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QUALITY DIFFERENTIATION IN EAST-WEST EUROPEAN AGRO-FOOD TRADE DURING THE PRE-ACCESSION¹

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ABSTRACT. *The paper analyses the quality differentiation in Central and Eastern European countries (CEEC-14) and European Union (EU-15) agro-food trade during the pre-accession years using panel regressions. The hypotheses are based on supply-side factor endowment and economic geography, and demand-side level of economic development variables. The CEEC-14 agro-food specialization to the EU-15 is in bulk raw commodities at lower export price-quality compared to the other exporters to these markets. The CEEC-14 export price-quality competitiveness on the EU-15 markets is better in processed intermediates and consumer-ready food, but the export size is smaller and varies by the CEEC-14, implying structural problems and opportunities for transformations in the food processing businesses and marketing chain. The panel regression analysis confirms that the CEEC-14 agro-food quality differentiation on the EU-15 markets is explained by comparative advantages from the relative factor endowment.*

KEYWORDS: quality differentiation, factor endowment, Central and Eastern European countries, European Union, agro-food trade.

JEL classification: F14, F15, Q17, M16, O57.

Introduction

During the last two decades, the former communist economies of Central Eastern European countries (CEECs) have been subject to deep structural changes with increasing trade openness and foreign direct investment (FDI) inflow (e.g. Katona, 2005). There has been a considerable reorientation of exports towards the European Union (EU), away from the former partners in the Council of Mutual Economic Assistance. Despite trade reorientations, trade volume has increased significantly over time. The question is what the source of this CEEC trade growth is during the pre-accession years to the EU membership, and has the quality of trade remained similar, deteriorated or improved?

The previous studies have analyzed the problems of increasing the efficiency and competitiveness of the CEEC economies (e.g. Melnikas, 2004; Biljan-August, 2004). Rodríguez-Pose, Gill (2006) find that regional disparities arising from trade are largely caused by sectoral shifts in trade composition. There is no evidence for any massive changes in the specialization pattern between the EU-15 and the New EU Member states from CEECs (e.g., Zaghini, 2005; Fertő, 2007). Kandogan (2005) emphasizes the role of export quality and export restructuring for the rise of trade. The most recent research provides some insights on the export quality and quality upgrading of CEECs' trade with the EU. Some studies have underlined that most of intra-industry trade (IIT) between CEECs and the EU is in low-value added vertical IIT (e.g., Smith & Dråbek, 1995; Ferragina & Pastore, 2005). Trade specialization towards vertical IIT segments involves the exchange of goods belonging to the same industry, but of different quality. Quality product differentiation towards low quality vertical IIT depends mainly on factor endowment differentials and comparative (dis)advantages in sectors between the two partners. Kandogan (2005, 2006) shows that "although CEEC are in a significantly better trade position than the Commonwealth of Independent States (CIS)", also in the CEEC there are still a large number of products with structural problems. Insufficient FDI, the Outward Processing Trade in European Agreements, and not fully exploited human capital are suggested as possible factors. Dulleck *et al.* (2005)

analyzing CEEC-10² pointed out that there is a significant difference in quality upgrading across country groups and across the various types of quality upgrading.

Until now the research on quality in trade has focused mainly on manufactured products and paid less attention to agro-food trade. However, the agricultural sector plays an important role in the EU enlargement process due to its political sensitivity (e.g. Toming, 2007). Thus, *the aim of the paper* is to investigate the determinants of the quality differentiation of CEEC-EU agro-food IIT using the price-quality gap index during the pre-accession years 1995-2003. The paper contributes to the existing literature in the following three directions. *First*, as the first study so far to investigate the quality differentiation of CEEC-EU agro-food IIT by using the price-quality gap index.³ A special focus is on the pre-accession years to the EU membership when the CEEC experienced transformations and adjustments in business and economics to comply with higher quality requirements. *Second*, as the first study that in the comparative analysis investigates determinants of the quality differentiation of CEEC-EU agro-food trade, explanatory supply-side and demand-side variables across CEEC's, and their impacts on the CEEC-EU agro-food price-quality gaps. *Third*, by analyses of transformations in regional agro-food quality differentiation and development policy relevance, which are important for better understanding of the CEEC net agro-food quality specialization patterns and their implications for adjustment and reallocation of factor endowments and adaptation to the needs of the competition on the enlarged EU market.

The rest of the article is structured as follows. *Section 1* reviews the literature on the quality of trade. *Section 2* describes the methodology and data used. *Section 3* presents empirical results on the price-quality gaps in CEEC-EU agro-food trade; the analysis of similarities and differences in supply-side agricultural natural, labour and physical factor endowments, human capital, FDI, market size and demand-side gross domestic product per capita (GDPCAP); and the regression results on determinants of quality differentiation in CEEC-EU agro-food trade. Finally, *Section 4* sums up the main findings and derives policy implications.

1. Literature Review on Trade Quality

More recent literature in international trade argues on the existence of differences across countries in the quality of the products that they produce and export. The existence of product quality differences across countries suggests that quality affects the direction of international trade and that countries specialize not only on the quantity and the variety of the products they produce and export, but also on quality level as a determinant of bilateral trade volumes (Schott, 2004; Hummels & Klenow, 2005; Hallak, 2006; Faruq, 2006).

