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d'Artis Kancs, Pavel Ciaian and Jan Pokrivcak

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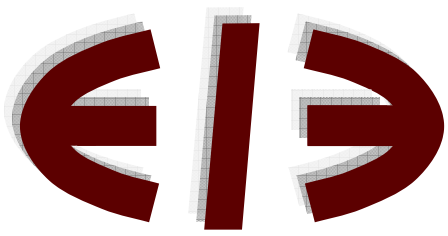

EERI
Economics and Econometrics Research Institute
Avenue de Beaulieu
1160 Brussels
Belgium

Tel: +322 299 3523
Fax: +322 299 3523
www.eeri.eu

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Abstract

The present study examines factor content of the CEE transition country agricultural trade. We examine the relative country abundance for labour, capital and land, and test the Heckscher-Ohlin-Vanek (HOV) hypothesis. Our empirical findings suggest that the factor content of agricultural exports and imports is rather similar in CEE and most of the agricultural trade flows do not satisfy the HOV prediction. In order to explain the general lack of agricultural specialisation and the observed paradox in the CEE's agricultural trade, we examine the role of transaction costs and market imperfections. We find that transaction costs and market imperfections distort farm specialisation and hence factor content of agricultural trade.

Keywords: Factor Content, Agricultural Trade, Comparative Advantages, Transaction Cost.

JEL classification: F12, F14, D23, Q12, Q17.

1 Introduction

Relative factor endowment models continue to play a prominent role in international trade literature. There are two principal reasons why one of the key objectives of international economic research has been to account for the factor content of trade. The first is that economists want to trace the effects of international influences on relative and absolute factor prices within a country. The Heckscher-Ohlin (HO) model and its variants, with their emphasis on trade arising from differences in the availability of productive factors, provide a natural setting for such investigations (*Davis* and *Weinstein* 2001).

The second reason for the focus on the factor content of trade is that it provides a precise prediction against which to measure how well the trade models work. The

relative factor endowment models are extraordinary in their ambition. They propose to describe, with but a few parameters and in a unified constellation, the endowments, technologies, production, absorption, and trade of all countries in the world. This juxtaposition of extraordinary ambition and parsimonious specification have made these theories irresistible to empirical researchers (*Davis* and *Weinstein* 2001).

Complementing previous empirical studies of factor content of aggregate developed country trade, the present paper estimates factor content of the CEE agricultural trade.[1] More precisely, we test the hypothesis relating the relative country endowment and technology advantages to the factor content of agricultural trade: whether agricultural exports of countries with comparative advantages in labour intensive products contain lower capital/labour ratio than agricultural exports of countries with comparative advantages in capital intensive products.

In contrast to most studies in past, which mostly examine factor intensities in the developed country manufacturing trade, in this paper we test if the CEE's agricultural trade follows the trade pattern suggested by the HO's relative factor endowment theory. Furthermore, since our focus is on the CEE's agricultural trade, in light of technological differences arising from the dual farm structure, we attempt to identify the role of transaction costs in the CEEs' specialisation pattern. Our focus on CEE is motivated by the recent systemic change taking place in CEE, which offers a natural experiment for studying country specialisation and factor services in trade. Our focus on factor content of agricultural trade is motivated by the fact, that agricultural sector is considerably more important in CEE than in developed market economies.

The second peculiarity of CEE relates to farm specialisation. In developed market economies the pattern of specialisation is fully determined by inter-industry differences in the expected profits (if we abstract from strategic considerations of firms). This is entirely different in centrally planned economies, where firm specialisation is largely determined by central planners. The Central and Eastern Europe during the Soviet period was a great example of a system-wide central planning, where the central planning process has led to a high and arbitrary degree of regional division of labour and regional specialisation (*Swinnen* 1999; *Lerman et al* 2002).

The centrally planned pattern of regional specialisation became unsustainable, when the transition to market economy started. Facing hard budget constrains the formerly state-subsidised farms became unprofitable under free market conditions and had to be restructured and reorganised. Transition process in agriculture involved privatisation of agricultural recourses and farm restructuring. The predominant form of privatisation of agricultural land and other assets in CEE countries was restitution to former owners (*Swinnen* 1999; *Lerman* 2001). The privatisation process was followed by farm restructuring. 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 family farms that were significantly smaller in size than cooperatives, but

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

comparable to their Western European or American counterparts. However, not all cooperative farms broke up into family farms. Some cooperatives were transformed into corporate farms. In these cases old socialist cooperatives were turned into cooperatives of new owners of agricultural assets (including land), joint-stock companies, limited-liability companies or partnerships (*Swinnen* 1999).

