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# The Export Competitiveness of the EU Dairy Industry

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# **The Export Competitiveness of the EU Dairy Industry**

## **Abstract**

The European Union's dairy industry has become increasingly export oriented and consequently the income of EU dairy farmers depends partly on their dairy processing firms' ability to successfully market dairy products in extra-EU markets. The export competitiveness of the EU dairy industry was examined on the basis of various indicators in order to identify structural determinants of export market success for a panel of EU country exports. Dynamic GMM panel results highlight the importance of innovation and investment for export competitiveness in world markets. The number of dairy products with protected geographical indication per country had no statistically significant effect.

**Keywords:** export competitiveness, dairy trade, dynamic panel data model

## **1 Importance of export competitiveness for the EU milk industry**

The milk sector is the largest sector in European agriculture, contributing about 14.1 % of the total production value (in 2015). The total amount of milk produced in the European Union (EU) was around 165 million tonnes in 2014. Furthermore, the EU is an important exporter of milk products, especially cheese. The main exporters in this context are Germany, France, the Netherlands, Poland, Italy and the United Kingdom (UK), which produce about 70 % of the EU's milk (European Commission, 2016a). Past reforms of the Common Agricultural Policy have exposed EU producers to a lower intervention price level. The abolition of the milk quota on 30 March 2015 has been introduced gradually through quota increases. Politically this was possible because global dairy prices since 2007 have risen higher than EU prices and farmers wanted to benefit from export opportunities.

However, in 2009, 2012 and 2015/16, Europe (and most other countries) experienced periods of relatively low milk prices that were mirrored by relatively low world market prices for processed dairy products. At the same time, aggregate milk demand has been tending to stagnate in industrial countries, but is rising in developing and emerging countries (European Commission, 2017).

Therefore, the aim of this study was to model the export competitiveness of EU countries in the milk sector and identify structural factors that could be related to this. Several indices on export competitiveness were used and evaluated for a panel of EU member countries.

This paper is organised as follows: the following section defines the concept of competitiveness based on a literature review, section 2 introduces the indicators of export competitiveness, the set of covariates and the modelling approach, section 3 presents the data, section 4 gives the descriptive and estimated results of this study and finally section 5 presents the conclusions.

## **2 Measuring export competitiveness**

### **Theoretical background**

Generally, the term "competitiveness" has no clear definition in economic theory (Sharples, 1990; Ahearn et al., 1990). However, one constant feature across the literature seems to be that

competitiveness should be interpreted as a relative measure and therefore needs to be measured in comparison to other firms, products, sectors or countries. For instance, the Organization for Economic Cooperation and Development (OECD) defines competitiveness as the “ability of companies, industries, regions, nations and supranational regions to generate, while being and remaining exposed to international competition, relatively high factor income and factor employment levels on a sustainable basis” (Hatzichronoglou, 1996). In contrast, the European Commission defines competitiveness as “a sustained rise in the standards of living of a nation or region and as low a level of involuntary unemployment as possible” (European Commission, 2009).

Conceptually, there are two ways of measuring competitiveness: the neoclassical way, which uses indices such as comparative advantage or import and export indices to compare a nation’s competitiveness, or the approach taken in the literature on strategic management, investigating company structure and strategy in order to compare different companies (Porter, 2014).

To portray a robust and reliable picture of EU dairy export competitiveness, five trade indicators were considered, namely export market share (XMS), export market penetration (XMP), residuals of constant market share ( $CMS_{Resid}$ ), normalised revealed comparative advantage (NRCA) and trade balance index (TBI). Each of these indices focuses on different aspects of competitiveness. Multiple similarities among several measures allow significant conclusions to be drawn.

As a result of Melitz (2003), it is now widely anticipated that only the most productive companies engage in export activities while the least productive firms will exit the market. Consequently, high productivity and a high level of export competitiveness should be related and it should be possible to assess the competitiveness of the European milk sector based on trade values, as was done here.

Drescher and Maurer (1999) studied the German dairy sector and its competitiveness in different product categories between 1983 and 1993. They also used XMS and revealed comparative advantage (RCA) and explored Germany’s loss in market shares in butter, cheese and milk products over the respective period. They compared export shares in terms of value and quality and concluded that export shares stagnated in terms of value, but also mentioned a decrease in terms of quantity.

