Intra-Industry Trade in Horizontally and Vertically Differentiated Agri-Food Products between Hungary and the EU

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Abstract

Intra-industry trade in agri-food products between Hungary and the EU is shown to be low and dominated by vertically rather than horizontally differentiated products, suggesting higher economic adjustment costs. Following recent empirical studies, we then test econometrically for the determinants of this trade using different measures of horizontal and vertical trade, and employing an array of popular explanatory variables. Results suggest that separating the measure of intra-industry trade into vertical and horizontal provides for better estimation and supports the contention that the determinants may differ by type of trade. In the regression analysis, the level of intra-industry trade is found to serve as a better dependent variable than the degree or share of intra-industry trade.

Keywords intra-industry trade, product differentiation, Hungary

1. Introduction

The definition of intra-industry trade emphasises 'two-way trade in similar products'. In empirical analysis, therefore, it is necessary to define the meaning of 'similar products' and 'two-way' trade. Similarity of products also has significance from a theoretical point of view, as an important distinction exists in the literature between horizontal and vertical product differentiation. Essentially, the former occurs when different varieties of a product are of a similar quality, and the latter when varieties are of different qualities. The significance of this distinction is that the industry and country characteristics associated with intra-industry trade may differ depending on the type of product differentiation (Greenaway *et al.* 1994 and 1995). There is a large literature, both theoretical and empirical, on intra-industry trade, most of which is focused (implicitly) on horizontal differentiation. Although some earlier models were associated with vertically differentiated products (e.g. Falvey, 1981, and Falvey-Kierzkowski, 1985), empirical investigations of the determinants of intra-industry trade usually have not distinguished between vertical and horizontal differentiation; Henry de Frahan and Tharakan (1998 and 1999) are notable exceptions.

There exists an additional reason for the underlying importance of vertical intra-industry trade, in that it has some potential concerns for welfare analysis of economic integration (Blanes and Martin, 2000). Intra-industry trade models based on horizontally differentiated products are associated with low adjustment costs from regional integration and trade liberalisation. However, these costs can be significantly higher for vertically differentiated products, for two reasons. First, the factor content of exports and imports may be different, similar to *inter*-industry trade (Greenaway and Hine, 1991). Second, if intra-industry trade leads to higher quality products displacing lower quality products, then countries that produce the latter are likely to suffer unemployment, which if not compensated by lower prices and access to the higher quality products, will cause negative welfare effects (Shaked and Sutton, 1994; and Motta, 1992).

In this paper we investigate the determinants of Hungary's intra-industry trade in horizontally and vertically differentiated agri-food products with the EU, over the period 1992-98. The next section outlines two approaches to measuring horizontal and vertical intra-industry trade. In section 3 these approaches are applied to our trade data. The procedure for investigating the determinants of intra-industry trade are outlined in section 4, and the results of applying this procedure are presented in section 5. Section 6 contains a summary and some conclusions.

2. Measuring vertical and horizontal intra-industry trade

Over the last decade there has been a number of attempts at measuring horizontal and vertical intra-industry trade, based on quality differences. Cooper *et al.* (1993) applied an hedonic regression to identify the relative importance of a range of product characteristics in influencing price. But, as the authors admit, their method is very data intensive and is more satisfactory for the analysis of a particular product than for a multi-product investigation.

An alternative approach is to infer quality differences from measurement of demand elasticities among products from different sources. Following this procedure, Brenton and Winters (1992) interpreted the lower demand elasticities of domestically produced goods, compared to demand elasticities for imports, as an indicator of their higher quality.

