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Horizontal intra-industry trade in agri-food products in the enlarged European Union

International trade theory suggests that advanced trade integration may lead to higher levels of intra-industry trade (IIT). The enlargement of the European Union (EU) during last decade is as a good example for which to analyse the IIT in agri-food products. The aim of the paper is to analyse the pattern and drivers of horizontal IIT within the EU between 1999 and 2010. Previous empirical studies fail to provide an exact link between the theory and the data. Thus, a new empirical strategy developed to test the predictions of Helpman and Krugman (1985) model is employed. At the country level, Belgium, France, Netherlands and Germany report the highest levels of IIT within the EU. The calculations mainly support Cieslik's (2005) proposal to find the missing link between empirics and theory of IIT. In addition, the results are robust to alternative subsamples.

Keywords: intra-industry trade, agri-food products, EU enlargement, relative factor endowments

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Introduction

In recent decades intra-industry trade (IIT) has become a widespread phenomenon with its growing role in international trade, providing strong incentives for theoretical and empirical research. New trade theory offers several models to explain IIT based on different assumptions on product differentiation. In the case of horizontal product differentiation the usual conclusions are about the role of factor endowments and scale economies that stem from the framework of monopolistic competition. This framework, summarised in Helpman and Krugman (1985), and often referred to as the Chamberlin-Heckscher-Ohlin (C-H-O) model, allows for inter-industry specialisation in homogeneous goods and IIT in horizontally differentiated goods. This model suggests a negative relationship between differences in relative factor endowment, proxied usually by GDP per capita and the share of IIT. The available empirical evidence provides rather puzzling evidence on the impact of relative factor endowments on IIT. One of the possible explanations of the diverging results is that the majority of empirical studies fail to provide any exact link between theory and data. Empirical studies on IIT usually employ a rather eclectic approach using simply the most common explanatory variables to test hypotheses based on different theoretical frameworks.

The formation of stronger economic ties between European countries due to the creation and expansion of the European Union (EU) has contributed to an increase in IIT among EU Member States. There is a wealth of literature on the IIT between a particular EU Member State and its partner (see for recent examples Jensen and Lüthje, 2009; Milgram-Baleix and Moro-Egido, 2010). However, a significant proportion of the studies still focus on industrial products. Although the importance of IIT has already been well documented in agri-food sectors since the late 1990s (Fertő, 2005, 2007), in the last decade research on the determinants of agri-food IIT has remained limited. The main reason is probably that agricultural markets are still usually assumed to have perfect competition. But, recent studies support the view that agricultural markets can be characterised by imperfect competition (Sexton, 2013) and IIT has an increasing role in agricultural trade for both developed and developing countries (e.g. Leitão and Faustino, 2008; Wang, 2009; Leitão, 2011; Rasekhi and Shojaee, 2012; Varma, 2012). In addition, recent studies (e.g. Jámbor, 2014a, b; Fertő and Jámbor, 2015) suggest that the role of IIT has been increasing in agricultural trade between EU Member States.

The aim of the paper is to analyse the pattern and drivers of horizontal IIT within the EU in the period 1999-2010. This paper is the first attempt to analyse agri-food trade within the EU including all bilateral agri-food trade relationships. Such an approach aims to contribute to the literature of the field in five ways. Firstly, specific theoretical models are tested instead of the usual eclectic approach. More specifically, following Helpman (1987) and Hummels and Levinsohn (1995) the focus is on the theoretical relationships between factor proportions and horizontal IIT within the original Helpman-Krugman (1985) model. Moreover, the impact of the sums of capital-labour rations is controlled as proposed by Cieslik (2005). Secondly, a multilateral dataset is employed instead of the bilateral framework still predominating recent empirical research. Thirdly, this approach raises an additional issue, namely the accuracy of trade data. In the bilateral approach, studies use data only from the exporter point of view. However it is well known, although less investigated, that trade data are very rarely symmetric. Thus, special attention is paid here to analysing the possible bias due to the asymmetric nature of trade data. Fourthly, research using panel data in the empirical IIT literature should face some additional issues coming from recent developments of panel data econometrics which are not always tackled carefully. Consequently, this analysis moves beyond simple pooled OLS and standard static panel models. Finally, although the Helpman-Krugman model is based on horizontal product differentiation, empirical tests of their model usually neglect the distinction between horizontal and vertical IIT when they measure the IIT. Thus this paper concentrates only on horizontal IIT indices.