On the supply-side, as the theoretical backgrounds to test hypotheses on determinants of the quality differentiation in agro-food trade in panel regressions, we employ the neo-Heckscher-Ohlin model (Falvey, 1981; Falvey & Kierzkowski, 1987), an economic geography model based on market size (Helpman & Krugman, 1985; Krugman & Venables, 1995), and CEEC-EU economic integration. Based on the predictions of the neo-Heckscher-Ohlin model and the economic geography model, we expect a positive relationship between factor endowment variables and quality of agro-food trade on one hand, and between FDI and

² As CEEC-10 are included: CEEC-8 (the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, and Slovenia), that joined the EU in 2004, and Bulgaria and Romania, that joined the EU in 2007.

³ As CEEC-14 are included the CEEC-10, then Bosnia and Herzegovina, Croatia, FYR of Macedonia, and Serbia and Montenegro. The latter prior to 2004 belonged to the same country with Serbia.

quality of agro-food trade on the other. Schott (2004) argues that higher export unit values in rich countries are associated with relative endowments of physical and human capital. Hummels and Klenow (2005) find that quality differentiation and higher export prices are associated with larger endowments of capital. Similar to Stiglitz (1987) they argue that quality differences explain differences in export unit values. Flam and Helpman (1987) argue that “quality differences are driven by technological differences rather than endowment differences. The innovative and capital rich countries are more likely to export high quality produce” (Faruq, 2006). FDI improves the technology and countries with a higher level of FDI export higher quality differentiated products (Reganati & Pittiglio, 2005; Caetano & Gallego, 2006). The market size effect is used as a control variable without a priori expectations on the direction of the association with the agro-food quality differentiation. The Helpman and Krugman (1985) model suggests that the home market effect is the tendency for the differentiated-product industry to concentrate in the large market, making it a net exporter of these goods, whilst the homogeneous good is produced by the smaller country. Greenaway and Torstensson (2000) “reinterpret the model, arguing that in the case of developed countries the larger country is a net exporter in high quality products, and a net importer in low quality products. In our case the partner of CEEC countries is the EU-15, which is a large country in the spirit of the model. The CEEC-EU economic integration is expected to improve the CEEC agro-food quality differentiation on the EU-15 markets”.

On the demand-side, we employ Linder’s (1961) hypothesis on the role of quality differences as a determinant of the direction of trade that in richer countries consume and import high-quality goods in larger proportions than poorer countries. The demand-side model is based on level of economic development. Fan (2005) and Hallak (2006) formalize Linder’s (1961) hypothesis and suggest that consumer demand for quality depends on their human capital (and income). Countries with larger human capital stock (and income) will demand higher quality goods. Hallak (2006) finds strong evidence of a positive association between per capita income and demand for quality. Bojnec and Fertő (2009) argue that the impact of per capita income can be country-specific regarding quality of agro-food exports. The differences in the results on the determinants of the quality differentiation might differ by different commodity groups by the degree of product processing.

The theory suggests that the elasticity of export supply with respect to national income should be higher for differentiated products (Rauch, 1999). “Rich countries have a comparative advantage in the production of high-quality goods that is stemming from productivity or factor endowment differences.” Hallak (2006) argues that quality differentiation appears to be stronger for differentiated goods than for reference-priced goods, and stronger for the latter than for homogeneous goods. We aim to investigate the CEEC agro-food trade to the EU-15 during the pre-accession that is pertained to the patterns and determinants in the quality differentiation in CEEC-EU agro-food trade by the degree of product processing.

2. Methodology and Data

Three different approaches to measure trade quality have been developed in literature. *First*, literature on IIT employs export-to-import unit values to distinguish between horizontal and vertical (low and high quality) IIT in matched bilateral trade for a certain country’s product group (e.g. Greenaway *et al.*, 1994). Similarly, trade competition literature uses export-to-import unit values to distinguish between price and quality competition in trade (e.g. Aiginger, 1997; Ulff & Nielsen, 2000). *Second*, export price indices as quality indices based

on bilateral Fisher indices as the two-year average are employed by Hallak (2006) to estimate product quality and the direction of trade. *Third*, price-quality gap index as a proxy of quality product differentiation was developed by Landesmann and Burgstaller (1997) and employed by Ferragina and Pastore (2005) and in this paper.

The price-quality gap index, PG_{ci} , equals the sum of the ratios of the prices at which the n items j , belonging to the same agro-food product groups c , $I(c)$, are exported to EU markets, and the average price of the same item in total EU imports, $p_{EU,j}$ weighted by the share of the same product item in country i 's total agro-food exports to the EU, $sx_{i,j}$

$$PG_{ci} = \sum \left(\frac{p_{c,j}}{p_{EU,j}} \right) \times sx_{ij}, \quad j \in I(c), \quad \sum sx_{i,j} = 1 \quad (1)$$

Unit values per weight of exports for a CEEC-14 and imports for EU-15 by products have been used for assessing product quality. The weighted PG_{ci} index is scaled that it takes the value of 1.0 for total EU-15 agro-food imports, whereas values below 1.0 mean exports of agro-food products by a CEEC-14 on EU-15 markets at prices below the average of total EU-15 imports of that agro-food product, and vice versa for values higher than 1.0.

The literature on the use of "export/import unit values for assessing trade types, product qualities and price competition is mixed. 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., King, 1993; 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, price competition and quality competition literature" (e.g., Greenaway *et al.*, 1994; Aiginger, 1997; Ulff & Nielsen, 2000; Kandogan, 2005) under the assumption that, even with imperfect information, prices tend to reflect quality (Stiglitz, 1987) and determine the direction of trade. Notwithstanding their shortcomings, the PGs may provide an important insight into agro-food trade between CEEC and EU during the analyzed pre-accession years.