Unit value, as an indicator of the average price of a particular good, can also be used for assessing product quality in trade data. The underlying assumption is that relative prices are likely to reflect relative qualities (Stiglitz, 1987). However, using unit value as a measure of quality has some disadvantages. High price can be associated with imperfect information. In the short run, consumers can buy high price goods due to inertia or because it is costly to shift to other suppliers (Oulton, 1991). Nevertheless, price may be a satisfactory measure of quality because it is a reasonable source of information about consumers' assessment of products. Unit values can be calculated in several ways: per item, per tonne, per square metre, etc. Whichever, the computation of unit values presents some problems (Greenaway *et al.*, 1994). First, unit values per item may be positively associated with size, whereas other characteristics more closely related to quality, like durability and reliability, may be inversely associated with size, causing interpretation problems. However, this disadvantage may be not a serious problem for a wide range of products. Second, unit values per weight are also problematic. A higher quality product may be made out of heavier material, and therefore its unit price per tonne is lower than that of an inferior quality product made out of lighter material. Although Greenaway *et al.* (1994) cite an example where the unit values per tonne and unit values per item are highly correlated, this is unlikely always to be the case. Lastly, unit values of two bundles of products may differ. Prices of individual products may differ between the bundles, or the mix of products may differ in such a way that one bundle consists of a higher share of higher quality goods. Thus, the unit value of a bundle of products may need to be adjusted appropriately.

Despite these shortcomings, the use of unit values has become common in the measurement of horizontal and vertical intra-industry trade. Abd-el-Rahman (1991) first proposed using unit values per tonne to distinguish horizontally and vertically differentiated products. This was developed by Greenaway *et al.* (1994, 1995), who defined trade flows as horizontally differentiated where the spread in the unit value of exports, relative to the unit value of imports, is less than 15% at the five-digit SITC (Standard Industrial Trade Classification) level. Where relative unit values are outside this range products are considered as vertically differentiated. The presumption is that transport and other freight costs do not cause a difference in export and import values by more than 15%. Furthermore, both Abd-el-Rahman (1991) and Greenaway *et al.* (1994, 1995) demonstrated that increasing the range from 15 to 25% did not radically alter the division of trade into horizontally and vertically differentiated products.

Therefore, bilateral trade of a horizontally differentiated product, j, occurs where the unit values of exports (UV_j^x) and imports (UV_j^m), for a particular dispersion factor (α=0.15), satisfies the following condition:

$$(1) \quad 1-\alpha \leq \frac{UV_j^x}{UV_j^m} \leq 1+\alpha.$$

Similarly, bilateral trade of a vertically differentiated product is defined as being where the relative unit values of exports and imports are outside this range:

$$(2) \quad \frac{UV_j^x}{UV_j^m} < 1-\alpha, \quad \text{or} \quad \frac{UV_j^x}{UV_j^m} > 1+\alpha.$$

Applying this ±15% unit price threshold, we compute measures of horizontal and vertical intra-industry trade using two approaches. The first, after Greenaway et al. (1994), produces indices similar in construction to the Grubel-Lloyd (GL) index, based on balanced trade. The second approach, after Fontagné and Freundenberg (1997), produces trade shares, employing a different definition of intra-industry or two-way trade. "Trade in an item is considered to be 'two-way' when the value of the minority flow (for example imports) represents at least 10% of the majority flow (exports)" (Fontagné and Freundenberg, 1997, p. 30). Thus, intra-industry trade in product j requires that the following condition be satisfied, where X and M describe the value of exports and imports:

$$(3) \quad \frac{Min(X_j, M_j)}{Max(X_j, M_j)} \geq 10\%$$

When the minority trade flow is below this level it is defined as *inter*-industry or one-way trade. Using this second approach, total trade can be classified as horizontal two-way trade (HTWT), vertical two-way trade (VTWT), or one-way trade. In contrast to Grubel-Lloyd type measures, each of these three trade types may contain a deficit or surplus.

Finally, we note that these two approaches to measuring horizontal and vertical intra-industry trade may also be subject to the criticism of Nilsson (1997, 1999), namely that they measure the *degree* rather than the *level* of such trade.

3. Horizontal and vertical intra-industry trade for Hungary in agri-food products

Using the two approaches outlined above, we compute measures of intra-industry trade in horizontally and vertically differentiated agri-food products between Hungary and the EU, for the period 1992 to 1998. The data are supplied by the OECD. Summary results are presented for horizontal intra-industry trade (HIIT), vertical intra-industry trade (VIIT) and total intra-industry trade (TIIT), using the first approach; and for horizontal two-way trade (HTWT), vertical two-way trade (VTWT) and one-way trade, using the second approach.

