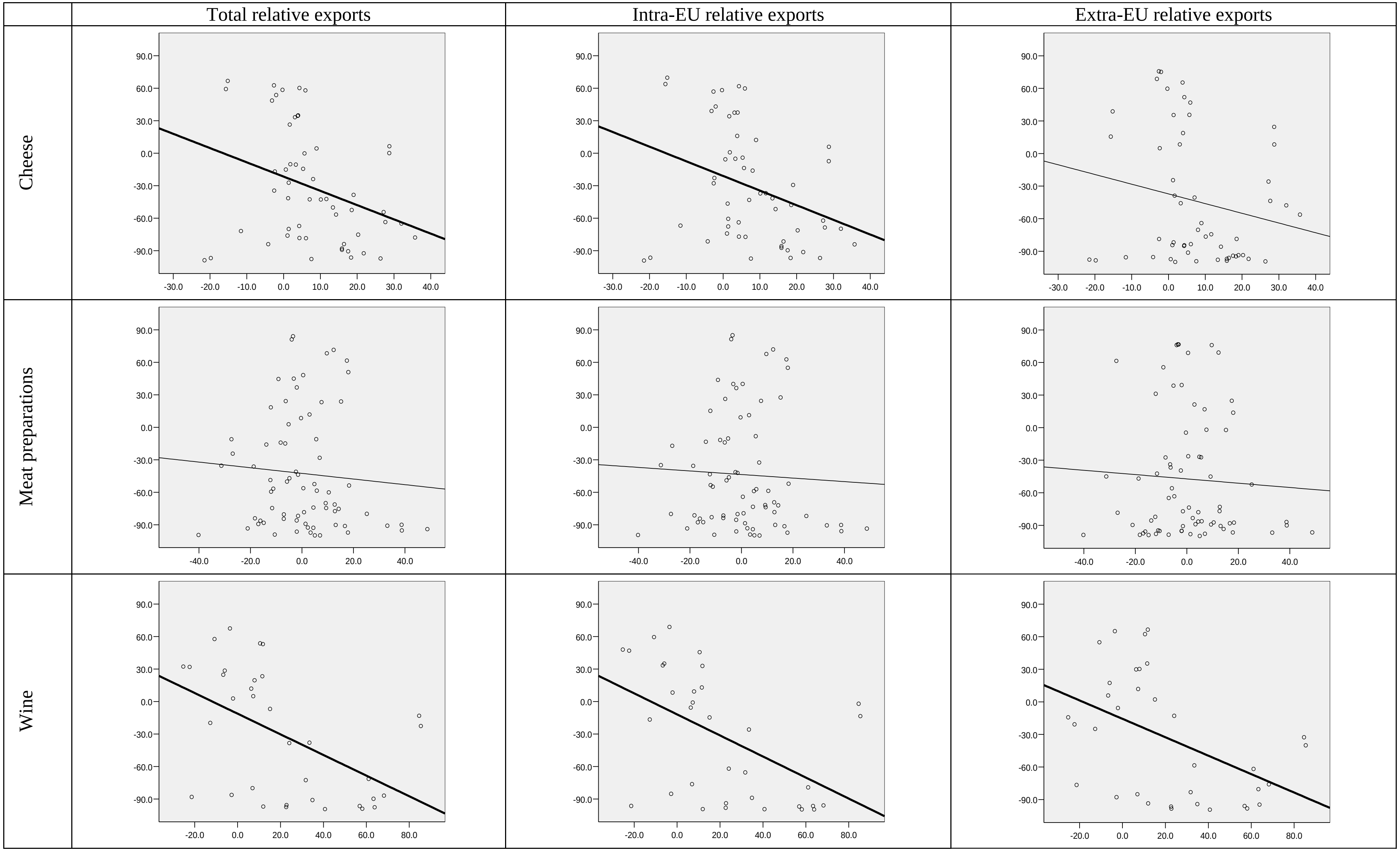
	DE	IT	FR	ES	GB
Cheese	27	25	31	13	15
Meat preparations	36	35	41	34	36
Wine	17	25	25	24	–

Figure 1. Germany, absolute measurement (per capita exports in € (y-axis) versus unit values €/kg (x-axis))