Carraresi and Banterle (2008) used XMS and RCA index as well to investigate the EU’s agri-food and agricultural sector. In 2015 they used the same indices to assess the effects of the EU accession of Central and Eastern European countries and the effects of the financial crisis in 2008. They found that Germany and the Netherlands profited most from enlargement of the EU, France and Belgium’s competitiveness declined, and Spain and Italy were more or less stable.

This study follows up these ideas and extends the estimation of determinants that explain the differences in export success between EU member countries. To our knowledge this is the first study investigating the competitiveness of the dairy sector over a period of time in all EU countries. Furthermore, analysing sector specific determinants which influence the competitiveness is another essential contribution of this study.

### **Measurement concept**

Table 1 below presents the export competitiveness indices that were used in this study and explains each of them briefly.

[Table 1]

Initially the export market power of all EU countries was considered by observing their market shares in exports and market penetration. Export market share is calculated as follows:

$$XMS = \frac{X_r^i}{X_W^i} \quad (2.1)$$

where  $X^i$  denotes the value of exports in 1000 USD for product group  $i$  of country  $r$  and the *world* respectively. The value is 1 if one country is the only exporter in the world for that product.

In contrast to XMS, export market penetration (XMP) is described by:

$$XMP = \frac{X_r^i}{M^i} \quad (2.2)$$

where  $X_r^i$  indicates the number of export countries to which country  $r$  exports product  $i$ .  $M^i$  is related to the number of all countries that import product  $i$ . If, for example, 200 countries in the world import milk products and Germany exports to 100 of them, then Germany's  $XMP = 0.5$ .

The trade balance index (TBI) is the next index that was computed:

$$TBI_r^i = \frac{X_r^i - M_r^i}{X_r^i + M_r^i} \quad (2.3)$$

where  $TBI_r^i$  denotes the TBI of country  $r$  for product  $i$ .  $X_r^i$  and  $M_r^i$  indicate exports from and imports into country  $r$  of product  $i$ . The range of this index is  $[-1; +1]$ , where values  $<0$  indicate net importers of the respective product (Lafay, 1992). If the value is  $>0$  the country exports more than it imports. It should be noted that not only growing exports, but also shrinking imports increase the TBI.

Furthermore the normalised revealed comparative advantage (NRCA) index was calculated for each country (Yu et al., 2009). Since it is normalised, it is a preferred measure of competitiveness across countries and time periods. The NRCA is computed as follows:

$$NRCA_r^i = \frac{X_r^i}{X_{Ag}} - \frac{X_r * X^i}{X_{Ag} * X_{Ag}} \quad (2.4)$$

where  $NRCA_r^i$  indicates the normalized revealed comparative advantage of country  $r$  for product  $i$ . However  $X_r$  denotes all exports of country  $r$  of all product groups and  $X^i$  stands for all world exports of product  $i$ .  $X_{Ag}$  contains all exports of agricultural products in the world. This index has a range from  $[-1/4; +1/4]$ . Values  $<0$  ( $>0$ ) indicate a comparative disadvantage (advantage) for the respective product (Yu et al., 2009). Intuitively, the index expresses a country's observed export specialisation for a certain product category relative to the export specialisation for that product, as would be expected given the country's overall trade volume and specialisation in other industries. For instance, an index value of zero implies that the country would export just as much of a product as would be expected given i) the country's share of total world trade, and ii) for all countries together the share of that the specific product category's total world exports. Thus an NRCA of 0 represents for any country or sector the comparative neutral point of no relative specialisation.

This study distinguished between worldwide and extra-EU comparative advantages. Therefore, the NRCA indices were calculated in two ways: first trade with all countries in the world, intra and extra-EU countries (NRCAworld) was included, whereas the second index included only the trade of the respective EU member with non-EU members (NRCAexclEU). This made it possible to compare overall competitiveness (with EU trade) and extra-EU competitiveness in the dairy sector. If, for example, a country has a comparative advantage for dairy products in terms of NRCAworld, but a comparative disadvantage (or lower values) in terms of NRCAexclEU, it can be concluded that this country is more specialised in exporting to EU members than in exporting to non-EU members.

