Intra-industry trade in the wine industry in the enlarged European Union

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1. Introduction

Last decades the intra-industry trade (IIT) became widespread phenomena with 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 assumption 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 intra-industry trade 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. Alternatively, the vertical IIT models developed by Falvey (1981), Falvey and Kierzkowski (1987) and Flam and Helpman (1987) predict a positive relationship between IIT and differences in relative factor endowment. The available empirical evidence provides rather puzzling evidence on the impact of relative factor endowments on the IIT. One of possible explanation of diverging results is that majority of empirical studies fail to provide exact link between theory and data. Empirical studies on IIT usually employ 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 EU contributed to an increase in intra-industry trade among European countries. There is a wealth of literature on the IIT between a particular EU country and its partner (see for recent examples Jensen and Lüthje 2010, Milgram-Baleix and Moro-Egido 2010). However significant part of the studies still has focused on industrial products. Interestingly, the industry level studies are still scarce especially in the food industry (see exeption Christodolou 1992, Pieri et al 1997). The enlargement of the European Union during last decade is as a good example to analyse the IIT in wine products. The aim of the paper is to analyse the pattern and drivers of IIT in the wine industry within European Union between 2000 and 2011. This paper is the first attempt to analyse wine trade within EU. More specifically, following Helpman (1987) and Hummels and Levinsohn (1995) we focus on the theoretical relationships between factor proportions and intra-industry trade within original Helpman-Krugman framework. Moreover, we control the impact of the sums of capital-labour rations as proposed by Cieslik (2005). Our additional contributions are following. We employ multilateral dataset instead of bilateral framework still predominating recent empirical research. In addition, although Helpman-Krugman model based on horizontal product differentiation, empirical tests of their model are usually neglect the distinction between horizontal and vertical IIT, when they measure the IIT. However, because the main focus in empirical IIT literature is to analyse the effect of relative factor endowments on the IIT, we can test both horizontal and vertical IIT models using the same modelling framework. Thus we check the robustness of our results using total and horizontal and vertical IIT indices.

2. 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 country 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 gravity-like equation that explains the relationship between 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 Helpman-Krugman (1985) model does not predict unique theoretical relationship between IIT and relative country size if we keep differences in capital to labour ratios unchanged. Thus Cieslik (2005) develop a formal model to eliminate this shortcoming providing two complementary propositions. First, the share of IIT between two countries is larger the sum of their capital-labour ratios, given the fixed difference in their capital labour proportions. Second, 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 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.

The theoretical models for vertical IIT developed by Falvey (1981), Falvey and Kierzkowski (1987) and Flam and Helpman (1987), overcome the traditional indetermination of the direction of IIT, and they allow us to establish the pattern of varieties that are produced each country. Falvey (1981) and Falvey and Kierzkowski (1987) assume a perfectly competitive market with two countries, two goods (a homogeneous product and a differentiated one) and two factors (labour and capital). They introduce technological differences between countries, but only in the homogeneous product sector. In the differentiated sector it is assumed that more capital is used in producing higher quality varieties than in lower quality ones. So, the higher income, relatively capital-abundant country specialises in exporting relatively high quality varieties, while the lower income, relatively labour-abundant country specialises in exporting low quality varieties. The second group of the models turns to a more heterodox explanation in line with the neo-Ricardian and neo-factorial models (Gabszewicz et al. 1981, Shaked and Sutton 1984). A similar model of IIT in vertically differentiated products to Flam and Helpman (1987) is created in which North-South trade is determined by differences in technology, income and income distribution. Stokey (1991) and Copeland and Kotwal (1996) also assign a different aspect of the income distributions explaining VIIT. Their models predict that VIIT to be more prominent among countries with a high degree of income distribution overlap.

3. 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 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 denotes the share of industry i in total trade.
Literature suggests several options to disentangle the 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% 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 ά=0.15. The choice of 15 per cent range is rather arbitrarily, thus already Greenaway et al. (1994) proposed to widen the spread to 25 per cent. Interestingly, the papers checking the possible impact of various thresholds on results confirm that results coming from the selection of the 15% range do not change significantly when the spread is widened to 25% (Jensen and Lüthje 2009). 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 denote 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). Blanes and Martín (2000) emphasise the distinction between high and low vertical IIT. They define low vertical IIT when the relative unit value of a good is below the limit of 0.85, while unit value above 1.15 indicates high vertical IIT.