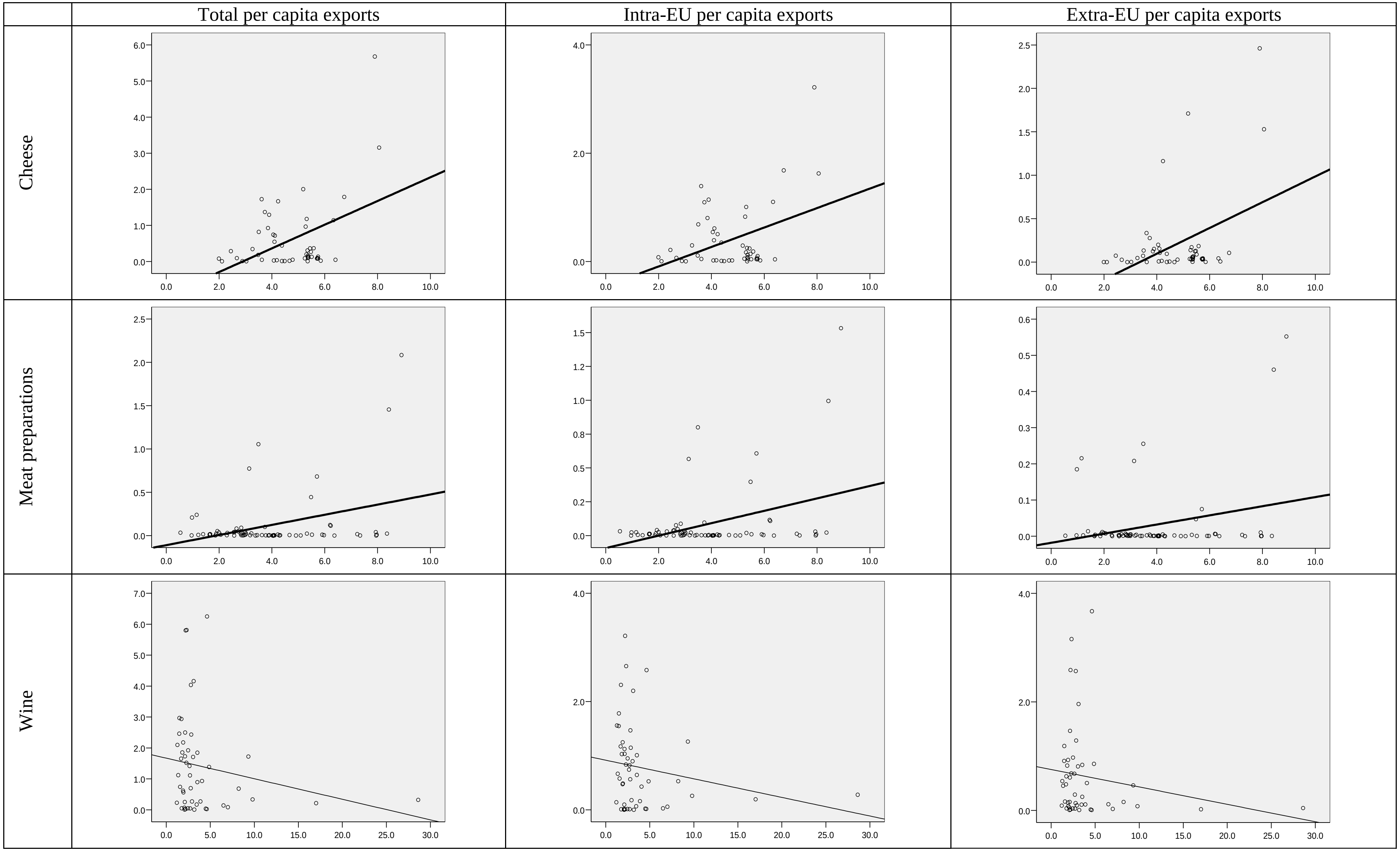
Note: **bold** regression lines indicate that the slope coefficient is statistically significant at the 95% confidence level.

Figure 2. Germany, relative measurement (deviations from expected values (y-axis) versus deviations from average unit values (x-axis))