An alternative and well-established concept for measuring export competitiveness is the concept of constant market shares (CMS). The so-called CMS residual measures how much a country's exports have grown during a year and for a certain product compared to world exports of this product. The CMS was derived according to Leamer and Stern (1970):

$$CMS_{Resid,t+1}^i = v_r^i - v_w^i = \frac{v_{r,t+1}^i}{v_{r,t}^i} - \frac{v_{w,t+1}^i}{v_{w,t}^i} \quad (2.5)$$

The residuals of the CMS analysis ( $CMS_{Resid}$ ) are given by the difference between export growth rates,  $v$ , for a country's exports ( $v_r^i$ ) and world exports ( $v_w^i$ ) for product  $i$ , where  $r$  denotes the respective country and  $w$  stands for the world. For example, if exports of global dairy products grew by 2 % from 2015 to 2016 and a country's growth rate was 3 % in the same period, this country would have a computed CMS residual of +1 %. This can be interpreted as the net competitive advantage after taking changes in the global import demand for dairy products into account.

### Econometric estimation strategy

Referring to Blundell and Bond (1998), a dynamic panel data (DPD) model was used which has been developed for datasets with many panels but few time periods. The underlying assumption is that there is no autocorrelation in idiosyncratic errors. Furthermore, it is assumed that panel-level effects are uncorrelated with the first difference of the first observation of the dependent variable. To estimate and evaluate the estimators, an AR(1) model was used with fixed effect decomposition of the error term to control for individual-specific effects. The estimation results generally refer to the one-step estimator with robust standard errors because convergence on the computation of Windmeijer (2005) was not achieved with robust standard errors for the two-step estimator. The overall form of the model was as follows:

$$y_{it} = \alpha y_{i,t-1} + \beta'_1 x_{i,t} + \beta'_2 x_{i,t-1} + u_{it} \quad (2.6)$$

For  $i = 1, 2, \dots, N$  and  $t = 2, 3, \dots, T$ ,  $N$  is large,  $T$  is fixed and  $|\alpha| < 1$ , while  $u_{it} \equiv \eta_i + \vartheta_{it}$  describes the decomposition of the error term. The individual effects  $\eta_i$  are treated stochastically. Therefore, these effects are necessarily correlated with the lagged dependent variable  $y_{i,t-1}$ . Furthermore, the disturbances  $\vartheta_{it}$  are assumed to be serially uncorrelated. Due to the correlation of the  $y_{it}$ 's the ordinary least square (OLS) estimator of  $\alpha$  would be inconsistent. Since the lag of  $y_{it}$  is an explanatory variable, it is endogenous and therefore correlated with the error term. This correlation does not disappear if the number of observations increases (Bond, 2002). To remedy this, the model was first-differenced to get rid of  $\eta_i$ . Afterwards  $y_{i,t-2}$  was used as an instrument for  $\Delta y_{i,t-1} = y_{i,t-1} - y_{i,t-2}$ . These instruments were not correlated with  $\Delta \vartheta_{it}$ , as long as  $\vartheta_{it}$  is not serially correlated itself (Baltagi, 2013). Further explanatory variables were also potentially endogenous and were treated as such within the estimations. However, due to the absence of suitable external instruments, the GMM instrumentation strategy proposed by Blundell and Bond (1998) was extended to include these variables as well. Only the explanatory variables on EU/euro membership were treated as exogenous.

### The model

Given these alternative measures for export competitiveness from above, it was of interest to identify structural factors that can be related to the strategies of the processing firms in the average EU country. Table 2 presents a set of such structural factors that were identified based on the literature review of recent reports assessing individual aspects of dairy chain performance in the European Union (Tacken et al., 2009; Jansik et al., 2014) and provides our hypotheses we will test in the estimation:

[Table 2]

