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Country and industry specific determinants of intra-industry agri-food trade in the Baltic Countries

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Abstract: The article analyses the country and industry specific determinants of the horizontal and vertical intra-industry agri-food trade between the Baltic Countries and the European Union in 1999–2013. Results obtained by the GMM panel model estimations suggest that distance is negatively related to IIT, implying that geographical distance is an obstacle for intra-industry agri-food trade. Moreover, factor endowments are ambiguously related to IIT as land is found to be negatively, while labour and machinery to be positively related to both sides of the IIT. Results also show that product differentiation fosters two way trade of the quality-differentiated goods as a positive relationship exists between the agricultural employment and IIT. As to productivity, all model runs show a negative relationship for HIIT but positive for VIIT, implying that low-quality product exports dominate the agri-food trade of the Baltic Countries. Furthermore, FDI was also found to have a negative relationship with IIT, suggesting that foreign capital does not foster IIT.

Keywords: agricultural trade, trade, Baltic Countries, determinants, European Union, gravity model

During the last decades, intra-industry trade (IIT) has become a widespread phenomenon with a growing role in international trade (Brülhart 2009). The formation of stronger economic ties between the European countries due to the creation and expansion of the EU contributed to an increase in intra-industry trade among European countries.

Despite the importance of the topic, the majority of literature is focused on IIT of industrial products with agricultural produce usually neglected in the empirical works (McCorriston and Sheldon 1991), possibly because agricultural markets are assumed to be competitive. However, recent studies support the view that agricultural markets can be characterized by imperfect competition (Sexton, 2013) and IIT has an increasing role in agricultural trade for both developed and developing countries (e.g. Leitão 2011; Rasekhi and Shojaee 2012; Wang 2009; Varma 2012). Moreover, the majority of literature is focused on a single country and many simply neglect the importance of the horizontal/vertical distinction of IIT.

The aim of this article is to identify both the country and the industry specific determinants of the horizontal and vertical intra-industry agri-food trade between the Baltic Countries and the European Union in 1999–2013. Such an approach aims to contribute to the literature of the field in four ways: (1) analysing a group of countries instead of a single country, (2) focusing on agri-food products, (3) distinguishing between the horizontal and vertical IIT and (4) analysing both country and industry specific determinants.

THEORETICAL FRAMEWORK

Traditional trade theories assume constant returns to scale, homogenous products and perfect competition and aim to explain inter-industry trade based on comparative advantages. However, a significant portion of the world trade over since the 1960s took the form of intra-industry trade rather than the inter-industry trade. Consequently, the traditional trade models proved to be inadequate in explaining this new trade pattern as there is no reason for developed countries to trade in similar but slightly differentiated goods.

In the 1970's, an increasing amount of research dealt with this issue, providing a theoretical basis for intra-industry trade (IIT), defined as the simultaneous export and import of products belonging to the same statistical product category. The first synthesising model of IIT was developed by Helpman and Krugman (1985), creating a framework for intra-industry trade theory by using the Chamberlin monopolistic com-

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petition theory. This model combines monopolistic competition with the Heckscher-Ohlin (HO) theory, incorporating factor endowments differences, the product differentiation and increasing returns to scale. It has pointed out that comparative advantages drive inter-industry trade through specialisation, while the economies of scale drive intra-industry trade.

According to the pioneering work of the Falvey (1981), notions of the horizontal and vertical product differentiation have come into existence in the literature. The horizontal intra-industry trade (HIIT) refers to homogenous products with the same quality but with different characteristics, while the vertical intra-industry trade (VIIT) means products traded with a different quality and price. Following the author's work, three types of bilateral trade flows may occur between countries: inter-industry trade, HIIT and VIIT.

The horizontal differentiation is more likely between countries with similar factor endowments, while according to Falvey and Kierzkowski (1987), the vertically differentiated goods occur because of the factor endowment differences across countries. As the authors suggest, the amount of capital relative to labour used in the production of the vertically differentiated good indicates the quality of the good. Consequently, the higher-quality products are produced in capital abundant countries, while the lower-quality products are produced in labour abundant countries. Thereby, the vertical IIT occurs as the capital abundant country exports higher-quality varieties as well as the labour abundant country exports lower-quality products. It is therefore predictable that the share of IIT will increase as the countries' income and factor endowments diverge.

EMPIRICAL EVIDENCE

The role of intra-industry agri-food trade analyses seems to have increased in the scientific literature recently (Fertő and Soós 2009; Bojnec and Fertő 2012; Jámbor 2014). The first strand of literature is concentrating on identifying and analysing the *country specific determinants* of IIT. In doing so, Fertő (2005) analysed VIIT and differences in factor endowment between Hungary and the EU15 agri-food products trade and found a positive relationship between the factor endowment and the vertical IIT, while a negative correlation was pointed out in the case of distance. Fertő (2007) analysed the Hungarian intra-industry agri-food trade patterns with the EU15 and proved that the determinants for the horizontal and vertical IIT differed. The horizontal intra-industry trade was negatively associated with the differences in per capita income, the average GDP, distance and the distribution of income, while income and distance was found to be positively related to VIIT.