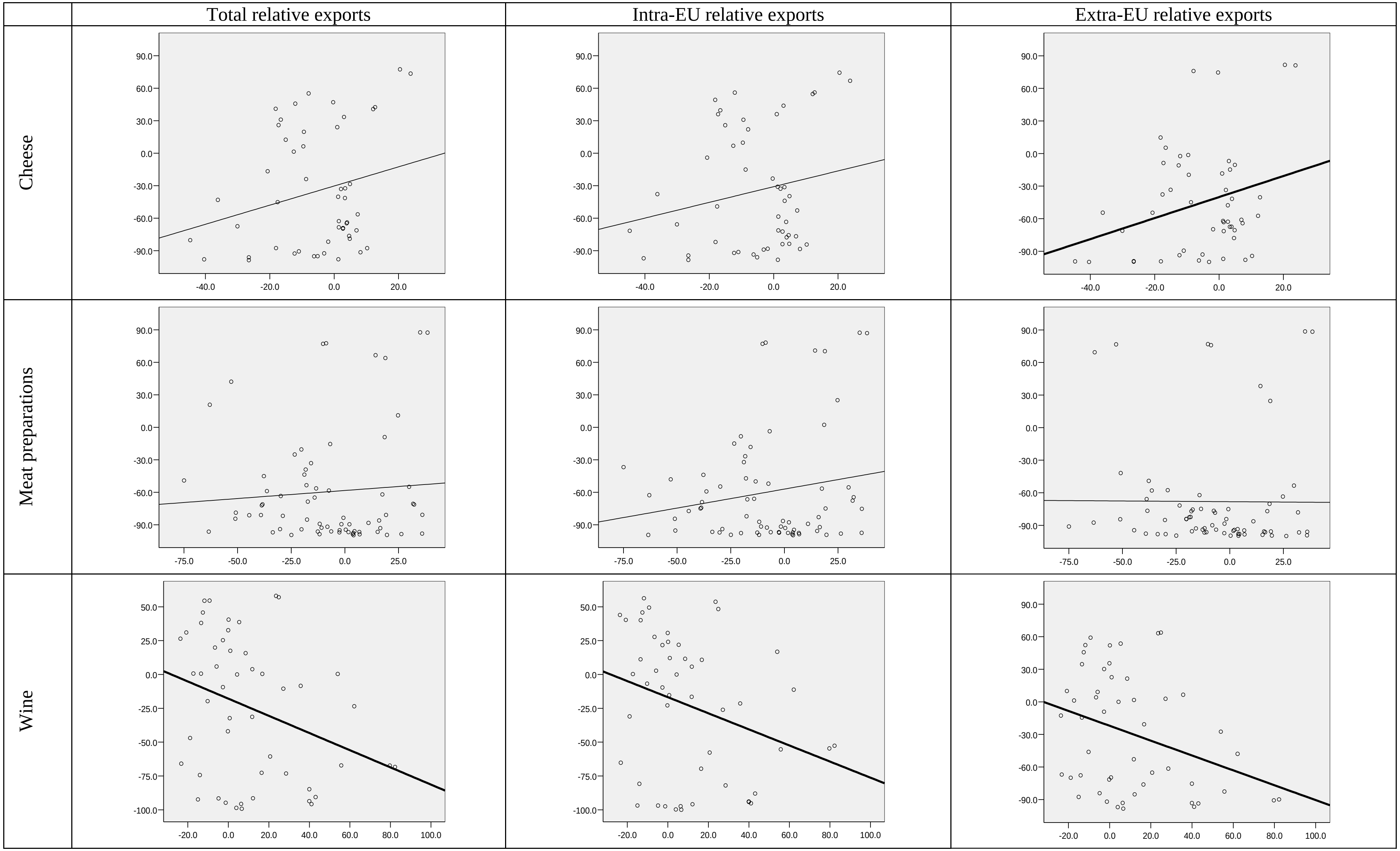
Note: **bold** regression lines indicate that the slope coefficient is statistically significant at the 95% confidence level.

Figure 3. Italy, absolute measurement (per capita exports in € (y-axis) versus unit values €/kg (x-axis))



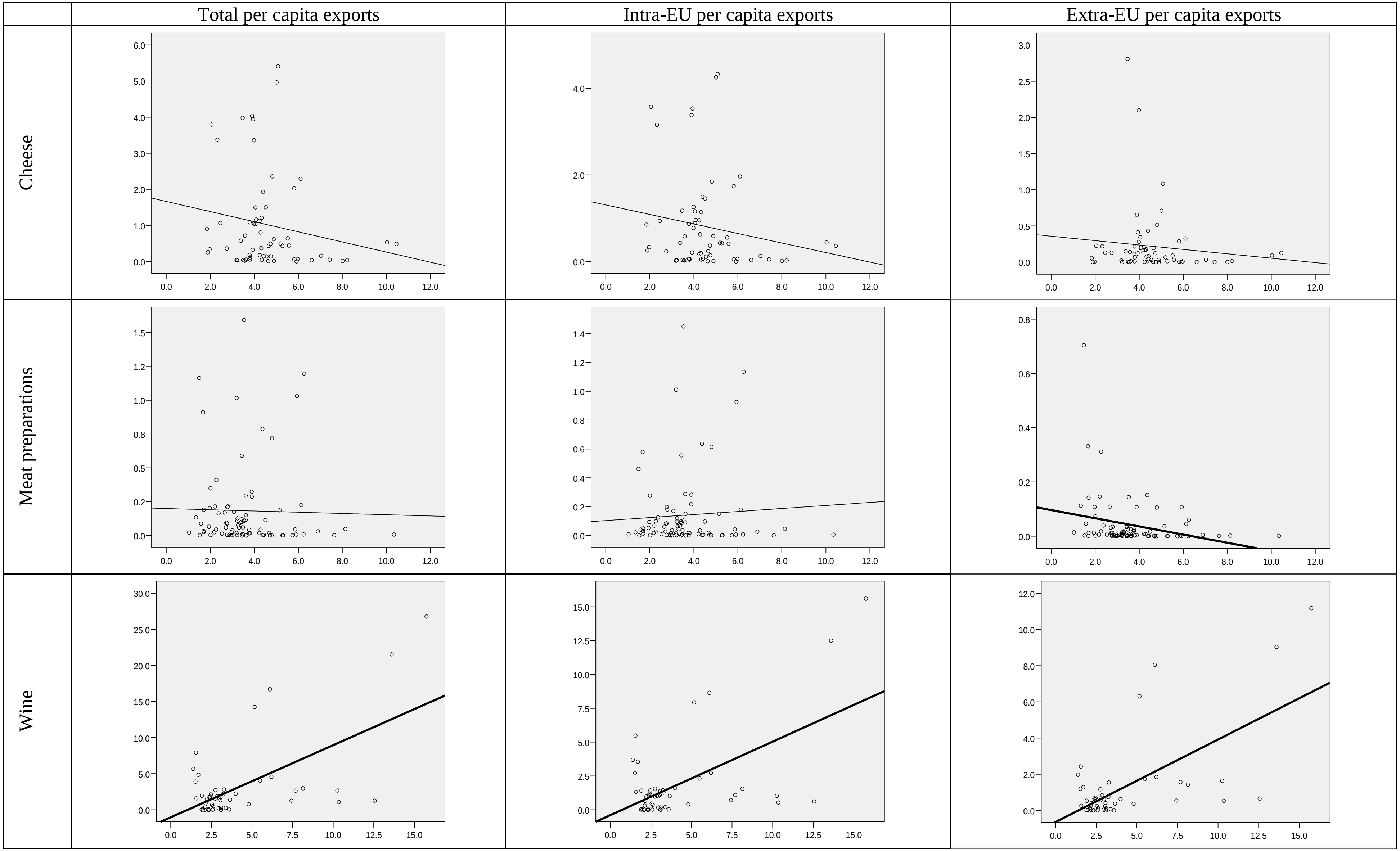
Note: **bold** regression lines indicate that the slope coefficient is statistically significant at the 95% confidence level.