We employ trade data from the UN Comtrade database with the **World Integrated Trade Solution** (WITS) software developed by the World Bank using the ISIC Revision 2 system (four digit level). Wine trade is defined as trade in product groups coded in ISIC-3132. Our analysis focuses on the period 2000-2011. In this context, the EU is defined as the member states of the EU27.

4. Econometric specifications

We use three different specifications to test theoretical propositions of Helpman-Krugman model and modified versions developed by Cieslik (2005). Early tests of Helpman-Krugman based on following specifications introduced by Helpman (1987).

$$lnIIT_{ijt}=\alpha_0+\alpha_1 lnDGDPC_{ijt}+\alpha_2 min(lnGDP_{it}, lnGDP_{jt})+\alpha_3 max(lnGDP_{it}, lnGDP_{jt})+_{ij}+\varepsilon_{ij} \quad (5)$$

where IIT is the bilateral GL index.

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

$$lnIIT_{ijt}=\alpha_0+\alpha_1 lnDGDPC_{ijt}+\alpha_2 sum(lnGDP_{it}, lnGDP_{jt})+\alpha_3 lndispersion_{ijt}+ \varepsilon_{ijt} \quad (6)$$

where dispersion is can expressed is 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) we estimate following model:

$$lnIIT_{ijt}= \alpha_0+ \alpha_1 lnDCAPLAB_{ijt} + \alpha_2 lnsumCAPLAB_{ijt} + \varepsilon_{ijt} \quad (8)$$

From capital-labour ratios the physical capital was estimated by perpetual inventory method. Table 1 provides an overview of the description of variables and related hypotheses.

Table 1: Description of independent variables

Variable	Variable description	Data source	Sign
lnDGDPC	The logarithm of per capita GDP absolute difference between trading partners measured in PPP in current international USD	WDI	-/+
lnGDPmin	The logarithm of minimum GDP measured in PPP in current international USD	WDI	+
lnGDPmax	The logarithm of maximum GDP measured in PPP in current international USD	WDI	-
lnGDPsum	The logarithm of sum of GDP of trading partners measured in PPP in current international USD	WDI	+
lndispersion	The logarithm of absolute difference between trading partners capital city measured in kilometres	WDI	+
lnDCAPLAB	The logarithm of absolute difference of capital labour ratios between trading partners	Penn World Tables	-/+
LnsumCAPLAB	The logarithm of sum of capital labour ratios between trading partners	Penn World Tables	+
lnDIST	The logarithm of absolute difference between trading partners capital city measured in kilometres	CEPII	-

Source: Own composition

5. The nature of intra-industry trade

One well-known problem in empirical IIT analysis including is stability of classification of IIT types (Nielsen and Lüthje 2002). The literature on the use of export/import unit values for assessing trade types, product qualities is mixed (Bojnec and Fertő 2010). International export/import unit values may differ and be volatile due to product mix and short run consumers' preferences, as a reason for criticism of their use in competitiveness and other economic analyses (e.g. Silver, 2007). On the other hand, there are no other available data to address the analyzed questions, for the reason that the use of export/import unit values is widespread in the empirical trade literature (e.g., Greenaway et al, 1994) under the assumption that, even with imperfect information, prices tend to reflect quality (Stiglitz, 1987) and determine the direction of trade. To check the stability of classification in IIT types we employ Markov transition probability matrix. We distinguish three different trade types: low vertical IIT, horizontal IIT and high vertical IIT.