It can be seen from Table 1 that, over the period, Hungary's intra-industry trade in agri-food products with its EU partners was rather low and mainly of a vertical nature. For the EU15, total intra-industry trade was 0.23 (HIIT 0.04 and VIIT 0.19) and total two-way trade was 0.41 (HTWT 0.07 and VTWT 0.34). The countries showing the highest total intra-industry trade are Portugal and Finland, under both types of measurement. With regards to horizontal intra-industry trade, Portugal has the highest HIIT index (0.16) and highest HTWT share (0.24). Otherwise, horizontal type trade is extremely low. The highest measures of vertical type trade are for Finland (VIIT 0.28 and VTWT 0.48). These summary results should be interpreted with care, because the coefficients of variation around these mean values are high, especially for the horizontal intra-industry trade measures, implying significant variability from year to year. From the measures in Table 1 it can be concluded that the most prevalent type of trade between Hungary and its EU partners over the period was one-way, or *inter*-industry, suggesting perhaps complementarity rather than competition in agri-food production. Intra-industry trade was dominated by vertical type trade, suggesting higher economic adjustment costs than would be the case with horizontal type trade.

In almost all cases, the TIIT indices and total two-way trade shares are higher than the corresponding traditional GL indices (not shown). Furthermore, although TIIT and total two-way trade display a reasonably similar pattern (the simple correlation coefficient between them is 0.82), this is not the case when they are compared with the GL indices. The simple correlation coefficient between the TIIT and GL indices is 0.54, and between the total two-way trade shares and the GL indices is 0.43. This points to a potentially serious problem in econometric identification of the determinants of intra-industry trade, and underlines doubts over use of the GL index for such purpose. The problem is compounded because there is no consensus in the literature as to the most appropriate measure of horizontal and vertical intra-industry trade to use in empirical analysis. Furthermore, we have no theoretical *a priori* indication as to which measure is best.

Finally, Rajan (1996) and Nilsson (1997 and 1999) argue that, in general, the *degree* of intra-industry trade, as measured by the GL index, is a poor indicator of the *level* of intra-industry trade. This also appears to be the case with the indices and shares reported in Table 1. Correlation coefficients show that there is no association between the measures of intra-industry trade, based on the two approaches we have used, and the corresponding levels of these types of trade (Table 2). However, following Nilsson, we divide the first of our two measures by the number of product lines to derive an 'index per product', and this provides a better indication of the level of intra-industry trade (see final column of Table 2). It appears that Nilsson's criticism of the traditional GL index is also valid for the measurement of horizontal and vertical intra-industry trade.

4. Testing for the determinants of intra-industry trade

In this section, we test for the determinants of intra-industry trade between Hungary and its EU partners. We examine whether the hypothesised relationships between various determinants and intra-industry trade, arising from the literature, hold for Hungary's trade in agri-food products. It is clear from empirical studies that there is no universally accepted procedure to follow. Many studies do not relate directly to a specific model, but rather attempt to regress a measure of intra-industry trade on a range of possible explanatory variables. Another feature of these studies is that, in general, they do not distinguish between horizontal and vertical intra-industry trade, but focus on total intra-industry trade, as measured by the GL index. (As we previously noted, Henry de Frahan and Tharakan [1998 and 1999] are exceptions).

We follow Greenaway *et al.* (1994, 1995 and 1999) in testing for the determinants of intra-industry trade and employ similar explanatory variables. A number of regressions are run using our different measures of horizontal and vertical intra-industry trade as the dependent variable. Lack of appropriate data forces us to focus only on the country-specific (as opposed to industry-specific) explanatory variables. Our hypotheses regarding these country characteristics are based both on theoretical models of intra-industry trade and on previous empirical studies. They are outlined below.