The next section presents the theoretical foundation of the empirical model, and this is followed by a brief outline of the standard measurement of IIT. These approaches are then applied to the data set used in this research. The theoretical basis for investigation of the country-specific determinants of IIT is outlined next, and the results of the regression analysis are then presented, followed by a summary and some conclusions.

Theoretical framework

The traditional IIT model, often referred to as the Chamberlin-Heckscher-Ohlin (C-H-O) model, assumes that goods are horizontally differentiated. In these models (Krugman, 1979; Lancaster 1980; Helpman 1981), IIT opens up in monopolistically competitive markets, with increasing returns to scale on the supply side and diverse consumer preferences on the demand side. Helpman and Krugman (1985) add factor endowment differences to a model that explains the co-existence of intra- and inter-industry trade. Consider two countries (A and B), two factors (labour and capital) and two goods: a homogeneous commodity which is relatively labour intensive and a differentiated product which is relatively capital intensive. If country A is relatively labour-abundant and country B is relatively capital abundant, Helpman and Krugman (1985) show how country A tends to export homogeneous product and both countries import the differentiated good. This model predicts that IIT will decrease as countries' factor endowments diverge. Moreover, Bergstrand (1990) expanded earlier theoretical works by proposing a new framework, using a gravity-like equation that explains the relationship between the share of IIT in total trade and factor endowments as well as income. Important determinants of the share of IIT in total bilateral trade in the Bergstrand model are: differences in income, average income and average capital-labour ratios as well as differences therein.

However Cieslik (2005) points out that previous empirical studies fail to provide an exact link between the theory and the data. He shows that the Helpman-Krugman (1985) model does not predict any unique theoretical relationship between IIT and relative country size if we keep differences in capital to labour ratios unchanged. Thus Cieslik (2005) developed a formal model to eliminate this shortcoming, providing two complementary propositions. Firstly, the share of IIT between two countries is larger than the sum of their capital-labour ratios, given the fixed difference in their capital-labour proportions. Secondly, the share of IIT between two countries is larger the smaller the difference in their capital-labour ratios given the constant sum of their capital-labour ratios. His results imply that the theory finds support in the data when we control for the sum of capital-labour ratios in the estimating equations instead of relative country-size variables.

Measuring intra-industry trade

The basis for the various measures of IIT used in the present study is the Grubel-Lloyd (GL) index (Grubel and Lloyd, 1975), which is expressed formally as follows:

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

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 the level of countries and industries as follows:

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

where w_i denotes the share of industry i in total trade.

The literature suggests several options to disentangle horizontal and vertical IIT. Greenaway *et al.* (1995) developed the following approach: a product is horizontally differentiated if the unit value of export compared to the unit value of import lies within a 15 per cent range, and otherwise they define 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 $\alpha = 0.15$. The choice of a 15 per cent range is rather arbitrarily, thus already Greenaway *et al.* (1994) proposed that the spread should be widened to 25 per cent. Interestingly, the papers that check the possible impact of various thresholds on results confirm that results coming from the selection of the 15 per cent range do not change significantly when the spread is widened to 25 per cent (Jensen and Lüthje, 2009). Based on the logic above, the GHM index comes formally as follows:

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

where X and M denote export and import, respectively, while p distinguishes horizontal or vertical IIT, j is the number of product groups and k is the number of trading partners (j, $k = 1, \dots n$).

Trade data from the Eurostat COMEXT database using the HS6 system (six digit level) are employed. Agri-food trade is defined as trade in product groups HS 1-24, resulting in 964 products using the six digit breakdown. The analysis focuses on the period 1999-2010. In this context, the EU is defined as the Member States of the EU-27.

Econometric specifications

Three different specifications are used to test the theoretical propositions of Helpman-Krugman (1985) model and modified versions developed by Cieslik (2005). Early tests of Helpman-Krugman were based on the following specifications introduced by Helpman (1987):

$$\begin{aligned} \ln IIT_{ijt} = {} & \alpha_0 + \alpha_1 \ln DGDPC_{ijt} + \\ & \alpha_2 \min(\ln GDP_{it}, \ln GDP_{jt}) + \\ & \alpha_3 \max(\ln GDP_{it}, \ln GDP_{jt}) + v_{ij} + \varepsilon_{ijt} \end{aligned} \tag{5}$$

where *IIT* is the bilateral GL index.