The econometric model of the quality differentiation in CEEC-EU agro-food trade based on price-quality gap index, which is empirically tested, is specified in the following way:

$$\ln PG_{cit} = \alpha_0 + \alpha_1 \ln LANDCAP_{it} + \alpha_2 \ln AGPOPUL_{it} + \alpha_3 \ln TRACTORLAND_{it} + \alpha_4 \ln EDUC_{it} + \alpha_5 \ln PATENT_{it} + \alpha_6 \ln FDI_{it} + \alpha_7 \ln GDP_{it} + \alpha_8 \ln GDPCAP_{it} + \alpha_9 CEEC + \alpha_{10} YEAR + \varepsilon_{cit} \quad (2),$$

$c = 1, \dots, 4. \quad i = 1, \dots, 14. \quad t = 1995, \dots, 2003$

where PG is the price-quality gap index, c is product group, i is country, and t is time for the analyzed pre-accession years 1995-2003. The dependent variable is a price-quality gap index (Landesmann & Burgstaller, 1997; Ferragina & Pastore, 2005), which provides a proxy for CEEC-14 agro-food quality differentiation relative to the other exporters on the EU-15 markets. LANDCAP is the arable agricultural land per capita as a proxy for natural factor endowment in agriculture and AGPOPUL is a proxy for labour factor endowment in agriculture. TRACTORLAND is tractor per arable agricultural land as a proxy for physical factor endowment in agriculture. EDUC is a proxy for human capital endowment and PATENT is a proxy for research and development activities. FDI is foreign direct investment. These explanatory variables are included in the regression as the supply-side variables of relative factor endowments that are linked to factor proportion models of vertical IIT (Falvey,

1981; Falvey & Kierzkowski, 1987). In general, we expect their positive associations with the PG as a richer relative factor endowments improve quality of exports of higher value-added products. However, we also test whether agro-food products are homogeneous or differences might exist by the degree of product processing. Gross domestic product (GDP) is a proxy for the market size. The GDP variable has been used as a broad test of proposition stemming from the economic geography literature (Helpman & Krugman, 1985; Krugman & Venables, 1995). The GDP association with the PG might be with mixed sign depending on the utilization of economies of scale that are pertained to the economic geographic market size. GDPCAP is the per capita GDP, which is a general proxy for the factor endowment, but in our case it is used as a proxy for economic development as the demand-side explanatory variable (Linder, 1961). We expect that its association sign with the PG depends on the degree of agro-food product processing. The CEEC-8 is a country dummy variable representing individual analyzed CEEC-8s, which joined the EU in 2004. We check whether CEEC-14 is a homogeneous group. We assume that the CEEC-8 that joined the EU in 2004 (the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, and Slovenia) is more advanced in terms of trade integration than other analyzed CEECs. A specific feature of agriculture is its vulnerability to weather conditions that might cause fluctuations in volume of production and trade, market and export prices of agricultural and horticultural products. Due to this we include a year-dummy to capture annual fluctuations in the price-quality gap index for bulk raw commodities and for horticultural products, respectively.

The price-quality gap index of quality product differentiation in equation (1), PG_{ci} , which is used as the dependent variable in the econometric analysis in equation (2), is calculated using OECD detailed trade statistics for the pre-accession years from 1995 to 2003. The agro-food trade is defined by the EU-Commission (1999). The sample consists of 255 items at four-digit level in the Standard International Trade Classification (SITC) system. The data sources for the explanatory variables specified in equation (2) are collected by CEEC-14 countries i and by the analyzed years t from various data sources. The LANDCAP variable is defined as arable agricultural land per capita in 1000 hectares. The AGPOPUL is the share of agricultural population in total population. The TRACTORLAND is the number of tractors per arable land. The data source of these factor endowment variables is the Food and Agricultural Organization of the United Nations (FAO, 2007) at its website FAOSTAT (<http://faostat.fao.org>). The EDU is the school enrollment at secondary stage as a per cent of gross enrollment. The PATENT is the number of patent applications for non residents. The FDIs are measured by the FDI net inflows in per cent of GDP. The GDP measures the size of the economy and is defined as total GDP in billions of 2000 US\$. The GDP per capita (GDPCAP) is expressed in 2000 thousands of US\$. The data source of these explanatory variables is the World Development Indicators.

3. Empirical Results

3.1 East-West European agro-food trade developments

Following Chen *et al.* (2000) we classify agro-food trade into four commodity groups by the degree of product processing: bulk raw commodities, processed intermediates, consumer-ready food, and horticulture (*Table 1*).

Table 1. CEECs agro-food exports to EU-15 by product groups (% of agro-food exports)

	1995				2003			
	1	2	3	4	1	2	3	4
Bosnia and Herzegovina	54	1	45	0	63	19	15	2
Bulgaria	26	10	53	11	35	6	49	10
Croatia	60	8	29	3	47	7	44	2
Czech Republic	53	17	24	6	43	15	39	3
Estonia	79	5	14	1	76	2	21	1
Hungary	23	16	53	7	26	16	50	8
Latvia	87	8	4	0	93	2	5	0
Lithuania	62	12	20	6	50	22	26	2
FYR of Macedonia	11	4	78	6	23	3	62	11
Poland	22	18	54	6	13	13	66	9
Romania	22	30	33	15	45	25	22	9
Serbia and Montenegro	8	6	80	7	16	6	75	3
Slovakia	57	24	13	6	58	17	22	3
Slovenia	44	15	36	5	42	13	42	3

Notes: 1: Bulk raw commodities; 2: Processed intermediates; 3: Consumer-ready food; 4: Horticulture.