Leitão (2011) was in search for the determinants of the United States' agricultural IIT and showed that it was positively influenced by the average GDP, FDI and the trade imbalance, while it had a negative relationship with the differences in the per capita GDP. Rasekhi-Shojaee (2012) investigated the country specific determinants of the vertical and total intra-industry trade between Iran and its main trading partners and proved that the vertical IIT was positively influenced by land endowments, but negatively affected by the size of the trading partners. Caetano and Galego (2007) were searching for the determinants of intra-industry trade within an enlarged Europe and also found that the determinants of the horizontal and vertical IIT differed, although both had a statistically significant relationship with a country's size and the foreign direct investment. According to their results, the country size, the income per capita differences and the geographic distance were found to be important factors for IIT, especially for the horizontal IIT.

Jensen and Lüthje (2009) analysed driving forces of VIIT in Europe and identified the production size, the geographical proximity, the average income per capita and the income distribution overlap as the major ones. It was proven that countries characterized by being on a high economic level and by being large economies had a higher bilateral VIIT with each other than with other countries. Furthermore, countries with a large income distribution overlap tended to have a large VIIT, while countries far from each other had a lower VIIT than the countries close to each other.

Gabrisch (2009) was searching for the determinants of VIIT between the old and new member states of the EU and found the country-pair fixed effects to be of a high relevance for explaining the vertical intra-industry trade. More concretely, the technology differences were positively, while the differences in the factor endowment were negatively correlated with the vertical intra-industry trade. Moreover, changing bilateral differences in the personal income distribution during the transition of the NMS found to be contributed to changes in the vertical intra-industry trade.

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Fainštein and Netšunajev (2011) analysed intra-industry trade patterns in the Baltic States and showed that the market size was positively related to IIT. However, a negative relationship between the distance and the share of IIT was found together with a negative correlation between the difference in human capital and IIT. Ambroziak (2012) investigated the relationship between FDI and IIT in the Baltic countries and found that FDI stimulated not only VIIT in the region but also HIIT. He found that differences in the country size and income were positively related to IIT as are FDI, while the distance and IIT showed a negative relationship. Pittiglio (2014) analysed intra-industry trade of intermediate goods in Italy and concluded that differences in the factor endowments and the R&D as well as the regional trade agreements enhanced VIIT, while the distance and VIIT was negatively related. Jámbor (2014) and Fertő and Jámbor (2015) analysed the country specific determinants of IIT for agri-food products for the NMS and found that the factor endowments are ambiguously related to the agri-food horizontal and vertical intra-industry trade. Economic size was found to be positively and significantly related to both types of IIT, while the distance and IIT were found to be negatively related in both cases. Proença and Faustino (2015) analysed the Portuguese IIT trade patterns in a global context by applying a semiparametric procedure on their dataset and found that differences in the GDP per capita and capital endowments fostered IIT, while the trade imbalances were negatively related to IIT.

The other strand of the literature is searching for the *industry specific determinants* of IIT. Loerstcher and Wolter (1980) analysed the industry-specific determinants of intra-industry trade (IIT) for 13 OECD countries and found a positive relationship between the product differentiation and intra-industry trade, while the economies of scale and IIT were found to be inversely related. Hartman et al. (1993) investigated IIT for food processing in the United States and by using an OLS model, they found the product differentiation and the economies of scale to be positively related to IIT, while the industrial concentration was found to have a negative impact on IIT. Bergstrand (1983) also analysed the OECD countries IIT and found that the economies of scales were negatively related to both sides of IIT.

Lee (1989) investigated intra-industry trade for thirteen Pacific countries and found that the product differentiation and FDI were positively related to IIT, while the industrial concentration and IIT were found to be inversely related. Faustino and Leitão (2007) were in search for the determinants of intra-industry trade for Portugal in 1995–2002 and suggested that the physical capital had a negative impact on vertical intra-industry trade, meaning that Portugal exported low-quality products to the European Union.

Leitão and Faustino (2008) investigated intra-industry agri-food trade patterns for Portugal in 1995–2003 and found that the economies of scales had a positive, while the industrial concentration had a negative impact on IIT. Bojnec (2001) analysed the effects of trade liberalisation on intra-industry agri-food trade flows for Central and Eastern European Countries and found diversification as one of the most important effects. Lapinska (2014) also searched for the determinants of the agri-food IIT between Poland and the European Union and found that IIT was positively influenced by the trade intensity, economic development, the EU membership, while the relative economic sizes and the trade turnover imbalances were found to be negatively related to IIT.

