COMPARATIVE ADVANTAGES, TRANSACTION COSTS AND FACTOR CONTENT IN AGRICULTURAL TRADE: EMPIRICAL EVIDENCE FROM THE CEE*

1. Introduction

The present study analyses the factor content of the Central and East European (CEE) agricultural trade. Adopting the relative factor endowment model we test for the relative importance of cross-country technology differences, the relative factor abundance, and the role of firm heterogeneity and transaction costs in the factor content of the CEE agricultural trade. According to Davis and Weinstein (2001), the Heckscher-Ohlin (HO) model and its variants, with their emphasis on trade arising from differences in the availability of productive factors, provides a natural setting for such investigations.

There are several reasons for focusing on the CEE's agricultural trade. First, compared to developed countries, agricultural sector is still very important in terms of GDP and employment shares in the CEE. Second, the EU common agricultural policy (CAP) heavily supports the EU agricultural sector including the CEE. Our findings serve toward a better understanding of efficient allocation of these funds. Third, agriculture was one of the most distorted sectors during the central planning period. The following transition toward a market economy offers a natural experiment for investigating the role transaction costs and market imperfections in agricultural production and trade. According to previous evidence, transaction costs may prevent the adjustment of the distorted centrally-planned farm organisation, factor allocation, specialisation and hence the factor content of the CEE transition country agricultural trade.

* The authors acknowledge helpful comments from Luca Salvatici as well as GTAP, EAAE and IAAE conference participants in Helsinki, Ghent, Santiago and Beijing. The authors acknowledge financial support from the European Commission FP7 project "New Issues in Agricultural, Food and Bioenergy Trade" (AgFoodTrade). The authors are solely responsible for the content of the paper. The views expressed are purely those of the authors and may not in any circumstances be regarded as stating an official position of the European Commission.

According to general equilibrium models of international trade, countries trade with each other because of their differences or due to increasing returns in production. Ricardian model of international trade states that differences in technology between trading partners determine the trade pattern while Heckscher-Ohlin model asserts that countries trade because of differences in relative factor endowments. Countries with equal endowments and technology still trade especially in industrial products, according to new trade theory, if they specialise in different varieties of the same product. In this case trade is driven by increasing returns in production and product differentiation (Abo-Zaid, 2010; Campbell, 2010; Rashid and Razzaq, 2010; Mitze, 2010).

The commodity version of the Heckscher-Ohlin model, often called Heckscher-Ohlin-Samuelson (HOS) model, predicts that a country will export those goods which require intensive use of the country's abundant factors, i.e., a relatively capital abundant country will export capital intensive goods while a relatively labour abundant country will export relatively labour intensive goods. The factor-content version of the Heckscher-Ohlin theory, Heckscher-Ohlin-Vanek (HOV) model, on the other hand deals with the factor content of trade rather than with the trade pattern of individual products. Produced goods contain labour, capital or land services and export of goods involves also export of services of factors of production. HOV theory states that countries will export the services of their abundant factors (Vanek 1968). This implies that in capital abundant country capital labour ratio will be higher in production than in consumption, i.e. capital abundant country exports capital services while labour abundant country exports labour services (Leamer, 1980).

HOV formulation of the Hecskcher-Ohlin theory has been extensively empirically tested. Empirical tests used mostly aggregate manufacturing data for developed countries. In the present paper we estimate factor content of the CEE[1] agricultural trade. We are interested whether the CEE's agricultural trade follows the trade pattern suggested by the Heckscher-Ohlin theory.

The focus on agricultural trade is motivated by the lack of similar studies in the literature. Heckscher-Ohlin theory was tested on agricultural data only by Schluter and Lee (1978) and Lee *et al*. (1988) who used US data, however. In this paper we focus on agricultural trade in CEE countries.

[1] In the present study the CEE refers to the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia.

HOV model assumes identical technology among the countries. This need not be the case in CEE agriculture, however, and has to be taken into account. Agricultural production in some CEE countries is concentrated on small individual farms (IF) while in other countries large corporate farms (CF) cultivate most of the agricultural land. Furthermore, in some CEE countries there is a mixture of individual farms and cooperatives. The evolution of farm structures is the result of different privatisation and restructuring policies adopted in individual CEE countries.

The choice between individual farms and cooperatives is based, in developed economies, on relative efficiency of the farm organisation in given production. Large cooperatives are more suitable for capital intensive production while individual farms are more efficient in production of labour intensive agricultural commodities (Allen and Lueck, 1998). The switch from one type of farm organisation to another is however very costly in transition countries (Ciaian and Swinnen, 2006) unlike in the developed countries. This is due to high transaction costs stemming from poor functioning of some markets like credit market or land market in transition countries. The initial choice of privatisation and restructuring policies has therefore a strong impact on farm organisation and the production of commodities in the long run. Countries that preserved large cooperatives are expected to specialise in more capital intensive production than, *ceteris paribus*, countries that created individual farms by privatisation and restructuring.

The present paper makes three contributions to the existing empirical trade literature: (i) it extends the existing literature of factor content of trade by specifically focusing on agricultural trade and including land among the primary factors; (ii) it attempts to identify the role of transaction costs as a driver of agricultural trade flows; and (iii) it provides the first insights about factor content of international trade in the CEE transition countries, which have been neglected in the previous literature.

2. Relative factor intensities in the CEE trade: literature review

A general finding of the existing literature is that factor content of the CEE trade has been changing since the beginning of transition (e.g., World Bank, 2005; Kancs *et al*., 2008). Both merchandise exports and imports are more skilled labour and capital intensive. (Landesmann and Stehrer, 2002).

Dulleck and Foster (2004) distinguish between CEE-5 (the Czech Republic, Hungary, Poland, Slovakia and Slovenia) and the rest of the CEE (Bulgaria, Rumania and the Baltic States). According to Dulleck and Foster, CEE-5 are upgrading their products using more skilled labour and capital, while the rest of CEE remains seemingly in the trap of low quality specialisation of production and trade.

Accinelli *et al*. (2010) study the pattern of trade specialisation of CEEs. He finds that all the CEEs are above-average exporters in low and medium/low-skill-intensive industries, and relative net importers in medium-high and high-skill-intensive industries. Over time some catch-up with the EU is observed, i.e. convergence but also a de-specialisation trend is visible[2].

Egger *et al*. (2007) use gravity approach to find differences between EU-CEE, EU-EU, and CEE-CEE trade. EU-CEE trade was adjusting rapidly to reducing trade frictions in the early years of transition, while differences in relative factor endowments were the main determinant of the development of CEE-CEE trade. Moreover, EU-CEE and CEE-CEE trade is more sensitive to distance than EU-EU trade which is based on differences in business cycle, endowments or increasing returns to scale.

Nemen (1995) uses cluster analysis to divide industries into five distinctive groups representing different factor intensities. Nemen finds that trade of developed EU-15 countries (northern EU-15 countries) with CEE is characterised by large and positive trade balances in industry groups that are intensive in technology and human capital while less developed EU-15 countries (southern old EU countries), which have a large and positive trade balance in industries that use relatively little capital. This suggests that more developed northern EU-15 countries have a comparative advantage relative to CEE in technology and human capital intensive industries, while less developed southern EU-15 countries have a comparative advantage in capital extensive industries. Nemen further observes that CEE countries have factor endowments rather similar to those of South Europe. From Nemen's analysis it follows that in the long run CEE has a comparative advantage in labour intensive industries.