Source: authors' calculations based on OECD dataset.

For most of the CEECs (Bosnia and Herzegovina, Estonia, Latvia, Lithuania and Slovakia, as well as for Croatia and the Czech Republic), bulk raw commodities are the most important in total agro-food exports to the EU-15 during the pre-accession. This group of products are defined to be those with a lower-degree of food processing and thus also with a lower-value added per unit of product. For none of the CEEC did processed intermediates prevail in total agro-food exports to the EU-15. The greatest share of this group in agro-food exports to the EU-15 markets is found for Romania. Moreover, Bulgaria, Hungary, Former Yugoslav Republic (FYR) of Macedonia, Poland, and Serbia and Montenegro, in agro-food exports to the EU-15 markets, are specialized towards consumer-ready food that pertains to the highest degree of food processing. None of the CEEC in agro-food exports to the EU-15 markets is specialized towards horticulture.

For bulk raw commodities, the price-quality gap index indicates that the CEEC agro-food export prices were comparatively lower than for the other exporters of similar products from the rest of the world to the EU-15 markets (*Table 2*). The FYR of Macedonia and to a lesser extent Romania are the major exception in a positive direction. The CEEC export price-quality competitiveness on the EU-15 markets was considerably better in processed intermediates. This finding holds for the each of the analyzed CEEC, particularly for Bulgaria. Close to break-even-point were found the Czech Republic and Estonia as well as Poland and Romania. However, in addition to differences by the CEECs, the variations are found also by the analyzed years particularly for Bulgaria and Lithuania. Moreover, in consumer-ready food, the CEEC export price-quality competitiveness is greater than for the other exporters of similar products from the rest of the world to the EU-15 markets. Close to the break-even-point were found Croatia, Hungary, the FYR of Macedonia, and Poland. These findings imply that in processed agro-food products the CEECs are specialized towards niche products where it has been possible to achieve a higher export price-quality. The relatively high standard deviation is found for Bosnia and Herzegovina, the Czech Republic, Estonia, Romania, and Slovenia, which indicates instabilities over time. Finally, also for horticulture the CEEC export prices were found to be higher than for the other exporters to the EU-15 markets. The major exceptions were found for Poland and the Czech Republic, whereas Bulgaria and

Hungary came close to the break-even-point. A greater variation by analyzed pre-accession years is found for Bosnia and Herzegovina, Latvia, FYR of Macedonia, Serbia and Montenegro, and Slovenia.

Table 2. CEEC price-quality gap indices (average 1995-2003)

	Mean value				Standard Deviation			
	1	2	3	4	1	2	3	4
Bosnia and Herzegovina	0.77	1.18	2.06	3.78	0.06	0.13	1.21	1.65
Bulgaria	0.78	10.51	1.26	1.03	0.08	7.13	0.10	0.14
Croatia	0.79	1.23	0.97	1.70	0.04	0.44	0.15	0.45
Czech Republic	0.90	0.97	2.66	0.63	0.03	0.20	1.00	0.18
Estonia	0.91	1.01	1.71	1.42	0.09	0.11	1.04	0.28
Hungary	0.83	1.75	0.99	0.98	0.06	0.55	0.06	0.08
Latvia	0.75	1.11	1.19	41.48	0.06	0.15	0.37	38.34
Lithuania	0.67	3.54	1.14	4.43	0.08	1.36	0.12	0.98
FYR of Macedonia	1.11	1.46	1.03	2.00	0.10	0.25	0.24	1.86
Poland	0.95	1.05	1.02	0.74	0.09	0.25	0.03	0.07
Romania	1.01	1.05	2.12	1.37	0.14	0.32	1.46	0.29
Serbia and Montenegro	0.90	1.13	1.55	4.02	0.10	0.50	0.26	1.18
Slovak Republic	0.74	1.51	2.27	1.13	0.04	0.61	0.58	0.27
Slovenia	0.84	2.54	3.52	6.22	0.06	0.81	1.05	7.49

Notes: 1: Bulk raw commodities; 2: Processed intermediates; 3: Consumer-ready food; 4: Horticulture.

Source: authors' calculations based on OECD dataset.

Table 3. CEECs price-quality gap indices in 1995 and 2003

	1995				2003			
	1	2	3	4	1	2	3	4
Bosnia and Herzegovina	0.68	1.00	1.33	0.00	0.82	1.18	1.25	3.86
Bulgaria	0.83	1.08	1.26	1.27	0.87	1.94	1.45	1.03
Croatia	0.79	1.37	0.89	2.25	0.85	1.52	1.09	1.66
Czech Republic	0.94	0.88	4.37	1.08	0.95	1.42	1.48	0.60
Estonia	0.85	1.16	1.58	1.39	1.03	1.08	1.27	1.24
Hungary	0.80	1.18	0.99	0.88	0.92	2.66	1.12	1.10
Latvia	0.68	1.12	0.91	6.33	0.85	1.09	1.48	74.11
Lithuania	0.61	0.83	1.28	5.66	0.81	4.26	1.25	5.10
FYR of Macedonia	1.09	1.52	1.52	4.22	1.09	1.51	1.04	2.07
Poland	0.81	0.92	0.97	0.70	1.10	1.37	1.06	0.78
Romania	0.83	0.80	1.25	0.96	1.10	1.05	2.73	1.52
Serbia and Montenegro	0.76	2.41	1.42	1.50	1.09	0.99	1.22	3.21
Slovak Republic	0.68	0.89	2.96	0.74	0.78	1.42	1.97	1.21
Slovenia	0.77	1.33	4.80	2.31	0.94	1.73	2.51	14.99

Notes: 1: Bulk raw commodities; 2: Processed intermediates; 3: Consumer-ready food; 4: Horticulture.