To separate the effect of absolute country size from the impact of relative country size, Helpman (1987) suggests the following modification of equation (5):

$$\ln IIT_{ijt} = \alpha_0 + \alpha_1 \ln DGDPC_{ijt} + \alpha_2 \text{sum}(\ln GDP_{it}, \ln GDP_{jt}) + \alpha_3 \ln dispersion_{ijt} + v_{ij} + \varepsilon_{ijt} \quad (6)$$

where dispersion is expressed by the following:

$$dispersion = \ln\left[1 - \left(\frac{GDP_i}{GDP_i + GDP_j}\right)^2 - \left(\frac{GDP_j}{GDP_i + GDP_j}\right)^2\right] \quad (7)$$

To test two propositions by Cieslik (2005) the following model was estimated:

$$\ln IIT_{ijt} = \alpha_0 + \alpha_1 \ln DCAPLAB_{ijt} + \alpha_2 \ln \text{sum}CAPLAB_{ijt} + v_{ij} + \varepsilon_{ijt} \quad (8)$$

From capital-labour ratios the physical capital was estimated by the perpetual inventory method. The variables and related hypotheses are summarised in Table 1.

The nature of intra-industry trade

One well-known problem in any research in empirical trade analysis including IIT is that of the accuracy of the data used. Most researchers study IIT bilaterally, that is one country's trade with several others, using the data of the former one. Mostly it is a member of the OECD, with a good reputation for reporting accuracy. Consequently an index measuring IIT between two countries should remain invariant if it is calculated from trade data reported by a certain country or by data reported from its trade partner due to the symmetry of the formulae. This is so obvious that articles often do not even mention the issue. However, investigation of multilateral trade between different combinations of OECD and non-OECD countries reveals serious inconsistency in the accuracy of trade data (Fertő and Soós, 2009). Jensen and Lüthje (2009) provide some evidence that data accuracy is less severe for the trade within Europe. To see whether this is the case, correlations between horizontal intra-industry trade (HIIT) indices based on trade data reported by a country and data reported by its partner countries are presented in Figure 1.

The first striking finding is that correlation indices range significantly across countries from 0.05 to 0.95. Secondly, a higher level of economic development does not necessary imply higher accuracy of trade data, see for example Luxembourg and the UK. In short, in line with Fertő and Soós (2009), this preliminary analysis cast some doubt on trade data accuracy.

The level of HIIT is rather low in agri-food trade in the EU (Figure 2). However, one may observe considerable differences between countries. Germany Belgium, France and Netherlands, Austria and Denmark record the highest HIIT indices.

Table 1: Description of independent variables.

Variable	Variable description	Data source	Sign
$\ln DGDPC$	The logarithm of per capita gross domestic product (GDP) absolute difference between trading partners measured in PPP in current international USD	WDI	-
$\ln GDP$min	The logarithm of minimum GDP measured in PPP in current international USD	WDI	+
$\ln GDP$max	The logarithm of maximum GDP measured in PPP in current international USD	WDI	-
$\ln GDP$sum	The logarithm of average GDP absolute difference between trading partners measured in PPP in current international USD	WDI	+
$\ln dispersion$	The logarithm of absolute difference between trading partners capital city measured in kilometres	WDI	+
$\ln DCAPLAB$	The logarithm of absolute difference of capital labour ratios between trading partners	Penn, WDI	-
$\ln$ sum$CAPLAB$	The logarithm of sum of capital labour ratios between trading partners	Penn, WDI	+
$\ln DIST$	The logarithm of absolute difference between trading partners capital city measured in kilometres	CEPII	-

WDI: World Bank World Development Indicators database; Penn: Penn World Table 7.0; CEPII: Centre d'Études Prospectives et d'Informations Internationales.
Source: own composition