Ekanayake and Veeramacheni (2009) were in search for the horizontal and vertical intra-industry trade patterns between the US and the NAFTA countries and found a positive relationship between the product differentiation and IIT. Cernosa (2009) analysed the industry-specific determinants of IIT in Slovenia and found the product differentiation, the economies of scale, the industrial concentration and multinational firms as the determinant factors of IIT.

In short, the studies highlighted the increasing role of intra-industry trade in agri-food trade. In addition, in line of the recent empirical evidence, the papers confirm that the horizontal and vertical IIT are influenced by different factors and therefore the distinction makes sense.

MEASURING THE VERTICAL AND HORIZONTAL INTRA-INDUSTRY TRADE

Several methods exist to measure intra-industry trade. First, the classical Grubel-Lloyd (GL) index has to be mentioned, which is expressed formally as follows (Grubel and Lloyd, 1975):

$$GL_i = 1 - \frac{|X_i - M_i|}{(X_i + M_i)} \quad (1)$$

where X_i and M_i are the value of exports and imports of product category i in a particular country. The

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GL index varies between 0 (complete inter-industry trade) and 1 (complete intra-industry trade) and can be aggregated to the level of countries and industries as follows:

$$GL = \sum_{i=1}^{n} GL_i w_i \text{ where } w_i = \frac{(X_i + M_i)}{\sum_{i=1}^{n}(X_i + M_i)} \quad (2)$$

where w_i comes from the share of industry i in the total trade. The high level of intra-industry trade between two countries refers to a higher degree of economic integration (Qasmi and Fausti 2001). However, several authors criticised the GL-index, for five main reasons: (1) aggregate or sectoral bias, (2) trade imbalance problem, (3) geographical bias, (4) inappropriateness to separate the horizontal and vertical intra-industry trade (HIIT and VIIT), (5) inappropriateness for treating dynamics. Detailed discussion of these problems but the fourth would distract from the basic aim of this paper; a comprehensive review can be found in Fertő (2004).

The fourth problem of the GL-index is given by the joint treatment of the horizontal and vertical trade. Literature suggests several possibilities for solving this problem. Among these solutions, the most widespread one is based on unit values developed by Abd-el Rahman (1991). The underlying presumption behind unit values is that the relative prices are likely to reflect the relative qualities. According to the widespread view in the literature based on this presumption, horizontally differentiated products are homogenous (perfect substitutes) and of the same quality, while the vertically differentiated products have different prices reflecting a different quality (Falvey 1981). According to the method of Greenaway et al. (1995), a product is horizontally differentiated if the unit value of export compared to the unit value of import lies within a 15% range at the five digit SITC level. If this is not true, the GHM method is talking about vertically differentiated products. Formally, this is expressed for the bilateral trade of horizontally differentiated products as follows:

$$1 - \alpha \leq \frac{UV_i^X}{UV_i^M} \leq 1 + \alpha \quad (3)$$

where UV means unit values, X and M means exports and imports for goods i and $\acute{\alpha} = 0.15$. If this equation is not true, the GHM method talks about vertically differentiated products. Furthermore, Greenaway et al. (1994) added that results coming from the selection of the 15% range do not change significantly when the spread is widened to 25%. Blanes-Martin (2000) developed the model further and defined a high and low VIIT. According to their views, a low VIIT means that the relative unit value of a good is below the limit of 0.85, while the unit value above 1.15 indicates a high VIIT.

Based on the logic above, the GHM index comes formally as follows:

$$GHM_k^p = \frac{\sum_j \left[\left(X_{j,k}^p + M_{j,k}^p\right) - \left|X_{j,k}^p - M_{j,k}^p\right|\right]}{\sum_j \left(X_{j,k} + M_{j,k}\right)} \quad (4)$$

where X and M stands for export and import, respectively, while p distinguishes the horizontal or vertical intra-industry trade, j is for the number of product groups and k is for the number of trading partners (j, k = 1, ... n).