Source: authors' calculations based on OECD dataset.

Viewed dynamically, improvements in the CEEC price-quality gap index on the EU-15 markets are seen for Hungary, Poland, and Romania, but also for Latvia (except for processed intermediates), for Bosnia and Herzegovina, Slovakia, and Slovenia (for the latter three except for consumer-ready food), and for Bulgaria and Croatia (for the latter two except for horticulture) (*Table 3*). These improvements imply a certain catch-up in the CEEC price-quality gap index during the pre-accession. For Serbia and Montenegro, worsening is seen for

processed intermediates and consumer-ready food, for the Czech Republic worsening is seen for consumer-ready food and horticulture, and for Estonia worsening is seen for processed intermediates, consumer-ready food, and horticulture. The worsening indicates some deterioration in the price-quality gap index.

3.2 Factor endowments, economic geography, and level of development

Agricultural production and thus agro-food international trade might be determined significantly by factor endowment, economic geography and level of economic development variables and their differentials between CEECs. This is a reason that we first investigate these explanatory variables across CEEC-14 to examine their similarities and differences (*Table 4*). The standard deviation for the mean values for the specified explanatory variables, their minimum and maximum values in *Table 4* indicate rather a large variation in factor endowment variables by the CEEC-14 and by the analyzed years for LANDCAP, AGPOPUL, and TRACTORLAND. The similar finding holds for PATENT and to a lesser extent for EDUC. The size of FDIs and the level of development measured by GDPCAP also vary by the CEEC-14 and over the analyzed pre-accession years. Considerable differences are also seen for the size of the CEEC economies as confirmed by the market size variable, GDP.

Table 4. Summary statistics of explanatory variables (average 1995-2003)

Variable	Number of observations	Mean value	Standard Deviation	Minimum	Maximum
LANDCAP	126	0.59	0.16	0.24	1.02
AGPOPUL	126	11.68	5.08	1.37	24.49
TRACTORLAND	126	41.93	50.94	0.72	222
EDUC	126	42.53	13.76	21.71	70.97
PATENT	126	67981.27	55003.99	198	238771
FDI	126	4.14	3.19	-0.07	16.89
GDPCAP	126	3,425.23	2,116.82	389.97	10392.14
GDP	126	29,000	39,100	1,330	177,000

Source: authors' calculations.

These descriptive statistics on factor endowments, economic geography and level of economic development explanatory variables confirm differentials in these variables by the CEEC-14 as a reason that, in addition to the mean values of these explanatory variables for the analyzed pre-accession period 1995-2003, we are also interested in their mean values by the individual CEEC-14 to identify possible factor endowment, economic geography, level of economic development advantages/disadvantages for agro-food production and exports across the CEEC-14. Lithuania is found to be the richest by natural factor endowment LANDCAP and Slovenia the poorest one (*Table 5*). However, we do not investigate differentials in agricultural land structures, agricultural land quality, climatic and similar conditions, which can be also important for efficiency in agricultural land use for agricultural production and for international trade.

The share of agricultural population in the total population (AGPOPUL) is the highest for Poland and Serbia and Montenegro and the lowest in Slovenia. The differential in this variable implies also possible differences in the level of economic development as being higher for the least developed and being lower for the more developed countries.

The number of tractors per arable land (TRACTORLAND) as physical factor endowment in agriculture is the highest in the countries with prevailing traditional small-scale

family farming (Slovenia, Poland, Serbia and Montenegro), but somewhat surprisingly, the lowest for Croatia, which has the typical bi-modal farm structure of a smaller number of large sized farms and a greater number of smaller farms.

Table 5. Summary statistics of explanatory variables by CEEC-14 (average 1995-2003)

Country	LANDCAP	AGPOPUL	TRACTORLAND	EDUC	PATENT	FDI	GDPCAP	GDP
Bosnia and Herzegovina	0.58	5.73	13.52	36.75	48,083.67	2.36	1,033.8	3,870
Bulgaria	0.71	8.20	6.36	42.85	75,567.78	5.27	1,558.6	12,600
Croatia	0.66	9.17	1.03	33.27	77,253.67	4.76	4,075.5	18,300
Czech Republic	0.42	8.48	20.66	31.03	42,441.56	6.45	5,376.4	55,200
Estonia	0.68	11.57	55.89	58.26	74,851.44	6.60	3,841.8	5,300
Hungary	0.59	12.51	16.88	40.18	54,514.67	6.87	4,400.5	44,600
Latvia	0.73	12.29	32.21	60.54	80,498.11	4.59	3,131.7	7,500
Lithuania	0.91	15.47	30.84	55.40	80,441.89	3.59	3,215.8	11,300
FYR of Macedonia	0.63	13.67	42.67	24.27	79,398.67	3.00	1,675.6	3,350
Poland	0.47	19.48	73.82	52.33	55,313.78	3.31	4,072.5	157,000
Romania	0.67	14.66	11.14	27.61	81,045.78	2.72	1,757.5	39,200
Serbia and Montenegro	0.56	20.89	66.52	36.75	47,182.44	1.76	981.2	9,160
Slovak Republic	0.44	9.33	10.30	29.88	75,700.00	4.89	3,694.7	19,900
Slovenia	0.26	2.19	205.20	60.61	79,444.33	1.86	9,137.6	18,200

Source: authors' calculations.