A significant feature of CEE's trade integration into the European and world markets was a rapid growth of intra-industry trade (IIT)

[2] In this context de-specialisation means increased share of intra-industry trade in total trade and smaller differences in factor endowments.

propelled by increasing returns to scale and product differentiation. At the beginning of transition IIT trade of CEEs and EU-15 was in the range of 20-50% and it was similar to the share of IIT of peripheral EU countries such as Finland, Greece or Portugal. The IIT's share of CEE trade increased during the 1990s reaching similar levels observed in Spain, Italy and other EU countries (50-70% for most of the CEE) (Kancs and Ciaian 2010b).

Specifically in agriculture, early literature predicted significant growth of net agricultural exports from the CEEC to the EU (Kancs and Ciaian, 2010a). Growth of trade was expected to be driven mainly by differences in factor endowments and by liberalisation of trade between EU and CEE countries via reducing tariffs, eliminating quotas and other non-tariff barriers, like sanitary and phytosanitary standards, quality, and import licensing, as well as differing regulatory policies that inhibited trade between CEE and EU-15 (Kancs and Ciaian, 2010a).

Hayes *et al*. (1994) use HOV methodology to predict the pattern of general and agricultural trade in the FSU. They measure the resource base of the FSU, assume US efficiency levels and predict the evolution of trade in FSU. The prediction is for the whole economy and for agricultural sector. From their analysis it follows that the FSU will become after full liberalisation of markets a significant net exporter of temperate agricultural products and net importer of tropical agricultural commodities. FSU will especially become a significant exporter of cereal grains.

Ferto (2005) is one of the few studies investigating factor content in CEE (specifically Hungarian) agricultural trade. He examines the relationship between the factor endowment and the pattern of IIT with agricultural products. Ferto distinguishes between horizontal and vertical product differentiation. Vertically differentiated products require different factor proportions while horizontally differentiated products require the same factor proportions. For the trade between Hungary and EU countries vertical product differentiation is found to be more important than horizontal product differentiation. Ferto confirms the predictions of the existing literature that vertical product differentiation is positively related to differences in factor endowments. The prevalence of the vertical IIT between CEE and EU-15 implies that there are adjustment costs related to reallocation of factors of production during integration of CEE into the EU.

Bojnec and Ferto (2008) investigate trade and trade structures, revealed comparative advantage and trade specialisation for the

twelve new member states of the EU (NMS-12), in the context of the enlarged EU-27, by comparing pre- and post-accession periods (1999-2006). They compare agricultural trade of CEE countries with that of old EU-15 countries. They apply empirical methods of trade structures, duration analysis, regression framework, Markov transition probability matrices and mobility indices to identify the dynamics in revealed comparative advantage, patterns of specialisation, and transitioning from raw agricultural to high processed agro-food products.

Based on these studies, which are representative for the existing literature on relative factor intensities in the CEE foreign trade, we may conclude that with respect to relative factor intensities the majority of the existing literature focuses either on manufacturing sectors or aggregate trade flows. In addition, the most recent CEE trade studies focus on IIT. The literature analysing factor content of CEE trade mainly focuses in describing how factor content of the CEE's imports and exports evolve over time and in comparison with the EU. Hence, in light of the scarce existing literature on factor content of the CEE agricultural trade, the present study will be one of the first studies on factor content of the CEE agricultural trade.

3. Conceptual framework

3.1 Previous Studies

Leontief (1953) was the first to test the Heckscher-Ohlin theory empirically. He found that the U.S. (the most capital-abundant country in the world) exported labour-intensive commodities and imported capital-intensive commodities, in contradiction with HO theory[3]. Hence, Leontief Paradox undermined the validity of the Heckscher-Ohlin theory.

The Leontief Paradox has generated a huge literature in the subsequent years. The HOV theorem has been frequently rejected (and Leontief paradox confirmed) for both US and other developed economies.

[3] Leontief calculated labour-output ratios and capital-output ratios for a number of industries in the U.S. economy. Using these coefficients, he then calculated the amount of labour and capital embodied in U.S. imports and exports. Leontief found that the capital-labour ratio embodied in imports exceeded the ratio embodied in exports by approximately 30%.

The methodology used by Leontief's and his followers has been criticised on many grounds (see e.g., Schott 2003 for an overview). Leamer (1980) showed theoretically that the paradox does not exist in the Leontief data if the possibility of unbalanced trade is allowed. However, even if the trade imbalance is correctly incorporated into the model, the Leontief paradox does not disappear entirely (Leamer, 1984; Bowen *et al*., 1987).

From the perspective of this paper, there is especially important criticism related to technology and omitting other factors of production from the empirical analysis. Leontief used a two-factor model (labour and capital), thus abstracting from other factors such as natural resources (land, climate, mineral deposits, forests, etc). Vanek (1959) pointed out that a commodity might be intensive in natural resources so that classifying it as either capital or labour-intensive would clearly be inappropriate. Vanek argues that the omitted factors help to explain the Leontief Paradox and he stresses the importance of restoring the traditional triad of capital, labour and land in factor endowment considerations.

Stern (1975) also emphasised the need for models of more than two factors because capital and labour are required to improve natural resources to give them economic value, and countries may certainly combine these factors in somewhat different proportions when producing natural resource-based products. Thus, consideration of natural resources is important in the examination of the effect of factor endowment on trade.

On the other hand, Sheldon and Roberts (2008) use the HOV set up to investigate current biofuels policies and consider two factors of production, land and capital, not labour. In their set up the rest of the world (especially Brazil) has a comparative advantage in land intensive production of biofuels based on traditional feedstock (corn or sugar cane) while the US has a comparative advantage in biofuel production based on cellulosic feedstock which is capital intensive and subject to economies of scale based on the industry.

The role of natural resources is especially important for agricultural production and trade in which land plays a crucial role. Leamer (1984) included agriculture in his study and included four types of land: tropical, arid, humid mesothermal and humid microthermal. Koo and Anderson (1988) use Heckscher-Ohlin theory to empirically investigate the impacts of resource endowments (land, labour, capital, and technology) on agricultural exports in exporting countries. Koo and Anderson confirm that land, labour, capital and technology determine agricultural trade.

In the Heckscher-Ohlin theory trade is driven by the relative differences in factor endowments between countries. Countries are assumed to use the same technology unlike in the Ricardian model where trade is driven by differences in technology between the countries. The frequent failures of empirical tests of the Hecskcher-Ohlin theory were a motivation for incorporating technological differences into the model (Kielyte, 2008). Technological differences were introduced either as differences in the matrixes of requirements of production factors to produce one unit of output or as adjustments to endowments due to differences in productivity of factors (Trefler, 1993 and 1995). The incorporation of technological differences improves the predictions of H-O model (Feenstra, 2004; Kancs, 2007).

In the case of agricultural production and trade in CEE countries, the technological differences stem from differences in farm structures (Ciaian and Swinnen, 2006; Allen and Lueck, 1998; Ciaian *et al*., 2009).

Summarising findings from the previous studies we may draw several conclusions important for the present article. First, as the Leontief's original study itself, most of the factor content studies to date have been applied to developed countries, because only these countries have the necessary input-output and trade data required for computing factor content of trade for each sector and trading partner (Davis and Weinstein 2001). According to our knowledge, there is no single study analysing factor content in all CEE transition country trade to date. Second, there are very few studies examining factor content of agricultural trade. Third, most of the previous studies have analysed factor content and the relative endowment only of labour and capital. However, the findings of Vanek (1959) and Stern (1975) suggest that omitting other factors might yield biased factor content estimates.