There is another popular method in the literature to distinguish HIIT and VIIT. Fontagné and Freudenberg (FF method, 1997) categorize trade flows and compute the share of each category in the total trade. They defined trade to be "two-way" when the value of the minority flow represents at least 10% of the majority flow. Formally:

$$\frac{Min(Xi, Mi)}{Max(Xi, Mi)} \geq 10\% \quad (5)$$

If the value of the minor flow is below 10%, the trade is classified as inter-industry in nature. If the opposite is true, the FF index comes formally as:

$$FF_k^p = \frac{\sum_j \left(X_{j,k}^p + M_{j,k}^p\right)}{\sum_j \left(X_{j,k} + M_{j,k}\right)} \quad (6)$$

After calculating the FF index, the trade flows can be classified as follows: horizontal two-way trade, vertical two-way trade and one-way trade. According to Fontagné and Freudenberg (1997), the FF index tendentiously provides higher values compared to the GL-type indices (like the GHM index) as Equation 5 refers to the total trade, treated before as the two-way trade. The authors suggest that the FF index rather complements than substitutes the GL-type indices as they have measured the relative weight of different trade types in the total trade. In conclusion, they found that the value of the GHM index is usually between the GL and FF index.

All the indices shown above measure the share of intra-industry trade instead of its level which is a much better index as Nilsson (1997) suggests. According to the author, IIT should be divided by the number of product groups in the total trade, resulting in an

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average IIT by the product group. By applying this logic to the horizontal and vertical IIT and formally expressing the Nilsson index as (Fertő 2004):

$$N_k^p = \frac{\sum_j \left[\left(X_{j,k}^p + M_{j,k}^p\right) - \left|X_{j,k}^p - M_{j,k}^p\right|\right]}{n^p} \quad (7)$$

where the numerator equals to that of the GHM index, while n refers to the number of the product groups in the total trade. Nilsson argues that his measure provides a better indication of the extent and volume of IIT than the GL-type indices and is more appropriate in the cross-country IIT analyses.

In order to calculate intra-industry trade indices, the article uses the Eurostat international trade database using the HS6 system (six digit breakdown) as a source of raw data. Agri-food trade is defined as the trade in product groups HS 1-24, resulting in 1229 products using the six digit breakdown. The article works with the trade data for the period 1999–2013 due to the data availability. In this context, the EU is defined as the member states of the EU-28.

THE NATURE OF INTRA-INDUSTRY TRADE IN THE BALTIC COUNTRIES

Using the methods outlined above, indices of the horizontal and vertical IIT for agri-food products were calculated between the Baltic Countries and the EU, for the period 1999 to 2013, using the Eurostat data. Table 1 indicates that the agri-food intra-industry trade is mainly vertical in nature in the countries analysed, according to all indices, suggesting the exchange of products of a different quality. However, low values for IIT (the sum of vertical and horizontal IIT) suggest that the inter-industry trade prevails in these countries' agri-food trade with the EU in the period analysed. These findings are consistent with the results of the previous research (Fertő 2005; Jámbor 2014) and with the previous studies indicating that the proportion of intra-industry trade was higher for food products involving a greater degree of processing (McCorriston and Sheldon 1991; Qasmi and Fausti 2001).

Table 1. Horizontal and vertical intra-industry trade in agri-food products between the Baltic Countries and EU member states in 1999–2013, by country

Country	Horizontal			Vertical		
	GHM	FF	N	GHM	FF	N
Estonia	0.01	0.02	1704	0.04	0.07	5005
Latvia	0.01	0.02	3400	0.04	0.07	6568
Lithuania	0.02	0.03	3985	0.05	0.08	7800

*N^H and N^V are measured in euro

Source: Own calculations based on Eurostat (2015)