Table 2: Markov transition probability matrix for classification of trade types (per cent)

	Low vertical IIT	Horizontal IIT	High vertical IIT
Low vertical IIT	64.2	6.0	29.8
Horizontal IIT	33.3	26.2	40.5
High vertical IIT	11.9	3.5	84.7

Source: Own calculations based on the Eurostat database

Table 2 presents the Markov transition probability matrix for the trade types for the probability of staying or passing from one state to another between the starting year (2000) and the ending year (2011). The diagonal elements of the Markov transition probability matrix indicate the probability of staying highly persistently with high vertical industry trade (85 per cent) and less persistent for horizontal IIT (26 per cent), low vertical IITs are 64 per cent. Moreover, there is the highest chance for horizontal IITs to move to high vertical IIT status (40 per cent). In short, our estimations reinforce the findings by Nielsen and Lüthje (2002), namely the IIT classification is rather unstable.

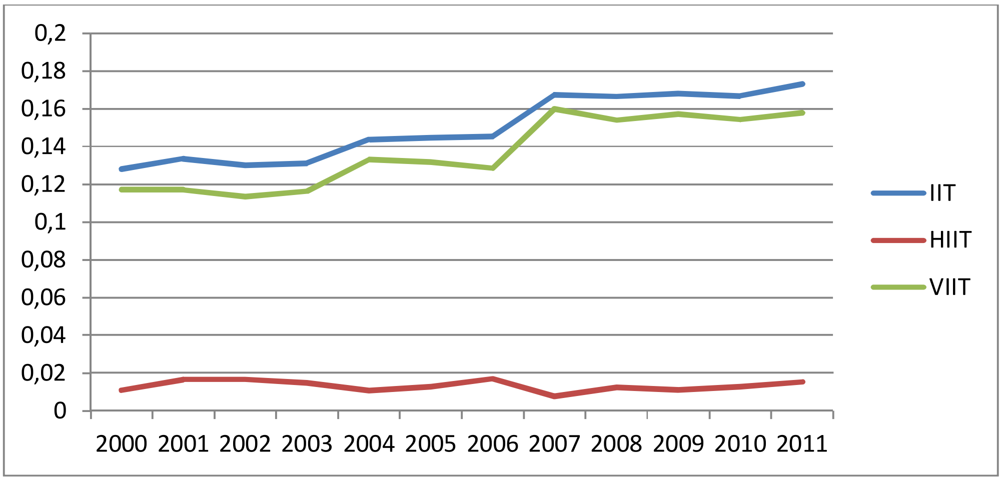

Figure 1: Development of wine IIT in the EU-27
Source: Own calculations based on Comtrade database with WITS

Figure 1 shows that total IIT is rather low (below 0.2) with an upwarding trend. There is also evidence of IIT, mainly of a vertical nature, suggesting the exchange of products of different quality. The dominance of vertical over horizontal type trade accords with the general findings of recent empirical literature.
We calculated the mean values of IIT indices by subsamples between Old Member States (OMS) and New Member States (NMS) for all combinations. The distributions of IIT types is varying a bit based on different sample, but predominant role of vertical IIT is confirmed in all samples. The share of horizontal IIT is the smallest in full sample and in all relations of member states. Moreover, the IIT is the highest between Old Member States and the lowest between New Member States

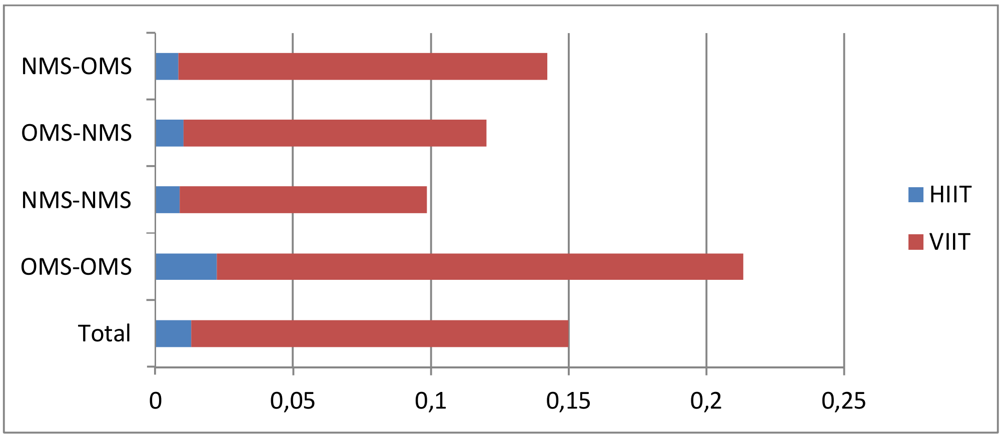

Figure 2: Types of wine IIT in the EU-27
Source: Own calculations based on Comtrade database with WITS

