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Intra-industry agri-food trade of the Baltic Countries

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Abstract

The article analyses patterns and country-specific determinants of the Baltic Countries agri-food trade with the European Union. Literature focusing on the country-specific determinants of vertical and horizontal intra-industry trade is rather limited and those analysing agricultural (or agri-food) trade are extremely rare. Therefore, the paper seeks to contribute to the literature by covering latest theory and data available on the topic to provide up to date results and suggestions. Moreover, it seeks to identify the determinants of horizontal and vertical intra-industry trade of the Baltic Countries after EU accession. Results suggest that agri-food trade of these countries is mainly inter-industry in nature but intra-industry trade is dominated by vertical elements. Results verify that determinants of horizontal and vertical IIT differ and suggest that economic size is positively, while factor endowments and distance are negatively related to both sides of IIT. However, the relationship between IIT and FDI is ambiguous.

Keywords Intra-industry trade, agriculture, Baltic Countries

JEL code Agriculture in International Trade: Q17

1. Introduction

Agri-food trade of the New Member States (NMS) has changed remarkably during the previous decade. One of the major factors contributing to such changes was EU accession, by which former trade barriers have diminished. The article analyses the patterns and determinants of Baltic Countries agri-food trade with the European Union by using the theory of intra-industry trade. There is a wide range of literature generally analysing intra-industry trade patterns but one important shortcoming of such literature is that it ignores the distinction between horizontal and vertical IIT and ignores the fact that they may have different determinants (Bojnec and Ferto, 2008). Literature focusing on the country-specific determinants of vertical and horizontal intra-industry trade is rather limited (Fainštein and Netšunajev, 2011) and those analysing agricultural (or agri-food) trade are extremely rare.

The paper seeks to contribute to the scant literature of the field in two ways. First, it covers latest theory and data available on the topic to provide up to date results and suggestions. Second, it seeks to identify the determinants of horizontal and vertical intra-industry trade of the Baltic Countries after EU accession.

In order to meet these aims, the article is structured as follows. The first part provides an overview of the literature and recent empirical studies of the topic, while the second summarises methods of horizontal and vertical IIT measurement. The third part describes some basic patterns of horizontal and vertical intra-industry agri-food trade between Baltic Countries and the European Union, followed by the presentation of hypotheses and empirical results. The last part concludes.

2. Literature review

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 since the 1960s took the form of the intra-industry trade rather than inter-industry trade. Consequently, 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 competition theory. This model combines monopolistic competition with the Heckscher-Ohlin (HO) theory, incorporating factor endowments differences, horizontal product differentiation and increasing returns to scale. It has pointed out that comparative advantages drive inter-industry trade through specialisation, while economies of scale drive intra-industry trade.

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

Horizontal differentiation is more likely between countries with similar factor endowments, while according to Falvey and Kierzkowski (1987), vertically differentiated goods occurs because of factor endowment differences across countries. As the authors suggest, the amount of capital relative to labour used in the production of vertically

differentiated good indicates the quality of the good. Consequently, higher-quality products are produced in capital abundant countries while lower-quality products are produced in labour abundant countries. Thereby 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 vertical IIT will increase as countries' income and factor endowments diverge.

Many studies have analysed the determinants of intra-industry trade in general (e.g. Leitão and Faustino 2008, Rasekhi 2008, Wang 2009), though just a limited amount of literature is focused on the country-specific determinants of vertical and horizontal intra-industry trade. Greenaway et al. (1994) were the first to analyse country-specific factors of horizontal and vertical intra-industry trade in the UK and found that vertical IIT is more important in the UK than horizontal IIT and that the inter-country pattern of vertical IIT is systematically related to a range of explanatory variables. Aturupane et al. (1999) searched for the determinants of horizontal and vertical intra-industry trade between Eastern Europe and the European Union and showed that the determinants of the two types of IIT are likely to differ, with vertical IIT being more a reflection of endowment or technology-based factors, and horizontal IIT being more dependent on factors such as scale economies and imperfect competition.