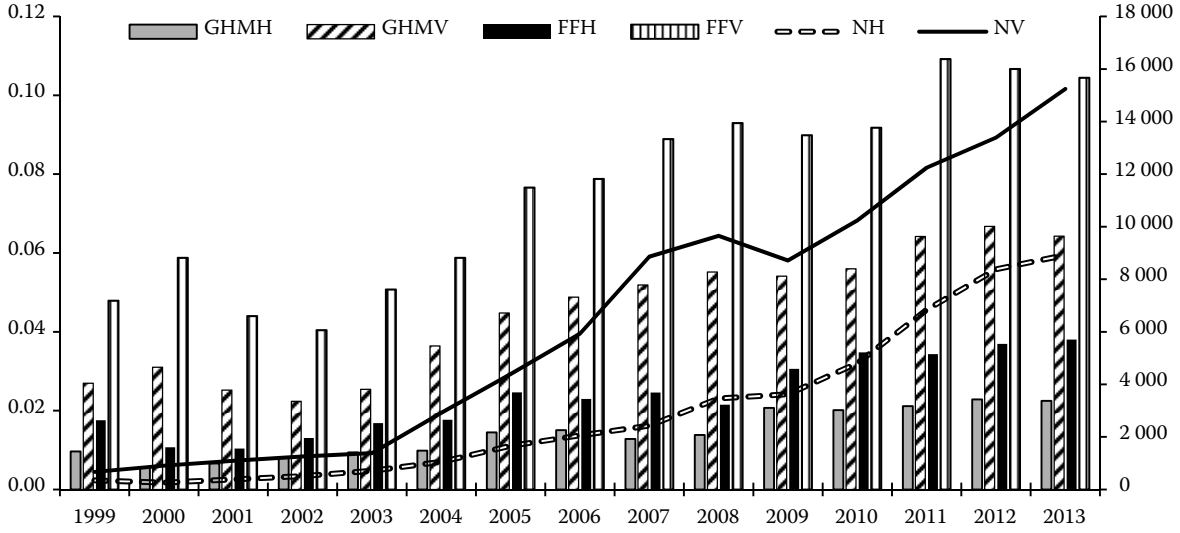

Figure 1. Horizontal and vertical intra-industry trade in the agri-food products between the Baltic Countries and the EU member states in 1999–2013 by time*

*N^H and N^V are measured on the right axis in euro

Source: Own calculations based on Eurostat (2015)

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Analysing the horizontal and vertical intra-industry agri-food trade in time shows a significant increase after the 2004 enlargement (Figure 1). The GHM and FF indices generally increased for the horizontal and vertical IIT two times from 2003 to 2013, while the N indices increased 11–12 times in the same period. The vertical IIT increased less than the horizontal IIT in all cases analysed.

Figure 2 provides further insights to the analyses above. Using the idea of Blanes and Martín (2000), VIIT was separated into vertically high and low categories, suggesting different qualities of trade. It is observable that a low vertical IIT predominates in the total IIT in the majority of the cases, indicating a low quality export products to the EU28 markets. Latvia had the highest share (52%) of the low vertical IIT in the total IIT in 1999–2013, while Lithuania had the lowest (37%). Similar results can be obtained if this pattern is analysed in time. The overall picture is quite unfavourable to the majority of countries as the trade of low quality products is usually associated with low prices and unit values, suggesting structural problems in agriculture (Ambroziak 2012).

In short, IIT is mainly of a vertical nature in the Baltic Countries' agri-food trade, suggesting the exchange of products of different quality. The share of IIT has been increasing significantly since the 2004 EU enlargement, though these countries are mainly exporting low quality agri-food products to the EU28 markets. However, it seems that the majority of agri-food trade has still remained one-way (or inter-industry) in nature, suggesting complementarity rather than competition in production (Fertő 2007).

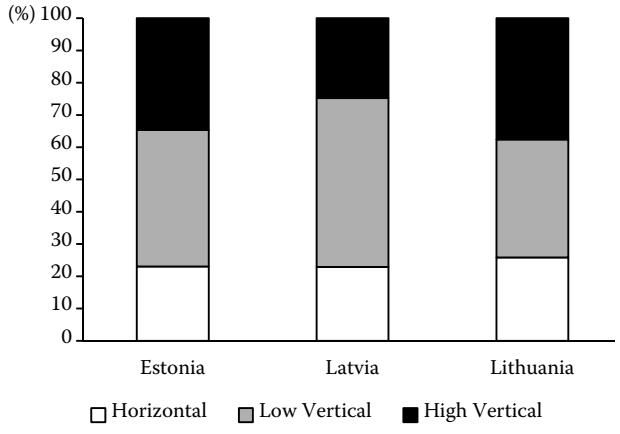

Figure 2. The pattern of IIT in agri-food products between the Baltic Countries and the EU member states in 1999–2013 by country (%)*

*Based on GHM-method

Source: Own calculations based on Eurostat (2015)

HYPOTHESES AND ECONOMETRIC SPECIFICATIONS

Based on the theoretical and empirical research to date, the following five hypotheses are tested in the article. Out of these, the first two are related to the country-specific, while the last three to the industry-specific determinants of HIIT and VIIT.

H1. Difference in factor endowments between trading partners increases (decreases) the share of the vertical (horizontal) IIT in the total trade. The difference in factor endowments is usually measured by the inequality in the per capita GDP, in line with the model developed by Falvey and Kierzkowski (1987). Linder (1961) considers that countries with similar demands have similar products, consequently the vertical type trade increases with differences in the relative factor endowments. Factor endowments are proxied by several variables. First, the logarithm of absolute value of the difference in the per capita GDP is used among each and every EU member state (lnDGDPC), which is expected to be positively (negatively) related to the share of the vertical (horizontal) IIT. Per capita GDP is measured in the PPP in current international dollars and the data comes from the World Bank WDI database.