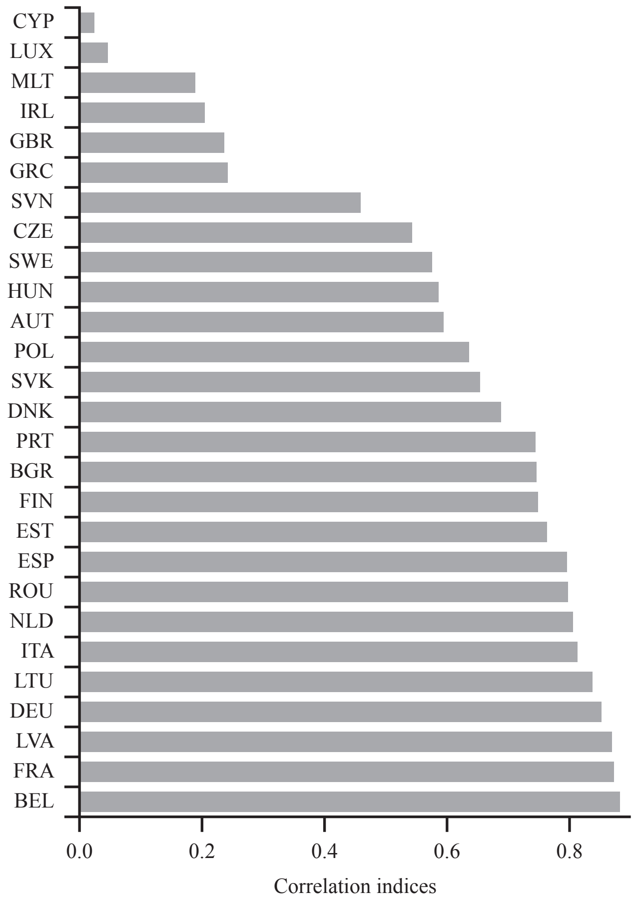

Figure 1: Correlations of horizontal intra-industry trade indices based on trade data reported by a country and data reported by its partner countries.
Source: own calculations based on the Eurostat database

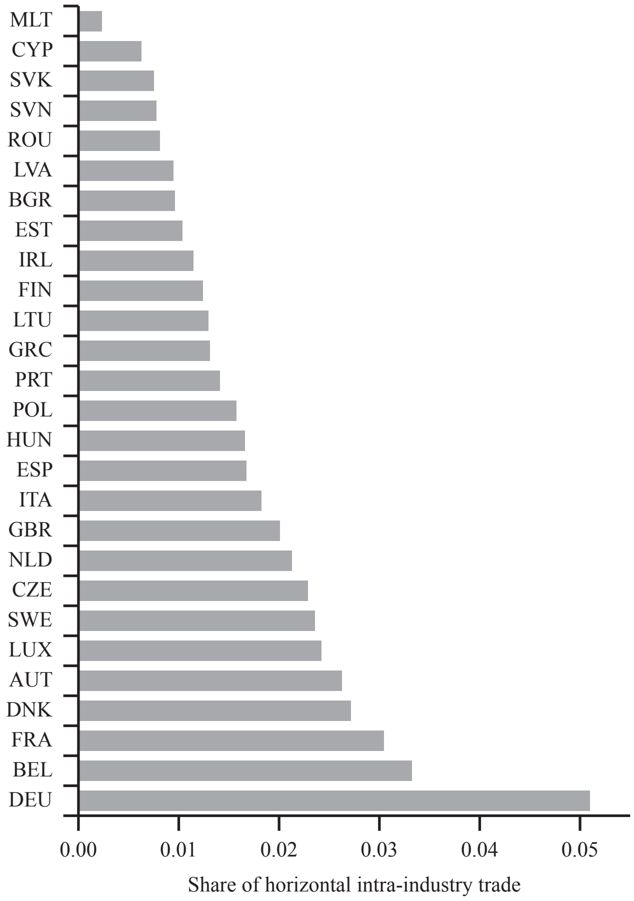

Figure 2: Agri-food horizontal intra-industry trade in the EU-27 by Member State.

Source: own calculations based on the Eurostat database

Regression results

Before estimating the panel regression models, the main model variables are pre-tested for unit root tests. A number of panel unit root tests are available. Considering the well-known low power properties of unit root tests, in this paper a battery of unit root tests are employed: the Levin *et al*. (2002) method (common unit root process), the Im *et al*. (2003) method (assuming individual unit root processes), ADF-Fisher Chi square and PP-Fisher Chi square, with different deterministic specifications (with constant, and with constant and trend). Mixed results were obtained (Table 2). The most important model variables such as the IIT and HIIT do not have unit roots, i.e. are stationary, with individual effects and individual trend specifications. GDP-related variables such as ln *GDPC*, ln *GDP*min and ln *GDP*max are more ambiguous in terms of unit root in a panel context. Five of the nine panel unit root tests reject the panel unit root null hypothesis for ln *GDPC*, while five of the nine panel unit root tests support the existence of panel unit root for ln *GDP*min and ln *GDP*max. We may conclude we do not have definite conclusions for rejecting/accepting the panel unit root. Capital-labour ratios variables show a clearer picture; the majority of tests reject the existence of panel unit root.