Figure 4. Italy, relative measurement (deviations from expected values (y-axis) versus deviations from average unit values (x-axis))



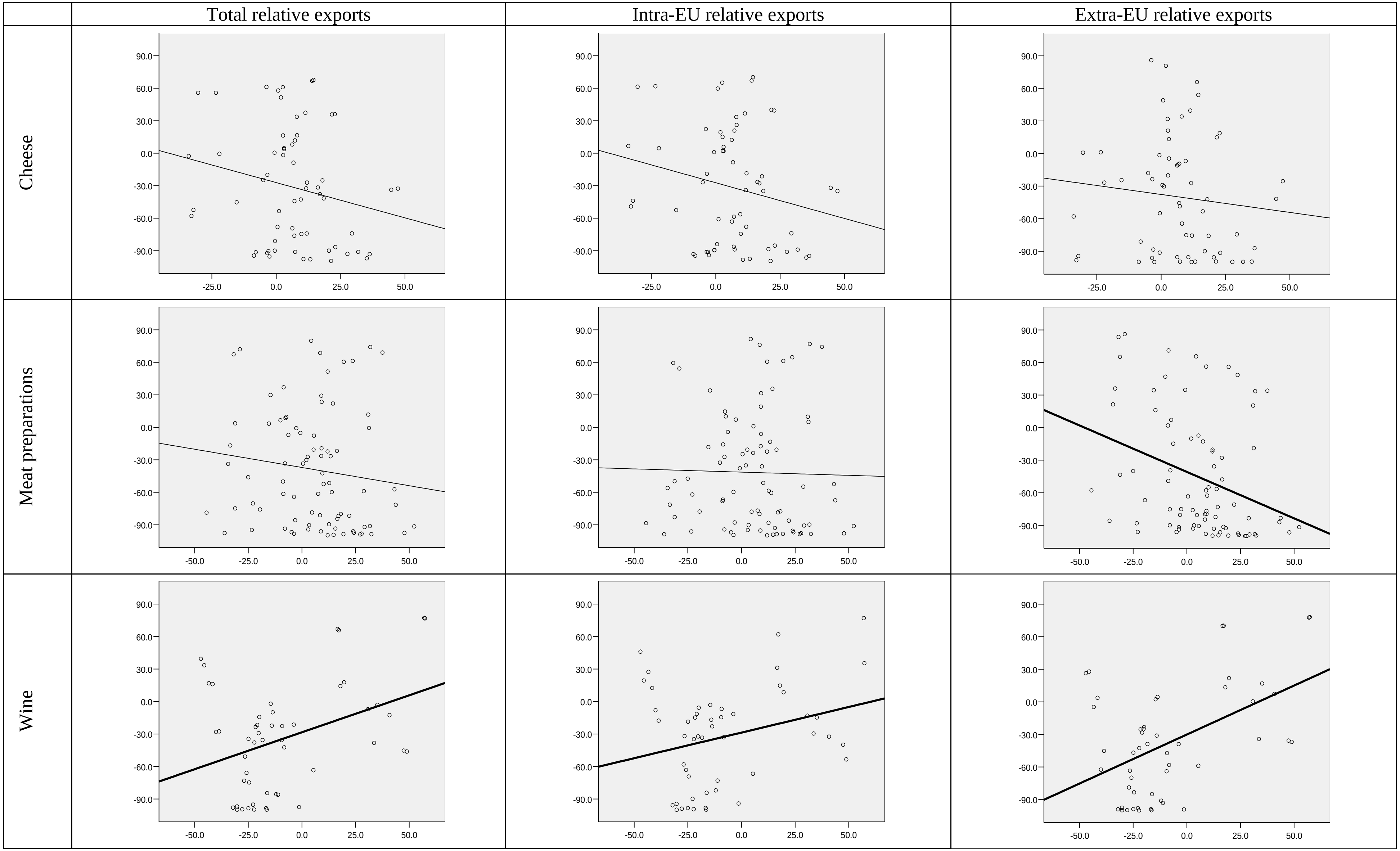
Note: **bold** regression lines indicate that the slope coefficient is statistically significant at the 95% confidence level.