The model structure is as follows:

$$y_{it} = \alpha y_{i,t-1} + \beta_0 d_{EU\_member_{it}} + \beta_1 d_{Euro_{it}} + \beta_2 EPO\_Patents_{it} + \beta_2 EPO\_Patents_{i,t-1} + \beta_2 EPO\_Patents_{i,t-2} + \beta_3 PDOPGICheese_{it} + \beta_3 PDOPGICheese_{i,t-1} + \beta_4 PDOPGIMilk_{it} + \beta_4 PDOPGIMilk_{i,t-1} + \beta_5 PersCost_{it} + \beta_5 PersCost_{i,t-1} + \beta_6 LNF_{it} + \beta_6 LNF_{i,t-1} + \beta_7 NetInv_{it} + \beta_7 NetInv_{i,t-1} + (\eta_i + \vartheta_{it}) \quad (2.7)$$

where  $y_{it}$  ( $y_{i,t-1}$ ) is export competitiveness (expressed via the respective index) in time  $t$  ( $t - 1, T - 2$ ). To approximate a country's agricultural structure,  $LNF$  is included as a control variable. The influence of patents regarding dairy issues is observed via  $EPO\_Patents$ .  $PDOPGI$  stands for a protected geographical indication. A distinction between protected regions for either cheese or other milk products makes it possible to control for differences within dairy product groups. Furthermore  $PersCost$  was used to explain the effect of personnel expenses on export competitiveness. How investments in goods in the dairy industry affect export success is captured by  $NetInv$ . Given the assumption that  $EPO\_Patents$  might be influenced not only from the year before, but also from two years ahead, two lags were included.

In this study export competitiveness,  $y_t$ , is expressed in the form of several trade and export performance indices, as discussed above.

### 3 Data sources and the imputation procedure

#### Data

UN COMTRADE sectoral trade data from the WITS database was used with the nomenclature "HS 1996" on the HS 6-digit level. The data for the descriptive analysis were from 2002 to 2015. Dairy products are captured by product category 04 and the corresponding subgroups. The relevant subgroups are 0401 to 0406<sup>1</sup> (UN COMTRADE, 2017).

As explanatory variables of export competitiveness, these data were used to compute the individual indicators of export competitiveness, as explained in Table 1. Further structural determinants used as explanatory variables and explained in Table 2 are available from EUROSTAT (milk collection data within the agriculture section of the database, as well as dairy industry statistics under the manufacturing of food products) (Eurostat, 2015), the European Patent Office (2016) and the European Commission's Database of Origin and Registration (2016b) to obtain information about the products of protected geographical regions. Since only EU members were considered, Croatia was not included because the country only joined the EU in 2013. The data basis for the panel regression refers to the years 2003-2014<sup>2</sup>.

#### Imputation procedure

Data for some of the structural indicators explained in table 2 were not available for every constitutive year. This posed a problem of missing values in the study's dataset and would have forced an estimation of an unbalanced panel, but there are few unbalanced dynamic panel estimators and this poses further analytical and computational challenges (Baltagi, 2013: 209). This problem was circumvented by imputing missing values in the data based on a Random Forest algorithm (Oba et al., 2003; Stekhoven and Buehlmann, 2012). Therefore, the R-package 'missForest' by Stekhoven (2015) was used. A decisive advantage is that this procedure gives a balanced panel and the regression can be run based on well-established estimation procedures.

The Random Forest method is a bootstrapping-based learning algorithm that uses the subset of complete observations as a training dataset under the assumption that missing values are

<sup>1</sup> Available upon request from the authors.

<sup>2</sup> Except for Croatia, Malta and Luxembourg. Malta and Luxembourg were omitted due to incomplete or negligible trade data.

missing at random. The imputation procedure trains the learning algorithm by randomly excluding values from the existing data and trying to predict them until no further improvement in production quality can be attained. In the case of this study's dataset, a classification error of 29 % was achieved. This means that roughly one in every four imputed values might be predicted inaccurately.

However, all the structural indicators in Table 2 referred to variables that are subject to long-term trends and are unlikely to exhibit high volatility for the unobserved years. Therefore changes between the observed periods were assumed to be consistent with long-term trends, such as net investments, the number of dairy farms or personnel costs.

## 4 Results

### Descriptive results

Table 3 presents an overview of all the export competitiveness indicators computed for each EU country in the dairy sector. Values are sorted according to the average export trade values in the milk sector. As can be seen, Germany has the highest export values of dairy products, followed by France and the Netherlands. Most individual countries in the EU do not show significant global export market shares (XMS) in the milk sector at all. Significant values were only observed for the Netherlands, France and Germany observed (more than 10 % each). Most of these exports are intra-EU exports, which is why Germany performs worse if NRCA<sub>world</sub> with NRCA<sub>exclEU</sub> are compared.