(i) Tastes and per capita income. The extent of intra-industry trade is positively correlated with similarity of the per capita income between trading partners, implying a greater similarity in their demand pattern (Lindner, 1961). We test this hypothesis using a measure of *dissimilarity* between per capita income in Hungary and each of its partner countries, namely Gross Domestic Product (GDP) per capita (DGDPC). However, per capita income is sometimes used as an indicator of relative factor endowments. Regarding horizontal intra-industry trade, this does not present a serious problem because the expected relationship is also negative. But it may be problematic for vertical intra-industry trade, because the models of Falvey (1981) and Shaked and Sutton (1984) predict a positive relationship between vertical intra-industry trade and the difference in factor endowments or per capita income.

(ii) Differences between sizes of the partner countries. Following Helpman (1981) we test whether the difference between the sizes of the trading countries is negatively related to the extent of intra-industry trade. This variable is measured by the difference of GDP between Hungary and its partner countries (DGDP).

(iii) Market size. According to Lancaster (1980) and Bergstrand (1990), we expect that the greater the average market size of two partner countries, the larger will be the scope for product differentiation and demand for imports of differentiated products. That is, we expect market size to be positively correlated with intra-industry trade. It is measured by the average GDP of Hungary and its trading partner (AVGDP).

(iv) Transportation costs. Intra-industry trade is generally regarded as being positively influenced by market proximity, largely as a consequence of transportation costs. We measure this variable as the geographical distance between Budapest and the capital city of each of Hungary's trading partners (DIS).

The data set includes 14 EU countries and seven years (1992-98), giving 98 observations. Previous empirical studies have used various estimation methods, including ordinary least squares (OLS) with linear and non-linear functions, and logit and tobit models. In our study we have many zero values for intra-industry trade (implying perfect *inter*-industry trade) and therefore cannot use specifications with a logged dependent variable or its logit transformation. For most cases the non-linear least squares method and tobit estimations could not be used due to identification problems. Thus, we tested the determinants of intra-industry trade employing linear and semi-log (lin-log) functions and the OLS method.[1] The lin-log specifications produced better results in all cases, and therefore only they are reported here. All of the OLS regressions and diagnostic tests were estimated using the software package Easyreg. The general specification of the model is as follows.

[1] Lack of sufficient time series data precluded the application of co-integration tests.

(4) $IIT_{ij} = \alpha_0 + \alpha_1 DGDPC_{ij} + \alpha_2 DGDP_{ij} + \alpha_3 AVGDP_{ij} + \alpha_4 DIS_{ij} + \varepsilon_j$,

where,
IIT_{ij} is the index or share of intra-industry trade (total, horizontal, vertical), with i=Hungary and j=EU member state;
$DGDPC_{ij}$ is the difference in per capita GDP between Hungary and its trading partner, in US$, calculated from the Euromonitor database;
$DGDP_{ij}$ is the difference in GDP between Hungary and its trading partner, in US$, computed from the Euromonitor database;
$AVGDP_{ij}$ is the average GDP of Hungary and its trading partner, in US$, calculated from the Euromonitor database; and,
DIS_{ij} is the distance between Budapest and the capital city of the trading partner, in kilometres, calculated from www.indo.com program.

The expected signs are $\alpha_1 < 0$ for total and horizontal intra-industry trade, $\alpha_1 > 0$ for vertical intra-industry trade, $\alpha_2 < 0$, $\alpha_3 > 0$, and $\alpha_4 < 0$.

5. Regression results

Total intra-industry trade

For total intra-industry trade we estimate three specifications, using the different measures computed in section 3 as the dependent variable: total intra-industry trade (TIIT), total two-way trade (TTWT) and average level of total intra-industry trade per product group (TIIT/p).

Table 3 shows that the two models with dependent variables of TIIT and TTWT have very low explanatory power and no significant coefficients. The model with the Nilsson type dependent variable (TIIT/p) has an R^2 of 0.36. In this equation the DIS variable is highly significant with the expected sign, AVGDP has the expected sign but is insignificant, and DGDPC and DGDP have unexpected signs, although the coefficients are not significant. We observe that all three models are heteroscedastic and two have normality problems. Overall, the regression results are disappointing.