To ensure that both variables are stationary *I*(0) and not integrated of a higher order, unit root tests are applied on first differences of all variables. All tests reject the unit root null hypothesis for the first differences (data not shown). It can be concluded that the panel is likely stationary.

Several estimation techniques are applied to equations (5, 6 and 8) in order to ensure the robustness of the results. Preliminary Hausman tests favour the use of fixed effect panel models for the majority of the models. However, there are some additional issues that have to be addressed when estimating such panel models. Firstly, heteroscedasticity may occur because trade between two smaller countries or between a smaller and larger country is probably more volatile than trade between two larger countries. The panel dataset is also subject to the existence of autocorrelation. Contemporaneous correlation across panels may occur because exporting to one country can take place as an alternative to exporting to another country. Similarly, adjacent exporter(s)'/importer(s)' time-specific shocks result in larger correlated error terms of their trade with their partners. Preliminary analysis (likelihood ratio tests, Wooldridge test for autocorrelations (Wooldridge, 2002) and Pesaran tests (Pesaran, 2004)) confirms the presence of heteroscedasticity, autocorrelation and cross-sectional dependence. Because the period of analysis used here is shorter than the cross sectional unit, to deal with issues of contemporaneous correlation the panel corrected standard error model (PCSE) is applied which controls for heteroscedasticity and the AR(1) type of autocorrelation and contemporaneous correlation across panels (Beck and Katz, 1995, 1996).

To check the robustness of the results to possible bias due to trade data inaccuracy, three different models are estimated for each case using total-, reporter- and partner-based samples.

Table 2: The results of four different panel unit root tests of the main panel regression model variables (p values).

	Intra-industry trade	**Horizontal Intra-industry trade**	**ln *DGDPC***	**ln *GDP*min**	**ln *GDP*max**	**ln *DCAPLAB***	**ln sum*CAPLAB***
With constant:							
Levin, Lin & Chu t*	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Im, Pesaran and Shin W-stat	0.000	0.000	0.214	0.991	1.000	0.000	0.000
ADF-Fisher Chi-square	0.000	0.000	0.007	1.000	1.000	0.000	0.000
PP-Fisher Chi-square	0.000	0.000	0.000	1.000	1.000	0.1538	1.000
With constant and trend:							
Levin, Lin & Chu t*	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Im, Pesaran and Shin W-stat	0.000	0.000	0.621	0.000	0.000	0.000	0.000
ADF-Fisher Chi-square	0.000	0.000	0.000	0.000	0.000	0.000	0.000
PP-Fisher Chi-square	0.000	0.000	1.000	1.000	1.000	1.000	1.000

See Table 1 for descriptions of the variables

Source: own estimations

Baseline models

Table 3 shows the results on the benchmark Helpman model (equation 5). Estimations highlight that relative factor endowments proxied by difference in per capita GDP do not have a significant impact on horizontal IIT for all specifications except the partner HIIT model. Country size effects are strongly significant, however ln*GDP*max variables has unexpected signs. In general, results are fairly robust to different and subsamples.

In the next step, the alternative specification of the benchmark model is considered to separate the effect of absolute country size from impact of relative country size (Table 4).

The results are rather mixed. Similarly to previous model, difference in per capita GDP does not influence significantly the HIIT except for the last specification. However, the estimations support a positive effect of relative and absolute country size. Again, the estimations are robust to various subsamples.

Table 3: The impact on horizontal IIT of relative factor endowments proxied by difference in per capita GDP using total-, reporter- and partner-based samples according to the benchmark Helpman model 1.

	Total	Reporter	Partner
ln*DGDPC*	0.0004	-0.0001	0.0010**
ln*GDP*min	0.0082***	0.0085***	0.0078***
ln*GDP*max	0.0015***	0.0007*	0.0023***
constant	-0.2193***	-0.2073***	-0.2326***
N	7722	3861	3861
R^2	0.0471	0.0473	0.0474

N: number of observations. ***/**/*: statistically significant, respectively at the 1%, 5%, and 10% levels
Source: own estimations

Table 4: The impact on horizontal IIT of relative factor endowments proxied by difference in per capita GDP using total-, reporter- and partner-based samples according to the benchmark Helpman model 2.