The present article attempts to address all three issues of the previous studies. First, this article departs from previous literature and examines factor content in the CEE transition country trade, where the pattern of foreign trade may be affected by transition processes. Second, the present study examines the theoretical predictions that relate the factor content of agricultural trade to cross-country differences in relative factor endowment. Agricultural trade is particularly important in CEE, where in some countries the share of farming sector in total GDP and employment amounts up to 12%. Third, in addition to the traditional factors such as capital and labour, our empirical analysis includes land. Considering land in

our study is additionally motivated by the fact that we examine the factor content of agricultural trade.

3.2 The Model

The Heckscher-Ohlin-Vanek (HOV) model is a multifactor, multicommodity, and multicountry model relating factor content of trade to factor endowments. The key assumptions of the HOV model are identical technologies across countries, constant returns to scale, identical and homothetic preferences across countries, differences in factor endowments, free trade in goods but not necessarily in factors of production and no factor intensity reversals. Factor intensity reversal refers to the situation where an industry is labour intensive at low relative price of labour and capital intensive at high relative price of labour. This possibility is assumed away here.

Assume that $r=1, \ldots, R$ index countries, $i=1, \ldots, I$ are industries; and $f=1, \ldots, F$ index factors. Let $A_r=[a_{if}]'$ be the FxI matrix of requirements of production factors to produce one unit of output in each industry in country r, where rows of the A_r matrix index factors and columns industries.

Let Y_r be the $(I\times 1)$ vector of outputs in each industry in country r and let D_r be the $(I\times 1)$ vector of demands for each good in country r. The net export vector of goods, T_r, originating from region/country r can then be written as:

$$T_r = Y_r - D_r \tag{1}$$

The factor content of trade, i.e. the $(F\times 1)$ vector of trade in factor services, can then be defined as:

$$F_r = A_r T_r = A_r Y_r - A_r D_r \tag{2}$$

Identical technologies across countries and factor price equalisation imply that matrices are the same across the countries, $A_r=A$. So we can write $F_r=AT_r=AY_r-AD_r$ and a positive value of an element in F_r indicates that the factor is exported and a negative value indicates that the factor is imported. Assuming full employment of all primary factors we can write $AY_r=V_r$, where V_r is the vector of endowments of factors in country r.

With equalisation of commodity prices by free trade and identical homothetic preferences across region/countries, region/country r's consumption vector must be proportional to the total world consumption:

$$Dr = s_r D_w \tag{3}$$

where s_r is country r's share in the world demand, D_w. Assuming that world production is equal to world consumption we obtain:

$$AD_r = s_r AD_w = s_r AY_w = s_r V_w \quad (4)$$

where V_w is the vector of world endowments of factors of production.

Together with the expressions for AV_r and AD_r we can derive the theoretical HOV hypothesis:

$$F_r \equiv AT_r = V_r - s_r V_w \quad (5)$$

The left hand side of equation (5) captures the production side of the HOV theorem and is often labelled as the measured factor content of trade. The right hand side of equation (5) captures the consumption/demand and is often referred to as the predicted factor content of trade. For factor f the equation (5) can be rewritten as:

$$F_{fr} = V_{fr} - s_r V_{fw} \quad (6)$$

Equation (6) relates country r's factor, f's net content of trade to its own and the world's endowments.

The relative factor abundance is defined as follows: if country r's endowment with factor f relative to world endowment of that factor exceeds region/country r's share in the world's GDP, i.e. $\frac{V_{fr}}{V_{fw}} > s_r$, then country r is abundant in factor f.

4. Empirical analysis

4.1 Data

In order to reveal the sectoral differences in the production and trade, we disaggregate the agricultural sector into eight sub-sectors. In order to account for international differences in production and demand, we disaggregate the CEE into eight countries (Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia).

The three principal data sources are the COMEXT (2004) trade data from Eurostat (2007), the GTAP 7 data base and the Farm Accountancy Data Network (FADN) farm level survey data. For the empirical analysis of factor content of trade we use the production and trade data for 2004.

The agricultural trade data are extracted from the COMEXT trade data base Eurostat (2007) and complemented by the GTAP 7 data base. The COMEXT data base provides trade data for all Member States of the EU on external trade with each other and with non-member countries. It contains data on external trade collected and

processed by all EU Member States and more than 100 trade partners, including USA, Japan and the EFTA countries. COMEXT contains several types of data from various sources (European Union, United Nations, IMF etc) and with different structures (corresponding to different nomenclatures such as CN, SITC Rev2, SITC Rev3 etc).

In addition to the bilateral trade flows, the GTAP data provides national input-output flows in the CEE and data for macroeconomic variables such as consumption, GDP, etc, which together with the FADN data are used to calculate the factor input requirements. The FADN is a standardised survey system of farms conducted once a year across all EU member states. In 2004 the FADN represented approximately 90% of the total utilised agricultural area (UAA) and accounted for more than 90% of the total agricultural production of the EU[4].

4.2 Factor Endowments in CEE

CEE countries differ in factor endowments (table 1). In table 1 land endowments are measured in hectares of agricultural land *per capita* while capital endowments are measured in thousands of Euros of capital per agricultural worker. Agricultural labour force endowment is proxied by the share of agricultural employment in the total employment in 1990. We use this proxy for agricultural labour force for two reasons: (i) it is highly correlated with the unobservable agricultural labour endowment[5]; and (ii) it is exogenous, i.e. it is not determined by farm labour demand in 2004[6]. Moreover, those workers which worked in agriculture until the nineties of the last century are experienced, many of them have agricultural education and, most importantly, they live in rural areas as their competitiveness for manufacturing jobs in cities is limited (Chopra and Kanji, 2010)[7].

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[4] In this paper we use the aggregated version of the FADN (2008).

[5] In the context of the present study the agricultural labour force captures both the size of agricultural workers and the size of agricultural employment seekers.

[6] We perform sensitivity analyses using alternatives measures of rural labour endowment (rural population density, rural unemployment rate and rural-urban wage gap). Given that the use of alternative proxies does not change the presented results significantly, they are not reported here for the sake of brevity.

[7] Although a certain share of them has left the rural regions, worker decision to leave is an endogenous process largely driven by wage differences and

TABLE 1 - *CEE Country Factor Endowment Ratios*

	Land/Labour land/capita, ha	Capital/Labour euro/capita	Agricultural labour % of total employment
Czech Republic	0.36	4078	9.6
Estonia	0.57	3411	16.3
Latvia	0.71	3283	19.5
Lithuania	0.76	2929	18.0
Hungary	0.58	4060	17.5
Poland	0.43	4364	25.8
Slovenia	0.25	6540	8.4
Slovakia	0.36	3952	10.7
CEE	0.50	4077	15.7

Source: Authors' calculations based on Eurostat and FAO (2008) data.

Of all CEE in our sample Lithuania and Latvia are the most land abundant countries with 0.76 and 0.71 hectares of agricultural land *per capita* respectively. Slovenia is the least land abundant country with only 0.25 hectares of agricultural land *per capita*.

The lowest ratio of capital per agricultural worker is in Lithuania (2929 Euro/capita); the highest in Slovenia (6540 Euro/capita). Countries with higher GDP *per capita* have higher capital/labour ratios (Davis and Weinstein 2001). Slovenia was the most developed country in our sample in terms of GDP *per capita* and GDP in Slovenia is almost two times higher than in Lithuania.

The absolute labour endowment in terms of agricultural employment share in total employment is reported in column 4 of the table 1. The smallest agricultural employment share in total employment in 1990 was in Slovenia – 8.4%. Also in the Czech Republic and Slovakia agricultural labour force was relatively small compared to the rest of the CEE. The most farm labour abundant country was Poland, where in 1990 more than one quarter of all economically active workers was employed in agriculture.