Horizontal intra-industry trade

The specifications yield somewhat better results when the dependent variable is changed to horizontal intra-industry trade (Table 4). For models with HIIT and HTWT, the overall explanatory power remains very low and the coefficients are insignificant. However, all variables have expected signs for the HTWT model, whilst the HIIT model has expected signs for DGDPC and DIS. The HIIT/p model's explanatory power is 0.56 and two of its coefficients are significant with expected signs (AVGDP and DIS). However, normality problems and heteroscedasticity are present for all three models.

Vertical intra-industry trade

Initially, regression equations for vertical intra-industry trade were estimated with the same four independent variables as applied above, but better results were obtained after omitting the DGDP variable, and these are reported in Table 5. The explanatory power is low for the VIIT and VTWT models, but the DGDPC variable is significant in both cases with the expected sign. The explanatory power of the VIIT/p model is 0.53 and all variables are significant with predicted signs. The null hypothesis of normality is accepted, but that of homoscedasticity is rejected. These results offer stronger support for the determinants of vertical intra-industry trade.

6. Summary and conclusions

We have attempted to identify horizontal and vertical intra-industry trade in agri-food products between Hungary and its EU partners, and then to test for the determinants of these different trade flows. Following recent empirical studies, we have estimated regression models using different measures of total, horizontal and vertical intra-industry trade. Our results suggest that separating a measure of intra-industry trade into its horizontal and vertical components may provide better estimation of the determinants of trade and clarify some contradictory findings in the empirical literature. This is especially the case for the inequality in GDP per capita variable, the sign of which is crucially dependent on the type of trade being modelled. Our results lend some support to the contention that there are different determinants for total, horizontal and vertical intra-industry trade. Another outcome is that adjusting the measure of intra-industry trade to reflect its *level*, after Nilsson, has resulted in much better results than those based on the degree or share of intra-industry trade. Consequently, use of Nilsson's measure in empirical analysis may be recommended not only for traditional GL-based investigations, but also for testing the determinants of horizontal and vertical intra-industry trade.

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Table 1 Horizontal and vertical intra-industry trade in agri-food products between Hungary and the EU (means, 1992-98)

Country	HIIT	VIIT	TIIT	HTWT	VTWT	One-way trade
Austria	0.09	0.18	0.27	0.12	0.33	0.55
Belgium	0.03	0.21	0.24	0.04	0.41	0.55
Denmark	0.03	0.19	0.22	0.06	0.34	0.60
Finland	0.09	0.28	0.37	0.17	0.48	0.35
France	0.01	0.16	0.17	0.01	0.27	0.72
Germany	0.01	0.17	0.18	0.03	0.35	0.62
Greece	0.02	0.10	0.12	0.02	0.16	0.82
Ireland	0.03	0.12	0.15	0.15	0.24	0.47
Italy	0.02	0.12	0.14	0.03	0.19	0.78
Netherlands	0.02	0.24	0.26	0.01	0.44	0.54
Portugal	0.16	0.24	0.39	0.24	0.31	0.17
Spain	0.04	0.14	0.18	0.10	0.25	0.65
Sweden	0.01	0.21	0.22	0.00	0.32	0.68
UK	0.01	0.13	0.14	0.01	0.23	0.75
EU15	0.04	0.19	0.23	0.07	0.34	0.59

Source: Authors' calculations based on SITC code data at four-digit level.
Note: HIIT is horizontal intra-industry trade; VIIT is vertical intra-industry trade; TIIT is total intra-industry trade; HTWT is horizontal two-way trade; and VTWT is vertical two-way trade.

Table 2 Correlation coefficients between measures and level of intra-industry trade

	HIIT	HTWT	HIIT/product
Level of HIIT	-0.016	-0.039	0.686

	VIIT	VTWT	VIIT/product
Level of VIIT	0.082	0.115	0.541

	TIIT	TTWT	TIIT/product
Level of TIIT	-0.129	-0.115	0.598

Source: Authors' calculations based on SITC code data.