The share of enrolled in secondary education (EDUC) is the lowest in the FYR of Macedonia and the highest in Slovenia and in the Baltic States (Estonia, Latvia, and Lithuania). The number of patents for non resident (PATENT) is the lowest in the Czech Republic and the highest in Romania.

The FDI net inflows in per cent of GDP (FDI) are the highest in Hungary, Estonia and the Czech Republic, and the lowest in Serbia and Montenegro and Slovenia. On the one hand this implies the openness and attractiveness of a country for FDI, but on the other hand this is a factor of economic growth providing opportunities for upgrading technologies, improving product qualities and for widening of market outlets.

GDP per capita (GDPCAP at constant 2000 US\$) in Slovenia, which during the pre-accession is the most developed among the CEEC-14, is more than nine times higher than in Serbia and Montenegro or in Bosnia and Herzegovina.

Poland is the largest by the size of GDP (at a constant 2000 million US\$), followed by the Czech Republic and Hungary. The FYR of Macedonia and Bosnia and Herzegovina are the smallest ones.

These descriptive statistics clearly confirm differentials in factor endowments in agriculture, economic geography, and level of economic development explanatory variables by the CEEC-14 and over time as a reason that the control country-dummy variable, CEEC-8, for the impact of the EU integration process during the pre-accession and the year-dummy variable for a possible impact of adverse weather conditions, which are important for agricultural production, are included in the regressions to capture these differences across CEEC-14 and vulnerabilities over time.

3.3 Regression analyses

We estimate a panel regression model to test the effects of factor endowment, the economic geographic market size, and the demand-side level of development on the price-quality gap index during the pre-accession. The regressions are estimated both with and without controlling for the country dummy variable by the CEEC-8, and with the year-dummies for primary bulk raw commodities and horticulture. We apply both the random effects (RE) and fixed effects (FE) regressions, employing generalized least squares, maximum-likelihood, and generalized estimating equation approaches. We present the results based on the generalized estimating equation (GEE) approach due to their best results in terms of statistical significance (*Table 6*).

Table 6. GEE estimates for the CEEC-14 agro-food trade with the EU-15, 1995-2003

	ln(PG)	
	(RE)	(RE)
ln(LANDCAP)	0.066	0.048
ln(AGPOPUL)	-0.301***	-0.332***
ln(TRACTORLAND)	0.134***	0.104***
ln(FDI)	-0.007	-0.010
ln(GDPCAP)	0.121	-0.033
ln(GDP)	-0.041	-0.010
CEEK-8	-0.196**	
Constant	-0.409	0.379
Wald χ^2	80.12	71.27
N	126	126
Hausman test χ^2		6.27

Notes: * p<0.1; ** p<0.05; *** p<0.01. RE – random effect model.

Source: authors' calculations.

The Hausman test is used to check whether the random (RE) or the fixed effect (FE) model is more appropriate. We present the estimations according to the results based on the Hausman tests by using the RE model. The country dummy variable is found to be negatively associated with the PG. The PG is negatively and statistically significantly associated with the AGPOPUL: the increase in the AGPOPUL by 1 percent reduces the PG by 0.30 to 0.33 percent. Labour hoarding in agriculture is reducing, whereas labour shrinking in agriculture is increasing the CEEC agro-food export price-quality competitiveness on the EU-15 markets vis-à-vis the other competitors on these EU markets. On the other hand, the PG is positively and statistically significantly associated with the TRACTORLAND. This implies that agricultural labour substitution by agricultural tractor mechanization has increased the CEEC agro-food price-quality competitiveness in the EU-15 markets vis-à-vis the other competitors on these EU-15 markets. The other explanatory variables are not found to be statistically significant. This holds also for a positive association between the PG and LANDCAP, and for a negative association between the PG and FDI on one hand, and for a negative association between the PG and GDP on the other. Finally, we try to control for a random shock using the year-dummy variable, but it was not found statistically significant.

Moreover, we present the regression results based on the GEE approach by main agro-food product groups by the degree of product processing. The regression results for the each agro-food product group are specified separately with and without the country dummy variable (*Table 7*). We use different specifications of the explanatory variables in the cases of

bulk raw commodities and horticulture on one hand, and in the cases of processed intermediates and consumer-ready food on the other. The former are likely to be in a greater extent associated with agricultural natural factor endowments and adverse weather conditions, but the latter might depend in a greater extent on human capital, FDI and technological improvements to export higher quality differentiated products.