	Total	Reporter	Partner
ln*DGDPC*	0.0004	-0.0001	0.0010**
ln*GDP*min	0.0048***	0.0046***	0.0051***
ln*dispersion*	0.0277***	0.0316***	0.0234**
constant	-0.2334***	-0.2233***	-0.2443***
N	7722	3861	3861
R^2	0.0466	0.0466	0.0473

N: number of observations. ***/**/*: statistically significant, respectively at the 1%, 5%, and 10% levels
Source: own estimations

New evidence

It is well known that the use of per capita GDP as a proxy for relative factor endowments is problematic. Linder (1961) already noted that inequality in per capita income may serve as a proxy for 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 income per worker as a measure of differences in factor composition and also using actual factor data on capital-labour and land-labour ratios. Interestingly, despite these limitations of the use of the GDP per capita, it has become a popular and dominating proxy for factor endowments in the empirical literature.

In the first step, the results focusing on the relationships between the IIT and differences in capital-labour ratios, with control for the variation in the sum of capital-labour proportions predicted by Cieslik (2005), are presented. The estimated coefficients are highly significant and consistent with the theoretical predictions (Table 5), irrespective to alternative subsamples. The absolute value of differences in capital-labour ratios negatively, while the sum of these ratios positively, influences the IIT.

Table 5: The impact on horizontal IIT of relative factor endowments proxied by capital to labour ratios using total, reporter- and partner-based samples according to the Cieslik model.

	Total	Reporter	Partner
ln*DCAPLAB*	-0.0052***	-0.0054***	-0.0049***
lnsum*CAPLAB*	0.0125***	0.0123***	0.0128***
constant	-0.1810***	-0.1676***	-0.1942***
N	7722	3861	3861
R^2	0.0300	0.0282	0.0325

N: number of observations. ***/**/*: statistically significant, respectively at the 1%, 5%, and 10% levels
Source: Own estimations

Sensitivity analysis

To check the robustness of the results, several alternative specifications including common control variables offered by the empirical literature are performed. Bergstrand (1990) suggests distinguishing the demand and supply side to explain the IIT. He argues that since the inequality in per capita incomes between countries seems to influence the share of IIT via two channels, both of them should be taken into account in econometric analysis. Cieslik (2005) proposes two different tests for Bergstrand's considerations. In the first step, the logs of the absolute value of the difference in GDP per capita and the logs of the sum of GDP per capita of trading partners are added, to control for divergence in tastes and the average level of development. Estimation shows that the capital-labour variables are significant and in line with theoretical expectations (Table 6). Both GDP per capita variables significantly influence the HIIT for all specifications.

Alternatively, the previous model is extended with absolute and relative country size variables. These results are more ambiguous (Table 7). The coefficients of difference in capital-labour ratios significantly and negatively influence the HIIT, confirming theoretical predictions. However, the sum of capital-labour ratios has become insignificant. The estimations of country size variables support *a priori*

Table 6: Sensitivity analysis of Cieslik model 1.

	Total	Reporter	Partner
ln*DCAPLAB*	-0.0044***	-0.0046***	-0.0041***
lnsum*CAPLAB*	0.0097***	0.0096***	0.0098***
ln*DGDPC*	-0.0081***	-0.0083***	-0.0079***
ln*GDPC*sum	0.0060***	0.0056***	0.0064***
constant	-0.1660***	-0.1478***	-0.1839***
N	7722	3861	3861
R^2	0.0739	0.0715	0.0772

N: number of observations. ***/**/*: statistically significant, respectively at the 1%, 5%, and 10% levels
Source: own estimations

expectations. The per capita GDP variables also have strong impacts on the HIIT.

Finally, the role of distance in explanation of the IIT is investigated. Bergstrand (1990) provided a formal justification for the relationship between HIIT and transport costs. These results support the traditional concerns, namely that distance is significantly and negatively related to the HIIT in all specifications (Table 8). At the same time, the estimates of the coefficients on differences and sums of capital-labour ratios have the predicted signs and remain statistically significant at the 1 per cent level.

Table 7: Sensitivity analysis of Cieslik model 2.

	Total	Reporter	Partner
ln*DCAPLAB*	-0.0021**	-0.0020**	-0.0022**
lnsum*CAPLAB*	0.0026	0.0020	0.0031
ln*GDP*sum	0.0034***	0.0035***	0.0032***
ln*dispersion*	0.0086	0.0117*	0.0054
ln*DGDPC*	-0.0074***	-0.0075***	-0.0073***
ln*GDPC*sum	0.0042***	0.0037**	0.0047***
constant	-0.1824***	-0.1671***	-0.1975***
N	7722	3861	3861
R^2	0.0784	-0.0020**	0.0802

N: number of observations. ***/**/*: statistically significant, respectively at the 1%, 5%, and 10% levels
Source: own estimations

Table 8: Sensitivity analysis of Cieslik model 3.