Table 3 Regression results for Hungary's total intra-industry trade

Independent variable (log)	Dependent variable		
	TIIT	**TTWT**	**TIIT/p**
Constant	1.541**	0.822	-3630295
	(2.014)	*(0.597)*	*(-1.253)*
DGDPC	0.0213	0.0810	47854
	(0.622)	*(1.318)*	*(0.370)*
DGDP	0.0521	-0.0582	313
	(1.056)	*(-0.655)*	*(0.002)*
AVGDP	-0.115	0.00663	283256
	(-1.624)	*(0.052)*	*(1.055)*
DIS	0.0147	0.0183	-473992***
	(0.476)	*(0.329)*	*(-4.059)*
Statistics			
N	98	98	98
Adjusted R^2	0.04	0.03	0.36
$F_{4,93}$	1.94	1.72	14.56
Diagnostics			
A: Normality $\chi^2_{2,5\%} = 5.99$	245.50	3.75	205.32
B: Homoscedasticity $\chi^2_{4,5\%} = 9.49$	63.33	40.37	19.92

Note: Diagnostics are: A: Jarque-Bera/Salmon-Kiefer test; B: Breusch-Pagan test.
Figures in parentheses are standard errors; significance levels are ***=1%, **= 5%, *=10%.

Table 4 Regression results for Hungary's horizontal intra-industry trade

Independent variable (log)	**Dependent variable**		
	HIIT	**HTWT**	**HIIT/p**
Constant	1.0218**	0.741	283,139
	(2.116)	*(0.889)*	*(0.085)*
DGDPC	-0.0286	-0.0260	24,357
	(-1.327)	*(-0.698)*	*(0.163)*
DGDP	0.0142	-0.0575	-330,154
	(0.455)	*(-1.070)*	*(-1.531)*
AVGDP	-0.0383	0.0422	671,695**
	(-0.856)	*(0.547)*	*(2.164)*
DIS	-0.0117	-0.00212	-1,233,283***
	(-0.602)	*(-0.063)*	*(-9.141)*
Statistics			
N	98	98	98
adjusted R^2	0.03	0.06	0.56
$F_{4,93}$	1.84	2.46	31.32
Diagnostics			
A: Normality $\chi^2_{2,5\%} = 5.99$	6170.37	978.87	101.12
B: Homoscedasticity $\chi^2_{4,5\%} = 9.49$	143.81	133.88	34.43

Note: Diagnostics are: A: Jarque-Bera/Salmon-Kiefer test; B: Breusch-Pagan test.
Figures in parentheses are standard errors; significance levels are ***=1%, **=5%, *=10%.

Table 5 Regression results for Hungary's vertical intra-industry trade

Independent variable (log)	Dependent variable		
	VIIT	**VTWT**	**VIIT/p**
Constant	0.116	0.0842	-7259388***
	(0.239)	(0.096)	(-4.204)
DGDPC	0.0554*	0.107**	257156**
	(1.876)	(2.007)	(2.454)
DGDP	-	-	-
	-	-	-
AVGDP	-0.0242	-0.0364	318077***
	(-1.637)	(-1.363)	(6.066)
DIS	0.0223	0.0202	-382741***
	(0.832)	(0.417)	(-4.017)
Statistics			
N	98	98	98
adjusted R^2	0.02	0.02	0.53
$F_{4,93}$	1.57	1.54	37.42
Diagnostics			
A: Normality $\chi^2_{2,5\%} = 5.99$	746.30	25.69	3.16
B: Homoscedasticity $\chi^2_{4,5\%} = 9.49$	52.11	34.21	14.79

Note: Diagnostics are: A: Jarque-Bera/Salmon-Kiefer test; B: Breusch-Pagan test.
Figures in parentheses are standard errors; significance levels are ***=1%, **=5%, *=10%.