Figure 5. France, absolute measurement (per capita exports in € (y-axis) versus unit values €/kg (x-axis))



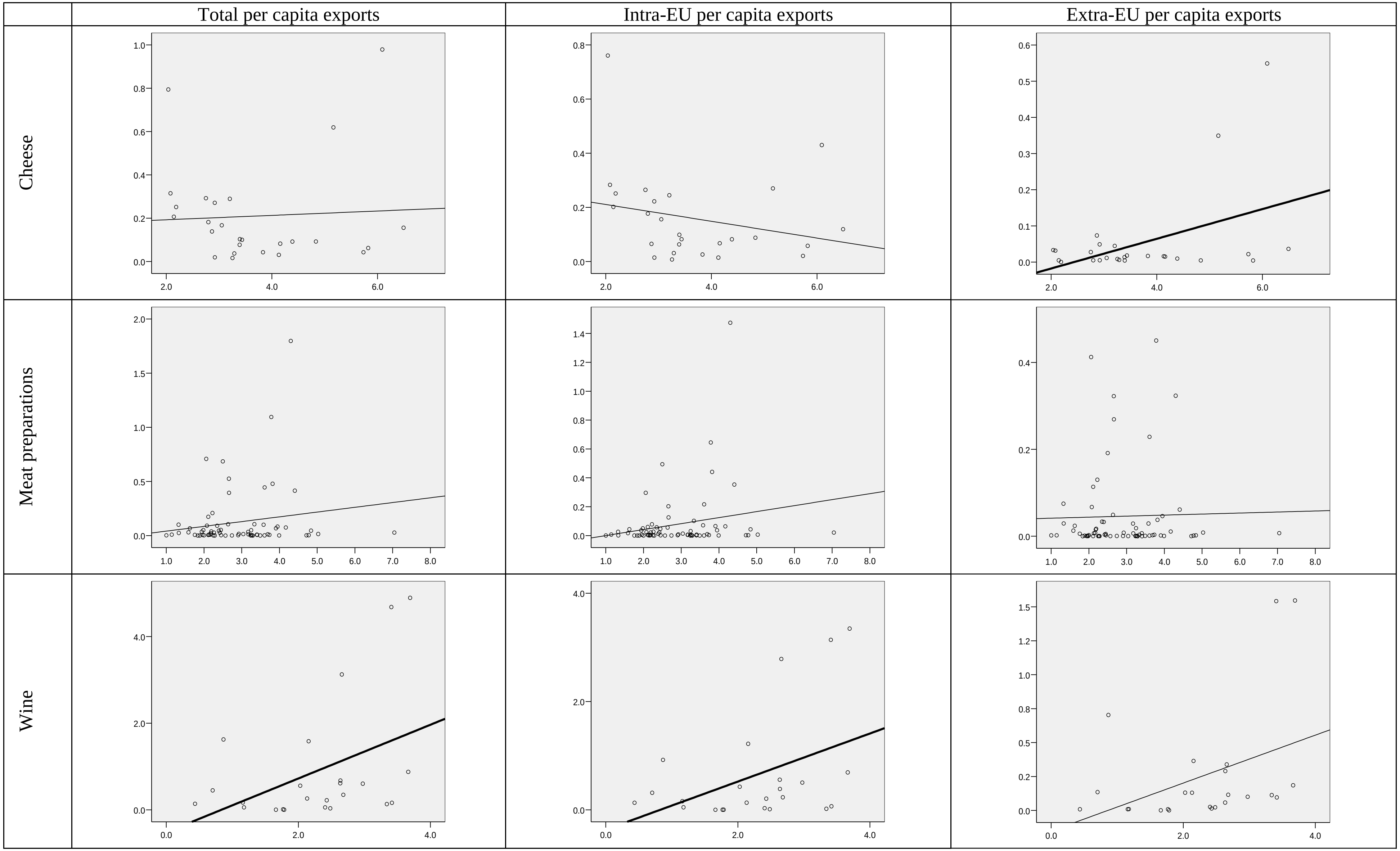
Note: **bold** regression lines indicate that the slope coefficient is statistically significant at the 95% confidence level.

Figure 6. France, relative measurement (deviations from expected values (y-axis) versus deviations from average unit values (x-axis))



Note: **bold** regression lines indicate that the slope coefficient is statistically significant at the 95% confidence level.