To obtain the country's relative factor abundance we compute a share of the country's factor endowment to the factor endowment

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employment opportunities. Hence, the current agricultural employment share cannot be considered as a measure of exogenous comparative advantages.

in all CEE countries and a share of the country's gross agricultural output (GAO) to the GAO in all CEE. The relative factor endowment is then the ratio of the share of the country's factor endowment and the share of the country's GAO. If country *r*'s endowment of factor *f* relative to the CEE endowment of that factor exceeds country *r*'s share in the CEE's GAO, i.e. $\frac{V_{fr}}{V_{fw}} > s_r$, then country *r* is abundant in factor *f*. The GAO and factor endowment shares by country are reported in table 2.

TABLE 2 - *Individual CEE Country Endowment with Land, Capital and Labour Relative to all CEE Countries*

	GAO share	Labour share	Land share	Capital share
Czech Republic	0.131	0.065	0.132	0.088
Estonia	0.014	0.010	0.030	0.014
Hungary	0.157	0.079	0.156	0.109
Lithuania	0.036	0.051	0.080	0.039
Latvia	0.022	0.026	0.045	0.024
Poland	0.572	0.696	0.467	0.680
Slovakia	0.047	0.036	0.074	0.028
Slovenia	0.021	0.037	0.017	0.017
Total CEE	1.000	1.000	1.000	1.000

Source: Authors' calculations based on FADN (2008) and Eurostat (2008) data.
Notes: GAO-Gross Agricultural Output.

The Czech Republic and Estonia are relatively abundant in land. Hungary is relatively scarce in all three factors – labour, land and capital. In contrast, Lithuania and Latvia are relatively abundant in all three factors – labour, land and capital. Poland is relatively abundant in labour and capital. Slovakia is relatively abundant in land and Slovenia is relatively abundant in labour but relatively scarce in land and capital. These estimates are roughly in line with the factor endowment ratios reported in table 1.

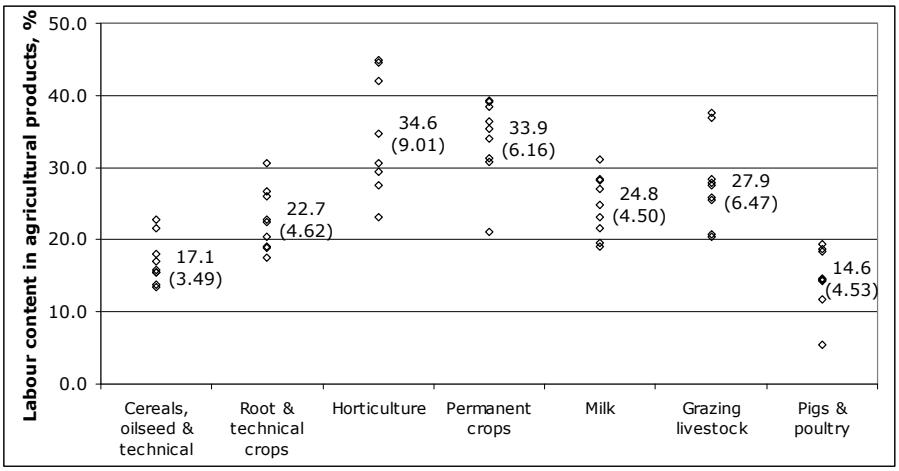
4.3 Relative Factor Intensities of Agricultural Production in CEE

The relative factor endowment differences across countries are especially an important source of comparative advantages if there are

sizeable differences in factor intensities among agricultural activities (commodities). Figure 1 shows the differences between various agricultural activities in the relative labour intensity across CEE. Labour content in percent is measured on the vertical axis and the seven agricultural activities on the horizontal axis. Dots in the figure 1 represent the eight CEE countries. The average values for each sector with the corresponding standard deviations are reported next to the columns.

As shown on figure 1, labour intensity significantly differs between agricultural activities (commodities) in CEE. For example the pig and poultry production (14.6% labour content in agricultural production) is on average 2.4 times more labour extensive than horticulture (34.6% of labour content in agricultural production). Similarly, cereal and oilseed production (17.1% labour content) requires almost two times less labour than permanent crops (33.9%). Hence, the existing differences in the relative factor intensities suggest that there are potential gains from international specialisation in agricultural production and trade.

FIGURE 1 - *Labour Content in Agricultural Products in CEE Countries*



Considering Heckscher-Ohlin theory, several predictions about production and trade specialisation in CEE countries can be made. First, labour abundant Latvia and Lithuania would produce and export products with relatively high land content, and import products with relatively low land content. Slovenia has the lowest

land endowment *per capita*, which would suggest the opposite pattern of factor content of agricultural trade. Second, farm labour abundant countries, such as Poland, which has three times higher agricultural labour endowment than other comparable CEE economies, e.g., Slovenia, would specialise in production and export of relatively labour intensive products relative to their agricultural imports. On the other hand, if other things were equal, agricultural labour scarce countries – the Czech Republic, Slovenia and Slovakia – would import relatively labour intensive goods and export labour extensive agricultural commodities.

4.4 Factor Content of CEE Agricultural Trade

Here we analyse agricultural exports from CEE to the rest of the world (RoW) (most of which go to the countries of the EU) and imports from the rest of the world (most of which originate from the EU) to CEE. Second, we examine the factor content hypothesis relating the relative country endowments to factor content of agricultural trade. Given that CEE countries and old EU countries are very different, the key underlying assumptions of the HOV theory (equal factor prices, identical technologies, etc.) are not satisfied. Hence, factor content of agricultural trade between these two groups of countries cannot be analysed in the standard HOV framework. We therefore proceed as follows: (i) we analyse factor content of the CEE-rest of the world (RoW) agricultural trade relying on qualitative analysis; and (ii) we calculate not only value of factor content of trade but also quantity ratios, which may reveal the role of factor price differences between the CEE and RoW play.

The content of factor services in the gross agricultural trade flows at a disaggregated level are reported in tables 3 and 4. In both tables columns 2-4 report factor content in agricultural imports to CEE from the RoW; and columns 5-7 report factor content in agricultural exports from CEE to RoW. We use EU-25 factor intensities in production to obtain factor shares of CEE imports in tables 3 and 4. This is a good approximation given that the most of the CEE trade is with the EU (more than 75%). For exports we use factor intensities in production of CEE countries themselves[8]. Given that

[8] The only exception is the Czech Republic. Due to unreliable factor price data we use Slovak factor intensities for the Czech Republic. However, given that

agricultural trade is not balanced for all countries in our sample, the factor content is calculated per unit of exports and imports.

TABLE 3 - *Factor Ratios of Agricultural Trade in 2004 (in Quantities)*

	Factor ratios in imports			Factor ratios in exports		
	L/A	*L/K*	*K/A*	*L/A*	*L/K*	*K/A*
Czech Republic	13.10	0.87	15.06	7.04	0.90	7.81
Estonia	10.68	0.85	12.54	6.79	1.34	5.07
Latvia	12.54	0.82	15.23	8.40	1.90	4.42
Lithuania	11.39	0.84	13.57	8.74	2.87	3.05
Hungary	11.28	0.76	14.78	9.58	0.82	11.62
Poland	12.26	0.87	14.07	23.36	2.10	11.10
Slovenia	9.65	0.81	11.92	17.58	1.53	11.46
Slovakia	10.58	0.76	13.92	5.92	0.97	6.11
CEE	11.35	0.82	13.80	9.25	1.40	6.60

Source: Authors' calculations based on Eurostat (2007), FADN (2008) and GTAP (2008) data.
Notes: *A*-land, *L*-labour, *K*-capital.