	Total	Reporter	Partner
ln*DCAPLAB*	-0.0046***	-0.0049***	-0.0044***
lnsum*CAPLAB*	0.0116***	0.0113***	0.0119***
ln*Dist*	-0.0000***	-0.0000***	-0.0000***
constant	-0.1533***	-0.1387***	-0.1677***
N	7722	3861	3861
R^2	0.0563	0.0561	0.0571

N: number of observations. ***/**/*: statistically significant, respectively at the 1%, 5%, and 10% levels
Source: own estimations

Summary and conclusions

The aim of the paper is to analyse the pattern and driving forces of the HIIT and relative factor endowments using the integrated Helpman and Krugman (1985) model. This framework predicts a negative relationship between differences in capital-labour ratios and the HIIT. However, there exists rather puzzled evidence to support this theory. Previous empirical studies have failed to provide an exact link between the theory and the data. Thus, an empirical strategy developed by Cieslik (2005) is employed to test the predictions of the Helpman and Krugman (1985) model.

The results show a low level of HIIT for agri-food products within the enlarged EU during the analysed period. At the country level, Belgium, France, Netherlands and Germany report the highest levels of IIT within the EU.

The empirical evidence suggests that the standard IIT theory finds some support in the data when the sum of capital-labour ratios instead of relative country-size variables is controlled in the estimating equations. In other words, the theory can work if an appropriate framework for empirical analysis is employed.

The results have several implications for future empirical work. Instead of using the usual eclectic and/or *ad hoc* approach, the empirical research on IIT should be based on specific theoretical models. Similarly to the vertical IIT literature, empirical research based on the C-H-O model should distinguish the horizontal from the vertical IIT. The calculations in this paper confirm the findings of Fertő and Soós (2009) that data accuracy can be a serious issue in empirical IIT research, although the estimations are relatively robust to various subsamples. Thus, sensitivity analysis is important for checking the robustness of results. Finally, the empirical research should use the relevant and new developments in panel data econometrics.

References

Beck, N. and Katz, J.N. (1995): What to Do (and Not to Do) with Time-Series Cross-Section Data. American Political Sciences Review **89** (3), 634-647. http://dx.doi.org/10.2307/2082979

Beck, N. and Katz, J.N. (1996): Nuisance vs. Substance: Specifying and Estimating Time-Series Cross-Section Models. Political Analysis **6** (1), 1-36. http://dx.doi.org/10.1093/pan/6.1.1

Bergstrand, J.H. (1990): The Heckscher-Ohlin-Samuelson model, the Linder hypothesis and the determinants of bilateral intra-industry trade. The Economic Journal **100** (403), 1216-1229. http://dx.doi.org/10.2307/2233969

Cieślik, A. (2005): Intraindustry trade and relative factor endowments. Review of International Economics **13** (5), 904-926. http://dx.doi.org/10.1111/j.1467-9396.2005.00544.x

Fertő, I. (2005): Vertically Differentiated Trade and Differences in Factor Endowment: The Case of Agri-Food Products between Hungary and the EU. Journal of Agricultural Economics **56** (1), 117-134. http://dx.doi.org/10.1111/j.1477-9552.2005.tb00125.x

Fertő, I. (2007): Intra-industry trade in horizontally and vertically differentiated agri-food products between Hungary and the EU. Acta Oeconomica **57** (2), 191-208. http://dx.doi.org/10.1556/AOecon.57.2007.2.3

Fertő, I. and Jámbor A. (2015): Drivers of Vertical Intra-Industry Trade: The Case of the Hungarian Agri-Food Sector. Agricultural Economics **46** (1), 113-123. http://dx.doi.org/10.1111/agec.12144

Fertő, I. and Soós, K.A. (2009): Treating trade statistics inaccuracies: the case of intra-industry trade. Applied Economics Letters **16** (18): 1861-1866. http://dx.doi.org/10.1080/13504850701719512

Greenaway, D., Hine, R. and Milner, C. (1994): Country-Specific Factors and the Pattern of Horizontal and Vertical Intra-Industry Trade in the UK. Weltwirtschaftliches Archiv **130** (1), 77-100. http://dx.doi.org/10.1007/BF02706010

Greenaway, D., Hine, R.C. and Milner, C.R. (1995): Vertical and Horizontal Intra-Industry Trade: A Cross-Industry Analysis for the United Kingdom. Economic Journal **105** (11), 1505-1518. http://dx.doi.org/10.2307/2235113

Grubel, H. and Lloyd, P. (1975): Intra-Industry Trade: The Theory and Measurement of International Trade in Differentiated Products. London: Macmillan.