Figure 7. Spain, absolute measurement (per capita exports in € (y-axis) versus unit values €/kg (x-axis))



Note: **bold** regression lines indicate that the slope coefficient is statistically significant at the 95% confidence level.

Figure 8. Spain, relative measurement (deviations from expected values (y-axis) versus deviations from average unit values (x-axis))

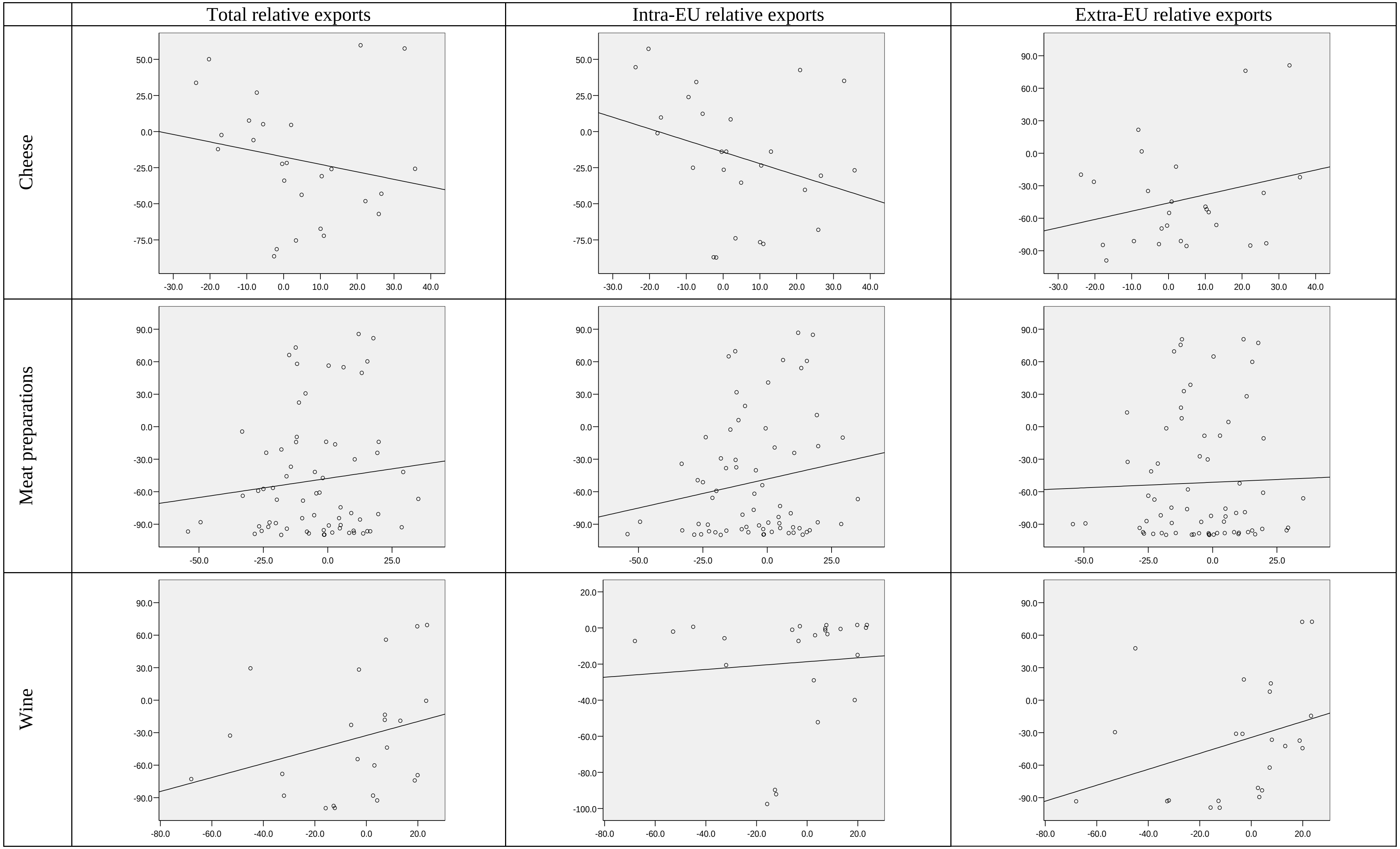


Figure 9. UK, absolute measurement (per capita exports in € (y-axis) versus unit values €/kg (x-axis))