There are differences in factor content ratios computed for exports and imports. On average, the CEE tend to have higher labour content relative to capital content in exports than in imports. Additionally CEE exports possess higher land content relative to capital and relative to labour than CEE imports. These facts are as predicted by the HOV theory because CEE countries are abundant in labour and land relative to EU-25.

For imports factor content ratios differ insignificantly between the countries. Relatively stronger cross country variation is observed for factor content ratios in exports. In particular Poland and Slovenia have high labour/capital (low capital/labour) content ratio in exports, while the opposite holds for the Czech Republic and Slovakia. The Czech Republic, Hungary and Slovakia have low labour/capital ratio (high capital/labour ratio) in exports compared to other countries. According to the HOV theory, the countries with relatively high *K/L* endowments (Slovenia, Poland in table 1) should have high relative

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both countries shared the same history until 1993, and have similar farm structure in 2004, using Slovak coefficients should not cause major differences in the factor content of trade data.

K/L content in exports. This is not true as Slovenia and Poland have relatively low K/L ratio in exports (table 3). On the other hand high K/L ratio in exports is observed for Slovakia and the Czech Republic and these countries do not possess the relatively high K/L endowments.

In both exports and imports capital represents the largest factor share, which on average accounts for 58.5% and 49.1% of export and import value, respectively (table 4). Agricultural imports of the CEE countries have higher labour content than exports (45.8% and 39.5%), whereas agricultural exports from CEE contain more capital than imports to CEE (58.5% and 49.1%). The third primary production factor land accounts on average for only 2.0% (5.1%) of export (import) value.

In contrast to the results reported in table 3, where we account only for relative factor quantities, in table 4, where we account for both relative factor quantities and factor prices, capital/labour ratio is higher in CEE agricultural exports than in CEE agricultural imports (labour/capital ratio is lower for exports than for imports). More expensive capital relative to labour in CEE, as compared to old EU member states, reverts the ratio of capital to other factors in trade, when factor content of trade is calculated in values. This finding is in contradiction to HOV theory predictions.

According to table 4, the variation of factor content in imports is rather small across the CEE countries. Similar to table 3, a stronger variation is observed for exports. Slovakia, the Czech Republic and Slovenia have the highest share of capital content in exports, whereas labour is the largest component of agricultural exports in Estonia, Lithuania and Poland.

TABLE 4 - *Factor Content Shares of Agricultural Trade in 2004 (in Values)*

	Factor shares in imports			Factor shares in exports		
	Land	Labour	Capital	Land	Labour	Capital
Czech Republic	4.68	47.65	47.66	1.50	28.64	69.86
Estonia	5.43	46.12	48.46	0.67	56.09	43.24
Latvia	4.70	46.40	48.89	1.21	42.00	56.79
Lithuania	5.24	46.44	48.31	2.36	46.82	50.81
Hungary	4.96	44.13	50.90	1.99	37.01	61.00
Poland	5.04	47.41	47.56	3.05	46.84	50.11
Slovenia	5.68	44.80	49.52	3.83	30.80	65.37
Slovakia	5.31	43.06	51.63	1.67	27.46	70.88
CEE	5.13	45.75	49.12	2.03	39.46	58.51

Source: Authors' calculations based on Eurostat (2007), FADN (2008) and GTAP (2008) data.

Notes: For each countries the sum of shares normalised to 1.

On average, the exported goods are more capital intensive than agricultural goods produced domestically (58.5% and 51.7%). In contrast, locally produced agricultural goods are more labour intensive than exported goods (45.9% and 39.5%). The average land content is slightly higher in the aggregate farm output compared to agricultural exports. Slovakia, Slovenia and Estonia have the largest differences in factor content between farm output and agricultural exports, which raises important questions about differences in the drivers of factor content in agricultural trade.

Summarising findings we may conclude that the HOV theory poorly predicts factor content of agricultural trade of the CEE countries. Agricultural imports of the CEE countries have higher labour content than exports (45.8% and 39.5%), whereas agricultural exports from CEE contain more capital than imports to CEE (58.5% and 49.1%). This is surprising given the fact that the major trading partner for the CEE countries is the EU-25 which is relatively labour and land scarce and capital abundant.

Also relatively capital abundant countries in the context of CEE are observed to export low capital/labour ratio (Slovenia and Poland) while relatively labour abundant countries are observed to export high capital/labour content as measured in quantities (Slovakia). When measured in value terms again Slovakia, the Czech Republic and Slovenia have the highest share of capital content in exports, whereas labour is the largest component of agricultural exports in Estonia, Lithuania and Poland. These findings do not confirm the HOV theory.

Many reasons are identified in the literature why HO theory does not provide good predictions about international trade. In the next section we argue that the key underlying assumptions (equal factor prices, identical technologies, etc.) of the HOV theory are not satisfied. A special attention is paid to differences in technologies stemming from the organisation of farm production in CEE.

5. Farm organisation and specialisation in CEE

5.1 Organisation of Farm Production in CEE

There are significant differences in the organisation of farm production between the CEE transition countries. Agricultural sector in some countries is dominated by large corporate farms, whereas in other countries small individual farms cultivate most of the land. These cross-country differences in the farm organisation in CEE countries are summarised in table 5. Slovenia and Poland have the

highest share of IF, while Slovakia and the Czech Republic have the lowest share of IF.

The structure of the farms in CEE countries is the outcome of communist policies that were in effect until 1990 as well as the policy decisions made in the early years of transition with respect to privatisation and restructuring of farms. The transition process that started in 1990s involved changes of both formal and informal rules. In general higher speed is observed in transition of formal rules while changes of informal rules were relatively slow-paced. Informal rules however have strong implications for the effectiveness of the sector and transaction costs (Pokrivcak *et al*., 2011).

Agricultural land was cultivated collectively during communist times. Land privatisation was therefore a significant step towards market economy. In most CEE countries land was resituated to former owners. Hungary combined the distribution of land to workers with the restitution to former owners (Lerman *et al*., 2002; Kancs and Weber, 2001). Similarly as in the case of land privatisation, non-land assets were returned to original owners or distributed to workers and/or landowners.

TABLE 5 - *Farm Structure in CEEC*

	Family farms		Transformed cooperative farms		Year
	Share of TAA (%)	Average size (ha)	Share of TAA (%)	Average size (ha)	
Czech Republic	28	20	72	937	2003
Hungary	59	4	41	312	2000
Poland	87	8	13	–	2003
Slovakia	12	42	88	1185	2003
Slovenia	94	–	6	–	2000
Estonia	63	2	37	327	2001
Latvia	90	12	10	297	2001
Lithuania	89	4	11	483	2003

Sources: Bulgaria: Bulgarian Ministry of Agriculture and Forestry; Czech Republic: Czech Statistical Office; Estonia: Statistical Office of Estonia; Hungary: European Commission; Poland: Central Statistical Office; Latvia: Statistical Office of Latvia; Lithuania: Statistical Office of Lithuania; Slovenia: Statistical Office of the Republic of Slovenia. TAA – Total Agricultural Area.

Farm restructuring followed after privatisation process. New private owners of farm assets and land were allowed to break away

from cooperative farms and to start individual farming. This led to the creation of many individual farms that were significantly smaller in size than cooperatives, but comparable to their Western European or American counterparts. But not all cooperative farms broke up into individual farms. Many cooperatives (those not entirely replaced by individual farms) were transformed. That is, old socialist cooperatives were turned into cooperatives of owners of agricultural assets (including land), joint-stock companies, limited-liability companies or partnerships.