However, the use of the per capita GDP as a proxy for the relative factor endowments is problematic. Linder (1961) already noted that the inequality in the per capita income may serve as a proxy for the differences in preferences as suggested. In addition, Hummels and Levinsohn (1995) argued that this proxy is appropriate only when the number of factors is limited to two and all goods are traded, thus they proposed the income per worker as a measure of differences in the factor composition and also using the actual factor data on the capital-labour and land-labour ratios. Interestingly, despite of these limitations in the use of the GDP per capita, it became a popular and dominating proxy for factor endowments in the empirical literature. However, the nature of factor endowments may also play an important role in specialization in the quality ranges. Thus, it is necessary to use more variables to consider various aspects of factor endowments including the physical, technological and human capital. The standard solu-

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tion is to employ the investment in physical capital, the R&D expenditures and the education expenditure (e.g. Milgram-Baleix and Moro-Egido 2010).

As the article analyses the agri-food trade patterns, the agricultural-related relative factor endowment variables are used as proxies for factor endowments. More specifically, three traditional agricultural factors as land, labour and capital are measured by the logarithm of the absolute value of the difference in agricultural land, labour and machinery per capita (lnDLAND, lnDLAB, lnDMACH) among the EU trading partners, which are expected to be positively (negatively) related to the share of the vertical (horizontal) IIT. Agricultural land per capita is measured in hectares/person (data source: the FAO), agricultural labour is measured in annual working units/person (data source: the Eurostat and the FAO), while agricultural machinery is measured in euro/person (data source: the FADN and the FAO).

H2. IIT will be greater the closer the countries are geographically. The distance between countries well reflects transport costs. It is evident that the closer the countries are, the cheaper the trade is. Variable lnDIST indicates the geographic distance between the reporting country and each of its trading partners by calculating the logarithm of the distance between the capital cities of trading partners in kilometres. The source of data is the CEPII database. LnDIST is expected to be negatively related to HIIT and VIIT.

H3: Vertical product differentiation fosters the vertical intra-industry trade. Vertical product differentiation (VPD), as a proxy for the quality-based trade, is usually found to be positively related to VIIT (Greenaway et al. 1995; Crespo and Fontoura 2004; Ekanayake and Veeramacheneni 2009). Based on Falvey and Kierzkowski (1987) and Shaked and Sutton (1987), higher quality products are assumed to be better traded than others. The VPD is measured by the percentage of employment in agriculture and the data is downloaded from the World Bank World Development Indicators (WDI) database. A positive sign is expected for VIIT, while a negative one for HIIT.

H4: Foreign direct investment discourages IIT. Foreign direct investments (FDI) play a crucial role in intra-industry trade as investing in production or processing facilities abroad encourages the trade of different quality products. However, the empirical literature does not always support this argument as it is evident from our literature review. FDI data comes from the WDI database and a negative sign for both sides is expected.

H5: Productivity is against IIT. It seems evident that most productive sectors have higher levels of product differentiation (Török and Jámbor 2013; Fertő 2015). However, the low-quality agri-food trade of the Baltic Countries implies a negative relationship between the productivity and IIT – therefore a negative sign is expected here. Productivity is proxied by the value added of an agricultural employer and data is coming from the WDI again.

The paper applies the gravity equation approach to analyse the determinants of the horizontal and vertical IIT in Baltic Countries agri-food trade with the European Union in 1999–2013. Such approach is methodologically correct as is evident from the systematic review of Reuben et al. (2013). Because the dependent variables range between zero and one, the logit transformation is employed, consistent with the recent studies (Leitão 2012; Turkcan and Ates 2010). The model by Flam and Helpman (1987) is tested with the following specification:

$$\begin{aligned} \ln IIT_{ijt} = {} & \alpha_0 + \alpha_1 \ln DGDPC_{ijt} + \alpha_2 \ln DLAND_{ijt} \\ & + \alpha_3 \ln DLAB_{ijt} + \alpha_4 nDMACH_{ijt} + \alpha_5 \ln DIST_{ijt} \\ & + \alpha_6 \ln VPD_{ijt} + \alpha_7 \ln FDI_{ijt} + \alpha_8 \ln PROD_{ijt} + v_{ij} + {}_{ij} \end{aligned} \quad (8)$$

Table 2 provides an overview of the description of variables and the related hypotheses.

In estimating the determinants of IIT, this study applies a dynamic panel data GMM-System model, elaborated by Blundell and Bound (1998) and used in the recent literature (Leitão 2012; Jámbor 2014). Although many other static panel data techniques are available in the literature including the pooled OLS, the fixed effects (FE) and random effects (RE), the feasible generalised least squares (FGLS) and the panel-corrected standard errors (PCSE) method, they are criticised for many reasons. First of all, these models ignore the unobserved cross-country heterogeneity (Turkcan and Ates 2010). Second, the static panel data models are unable to manage the heteroskedasticity and autocorrelation (Beck and Katz 1995). Third, Baltagi (2008) has shown that when endogeneity among the right-hand-side regressors matters, the OLS and random effects estimators are substantially biased and both yield misleading inferences. The problems of the serial correlation and endogeneity were solved by Arellano and Bover (1995) and Blundell and Bond (1998) by developing the GMM-system estimator. Moreover, the GMM estimator is efficient for panels with short time series (t) and large sample sizes (n) such as ours (Baltagi 2008). This research uses the Windmeijer (2005) criteria.