The highest export market penetration (XMP) was achieved by France, the Netherlands and Germany. These countries are engaged with most other countries in the trade of milk products. This shows that dairy exports of the EU countries are shipped to more and more trading partners all over the world. One exception to this is Bulgaria, which has reduced its number of trading partners since 2009. Estonia, Romania and Slovenia come last on average. This finding is in line with the slight downwards trend in XMS for the major export nations<sup>3</sup> of the Netherlands, France and Germany. If more countries engage in trade, there is less market share available for each of them. The TBI should be higher for countries which are more engaged in international trade or for countries which have a low home consumption. The highest TBI values were for Poland, Estonia and Finland, whereas Germany came ninth. Showing that even if Germany is an export oriented country, due to high own consumption they do not appear on the top of this rank.

Looking at CMS<sub>Resid</sub>, a completely different picture emerges. Latvia, Romania and Poland were the top three. This finding implies that these countries had the highest growth on average rates in the dairy export sector in 2002-2015 (only in the panel after EU accession). This shows a picture of more of a competitive edge being achieved after EU accession. Furthermore, it is not surprising that typical dairy exporting countries such as France, Germany, Denmark or the Netherlands appear to have very low or even negative CMS<sub>Resid</sub> values since they operate already at the competitive edge of the EU dairy sector.

[Table 3]

[Figure 1]

Figure 1 includes all the indices from table 3 and re-expresses them as ranks in order to facilitate a comparison of the different indices. The index ranks  $b$  displayed on the vertical axis of figure 1 are calculated as follows:

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<sup>3</sup> Not shown in the tables due to space restrictions, but can be obtained upon request from the authors



$$x_{1r} \leq x_{2r} \leq \dots \leq x_{nr} \Leftrightarrow (b_{1r} = \pi(x_{1r})) \leq (b_{2r} = \pi(x_{2r})) \leq \dots \leq (b_{nr} = \pi(x_{nr})) \mid b_n = n. \quad (4.1)$$

While  $x_{nr}$  denotes the real index value of index  $n$  in country  $r$ ,  $\pi(x_{ni})$  denotes the rank of the respective index among all EU countries when sorted from low to high. For example Germany has the largest share of total exports and therefore comes 25<sup>th</sup> since there are 25 countries in the sample ( $n=25$ ).

The sum of rank numbers  $M$  were calculated as follows:

$$M_{j,r} = \sum (b_{TBI,r} + b_{NRCA_{exclEU},r} + b_{NRCA_{world},r} + b_{XMP,r} + b_{XMS,r}) \quad (4.2)$$

For both formulas  $r$  denotes the particular country. The black line refers to the secondary axis and displays the average trade values for milk products in 1000 USD for each country. This allowed a comparison of the measures of export competitiveness with the actual trade values. According to Figure 1, France, Germany and the Netherlands are ranked one to three, even if they do not have the highest values in trade. Germany trades most. It might be assumed that Germany would therefore be the most competitive country, however according to these indices it is only ranked third.

Relatively high values were also found for  $CMS_{Resid}$  in Eastern European countries (such as Poland, Latvia and Romania). Countries that are known as common milk countries, such as France and Denmark, are at the bottom of this list, with Germany ranked 16<sup>th</sup> (9<sup>th</sup> best).

### Panel regression results

The model in equation (2.7) was estimated for both aggregate dairy product exports and individual categories. For this purpose, the indices were also computed for all subgroups and the corresponding models estimated in order to assess the overall robustness of the results. Table 4 presents selected results from the dynamic panel data model for the most relevant and meaningful subgroups.

[Table 4]

The results in table 4 reveal significant lags of the dependent variable throughout. This indicates strong dynamics in export competitiveness, implying that if the dairy industry in a country performed well in exporting in the previous period, it was more likely than not to do well in present and future periods. This variable captures the unobserved effects from export contacts and the specific skills accumulated within the exporting firms. Export competitiveness would appear not to be something that can be bought or switched on or off on demand. It requires continuous effort and the build-up of competencies that are otherwise not captured by these explanatory variables. This finding, however, was not confirmed for most specifications of the  $CMS_{Resid}$ . Apparently, this competitiveness indicator about short-term gains in exports does not depend as crucially on similar factors as the other indicators do. In general, this set of explanatory variables exhibited only poor explanatory power on the CMS residuals. It was concluded that CMS-type relative competitiveness for dairy product exports from EU countries overall is not related to any of the structural factors that were included in this study's model.