Depending on the methods of privatisation and government policies on restructuring, different farm structures emerged in different transition countries. While in Slovakia and the Czech Republic agriculture is still dominated by large transformed enterprises, Latvia, Lithuania and Estonia have created many small size individual farms. There is a whole spectrum of farm structures in between these two extreme cases (table 5).

Literature from the 1990s predicted that the large cooperative farms in CEEC would transform into individual farms and that the farm structure in CEEC would become similar to that in Western Europe and the USA. It was perceived that IF are more efficient than CF (Schmitt, 1991; Chopra and Kanji, 2010; 1996; Kancs and Weber, 2001). This transformation has not occurred in all CEE countries, however.

Ciaian and Swinnen (2006) provide a partial equilibrium theoretical model that explains why CF persist in CEE. According to them, large scale CF continue to use large part of land because emerging individual farms face significant transaction costs to obtain land from the established CF. Transactions costs include costs involved in bargaining with the farm management, in obtaining information on land and tenure regulations, in implementing delineation of the land and dealing with inheritance and co-owners (Prosterman and Rolfes, 1999; Swain, 1999; Ciaian and Swinnen, 2006).

5.2 Farm Organisation, Technology and Specialisation

The share of IF on land cultivation or output is strongly and negatively correlated with the average farm size. Countries with relatively high share of CF (low share of IF), e.g., the Czech Republic and Slovakia, have considerably larger farms than countries with high share of IF (e.g., Slovenia and Poland).

In terms of farm specialisation and factor content of agricultural trade, the share of IF and CF is important because the relative factor requirements in producing the same product are different between CF and IF. In other words IF use different technology than CF. The empirical evidence for the CEE is summarised in table 6, which reports the labour-capital ratio in CF and IF farm output by agricultural commodity in 2004. Columns 2 and 3 report the capital/labour ratio in IF and CF output, respectively. The last column reports the relative factor intensity of IF compared to CF.

The relative factor intensity estimates reported in column 4 suggest that in the CEE transition countries IF use less capital compared to CF, whereas CF use less labour compared to IF (table 2). IF use more labour per unit of capital in production of all agricultural commodities. Technological differences between IF and CF also differ by agricultural commodities. The most sizeable

TABLE 6 - *Capital/Labour Intensity in Agricultural Production by Commodity and by Farm Type in 2004*

Agricultural Commodity	$(K/L)_I$	$(K/L)_C$	$\frac{(K/L)_I}{(K/L)_C}$
Specialist cereals, oilseed and protein crops	3789.7	6266.2	0.60
Specialist other fieldcrops	3433.2	3651.6	0.94
Specialist horticulture	3173.6	3350.3	0.95
Specialist wine	3417.6	4192.2	0.82
Specialist orchards – fruits	4003.6	4175.6	0.96
Specialist olives	4872.9	–	–
Permanent crops combined	2246.1	2654.8	0.85
Specialist milk	2543.7	2731.0	0.93
Specialist cattle-rearing and fattening	2500.4	4445.2	0.56
Cattle-dairying, rearing and fattening combined	2200.0	2261.2	0.97
Specialist sheep and goats	2311.4	4049.8	0.57
Specialist granivores	2950.3	2974.0	0.99
Mixed crops	2355.8	2734.0	0.86
Mixed livestock, mainly grazing livestock	1751.8	2483.9	0.71
Mixed livestock, mainly granivores	1983.4	4619.3	0.43
Field crops-grazing livestock combined	2383.2	2628.6	0.91
Various crops and livestock combined	2575.2	2826.2	0.91

Source: Authors' calculations based on FADN (2008) data.

Notes: $(K/L)_I$ – capital/labour ratio in IF output, $(K/L)_C$ – capital/labour ratio in CF output, $(K/L)_I/(K/L)_C$ – relative factor intensity of IF compared to CF.

technological differences in terms of factor use are estimated for mixed livestock, where the relative content of capital to labour in output of IF amounts only to 43% of capital to labour content in output of CF. In contrast, pig and poultry production (specialist granivores) is nearly equally capital intensive between IF and CF – IF output contains 2950.3 EUR of capital per worker while equal CF output contains 2974.0 EUR of capital per worker.

From above it follows that there are differences in technology used by IF and CF. IF use more labour intensive technology while CF use more capital intensive technology. This also confirms the findings from the previous literature (e.g., Pollak, 1985; Allen and Lueck, 1998).

Technological differences between IF and CF and high transaction costs of adjusting farm organisation (from IF to CF and vice versa) are reflected in different specialisation patterns between IF-dominated and CF-dominated countries. The technology based Ricardian theory of international trade would therefore predict that countries with high share of IF (Slovenia and Poland) would produce and export relatively labour intensive products and import products with relatively high capital content. In contrast, *ceteris paribus*, we would expect that countries with high share of CF (Slovakia and Czech Republic) would produce and export relatively more capital intensive goods and import relatively more labour intensive goods.

6. The role of factor endowments and production technology in determining agricultural trade

We test empirically the two hypothesis: (i) the role of Ricardian technology differences in the bilateral trade of agricultural goods; and (ii) the Heckscher-Ohlin endowment hypothesis. Following Lai and Zhu (2007), both hypothesis are tested by performing a sign test. By performing the sign test we are comparing two matrices of the factor content of bilateral trade: the actually observed trade in factor services with the one predicted by the underlying relative factor endowment model. In the matrices a positive sign implies the export of the factor services and a negative sign implies the import of the factor services. By comparing the signs country-pair by country-pair between the two matrices allows us assessing the underlying model's performance in percentage. The minimum value of the sign test is 0.00, which indicates that signs of the two matrices do not match for none of the country pairs, suggesting that the model's performance

is very poor. The maximum value of the sign test is 1.00, which indicates that signs of the two matrices match for all country pairs, suggesting that the model's performance is excellent. Hence, the sign test indicates the percentage of country pairs that satisfy the tested hypothesis.

The sign test is performed for four different sets of countries. The full sample (EU-25) examines the hypothesis for all EU 25 member states. There are 300 unique bilateral trade flows in 2005. The sub-sample 'EU-15' consists of relatively capital abundant old EU member states and contains 105 unique bilateral trade flows[9]. The sub-sample CEE consists of relatively labour abundant new EU member states and contains 45 unique bilateral trade flows. Finally, we examine the factor content of bilateral trade between EU-15 and the CEE. This sub-sample consists of 75 unique bilateral trade flows.

For comparison purposes we also calculate sign test for total trade (agriculture and non-agriculture). This will serve to compare agricultural trade performs relative to total trade. We expect that the sign tests will perform better for the total trade than for the agricultural trade because the transaction costs and market imperfections are perceived to be stronger in rural areas than in other sectors (Binswanger and Rosenzweig, 1986).

Important is to note that in general the main results of our paper are not significantly affected by the EU agricultural policies. The EU intervenes in agricultural markets through trade measures, market price support, (decoupled and partially coupled) direct income payments and rural development policies (RDP). The trade measures and market price support are implemented at the EU level and are common for all EU countries. All countries considered in this paper are members of the EU (the CEE joined EU in 2004) which implies that the trade policy and the market price support do not distort the intra-EU agricultural trade.