Kandogan (2003) analysed IIT of transition countries and concluded that variables from the increasing returns trade theory, such as scale economies, similarity of income levels, and number of varieties produced play important roles in horizontal IIT, whereas factors such as comparative advantage or dissimilarity in income levels are more related to vertical IIT. Zhang and Li (2006) investigated country-specific factors of intra-industry trade in China's manufacturing and underlined that the more countries differ in relative country size and relative factor endowments, the less likelihood there is for IIT and horizontal IIT. They also emphasised that difference between countries in relative factor endowments lead to more inter-industry trade, which in turn suppresses IIT and vertical IIT.

Fertő (2005, 2007) analysed Hungarian intra-industry agri-food trade patterns with the EU15 and confirmed the comparative advantage explanation of vertical IIT, while stressing that using a measure of IIT that reflects the level of trade produces better regression results than those based on the degree or share of IIT.

Caetano and Galego (2007) were searching for the determinants of intra-industry trade within an enlarged Europe and found that determinants of horizontal and vertical IIT differed, although both had a statistically significant relationship with a country's size and foreign direct investment. Turkcan and Ates (2010) investigated for the determinants of IIT in the U.S. Auto-Industry and besides confirming that determinants of horizontal and vertical IIT differ, showed that vertical IIT is positively associated with average market size, differences in market size, differences in per capita GDP, outward FDI and distance, while it is negatively correlated with the bilateral exchange rate variable.

Leitao (2011) examined intra-industry trade patterns in the Portugese automobile sector and concluded that intra-industry trade occured more frequently among countries that were similar in terms of factor endowments as well as pointed out that no positive statistical association existed between HIIT and Heckscher-Ohlin variables. Ambroziak (2012) investigated the relationship between FDI and IIT in the Visegrad countries and found that FDI stimulated not only VIIT in the region but also HIIT.

2.1. Measuring horizontal and vertical IIT

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):

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

where X_i and M_i are the value of exports and imports of product category i in a particular country. The GL index varies between 0 (complete inter-industry trade) and 1 (complete intra-industry trade) and can be aggregated to level of countries and industries as follows:

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

where w_i comes from the share of industry i in total trade. 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 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 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 relative prices are likely to reflect relative quantities (Stiglitz, 1987). 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 vertically differentiated products have different prices reflecting 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 bilateral trade of horizontally differentiated products as follows:

$$1 - \alpha \le \frac{UV_i^X}{UV_i^M} \le 1 + \alpha \tag{3}$$

where UV means unit values, X and M means exports and imports for goods i and ά=0.15. If this equation is not true, 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 and Martín (2000) developed the model further and defined high and low VIIT. According to their views, low VIIT means that the relative unit value of a good is below the limit of 0.85, while unit value above 1.15 indicates high VIIT.

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

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

where X and M stands for export and import, respectively, while p distinguishes 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 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 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:

$$\frac{Min(Xi, Mi)}{Max(Xi, Mi)} \ge 10\% \tag{5}$$

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

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

After calculating the FF index, 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 GL-type indices (like the GHM index) as equation 5 refers to total trade, treated before as two-way trade. The authors suggest that FF index rather complements than substitutes GL-type indices as they have measured the relative weight of different trade types in total trade. In conclusion, they found that the value of 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 total trade, resulting in an average IIT by product group. Applying this logic to horizontal and vertical IIT, the Nilsson index is formally express as:

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

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

In order to perform calculations based on the above equations, 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 trade in product groups HS 1-24, resulting in 964 products using the six digit breakdown. The article works with trade data for the period 1999-2010. In this context, the EU is defined as the member states of the EU27. Three different approaches were used to calculate intra-industry trade indices (GHM, FF and the Nilsson-method), providing the basis for regressions run on the determinants of horizontal and vertical IIT.