The estimations were made with robust standard errors and were further tested for first-order and second-order autocorrelation. Not rejecting the null-hypothesis of first-order autocorrelated parameters does not violate the maintained statistical assumptions and is therefore not a sign of an invalid model (Baltagi, 2013: 159). Most important in this regard were the results for second-order autocorrelation. In general, p-values were found to be in line with the assumptions implied by this dynamic GMM estimator, which means that the null-hypothesis can be rejected and it can be concluded that there is no second-order autocorrelation in the model specifications, while the first-order autocorrelation should be expected and can be tolerated.

To assess the hypotheses from table 2, hypotheses (3), (6) and (7) were confirmed, hypotheses (2), (4) and (5) were not confirmed and hypothesis (1) was rejected. Hypothesis (3) related to the influence of dairy patents on export success. Positive significant relationships of patents were found on XMS, TBI and  $NRCA_{\text{exclEU}}$ . In contrast to this study's hypothesis that patents affect export success earlier after a lag of one or two years, it was found that they actually already influence export competitiveness in the year of application. This indicates that the patent itself may not stimulate exports, but that countries of innovative dairy industries are more export competitive. It was therefore concluded that the role of patents should perhaps be viewed rather as a proxy for innovativeness than as a direct determinant of export performance. New and more innovative products can be assumed to be more export competitive than established products. Furthermore, process-related innovations may save costs and can stimulate exports immediately. Hypothesis (6) concerned average net investments per milk processor and here it was found that investments influence export success with a lag of one year, which is in line with the hypothesis. Hypothesis (7) was also confirmed: high personnel costs in a country's dairy sector negatively influence the competitiveness of its dairy exports, and this effect occurs mostly in the same time period rather than in the lagged variables, which is an indication of the direct cost effects on exports.

Regarding hypotheses (2), (4) and (5) it was concluded that there is neither a positive nor a negative significant influence on export competitiveness for countries that have the euro as their currency. Furthermore, estimated coefficients for the number of products with a protected geographical status in an EU country appear to be insignificant overall and therefore on aggregate do not seem to have a beneficial effect on the country's dairy export performance.

Finally, the hypothesis that becoming an EU member would positively affect dairy export competitiveness has been rejected, with the caveat that significant coefficients were only found for the TBI of product group 0401, while others turned out to be insignificant. This implies that becoming an EU member reduces the TBI significantly in the case of fresh milk products, which is plausible because this indicator measures the ratio between exports and imports. Clearly, EU membership will increase consumers' access to fresh dairy product varieties, which may produce welfare gains even though the trade balance declines. However this may not affect exports in the same way.

## 5 Conclusions and discussion

The ability of European dairy processors to export competitively has become increasingly important in the last few years and is expected to continue to be an important source of revenue for EU dairy farmers as well. Following the standard paradigm in the new-new trade theory (Melitz, 2003), according to which only the most productive companies would engage in export activities, a dynamic panel of dairy product export performance of EU countries was estimated in order to test how selected structural indicators from each country's dairy industry may relate to export competitiveness. The ranking of competitiveness measures found that competitiveness was not necessarily proportional to the total dairy trade volume of any specific EU country. Germany was found to have the highest export values of all EU member states, but overall did not show the highest relative export performance in terms of the competitiveness indices. Considering Germany's large share of cooperative dairy processors, which are estimated to take in between 60 % and 70 % of Germany's raw milk production, in the near future export competitiveness may become the subject of internal discussions about the efficiency of dairy cooperative governance. The results highlighted the strong significance of net investments by dairy companies and the role of patents as an approximation for innovativeness. In contrast, the role of protected geographical origins was less important overall for global export performance.

This could be due to the method of simply counting the number of regions per country, but it could also reveal that these products tend to be bound more for the domestic EU market.

Policymakers and upcoming reforms of the common agricultural policy should therefore focus on promoting an innovative environment for the dairy sector, in which private firms and public research work hand in hand on innovations that will lead to product or process improvements in European dairy value chains. In turn, based on the results of the present study, dairy processing firms in cooperatives will have to see the efficient deployment of personnel as an effective measure for reducing costs and improving export competitiveness.