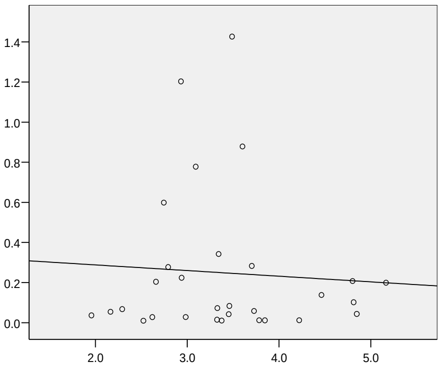
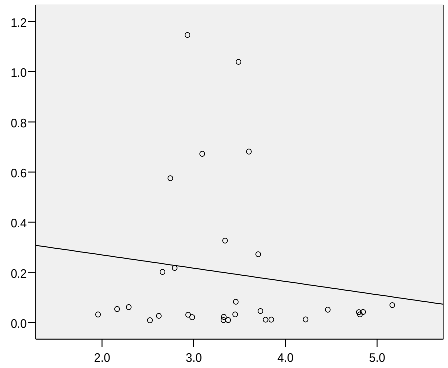
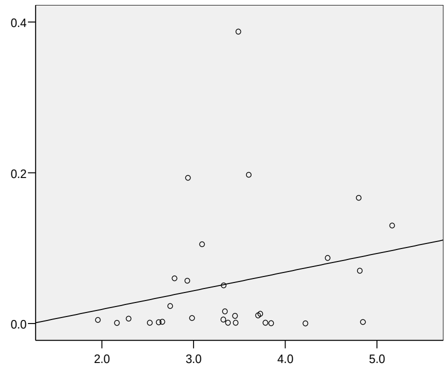
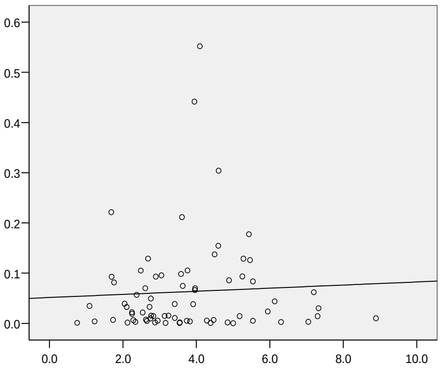
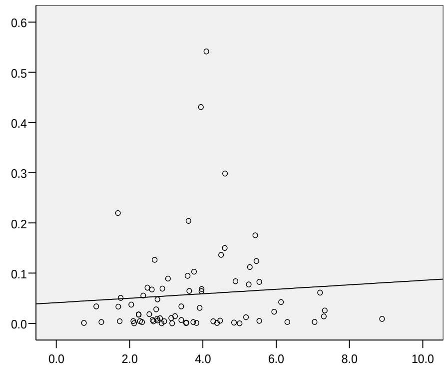
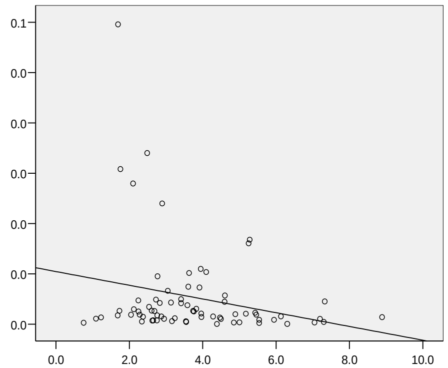
	Total per capita exports	Intra-EU per capita exports	Extra-EU per capita exports
Cheese			
Meat preparations			
Wine	– –	– –	– –

Figure 10. UK, relative measurement (deviations from expected values (y-axis) versus deviations from average unit values (x-axis))

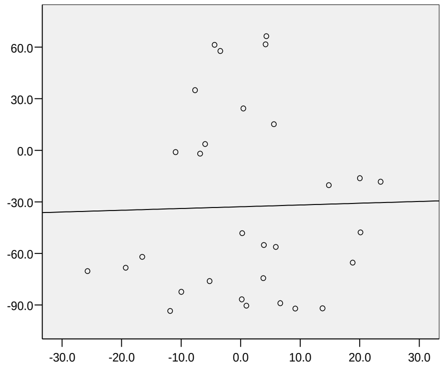
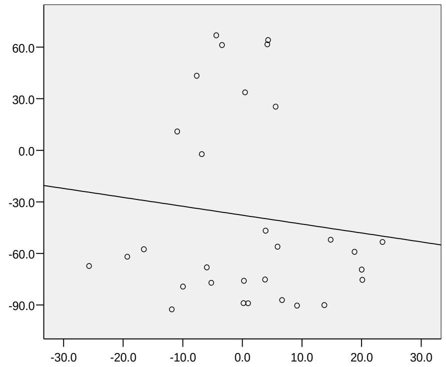
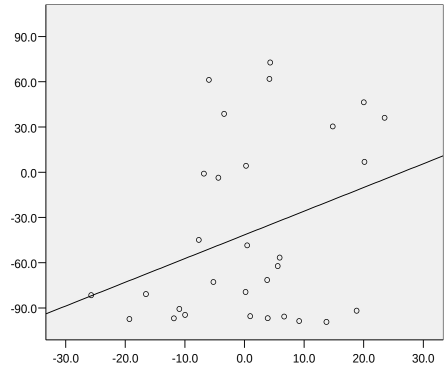
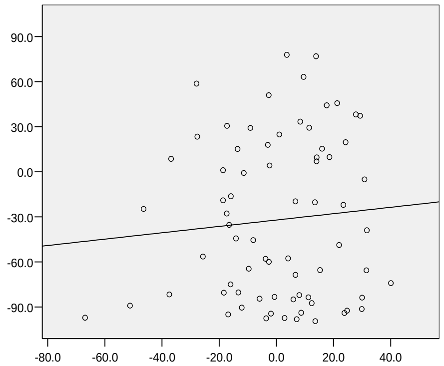
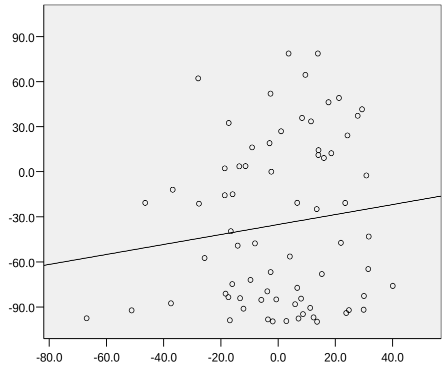
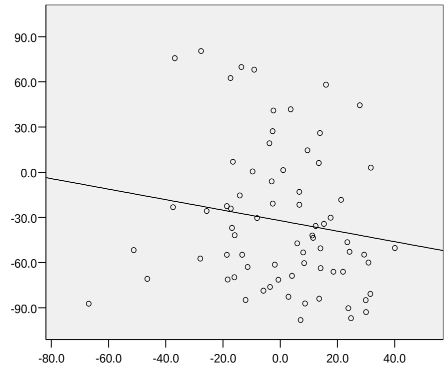
	Total relative exports	Intra-EU relative exports	Extra-EU relative exports
Cheese			
Meat preparations			
Wine	– –	– –	– –