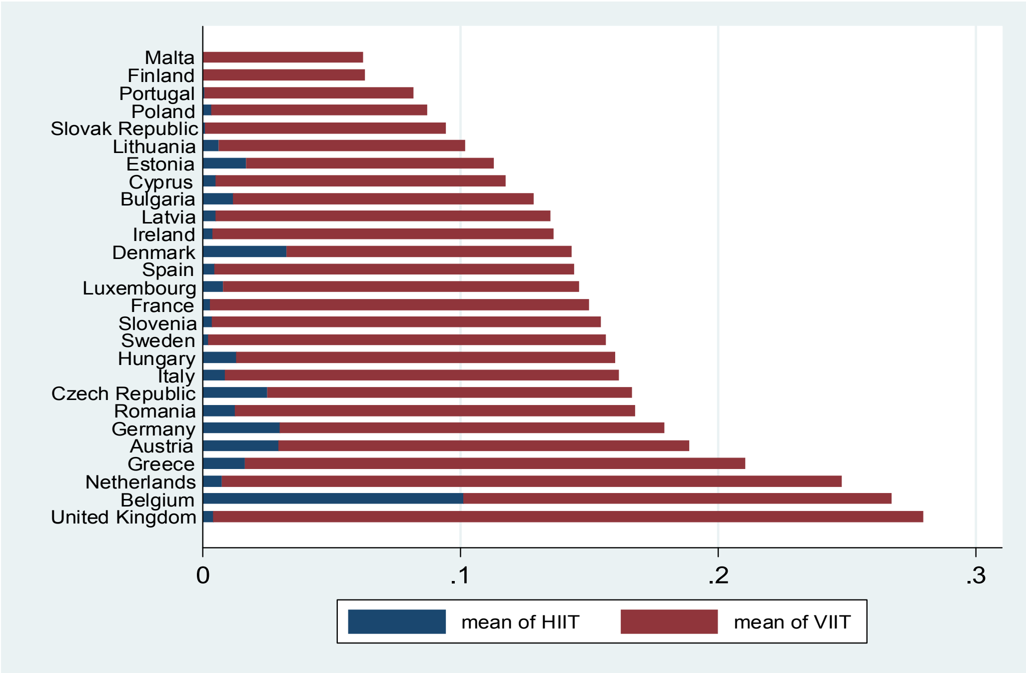

Figure 3: Wine IIT in EU-27 by countries
Source: Own calculations based on Comtrade database with WITS

The level of IIT and horizontal IIT is rather low in wine trade in the EU (Figure 3). However, one may observe considerable difference by countries. UK, Belgium, The Netherlands, Greece, Austria show the highest, while Malta, Finland and Portugal present lowest value of IIT indices.

6. 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 we employ a battery of unit root tests: Levin, Lin and Chu (2002) method (common unit root process), Im, Pesaran and Shin (2003) method (assuming individual unit root processes), ADF-Chi square, and PP-Chi square. In all cases we employ both drift without and with a specifications as a deterministic component and the lag length has been chosen according to the Modified Akaike Information Criterion (MAIC) proposed by Ng and Perron (2001)