Helpman, E. (1981): International trade in the presence of product differentiation, economies of scale and monopolistic competition. Journal of International Economics **11**, 305-340. http://dx.doi.org/10.1016/0022-1996(81)90001-5

Helpman, E. (1987): Imperfect Competition and International Trade: Evidence from Fourteen Industrial Countries. Journal of the Japanese and International Economics **1** (1), 62-81. http://dx.doi.org/10.1016/0889-1583(87)90027-X

Helpman, E. and Krugman, P. (1985): Market Structure and For-

eign Trade. Brighton: Harvester Wheatsheaf.
Hummels, D. and Levinsohn, J. (1995): Monopolistic Competition and International Trade: Reconsidering the Evidence. Quarterly Journal of Economics **110** (3), 799-836. http://dx.doi.org/10.2307/2946700
Im, K., Pesaran, H. and Shin, Y. (2003): Testing for unit roots in heterogeneous panels. Journal of Econometrics **115** (1), 53-74. http://dx.doi.org/10.1016/S0304-4076(03)00092-7
Jámbor, A. (2014a): Country-Specific Determinants of Horizontal and Vertical Intra-industry Agri-food Trade: The Case of the EU New Member States. Journal of Agricultural Economics **65** (3), 663-682. http://dx.doi.org/10.1111/1477-9552.12059
Jámbor, A. (2014b): Determinants of Intra-industry Agri-food Trade in the Visegrad Countries. Acta Alimentaria **43** (2), 246-253. http://dx.doi.org/10.1556/AAlim.43.2014.2.8
Jensen, L. and Lüthje, T. (2009): Driving forces of vertical intra-industry trade in Europe 1996-2005. Review of World Economics **145** (3), 469-488. http://dx.doi.org/10.1007/s10290-009-0022-5
Krugman, P. (1979): Increasing returns, monopolistic competition, and international trade. Journal of International Economics **9**, 469-479. http://dx.doi.org/10.1016/0022-1996(79)90017-5
Lancaster, K. (1980): Intra-industry trade under perfect monopolistic competition. Journal of International Economics **10**, 151-175. http://dx.doi.org/10.1016/0022-1996(80)90052-5
Leitão, N.C. and Faustino, H. (2008): Intra-industry trade in the food processing sector: the Portuguese case. Journal of Global Business and Technology **4** (1), 49-58.
Leitão, N.C. (2011): Intra-industry trade in the agriculture sector: The experience of United States. African Journal of Agricultural Research **6** (1), 186-190.
Levin, A., Lin, C. and Chu, C. (2002): Unit root tests in panel data: asymptotic and finite-sample properties. Journal of Econometrics **108** (1), 1-24. http://dx.doi.org/10.1016/s0304-4076(01)00098-7
Linder, S.B. (1961): An Essay on Trade and Transformation. New York NY: Wiley.
Milgram-Baleix, J. and Moro-Egido, A.I. (2010): The Asymmetric Effect of Endowments on Vertical Intra-industrial Trade. The World Economy **33** (5), 746-777. http://dx.doi.org/10.1111/j.1467-9701.2010.01238.x
Pesaran, M.H. (2004): General diagnostic tests for cross section dependence in panels. CWPE 0435. Cambridge: University of Cambridge.
Rasekhi, S. and Shojaee, S.S. (2012): Determinant factors of the vertical intra-industry trade in agricultural sector: a study of Iran and its main trading partners. Agricultural Economics (Czech) **58** (4), 180-190.
Sexton, R.J. (2013): Market Power, Misconceptions, and Modern Agricultural Markets. American Journal of Agricultural Economics **95** (2), 209-219. http://dx.doi.org/10.1093/ajae/aas102
Varma, P. (2012): An analysis of India's bilateral intra-industry trade in agricultural products. International Journal of Economics and Business Research **4** (1), 83-95. http://dx.doi.org/10.1504/IJEBR.2012.044246
Wang, J. (2009): The analysis of intra-industry trade on agricultural products of China. Frontiers of Economics in China **4** (1), 62-75. http://dx.doi.org/10.1007/s11459-009-0004-5
Wooldridge, J.M. (2002): Econometric Analysis of Cross Section and Panel Data. Cambridge MA: The MIT Press.