3. Horizontal and vertical IIT patterns

Using the above methods, horizontal and vertical intra-industry trade were calculated for agri-food trade between the Baltic Countries and EU27 for the period 1999-2010. Table 1 shows that agri-food intra-industry trade is mainly vertical in nature in the Baltic Countries, as evident from the vertical values compared to the horizontal ones. However, low values for total IIT (the sum of vertical and horizontal IIT) indicate that inter-industry trade prevails in these countries' agri-food trade with EU27 between 1999 and 2010. These findings are consistent with the results of previous research in the region (Ambroziak, 2012).

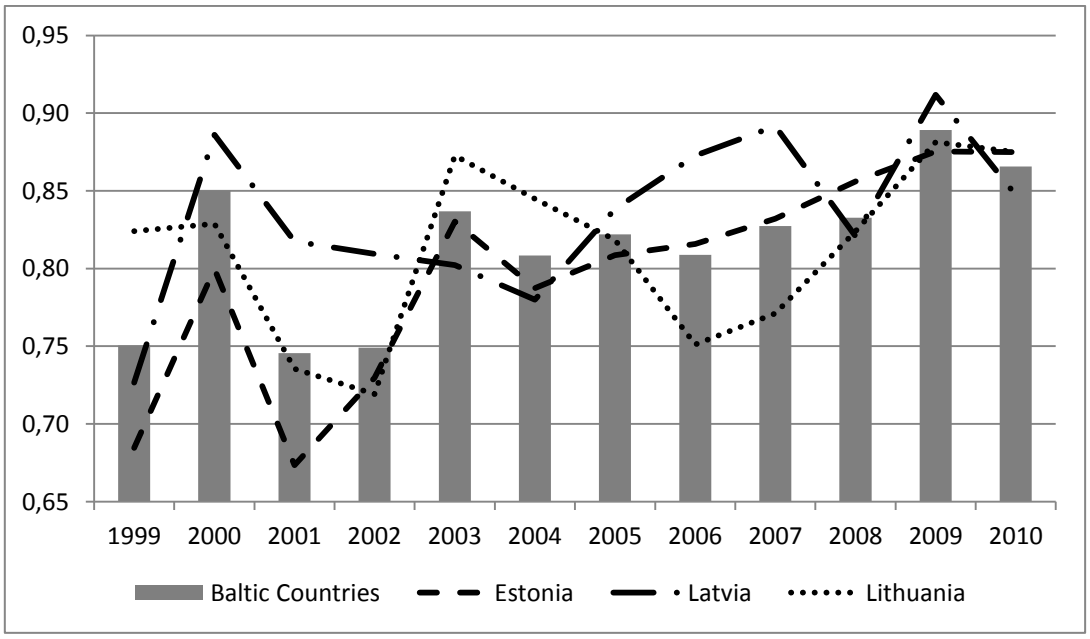
Table 1
Horizontal and vertical agri-food IIT in the Baltic Countries with EU27 trade in 1999-2010*

Indicator	Estonia			Latvia			Lithuania		
	1999-2002	2003-2006	2005-2010	1999-2002	2003-2006	2005-2010	1999-2002	2003-2006	2005-2010
GL	0.03	0.05	0.05	0.04	0.05	0.05	0.03	0.07	0.06
GHM^{H}	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01
GHM^{LV}	0.01	0.02	0.02	0.03	0.03	0.03	0.01	0.02	0.02
GHM^{HV}	0.01	0.02	0.02	0.01	0.02	0.02	0.02	0.03	0.03
FF^{H}	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.02	0.01
FF^{LV}	0.02	0.03	0.04	0.04	0.05	0.04	0.02	0.04	0.04
FF^{HV}	0.02	0.04	0.03	0.01	0.03	0.03	0.03	0.05	0.04
N^{H}	528	1212	920	481	1609	1640	647	2430	2660
N^{LV}	461	2383	3991	1165	3638	6230	627	3066	5577
N^{HV}	618	2426	4065	445	2303	4878	932	4834	7762

Source: Own calculations based on Eurostat (2012)
Note: For definitions of GHMp, FFp and Np, where p is horizontal (H) or vertical (V) intra-industry trade, see equations (4), (6) and (7) in the text. Np is measured in thousand euro.