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Table 2. Description of independent variables

Variable	Variable description	Data source	Expected sign	
			HIIT	VIIT
lnDGDPC	The logarithm of per capita GDP absolute difference between trading partners measured in PPP in current international USD	WDI	–	+
lnDLAND	The logarithm of agricultural area/capita absolute difference between trading partners measured in hectares/person	FAO	–	+
lnDLAB	The logarithm of per capita agricultural labour absolute difference between trading partners measured in annual working units/person	Eurostat, FAO	–	+
lnDMACH	The logarithm of per capita agricultural machinery absolute difference between trading partners measured in euro/person	FADN, FAO	–	+
lnDIST	The logarithm of absolute difference between trading partners capital city measured in kilometers	CEPII	–	–
lnVPD	Percentage of employment in the agri-food industry by trade partner	World Bank	–	+
lnFDI	Foreign direct investment, net inflows	World Bank	–	–
lnPROD	Value added by the employer	World Bank	–	–

Source: Own composition

RESULTS AND DISCUSSION

Before estimating the panel regression models, the model variables are pre-tested for the unit root tests. None of IIT variables, except GHM^H and N^H have unit roots, that is, they are stationary with the individual effects and individual specifications (Table 3).

By applying the GMM-SYS panel data method to the sample, it is apparent that the determinants of the horizontal and vertical IIT differ as expected. In general, it is also observable that the three indices produce quite similar results (Table 4). As another general observation, the lagged variables are positive and significant in all cases, similarly to Faustino and Leitão (2007) and Leitão (2011), indicating that the past performance plays and important role in the present indices.

As to the country-specific determinants of intra-industry trade, the GMM model shows that lnDLAND and lnDIST are negatively related to both sides of IIT, while lnLAB and lnDMACH are positively related in the majority of the cases. This suggests that the smaller the difference in agricultural land between the trading partners and the closer the countries are, the higher is the possibility that intra-industry trade appears. However, it seems strange that countries closer to each other in terms of agricultural labour and capital allocation have a higher IIT index. It also seems evident from our results that the GDP/capita differences well explain the agri-food IIT patterns, just as expected. The results seem to be highly significant for the vast majority of the cases. The models present consistent estimates, with no serial correlation (AB1, AB2 statistics). The specification Sargan test shows that there are no problems with the validity of the instruments used. The GMM system estimator is consistent if there is no second-order serial correlation in the residuals (AB2 statistics). The dynamic panel data are valid. We used the criterion of Windmeijer (2005) to the small sample correction.

As to industry-specific determinants, all variables analysed were found to be highly significantly and

Table 3. Panel unit root test results for the model variables

Variables	Without time trend		With time trend	
	adjusted *t*-statistic	probability	adjusted *t*-statistic	probability
GHM^H	0.8408	0.7998	1.5143	0.9350
GHM^V	–6.3453	0.0000	–9.9200	0.0000
FF^H	–28.6696	0.0000	–20.3223	0.0000
FF^V	–11.8929	0.0000	–14.5484	0.0000
N^H	2.1268	0.9833	2.5416	0.9945
N^V	6.7282	1.0000	–3.1364	0.0009
lnDGDPC	1.1633	0.8776	–1.7132	0.0433
lnDLAND	114.8273	1.0000	139.7052	1.0000
lnDLAB	–3.4278	0.0003	–4.9089	0.0000
lnDMACH	–0.2290	0.4094	22.6103	1.0000
lnVPD	28.3529	1.0000	30.4267	1.0000
lnFDI	–7.5582	0.0000	–7.3245	0.0000
lnPROD	14.3128	1.0000	48.5121	1.0000

Source: Own calculations based on Levin et al. (2002) method

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Table 4. Determinants of IIT in the Baltic agri-food sector