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## 7 Tables

**Table 1.** Competitiveness indices and measures

Index	Abbr.	Formula	Definition	Reference
Export market share	XMS	$XMS = \frac{X_r^i}{X_W^i}$	Share of product $i$ 's exports from country $r$ of world export for product $i$	
Export market penetration	XMP	$XMP = \frac{X_r^i}{M^i}$	Number of countries to which country $r$ exports product $i$ divided by all countries that import product $i$	
Trade balance index	TBI	$TBI_r^i = \frac{X_r^i - M_r^i}{X_r^i + M_r^i}$	States whether a country is a net-importer (TBI<0) or net-exporter (TBI>0) of product $i$	Lafay (1992)
Normalised revealed comparative advantage	NRCA	$NRCA_r^i = \frac{X_r^i}{X_{Ag}} - \frac{X_r * X^i}{X_{Ag} * X_{Ag}}$	Agricultural export share of country $r$ for product $i$ minus the comparative neutral point for the respective product group and country	Yu et al. (2009)
Residuals of constant market share	CMS <sub>Resid</sub>	$CMS_{Resid,t+1}^i = v_r^i - v_W^i$ $= \frac{V_{r,t+1}^i}{V_{t,r}^i} - \frac{V_{W,t+1}^i}{V_{W,t}^i}$	Growth rates of product $i$ from country $r$ minus world's growth rate for product $i$ ; gives residual growth rate of product $i$ in country $r$	Leamer and Stern (1970)

**Table 2.** Dependent variables and hypotheses

	<b>Variable</b>	<b>Description</b>	<b>Hypothesis</b>
(1)	d_EU_member	Dummy for EU membership; 0= no member, 1=member	Positive relationship regarding export competitiveness due to decrease of transaction costs and a common market
(2)	d_Euro	Dummy for member of the Eurozone; 0= no member, 1= member	Negative relationship regarding extra EU export competitiveness due to a strong euro in the observed period, but positive relationship for intra EU exports due to lower transaction costs which go along with a common currency
(3)	EPO_Patents	Number of dairy patents	Positive relationship regarding export competitiveness since the number of patents is taken as proxy for innovation
(4)	PDOPGI Cheese	Number of cheese products with a protected geographical status	Positive relationship regarding export competitiveness the more products in the country that have this label
(5)	PDOPGI Milk	Number of milk products (excluding butter) with a protected geographical status	Positive relationship regarding export competitiveness the more products in the country that have this label
(6)	NetInv	Net investments in material goods per milk processor (in € million)	Positive relationship regarding export competitiveness
(7)	PersCost	Personnel costs in production as share of output value (%)	Negative relationship regarding export competitiveness
Cont-rol	LNF	Agricultural area of the country	Control variable for a country's agricultural specification

**Table 3.** Average values of competitiveness measures (average of 2002-2015) sorted by average trade value of dairy exports

<b>Country</b>	<b>AvgTradeValues</b> in 1000 USD	<b>Market Share</b>	<b>Market Penetration</b>	<b>CMS Residuals</b>	<b>NRCAinkl EU</b>	<b>NRCAexk IEU</b>	<b>TBI</b>
DEU	8453687	0.14	0.78	0.00	0.004583	0.000725	0.75
FRA	6509181	0.11	0.80	-0.03	0.002810	0.001115	0.80
NLD	6388176	0.11	0.79	-0.01	0.002344	0.002068	0.77
BEL	3109836	0.05	0.69	-0.02	0.000994	0.000428	0.66
ITA	2281537	0.04	0.69	0.00	0.000184	0.000311	0.52
DNK	2254968	0.04	0.65	-0.05	0.001573	0.000860	0.67
IRL	1840057	0.03	0.55	-0.01	0.001435	0.000513	0.46
GBR	1480991	0.03	0.67	-0.01	-0.000037	-0.000109	0.54
POL	1436034	0.02	0.52	0.12	0.000573	0.000372	0.68
AUT	1180743	0.02	0.46	-0.02	0.000565	0.000001	0.47
ESP	911814	0.02	0.62	-0.03	-0.001084	-0.000225	0.34
CZE	650093	0.01	0.35	0.07	0.000331	0.000126	0.27
LTU	503386	0.01	0.33	0.06	0.000286	0.000168	0.52
FIN	500888	0.01	0.29	-0.03	0.000369	0.000384	0.21
GRC	364982	0.01	0.33	0.05	0.000067	-0.000019	-0.10
SWE	358791	0.01	0.35	0.05	0.000035	0.000046	0.16
PRT	304424	0.01	0.35	0.00	0.000050	0.000001	0.34
SVK	277547	0.00	0.23	0.09	0.000146	0.000019	0.03
HUN	209984	0.01	0.24	0.03	-0.000144	0.000004	-0.04
EST	168206	0.00	0.19	0.03	0.000140	0.000056	0.21