In line with the steadily increasing absolute VIIT numbers in the period, the share of VIIT in total IIT in the Baltic Countries shows also shows an increasing trend, indicating that more quality-based products are traded with EU27 (Figure 1). The highest increase can be seen in Estonia where VIIT gave 68% of total IIT in 1999, while it grew to 88% in 2010. In case of the Baltic Countries as a whole, a heavy decrease in the share of VIIT compared to total IIT after the millennium was followed by a stable rate of 80-90% after EU accession.

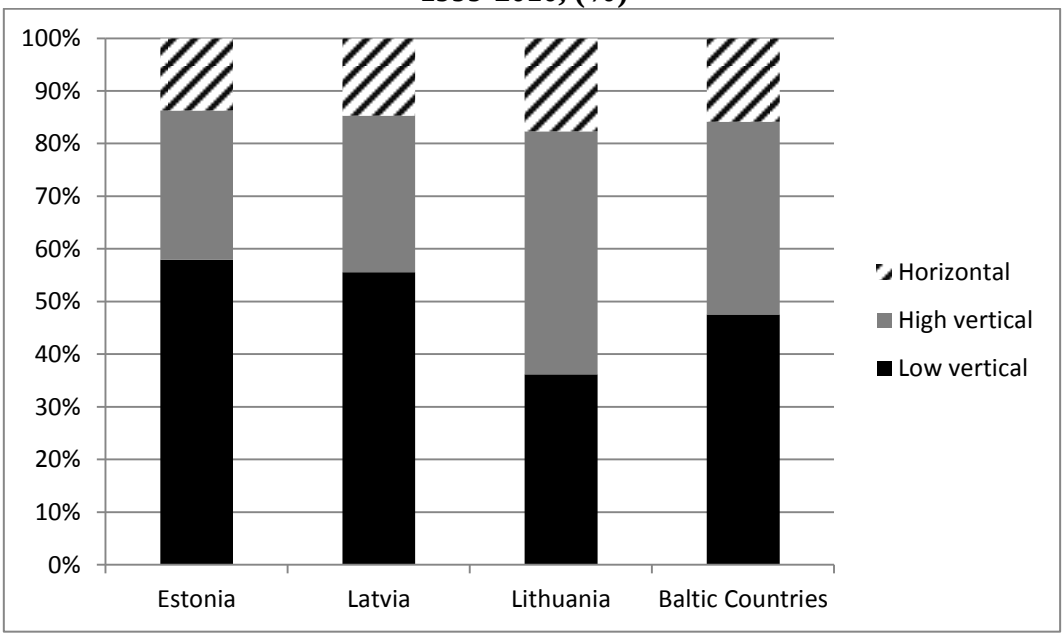
Figure 1
The share of vertical IIT in total IIT between the Baltic Countries and EU27, 1999-2010*



* Based on the GHM-method.
Source: Own calculations based on *Eurostat* (2012)

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. Taking into account the geographical patterns of IIT in the Baltic Countries, it becomes evident that low vertical IIT dominates agri-food trade (except for Lithuania), while the share of high vertical IIT varies around 30% in most cases. Similar results can be obtained if this pattern is analysed in time. The overall picture is quite unfavourable to all countries as the trade of low quality products is usually associated with low prices and unit values, suggesting structural problems in agriculture (Ambroziak, 2012).

Figure 2
The pattern of IIT in agri-food products between the Baltic Countries and EU27, 1999-2010, (%)*



* Based on the GHM-method.
Source: Own calculations based on *Eurostat* (2012)

In short, IIT is mainly of a vertical nature in the Baltic Countries, suggesting the exchange of products of different quality. Moreover, it seems that the majority of agri-food trade between these countries and its EU partners has still remained one-way (or inter-industry) in nature, suggesting complementarity rather than competition in production (Fertő, 2007).