Variable	Horizontal			Vertical		
	GHM	FF	N	GHM	FF	N
L1.IIT	0.2905***	0.2010***	0.2415***	0.2605***	0.2044***	0.4103***
lnDGDPC	0.0008***	0.0005***	–0.0200	–0.0014***	0.0019***	–0.2816***
lnDLAND	–0.0009***	–0.0026***	0.0479	–0.0071***	–0.0092***	–0.1164***
lnDLAB	0.0028***	–0.0009***	–0.2999	0.0100***	0.0246***	–0.1585***
lnDMACH	0.0013***	0.0020***	0.0599***	0.0040***	0.0048***	0.0927***
lnDIST	–0.0001***	–0.0001***	0.0004	–0.0001***	–0.0001***	–0.0009***
lnVPD	–0.0051***	–0.0075***	–1.0000***	0.0092***	0.0093***	–0.2330***
lnFDI	–0.0017***	–0.0034***	–0.2310***	–0.0021***	–0.0018***	–0.0807***
lnPROD	–0.0042***	–0.0042***	–0.0824***	0.0005***	0.0002***	0.0078***
Constant	0.0825***	0.1704***	7.3969***	0.0073***	–0.0689***	9.0442***
Observations	1176	1176	1176	1176	1176	1176
AB1 (*p*-value)	0.0263	0.0103	0.0000	0.0180	0.0096	0.0000
AB2 (*p*-value)	0.1219	0.1008	0.5508	0.3977	0.2948	0.5844
Sargan test (*p*-value)	0.9394	0.9433	1.0000	0.9205	0.9254	0.9942

***/**/*statistically significant, respectively at the 1%, 5%, and 10% levels

Source: Own calculations based on Eurostat (2015)

negatively related to HIIT in the majority of the cases, which is somehow different than initially expected. On the other hand, except for FDI, other industry-specific variables are positive for VIIT. These results suggest that the product differentiation fosters the two way trade of quality-differentiated goods. As to productivity, all model runs show a negative relationship with HIIT but positive for VIIT, implying that the low-quality product exports dominate the EU-28 agri-food trade, which could also be seen from Figure 2. Furthermore, FDI was also found to have a negative relationship with IIT, suggesting that the foreign capital does not foster IIT.

Our findings are similar to the majority of the literature (Fertő 2005; Turkcan and Ates 2010; Jámbor 2014) who found a negative relationship between the vertical IIT and the GDP per capita differences. Similarly to other studies on manufacturing sectors, the results do not support the comparative advantage explanation of the vertical IIT (Milgram-Baleix and Moro-Egido 2010). Contrary to Fertő (2005) and Rasekhi and Shojaee (2012), the agriculture-related variables are negative for most specifications. However, the results are similar to the previous studies (e.g. Blanes and Martin 2000; Jensen and Lüthje 2009) showing that the differences in land have a rather negative impact on the vertical IIT. Moreover, the proximity to markets still remains to be one of the most important explanations for intra-industry trade specialisation (McCorriston and Sheldon 1991). As to our results on the industry-specific determinants, the negative sign on the VPD is contrary to the majority of the empirical literature (Greenaway et al. 1995; Crespo and Fontoura 2004; Ekanayake and Veeramacheneni 2009), while the findings on productivity and is well in line with the majority of the literature (Török and Jámbor 2013; Fertő 2015).

On the whole, the first hypothesis of the article is rejected as the GDP/capita and the agriculture-related factor endowments are ambiguously related to IIT, contrary to the initial expectations. This suggests that similar factor endowments can lead to the trade of both homogenous and quality-differentiated agri-food products. Distance variables have the expected signs and are significant in the majority of the cases supporting hypothesis 2 and the classic gravity model stating that the geographical proximity fosters the agri-food trade. As to industry-specific determinants, hypothesis 3 is rejected on the basis that the vertical production differentiation was found to be negatively related to HIIT, while hypothesis 4 also does not hold as FDI was definitely found to have negative impacts on IIT. Hypothesis 5 is also rejected as productivity was found to have a positive relationship with VIIT.

Country and industry specific determinants of the horizontal and vertical agri-food IIT among the EU28 member states in 1999–2013 were analysed in the paper which has reached a number of conclusions.

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First, the results make it clear that the agri-food IIT is mainly of a vertical nature in the Baltic Countries, suggesting the exchange of products of a different quality. The share of IIT has been increasing significantly since the 2004 accession rounds, though the majority of these countries is exporting low quality agri-food products to the common market. However, it seems that the majority of agri-food trade of the Baltic Countries has still remained one-way (or inter-industry) in nature, suggesting complementarity rather than competition in production.

Second, by applying different specifications of the panel data models, it was proven that factor endowments are ambiguously related to both sides of IIT, suggesting that similar factor endowments can lead to the trade of homogenous as well as quality-differentiated agri-food produce. Third, the results show that distance and IIT are negatively related as is the common case in the classic gravity model, indicating that the geographical proximity fosters the agri-food trade (including HIIT and VIIT). Fourth, the product differentiation fosters the two way trade of the quality-differentiated goods. Fifth, all model runs show a negative relationship between the productivity and HIIT but positive for VIIT, implying that low-quality product exports dominate the EU28 agri-food trade. Last but not least, FDI were also found to have a negative relationship with IIT, suggesting that the foreign capital does not foster IIT. A future research might generalise these results by extending the size of the sample in terms of involving more countries, more variables or different time horizons.

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