Table 7. GEE estimates for the CEEC-14 by product groups with the EU-15, 1995-2003

	ln(PG)							
	Bulk raw Commodities		Processed Intermediates		Consumer-ready food		Horticulture	
	(RE)	(RE)	(RE)	(RE)	(RE)	(RE)	(RE)	(RE)
ln(LANDCAP)	-0.164	-0.257***	1.040***	1.042***	-0.578***	-0.703***	1.447*	1.648***
ln(AGPOPUL)	0.158**	0.117***	-0.779***	-0.781***	-0.409***	-0.283***	-0.626	-0.502***
ln(TRACTORLAND)	0.060***	0.013					0.146	0.261***
ln(EDUC)			0.531**	0.528***	-0.182	-0.005		
ln(PATENT)			-0.004	-0.004	-0.063**	-0.083***		
ln(FDI)	0.008	0.004	0.005	0.005	0.029	0.039	-0.166**	-0.143**
ln(GDPCAP)	0.144**	-0.051*	-0.323*	-0.326**	-0.309**	-0.110	-0.257	0.233
ln(GDP)	-0.001	-0.001	0.192***	0.192***	0.010	-0.018	-0.294	-0.295**
CEEC-8	-0.297***		-0.006		0.336**		0.717	
Year-dummies	Yes**	Yes***					Yes	Yes
Constant	-1.841***	-0.312	-1.037	-1.010	4.358***	2.813*	11.001**	7.065***
Wald χ^2	236.18	66.96	42.94	42.94	100.64	88.95	252.04	68.29
N	124	124	124	124	124	124	124	124
Hausman test χ^2		2.71		1.90		3.73		1.35

Notes: * p<0.1; ** p<0.05; *** p<0.01; RE – random effect model.

Source: authors' calculations.

In the case of bulk raw commodities, the PG is negatively associated with the LANDCAP. This is consistent with the factor endowment theory that the countries with the large natural factor endowment are more likely to specialize in low-price-quality exports. Moreover, the PG is negatively associated with the country dummy variable, and the country size (GDP), but the parameter for the latter is statistically not significant. Yet, in the regression with the country-dummy variable, the PG is positively and statistically significantly associated with the AGPOPUL, TRACTORLAND, and GDPCAP. The association between the PG and the FDI is positive, but statistically not significant. The results of the regression with the country dummy variable imply that the CEEC price-quality catch-up in bulk raw commodities on the EU-15 markets vis-à-vis the other competitors is driven by the CEEC supply-side human and physical factor endowments, as well as by the level of country economic development, but not by natural factor endowment and the CEEC market size. However, some differences are seen in the regression without the country dummy variable, where the association between the PG and the GDPCAP is negative and statistically significant. The regression without the country dummy variable confirms the negative impact of the supply-side natural factor endowment and the demand-side GDPCAP variables, but the positive impact of the supply-side agricultural human factor endowment on the CEEC price-quality gap index in bulk raw commodities on the EU-15 markets vis-à-vis the other world competitors, whereas the sign of the association for the other explanatory variables is statistically not significant. This implies the significant role of the CEEC country specific factors for the price-quality gap index in bulk raw commodities. In the both regressions, the associations between the PG and the year-dummies are positive and statistically significant suggesting the important role of adverse weather conditions for CEECs agricultural production, export of bulk raw commodities and their quality differentiation on the EU-15 markets.

In the case of processed intermediates, the PG is negatively and statistically significantly associated with the AGPOPUL and the demand-side GDPCAP, but positively and statistically significantly associated with the LANDCAP, EDUC and the GDP variables. The other explanatory variables are not found to be statistically significant. The reliance of the CEEC processed intermediates in the quality-price catch up on the natural and education human factor endowments and the economic geographic market size underlines the importance of the CEEC supply-side factors and the economic geography variable to exploit economies of scale.

In the case of consumer-ready food, the PG is negatively and statistically significantly associated with the LANDCAP, AGPOPUL, and PATENT. When the country dummy variable is used, then the PG is also negatively and statistically significantly associated with the demand-side GDPCAP, but positively and statistically significantly with the country dummy variable. These results imply that behind the possible CEEC price-quality catch up in consumer-ready food on the EU-15 markets vis-à-vis the other global competitors, the factors involved are not the CEEC supply-side agricultural factor endowments, nor the CEEC demand-side GDPCAP factor, but some other, CEEC country-specific factors.

Finally, in the case of horticulture, the PG is negatively associated with the AGPOPUL, FDI, and GDP. In the case of the regression without the country dummy variable these parameters are statistically significant, and vice versa in the case of the regression with the country dummy variable. A positive and statistically significant association is found for the LANDCAP and TRACTORLAND, particularly in the regression without the country dummy variable. The mixed sign of the association is found for the GDP, which is also not statistically significant. The impact of the year dummy variables is in general positive and insignificant in the regression with and without the country dummy variable. These results imply that the CEEC price-quality gap advantages in horticultural products on the EU-15 markets vis-à-vis other global competitors depend on the CEEC advantages in natural agricultural and physical factor endowments. The labour endowment, the FDI, and the CEEC market size have been found to contribute to strengthening the CEEC disadvantage in the high-quality segment for horticulture. This can be explained by the CEEC import specialization in these product groups and possible export specialization towards non-EU 15 markets.