What may affect the intra-EU agricultural trade are direct payments. The EU subsidises the agricultural sector through the decoupled and partially coupled direct payments. However, the strongest variation in direct payments is between EU-15 and CEE. Farms in EU-15 receive higher direct payments than farms in CEE. This variation in direct payments may affect the bilateral trade flows

[9] The results reported in Kancs *et al.* (2008) confirm that EU-15 is relatively capital-abundant whereas the CEE is relatively labour abundant, capital is relatively expensive in the CEE whereas labour is relatively expensive in EU-15.

between EU-15 and CEE (for EU-25). However, in 2005 the EU-15 started to decouple its direct payment implying relatively small impact on production and trade. Within the CEE the main bulk of direct payments are paid in form of decoupled area payments. The area payments are not linked to production or a particular sector and hence have minimal production and trade distortive effects.

Finally, the RDP allocates fund in rural economy through various measures such as less favoured area payments, environmental payments, farm investment, farm output diversification, subsistence farming and rural infrastructure. Their implementation rules are common for all EU countries. However, the allocation of funds to different measures and sectors may differ across EU countries. For example, if a country allocates RDP funds to a less competitive sector this may imply that our results will be underestimated while in the opposite case they will be overestimated. However, the share of the RDP funds on the total EU subsidies are relatively low (around 20%), of which a major part are allocated to decoupled less favoured area payments. This implies relatively small impact of RDP on the intra-EU trade.

6.1 Ricardian Technology Differences

The hypothesis of the Ricardian technology differences says that, on average, a country imports the services of those factors that are cheaper in its trading partner and exports the services of those factors that are more expensive for its trading partner. In order to empirically test the role of the Ricardian technological differences, $R_{od} \geq 0$, two variables need to be calculated and compared: (i) importer d's hypothetical unit cost of production; and (ii) exporter o's actual unit cost of production. The former can be calculated by using the importer's factor prices and the exporter's factor usage. The latter can be calculated using the actual exporter's factor prices and factor usage (see Kancs and Ciaian, 2010a).

We test the hypothesis of the Ricardian technology differences by performing a sign test for the bilateral trade flows with agricultural goods in 2005. Column 1 in table 7 reports the obtained sign statistics for the factor content of aggregate agricultural trade, which are defined as the percentage of country pairs that satisfy Ricardian technological differences hypothesis, $R^{A}_{od} \geq 1$. Column 2 reports the same statistics for the total trade, R^{T}_{od}.

The sign statistics for the agricultural trade reported in table 7

suggest that $R^A_{od} \geq 1$ is satisfied for 73% of the EU-25 country pairs. The p-value of the sign test is below 0.01, which means that the probability of having $R^A_{od} \geq 1$ for more than 73% of the time is less than 1%. Thus, the hypothesis $R^A_{od} \geq 1$ performs rather well for the EU-25 country pairs. According to row 3, the test statistics is even higher for the EU-15 – the hypothesis $R^A_{od} \geq 1$ is satisfied for 78% of bilateral trade flows of agricultural goods. Again, the hypothesis $R^A_{od} \geq 1$ cannot be rejected at the 1% significance level. The test performance is considerably lower for the CEE, where the hypothesis $R^A_{od} \geq 1$ is satisfied for 48% of bilateral trade flows. Moreover, the results are less significant. The sign statistics reported in table 7 also suggest that the test performance is reasonably good (69%) for the bilateral trade between the capital-abundant EU-15 and the labour-abundant the CEE countries.

TABLE 7 - *Ricardian Technology Differences and Factor Content of Bilateral Trade*

	$R^A_{od} \geq 1$ (1)	$R^T_{od} \geq 1$ (2)	Obs (3)
EU-25 (full sample)	0.73	0.81	300
	(0.01)	(0.01)	
EU-15 (capital-abundant)	0.78	0.85	105
	(0.01)	(0.01)	
CEE (labour-abundant)	0.48	0.72	45
	(0.04)	(0.03)	
EU-15 – CEE	0.69	0.78	75
	(0.03)	(0.02)	

Notes: Sign test results based; p-values in parenthesis; $R^A_{od} \geq 1$ test refers to agricultural trade; $R^T_{od} \geq 1$ test refers to the total trade.

The sign statistics for the total trade reported in column 2 suggest that $R^T_{od} \geq 1$ is satisfied for 81% of the EU-25 country pairs, which is higher than for the agricultural trade. As for the agricultural trade, the p-value of the sign test is below 0.01, implying high significance of the sign test results. Also for the EU-15 the sign test performance is higher for the total trade than for the agricultural trade (85% and 78%, respectively). This result is in line with our expectations, as specialisation adjustments in agriculture are considerably constrained by rural structural market imperfections as well as by agronomic

reasons, such as crop rotation. The most sizeable differences in the test performance between the total and the agricultural trade can be observed for the CEE (72% and 48%, respectively). These results provide an indirect evidence, that the agricultural trade in the CEE is different both with respect to the total trade in the CEE and with respect to the agricultural (and total) trade in the EU.

One general conclusion that we can draw from the Ricardian sign statistics is that the factor content of bilateral agricultural trade between the old EU member states (EU-15) reflects cross-country technology differences considerably better than agricultural trade between the CEE countries. Second, in line with our expectations, the sign test results reported in table 7 suggest that the underlying technology differences model performs considerably better for the total trade than for the agricultural trade. One reason is that by focusing on the agricultural trade only, we are neglecting the inter-sectoral specialisation between agriculture and manufacturing. Another reason is that the specialisation adjustments in agriculture may be more constrained by transaction costs as well as by agricultural specific agronomic reasons, such as crop rotation. Generally, these results are in line with previous studies analysing the factor content of bilateral trade, e.g., Choi and Krishna (2004); Lai and Zhu (2007); Kancs and Ciaian (2010), who report the sign test statistics between 0.82 and 0.96 for the aggregate trade.

6.2 Relative Factor Abundance

The hypothesis of the relative factor abundance says that exports of the capital-abundant countries embody a higher capital labour ratio than exports of the labour abundant countries. In order to empirically test the role of the Heckscher-Ohlin endowment differences, $HO_{od} \geq 0$, empirical data for factor prices and factor use is required, i.e.: (i) labour wages and capital rental rates for each country; and (ii) the amount of capital and labour embodied in each country's exports (see Kancs and Ciaian, 2010a).

We test the relative factor abundance hypothesis for two factors: labour and capital[10]. Column 1 in table 8 reports the obtained sign

[10] In the present study land and all other non-labour inputs are part of the composite factor 'capital'. Kancs and Ciaian (2010) extend the standard two factor version of the HO model by explicating land as a separate factor of production

statistics for the factor content of agricultural trade, which is defined as the percentage of country pairs that satisfy $HO^{A}_{od} \geq 0$. Column 2 reports the same statistics for the total trade, HO^{T}_{od}.

TABLE 8 - *Relative Factor Abundance and Factor Content of Bilateral Trade*

	$HO^{A}_{od} \geq 0$	$HO^{T}_{od} \geq 0$	Obs
	(1)	(2)	(3)
EU-25 (full sample)	0.80	0.87	300
	(0.01)	(0.01)	
EU-15 (capital-abundant)	0.83	0.89	105
	(0.02)	(0.01)	
CEE (labour abundant)	0.52	0.76	45
	(0.13)	(0.10)	
EU-15 - CEE	0.74	0.88	75
	(0.03)	(0.02)	

Notes: Sign test results; p-values in parenthesis; $HO^{A}_{od} \geq 0$ test refers to agricultural trade; $HO^{T}_{od} \geq 0$ test refers to the total trade.