Table 3: Panel unit root tests

	IIT	HIIT	VIIT	lnDGDPC	lnGDPmin	lnGDPmax	lnDCAPLAB	lnsumCAPLAB
Levin, Lin & Chu t*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
Im, Pesaran and Shin W-stat	0.000	0.000	0.000	0.000	0.000	0.000	0.999	1.000
ADF - Fisher Chi-square	0.000	0.000	0.000	0.000	0.000	0.000	0.999	1.000
PP - Fisher Chi-square	0.000	0.000	0.000	0.000	0.000	0.000	0.068	1.000
with trend								
Levin, Lin & Chu t*	0.000	0.000	0.000	0.080	0.000	0.000	0.000	0.000
Im, Pesaran and Shin W-stat	0.008	0.000	0.000	0.000	1.000	0.086	1.000	1.000
ADF - Fisher Chi-square	0.000	0.000	0.000	0.000	0.989	0.990	1.000	1.000
PP - Fisher Chi-square	0.000	0.000	0.000	0.000	0.997	1.000	0.000	0.003

Source: Own estimations

Table 3 presents the results of four different panel unit root tests (Levin, Lin and Chu; Im, Pesaran and Shin; ADF-Fisher Chi square, PP-Fisher Chi square). Mixed results were obtained. The most important model variables such as the IIT and HIIT and VIIT do not have unit roots, i.e. are stationary, with individual effects and individual trend specifications. The majority of tests indicate that explanatory variables are probably non-stationary with trend specifications, except lnGDPC variable.

To ensure that all IIT variables are stationary I(0) and not integrated of a higher order, we apply unit root tests on first differences of all variables. All tests (not shown here) reject the unit root null hypothesis for the first differences. In sum, we may conclude that panel is likely stationary.

We apply several estimation techniques to equation (5-6, 8) in order to ensure the robustness of the results. Preliminary Hausman tests favour to use of fixed effect panel models for majority of models. However, there are some additional issues that we have to be addressed when are estimated such panel models. First, heteroskedasticity 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 and Pesaran tests) confirms the presence of heteroscedasticity, autocorrelation and cross-sectional dependence. Because our analysed period is shorter than cross sectional unit, to deal with issues of contemporaneous correlation the panel corrected standard error model (PCSE) is applied which controls for heteroskedasticity and the AR(1) type of autocorrelation and contemporaneous correlation across panels (Beck and Katz, 1995, 1996).

6.1. Baseline models

Table 4 shows results on the benchmark Helpman model (equation 5). Estimations highlight that relative factor endowments proxied by difference in GDP per capita have significant impact in all models. The lnDGDPC negatively influences both the total IIT and the HIIT confirming prediction by the Helpman model. However we find also negative impact of the relative factor endowments on VIIT model which contradict to theoretical VIIT models. The lnGDPmin variables have expected signs with significance for all specifications. The lnGDPmax variables are significant with unexpected signs for IIT and VIIT specifications.

Table 4: Baseline Helpman model 1.

	IIT	HIIT	VIIT
lnDGDPC	-0.018***	-0.001*	-0.016***
lnGDPmin	0.011***	0.003***	0.009***
lnGDPmax	0.018***	-0.000	0.018***
constant	-0.453***	-0.036***	-0.417***
R^2	0.367	0.266	0.332
N	8424	8424	8424

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

Next step we consider the alternative specification of benchmark model to separate the effect of absolute country size from impact of relative country size. Our results are rather mixed (Table 5). Similarly to previous model, difference in GDP capita is significant with expected sign in the same case, namely for the IIT and the HIIT and unexpected for the VIIT. However, our estimations support positive and significant effect for the absolute and relative country sizes confirming theoretical expectations.

Table 5: Baseline Helpman model 2.

	IIT	HIIT	VIIT
lnDGDPC	-0.018***	-0.001*	-0.017***
lnGDPsum	0.045***	0.004***	0.042***
lndispersion	0.017***	0.004***	0.013***
constant	-0.880***	-0.069***	-0.811***
R^2	0.497	0.344	0.450
N	8424	8424	8424

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

6.2. 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 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 of these limitations of use of the GDP per capita, it became a popular and dominating proxy for factor endowments in empirical literature.

Table 6: Cieslik model

	IIT	HIIT	VIIT
lnDCAPLAB	-0.013***	-0.002**	-0.011***
lnsumCAPLAB	0.083***	0.009**	0.073***
constant	-0.761***	-0.085*	-0.676***
R^2	0.149	0.193	0.123
N	8424	8424	8424

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

In the first step we present 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). The estimated coefficients for sum of capital labour ratios are highly significant and consistent with the theoretical predictions (Table 6) irrespective to alternative specifications. The absolute value of differences in capital labour ratios has negative sign with significance for all models. Note, we expect positive impact for the VIIT model.