Conclusions and Policy Recommendations

This paper has focused on testing the relation of the supply-side factor endowments, economic geographic market size, and demand-side level of economic development as the determinants to explain the CEEC agro-food price-quality gap indices with the other global competitors on the EU-15 markets during the pre-accession by using panel regression analysis. The distinction has been made on a separate analysis of agro-food products by the degree of product processing: bulk raw commodities, processed intermediates, consumer-ready food, and horticulture. In the case of bulk raw commodities and horticulture the year dummy variable as an additional explanatory variable is used to capture the effect of adverse weather conditions. In the case of processed intermediates and consumer-ready food instead of agricultural natural and agricultural labour factor endowments are used the explanatory variables for education as a proxy for human capital and patents as a proxy for research and development activities.

We find that agro-food products by the quality differentiation are not homogeneous as it is usually assumed. The CEEC agro-food export specialization to the EU-15 markets during

the pre-accession is in low-quality bulk raw commodities at the lower export price-quality gap index vis-à-vis the other global competitors on the EU-15 markets. The CEEC export price-quality competitiveness on the EU-15 markets is considerably better in processed intermediates and consumer-ready food, where the CEEC export size is still smaller and varies by the CEEC. This implies structural problems within the CEEC agro-food supply chains during the pre-accession to utilize opportunities for agro-food processing and exports in higher value-added agro-food products. The evidence on the CEEC agro-food quality differentiation with the other global competitors on the EU-15 markets is explained by the CEEC's comparative advantages in relative factor endowments, where the CEEC-14 is not a homogeneous group. The considerable differentials between the CEEC-14 are found in the factor endowment, economic geographic market size, and level of economic development. The comparative advantages in natural agricultural resource endowments, LANDCAP, are found to pertain to quality differentiation in trade in horticultural products and processed intermediates, but not to the CEEC prevailing agro-food trade in bulk raw commodities. This finding suggests that the prevailing CEEC agro-food export specialization in low-quality bulk raw commodity to EU-15 markets, and the CEEC's smaller economic geographic market size – as suggested by the negative sign pertaining to the country size, GDP, except for the processed intermediates – could contribute to strengthening the CEEC disadvantages in high quality segments of consumer-ready food. The estimations provide support for the factor proportion model confirming the assumption of Heckscher-Ohlin-Samuelson that the abundance of physical capital increases the quality of exports. The negative sign for agricultural labour endowment, except for bulk raw commodities, provides a support for persistence in businesses for lower value-added and less quality competitive bulk raw commodities, but also agricultural labour shrinking and a reallocation of jobs from low-quality agro-food products to other more productive particularly non-agricultural activities. The investment in education improves the quality differentiation for processed intermediates, whereas unexpectedly the patents reduce the quality differentiation for consumer-ready food. The mixed signs for FDI, the economic geographic market size, the demand-side level of development, and the country dummy variable for the EU integration process during the pre-accession imply their different role for different quality segments of the CEEC agro-food exports to compete on the EU-15 markets. The random shock to capture annual volatility using the year dummies is found importantly for bulk raw commodities, but not for horticulture, processed intermediates and consumer-ready food implying dependence of traditional agriculture on adverse weather conditions as a need for its proper business management.

Among the most striking findings for the CEEC agro-food sectors is that restructuring of the agro-food sector and its shrinking role in the economy and trade are more likely to occur in order to adjust to the structures and competitive abilities of liberalized regional, European and global markets. The sustainable rural development is seen in synergy between agricultural and particularly non-agricultural, service activities, which are more likely to contribute to rationalization of agro-food production in line with international competition, whereas the increasing role of non-agricultural activities in rural economy is seen in job and income generating activities to mitigate labour-outflow migration pressures from rural areas. Therefore, one of the issues for future research is an analysis for the post-accession years and its comparisons with our findings for the pre-accession years.

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KOKYBĖS DIFERENCIACIJA RYTŲ-VAKARŲ EUROPOS ŽEMĖS ŪKIO PRODUKCIJOS PREKYBOJE PASIRENGIMO ES NARYSTEI LAIKOTARPIU

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SANTRAUKA

Straipsnyje tiriama Vidurio ir Rytų Europos šalių (CRE-14) žemės ūkio produkcijos kokybės diferenciacija, lyginant su kitais Europos Sąjungos (ES-15) rinkose veikiančiais pasaulinio masto konkurentais pasirengimo ES narystei laikotarpiu. Duomenų regresinė analizė naudojama, siekiant paaiškinti CRE-14 žemės ūkio produkcijos kokybės diferenciaciją su pasiūlos indėlio veiksnių, tiesioginių užsienio investicijų (TUI), ekonominės geografinės rinkos dydžio ir paklausos išsivystymo lygio aiškinamaisiais kintamaisiais.

Fizinio kapitalo gausa didina eksporto kokybę. Žemės ūkio įnašų (fondų skyrimo) rezultatas rodo, kad žemės ūkio darbų mažėja, ir atsiranda darbo vietų persikirstymo iš žemos kokybės žemės ūkio produkcijos gamybos į kitas našesnes ne žemės ūkio veiklas. Žmogiškasis kapitalas gerina perdirbtų tarpinių produktų eksporto kokybę. Sudėtiniai žymenys, dėl TUI, rinkos dydžio, ir išsivystymo lygio reiškia skirtingus jų vaidmenis Vidurio ir Rytų Europos žemės ūkio produkcijos eksporto ir kokybės diferenciacijai tirtose ES-15 rinkose.

REIKŠMINIAI ŽODŽIAI: kokybės diferenciacija, pastovaus įnašo veiksnys, Vidurio ir Rytų Europos šalys, Europos Sąjunga, žemės ūkio produkcijos prekyba.