LVA	164675	0.00	0.20	0.19	0.000118	0.000022	0.21
SVN	132380	0.00	0.15	0.04	0.000081	0.000027	-0.29
BGR	91989	0.00	0.32	0.08	0.000029	0.000020	0.14
CYP	62486	0.00	0.22	0.06	0.000060	0.000041	-0.41
ROM	46900	0.00	0.16	0.15	-0.000034	-0.000018	-0.35

**Table 4.** Dynamic panel estimation results<sup>4</sup>

<i>Export competitiveness</i>	XMS_0402 <sup>5</sup>	TBI_0401	TBI_0402	NRCA_0402_inc IEU	NRCA_0402_exc IEU
L1. (First lag of dependent variable)	0.896*** (0.030)	0.771*** (0.054)	0.737*** (0.057)	0.9064*** (0.040)	0.79757*** (0.057)
EPO_Patents related to milk production	0.001** (0.001)	0.016*** (0.007)	0.02** (0.011)	0.00001 (0.000)	0.00001* (0.000)
L1.	0.000 (0.000)	-0.002 (0.010)	-0.001 (0.010)	-0.00001 (0.000)	0.00000 (0.000)
L2.		0.008 (0.014)	0.021 (0.015)	0.00001 (0.000)	0.00001 (0.000)
PDOPGICheese				-0.00001 (0.000)	-0.00001 (0.000)
L1.				0.00001 (0.000)	0.00001 (0.000)
PDOPGIMilk	0.001 (0.001)	0.027 (0.020)	-0.009 (0.026)	0.00000 (0.000)	-0.00001 (0.000)
L1.	-0.001 (0.001)	-0.017 (0.017)	0.024 (0.022)	0.00000 (0.000)	0.00002 (0.000)
Net investments per dairy company	-0.001 (0.001)	0.085 (0.057)	0.006 (0.051)	0.00003 (0.000)	0.00001 (0.000)
L1.	0.002* (0.001)	-0.099 (0.074)	0.013 (0.044)	0.00005** (0.000)	0.00004*** (0.000)
Personnel costs relative to revenue	-0.031 (0.027)	-0.585 (1.011)	-2.378** (1.144)	-0.0022* (0.001)	-0.00165* (0.001)
L1.	-0.005 (0.032)	-1.574* (0.926)	-0.64 (1.109)	0.00149 (0.001)	0.00094 (0.001)
Total agricultural area	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.00000 (0.000)	0.00000 (0.000)
L1.	0.000* (0.000)	0.000 (0.000)	0.000 (0.000)	0.00000 (0.000)	0.00000 (0.000)
d EU member	-0.001 (0.001)	-0.302*** (0.081)	-0.049 (0.141)	-0.00001 (0.000)	0.00000 (0.000)
d_Euro	0.001 (0.001)	-0.002 (0.059)	-0.03 (0.028)	-0.00002 (0.000)	0.00000 (0.000)
AR(1)	P> z  0.044	P> z  0.002	P> z  0.001	P> z  0.044	P> z  0.014
AR(2)	0.675	0.454	0.883	0.806	0.691

Robust estimation, standard errors given in parentheses, constants not reported.

\*\*\*, \*\* and \* indicate significance at the 1, 5 and 10 % level respectively.

<sup>4</sup> Estimation results for further aggregations and subgroups of dairy products are not displayed here due to space restrictions, but can be obtained upon request from the authors.

<sup>5</sup> 0401: milk and cream, not concentrated; 0402: milk and cream, concentrated.

## 8 Figures

**Figure 1.** Export competitiveness ranks in contrast to average dairy export volume (average of 2002-2015). Own presentation