6.3. Sensitivity analysis

To check the robustness of our results we perform several alternative specifications including common control variables offered by empirical literature. First, we add two Helpman (1987) control variables including lnGDPmin and lnGDPmax. LnGDPmin variables are significantly positive as in Table 4 regardless of alternative specifications, whilst lnGDPmax variables have positive and significant impacts except the HIIT model (Table 7). More importantly, capital-labour variables are keeping their significance with expected signs for IIT/HIIT models.

Table 7: Sensitivity analysis 1.

	IIT	HIIT	VIIT
lnDCAPLAB	-0.010***	-0.002**	-0.008***
lnsumCAPLAB	0.044***	0.007*	0.037***
lnGDPmin	0.012***	0.002***	0.010***
lnGDPmax	0.013***	-0.001	0.014***
constant	-0.951***	-0.100**	-0.851***
R^2	0.352	0.341	0.310
N	8424	8424	8424

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

Table 8: Sensitivity analysis 2.

	IIT	HIIT	VIIT
lnDCAPLAB	-0.008***	-0.002*	-0.006***
lnsumCAPLAB	0.020***	0.005*	0.014***
lnGDPsum	0.042***	0.003***	0.039***
lndispersion	0.019***	0.004***	0.015***
constant	-1.114***	-0.110**	-1.004***
R^2	0.451	0.380	0.404
N	8424	8424	8424

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

Second, we extend our models with relative and absolute country size variables (Table 8). Capital-labour variables are remaining signficant with expected signs for IIT/HIIT models, whilst relative and absolute country size has strong positive impacts on the IIT at 1 per cent level.
Finally, we investigate the role of distance in explanation of the IIT. Bergstrand (1990) provided a formal justification for the relationship between horizontal IIT and transport costs. Our results support the traditional concerns, namely distance is signifcantly and negatively related to the IIT in all specifications (Table 9). At the same time, the estimates of the coefficients on sums of capital–labour ratios have predicted signs and remain statistically significant at the 1 percent level. Similarly to previous estimations, differences of capital–labour ratios have predicted signs with significance for IIT/HIIT models.

Table 9: Sensitivity analysis 3.

	IIT	HIIT	VIIT
lnDCAPLAB	-0.012***	-0.002**	-0.010***
lnsumCAPLAB	0.077***	0.008**	0.069***
lndistance	-0.097***	-0.017***	-0.081***
constant	-0.006	0.046	-0.052
R^2	0.763	0.178	0.570
N	8424	8424	8424

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

7. Summary and conclusions

The paper analyses the pattern and driving forces of the IIT in the wine industry and relative factor endowments using the integrated Helpman and Krugman model. This framework predicts a negative relationship between differences in capital–labour ratios and the IIT. However, there exists rather puzzled evidence to support this theory. Previous empirical studies fail to provide an exact link between the theory and the data. Thus, we employ a new empirical strategy developed by Cieslik (2005) to test the predictions of Helpman and Krugman (1985) model.

Our results confirm the increasing role of IIT within enlarged EU for wine products during analysed period. Estimations support the dominance of vertical over horizontal type trade accords with the general findings of recent empirical literature. At the country level, UK, Belgium, The Netherlands, Greece and Austria report the highest level of IIT within the EU.
Our empirical evidence suggests that the standard IIT theory finds some support in the data when we control for the sum of capital–labor ratios in the estimating equations instead of relative country-size variables. Although empirical research based on CHO framework usually neglects the distinction of horizontal and vertical IIT, our results are relatively robust to indices for total, horizontal and vertical IIT. Suprisingly, contrary to previous research factor endowments variables are not discriminate the HIIT and VIIT models as we would expect from different theoretical predictions. Our estimations also present a considerably high level instability in the IIT classifications which casts some doubts on the use of unit value approach to distinguish horizontal and vertical IIT

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