4. Determinants of horizontal and vertical IIT

As described in the literature review, theory argues that HIIT and VIIT determinants differ. This may explain why econometric analyses having total (horizontal and vertical) IIT as their dependent variable may be mis-specified. Therefore, the determinants of HIIT and VIIT will now be investigated separately for the Baltic Countries' agri-food trade with EU27. The balanced panel data set contains trade with each and every EU member state (26 members plus the reporter) for twelve years (1999-2010) and 964 products, resulting in almost 900,000 observations. As the majority of literature regresses a measure of IIT on a range of possible explanatory variables without any predefined method, this article uses panel estimation techniques, capturing both cross-sectional and time-dependent special effects. Therefore, consistent with the literature on the determinants of IIT, hypotheses are as follows:

H1. Difference in factor endowments between trading partners increases (decreases) the share of vertical (horizontal) IIT in total trade.

The difference in factor endowments is usually measured by inequality in per capita GDP, in line with the model developed by Falvey – Kierzkowski (1987). Linder (1961) considers that countries with similar demands have similar products, consequently vertical type trade increases with differences in relative factor endowments. Factor endowments are proxied by the logarithm of absolute value of the difference in per capita GDP between Estonia, Latvia, Lithuania and their trading partners (lnDGDPC), which is expected to be positively related to the share of vertical IIT. LnDGDPC is measured in PPP in current international dollars and data comes from the World Bank WDI database.

H2. The smaller the difference in economic size of the two partner economies, the higher the expected IIT in their trade.

The larger the international market, the larger the opportunities for production of differentiated intermediate goods and the larger the opportunities for trade in intermediate goods. The logarithm of the absolute difference in the average GDP of trading partners is used as a proxy for the average size of markets. LnAVGDP is measured in PPP in current international dollars and the source of data is also the World Bank WDI database. A positive sign for both horizontal and vertical IIT is expected.

H3. The larger the share of foreign direct investment (FDI) in the host country, the higher the share of HIIT and VIIT.

Multinational companies have crucial influence on IIT through their FDI activities. Investing in production facilities abroad creates the possibility to exchange products at different levels in the production stage, thereby contributing to IIT. The logarithm of the absolute difference of stocks of FDI (in billion USD) in the Baltic Countries is used to test this hypothesis. FDI is measured in current international USD and data is coming from the WDI database. A positive sign is expected for VIIT as well as HIIT.

H4. 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 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.

In order to test hypotheses above, the following standard panel regression model is employed:

$$\ln IIT_{ijt} = \alpha_0 + \alpha_1 \ln DGDPC_{ijt} + \alpha_2 \ln AVGDP_{ijt} + \alpha_3 \ln DFDI_{ijt} + \alpha_4 \ln DIST_{ijt} + v_{ij} + \varepsilon_{ij}$$

where $\ln IIT_{ijt}$ is log of measure of total, vertical, and horizontal IIT, i = Estonia/Latvia/Lithuania and j = EU27 partner country, t = time; $\ln DGDPC_{ijt}$ is the log of absolute difference in per capita GDP between i and j. LnAVGDP is the log of average value of GDP between i and j, while lnFDI is the log of absolute difference of FDI between i and j; lnDIST is log of distance between the capital cities of i and j. The expected signs for HIIT are

α_1 and α_4 <0, α_2 and α_3>0, while for vertical IIT are α_1,α_2,α_3>0 and α_4 <0. Table 2 provides an overview of the details associated with variables.

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	World Bank WDI database	-	+
lnAVGDP	The logarithm of average GDP absolute difference between trading partners measured in PPP in current international USD	World Bank WDI database	+	+
lnFDI	The logarithm of FDI net inflows absolute difference between trading partners measured in current international USD	World Bank WDI database	+	+
lnDIST	The logarithm of absolute difference between trading partners capital city measured in kilometres	CEPII database	-	-

Source: Own composition

5. Estimation results

The use of a fixed effects model to capture country differences was rejected as a time invariant regressor (lnDIST) is incorporated in the model. Random effects models have been estimated employing generalised least squares and maximum-likelihood approaches. The most robust results in terms of statistical significance were found with the former method, therefore only this specification is reported.