The sign statistics reported in table 8 suggests that the hypothesis $HO^{A}_{od} \geq 0$ is satisfied for 80% of the EU-25 country pairs. The p-value of the sign test is below 0.01, which means that the probability of having $HO^{A}_{od} \geq 0$ for more than 80% of the time is less than 1%. Thus, the hypothesis $HO^{A}_{od} \geq 0$ performs rather well for the EU-25 country pairs. The test statistics is even higher for the EU-15, where the hypothesis $HO^{A}_{od} \geq 0$ is satisfied for 83% of bilateral trade flows of agricultural goods and is significant at the 2% significance level. The test performance is considerably lower for the CEE, where the hypothesis $HO^{A}_{od} \geq 0$ is satisfied only for 52% of bilateral trade flows. Moreover, the results are considerably less significant. The sign statistics reported in table 8 also suggests that the test performance is quite good (74%) for the bilateral trade between the capital-abundant EU-15 and the labour-abundant CEE countries.

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for analysing the factor content of agricultural trade in a generalised three factor model. They find that the endowment of land and the quality of land are important determinants of the factor content of agricultural trade. However, they do not change the empirical results significantly, if land is accounted for in the composite factor 'capital'.

The sign statistics for the total trade reported in column 2 suggest that $HO_{od}^{A} \geq 0$ is satisfied for 87% of the EU-25 country pairs, which is higher than for the agricultural trade. Also for the EU-15 the sign test performance is higher for the total trade than for the agricultural trade (89% and 83%, respectively). This result is in line with our expectations, as specialisation adjustments in agriculture are considerably constrained by rural structural market imperfections and agronomic reasons. The most sizeable differences in the test performance between the total and the agricultural trade can be observed for the CEE (76% and 52%, respectively). Again, these results provide an indirect evidence, that the agricultural trade in the CEE is different both with respect to the total trade in the CEE and with respect to the agricultural (and total) trade in the EU.

The results reported in table 8 allow us to draw similar conclusions as in previous section. First, the factor content of bilateral trade between the old EU member states (EU-15) reflects the country relative factor abundance predicted by the underlying relative factor endowment model considerably better than agricultural trade between the CEE countries. Again, these results are in line with previous studies analysing factor content of bilateral trade, e.g., Choi and Krishna (2004); Lai and Zhu (2007); Kancs and Ciaian (2010). As for the Ricardian technology differences, the underlying relative factor endowment model performs considerably better for the total trade than for the agricultural trade. The two key reasons for differences in the test performance are that by focusing only on the agricultural trade we are neglecting the inter-sectoral specialisation between agriculture and manufacturing, and the specialisation adjustments in agriculture are generally more constrained by transaction costs and agronomic reasons.

7. Conclusions and policy implications

The objective of the present paper was to examine the factor content of the CEE transition country agricultural trade. In addition, the paper attempts to identify the potential role of transaction costs and market imperfections in farm organisation and trade specialisation. It is one of the first attempts: (i) to examine factor content in the CEE agricultural trade; and (ii) to examine how transaction costs and market imperfections may affect the relative factor content of the CEE agricultural trade.

Drawing on the COMEXT, GTAP and FADN data for 2004 we

found that there are differences in factor content of agricultural trade between individual CEE countries and between CEE and old EU member states. At the country level factor content between exports and imports is rather similar in the CEE agricultural trade flows. In both exports and imports the largest factor share is represented by capital, which on average accounts for 49% of imports and 59% of exports. These results are new and have not been reported for CEE in the literature before.

Analysing the potential role of transaction costs and market imperfections, we found some evidence that transaction costs and market imperfections may indeed co-determine farm organisation and sectoral specialisation, and hence factor content in agricultural goods. Our empirical findings suggest that when controlling for endowments (in terms of labour/capital endowment ratio), farm organisation is an important determinant of factor content of agricultural trade. Therefore, farm structure co-determines the type of products (in terms of labour/capital intensity) CEE countries export and import. Higher share of IF in land use implies higher share of labour content of exports and imports. However, these first results need to be verified econometrically, in order to draw general conclusions about the relationship between factor content in production and trade, and transaction costs in farm organisation and sectoral re-specialisation. Our results suggest that this is a promising avenue for future research and should be followed in future, when the required data for formal tests of the role of transaction costs and market imperfections become available.

On the basis of these results we derive two potential policy implications. First, in the presence of significant transaction costs and hence rigid farm structure, certain agricultural subsidies may be efficient in some countries, while inefficient in others, depending on the cross-country variation in farm structure. For example, before Slovakia joined the EU, the government granted farmers investment subsidies for horticulture. However, such policy is not efficient in the context of Slovakia where CF dominate the agricultural production and transaction costs of reorganising farm structure are considerable, because CF do not have competitive advantages in horticulture. A considerably more efficient policy would be to tackle transaction costs facilitating farm organisation adjustment.

Second, the existence of transaction costs of farm reorganisation may provide one explanation of variation in protection implemented across regions within CEE countries. Given that the marginal benefit of lobbying is decreasing in firm productivity, the political

demand for protection may emerge for inputs or outputs in which farms are less competitive. Given that different types of farms have different competitive advantage in terms of labour/capital ratio and CEE countries are heterogeneous in terms of farm organisation, the demand for protection will vary across countries particularly with liberalisation of markets caused by the EU accession. Countries with high share of CF will demand protection for labour intensive products, whereas IF dominant countries will demand protection for capital intensive products. These issues need to be accounted for in designing future agricultural policies in the enlarged EU as well as in other countries.

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ABSTRACT

The paper studies the determinants of the factor content in the EU foreign trade. The theoretical model relaxes several important assumptions such as factor price equalisation and introduces technological differences in the standard Heckscher-Ohlin model. Based on the agricultural production and trade data for the Central and East European (CEE) EU member states, we examine empirically three hypothesis, which relate cross-country differences in technology, relative factor abundance and transaction costs and market imperfections to the factor content of trade, we find that the first two hypotheses are confirmed by the majority of the developed EU countries, but rejected by roughly one half of the CEE transition country pairs. Second, we find that when accounting for transaction costs of farm (re)organisation, both hypotheses are confirmed by the majority of the CEE country pairs. These findings provide empirical evidence of market imperfections, and particularly, of transaction costs of farm (re)organisation in the CEE.

Keywords: Factor Content, Bilateral Trade, Relative Factor Abundance, Technological Differences, Agriculture, Transaction Costs

JEL classification: D23, F12, F14, R12, R58

RIASSUNTO

Vantaggi comparati, costi di transazione e contenuto dei fattori nel commercio agricolo: evidenze empiriche dai paesi dell'Europa centro-orientale

Questo lavoro esamina le determinanti del contenuto dei fattori nel commercio estero dell'Unione Europea. Il modello teorico tralascia postulati importanti come l'equalizzazione del fattore prezzo e introduce differenze tecnologiche nel modello standard Heckscher-Ohlin. Basandosi sui dati della produzione agricola e del commercio dei paesi comunitari dell'Europa centro-orientale, lo studio esamina empiricamente tre ipotesi che mettono in relazione le differenze *cross-country* nella tecnologia, l'abbondanza relativa dei fattori, i costi di transazione e le imperfezioni del mercato con il contenuto dei fattori del commercio. Si riscontra che le prime due ipotesi sono confermate per la maggioranza dei paesi UE sviluppati, mentre per circa la metà dei paesi comunitari in transizione dell'Europa centro-orientale devono essere rifiutate. Inoltre, spiegando i costi di transazione della riorganizzazione agricola, si riscontra che entrambe le ipotesi sono confermate per la maggioranza delle coppie di paesi comunitari dell'Europa centro-orientale.

Questi riscontri forniscono evidenze empiriche di imperfezioni del mercato e, in particolare, dei costi di transazione della (ri)organizzazione agricola nell'Europa comunitaria centro-orientale.