Table 2. Summary regression results (feasible GLS estimates) for a two-level hierarchical linear model with one repeated measurement; absolute measurement

Regressors	Dependent variable: per capita exports		
	Total	Intra EU	Extra EU
Tests of fixed effects (F-values)			
Intercept	33.5**	45.2**	10.5**
COUNTRY	7.9**	7.3**	5.0**
CATEGORY	6.4**	15.5**	3.0*
PERIOD	29.2**	33.3**	10.3**
Unit value	2.3	1.6	5.6**
Fixed effect parameter estimates			
Intercept	.646**	.638**	.137
Country = DE	.141	-.020	.094
Country = ES	.254	.037	.149
Country = FR	.786**	.451**	.301**
Country = UK	.271	.117	.104
Country = IT	0[a]	0[a]	0[a]
Category = CHEESE	-.361*	-.354**	-.140*
Category = MEAT PR	-.510**	-.526**	-.154
Category = WINE	0[a]	0[a]	0[a]
Period = 0 (1995-99)	-.142**	-.094**	-.043**
Period = 1 (2000-05)	0[a]	0[a]	0[a]
Unit value	.020	.011	.017*
Variance/covariance matrix components[†]			
σ_1^2	2.17**	.787**	.382**
σ_2^2	3.46**	1.22**	.646**
σ_{12}	2.69**	.957**	.482**
Model statistics			
# of obs.	744	744	744
Restr. –2 log lik.	1,650.0	996.0	581.8
AIC	1,656.0	1,002.0	587.8
BIC	1,670.0	1,015.8	601.6

Notes: ** statistically significant at least at 99% confidence level;
* statistically significant at least at 95% confidence level.
Significant levels are based on panel-robust standard errors.
[a] Reference category.
[†] Restricted maximum likelihood estimate.
Source: author's calculations from Eurostat data.

Table 3. Summary regression results (feasible GLS estimates) for a two-level hierarchical linear model with one repeated measurement; relative measurement (non-significant factors removed)

Regressors	Dependent variable: relative export performance		
	Total	Intra EU	Extra EU
Tests of fixed effects (F-values)			
Intercept	158.5**	155.9**	219.5**
CATEGORY	3.2*	5.5**	2.2
Relative unit value	1.0	.4	5.4**
Fixed effect parameter estimates			
Intercept	-31.38**	-26.13**	-34.923**
Category = CHEESE	.776	-4.92	-7.45
Category = MEAT PR	-13.13	-19.80**	-14.20*
Category = WINE	0[a]	0[a]	0[a]
Relative unit value (CHEESE)	-.161	-.156	-.040
Relative unit value (MEAT PR)	-.113	.024	-.356**
Relative unit value (WINE)	.017	-.111	.048
Variance/covariance matrix components[†]			
σ_1^2	2,922.5**	2,785.4**	2,966.6**
σ_2^2	2,826.8**	2,725.5**	2,961.7**
σ_{12}	2,666.1**	2,516.1**	2,662.0**
Model statistics			
# of obs.	744	744	744
Restr. –2 log lik.	7,313.9	7,344.6	7,453.0
AIC	7,319.9	7,350.6	7,459.0
BIC	7,333.7	7,364.4	7,472.8

Notes: ** statistically significant at least at 99% confidence level;
* statistically significant at least at 95% confidence level.
Significant levels are based on panel-robust standard errors.
[a] Reference category.
[†] Restricted maximum likelihood estimate.
Source: author's calculations from Eurostat data.

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