Three equations were estimated in line with the three methods of measuring intra-industry trade given in the literature review. Regarding the determinants of horizontal IIT, it is observable that all the three methods provide similar results (Table 3). LnDGDPC and lnDIST are negative for all estimations, while lnAVGDP and lnFDI show positive signs. It can also be seen that lnDGDPC and lnDIST are highly significant in all cases, while lnAVGDP and lnFDI are less significant. Note that results for the Nilsson-index remain to be less significant than the others. These results are in line with previous expectations on the signs of the relationship. None of the hypotheses above can be rejected.

Table 3: Determinants of horizontal IIT in the Baltic Countries

Independent variable	Dependent variable		
	GHM^H	FF^H	N^H
lnDGDPC	-0.0035*** (-3.46)	-0.0058** (-3.02)	-503.68** (-2.21)
lnAVGDP	0.0011** (2.02)	0.0020** (2.05)	216.17* (1.51)
lnFDI	0.0013** (1.99)	0.0036** (2.14)	65.88 (0.50)
lnDIST	-0.0036*** (-3.56)	-0.0057*** (-2.79)	-391.51** (-2.48)
Constant	0.0115 (1.40)	0.0207 (1.37)	1277.88 (0.60)

Note: Numbers in parentheses are z statistics; significance levels are *** = 1%, ** = 5%, * = 10%.
Source: Own calculations based on Eurostat (2012)

As to the determinants of vertical intra-industry trade, results by method (see Table 4) show similar signs than those occurred in the horizontal case. Note, however, that the signs for lnDGDPC and lnFDI are negative, contrary to previous expectations. Almost all variables seems to be less significant than in the previous case, though the three methods show similar signs for the variables. The first and third hypotheses above can be rejected.

Table 4: Determinants of vertical IIT in the Baltic Countries

Independent variable	Dependent variable		
	GHM^V	FF^V	N^V
lnDGDPC	-0.0034** (-0.69)	-0.0079* (-0.77)	-546.08 (-0.48)
lnAVGDP	0.0048** (2.22)	0.0088** (2.40)	1103.35*** (3.28)
lnFDI	-0.0066** (-0.68)	-0.0012 (-0.51)	-91.98 (-0.20)
lnDIST	-0.0084** (-1.98)	-0.0146*** (-3.99)	-2689.69*** (-3.78)
Constant	0.0135 (0.46)	0.0308 (0.61)	1222.99 (0.15)

Note: Numbers in parentheses are z statistics; significance levels are *** = 1%, ** = 5%, * = 10%.
Source: Own calculations based on Eurostat (2012)

Results above indicate that the Baltic Countries' intra-industry agri-food trade with EU27 is driven by differences in factor endowments, economic size of the countries, FDI patterns and geographical proximity. However, hypotheses on the signs for factor endowments and FDI in the vertical case had to be rejected. Moreover, it turned out that determinants of horizontal and vertical IIT are different in line with previous literature (Fertő, 2007).

5. Conclusion

The article analysed patterns and country-specific determinants of agri-food trade of the Baltic Countries with the European Union. Three different approaches were used to calculate intra-industry trade indices (GHM, FF and the Nilsson-method), providing the basis for regressions run on the determinants of horizontal and vertical IIT.

In general, the share of VIIT is significantly higher than the share of HIIT and agri-food trade of the Baltic Countries is dominated by inter-industry trade patterns, which is consistent with the findings of previous research. Taking into account the geographical patterns of IIT in the Baltic Countries, it becomes evident that low vertical IIT dominates agri-food trade in most cases.

As to empirical results, it is verified that determinants of horizontal and vertical IIT differ and suggested that economic size is positively, while factor endowments and distance are negatively related to both sides of IIT. However, the relationship between IIT and FDI is ambiguous. In general, the results are mainly in line with initial expectations.

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