The adjustment in farm organisation is constrained by significant transaction costs, as the transition process did not succeed to eliminate all constrains in adjusting farm organisation. According to *Ciaian* and *Swinnen* (2006), there still exist significant transaction costs in farm organisation adjustment in CEE. For example, the new land owners face significant transaction costs if they want to withdraw their land from former cooperative farms and relocate it. The transaction costs of farm reorganisation include costs involved in bargaining with farm management, in obtaining information on land and tenure regulations, in implementing the delineation of the land and dealing with inheritance and co-owners etc. (*Swinnen* 1999; *Prosterman* and *Rolfes* 2000; *Ciaian* and *Swinnen* 2006).

These findings suggest that the current specialisation pattern of former centrally planned farms largely depends on farm ability to reorganise their production form and farm structure. The farm ability to reorganise in turn depends on transaction costs and expected profits from the reorganisation. According to *Swinnen* (1999), the transaction costs are heterogenous across and within CEE and are largely determined by differences in political priorities, and hence are exogenous to firms. Hence, we expect that the soviet-period farm organisation, market imperfections and transaction costs of farm re-organisation would distort the profit maximising specialisation pattern of agricultural farms in CEE.

Drawing on the the methodology from the empirical trade literature and the theory of agricultural transition, 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.

The paper is organised as follows. Section 2 introduces the theoretical framework which is the basis for calculating factor content of trade in literature and the present study. Section 3 provides a brief overview of previous empirical studies on factor content of trade. Section 4 presents the empirical evidence of relative factor endowment and cross-country technology differences driven by differences in farm organisation in CEE. We derive the empirical hypothesis relating the CEE country comparative advantages in agriculture and factor content of agricultural trade. In section 5 we examine factor intensities of the CEE agricultural trade and test the HOV prediction. We also attempt to identify the role of transaction costs and market imperfections in determining farm specialisation and the pattern of agricultural trade. Section 6

concludes and outlines avenues for future research on factor content of agricultural trade.

2 Theoretical framework

In this section we outline the theoretical framework which is commonly used in previous and also in the present study for examining the factor content of foreign trade. According to the neo-classical general equilibrium models of international trade, countries and regions trade with each other because of their differences or due to economies of scale. Ricardian model of international trade (*Ricardo* 1817) states that differences in technology between trading partners determine trade pattern while Heckscher-Ohlin model states that countries trade because of differences in relative factor endowments.

The standard multifactor, multicommodity, and multicountry model for predicting factor content of trade is the Heckscher-Ohlin-Vanek (HOV) model. The key assumptions of the HOV model are identical technologies, and identical and homothetical preferences across countries; differences in factor endowment, free trade in goods and services and no factor intensity reversals. The HOV suggests that if all countries would have their endowments within their core of diversification, then factor prices were equalised across countries.

The HOV model relates factor content of trade to the relative country endowment with production factors and can be described as follows. Assume that $r = 1, ..., R$ index regions/countries, $i = 1, ..., I$ are industries; and $f = 1, ..., F$ index factors. Let $A = [a_{if}]'$ be the amount of production factors used to produce one unit in each industry, where rows of the A matrix index factors and columns industries. Matrix A_t measures the total factor demand, i.e. direct factor demand plus indirect factor use. According to *Deardorff* (1984), in the case of more traded goods than factors, the total factor intensities are important for explaining the trade flows. To see this we post-multiply the direct factor demand matrix, A_d, by the *Leontief*'s inverse, $(I - B_r)^{-1}$:

$$A_r = A_{rd} (I - B_r)^{-1} \tag{1}$$

where I is the identity matrix and B_r is the technical coefficient matrix (B_r matrix) computed from the region/country r's input-output table.

Let Y_{ir} be the $(I \times 1)$ vector of each industry i's input and let D_{ir} be the $(I \times 1)$ vector of demand for each good. The net export vector of goods, T_r, originating from region/country r can then be written as:

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

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

$$F_r = A_r T_r \tag{3}$$

Identical technologies across countries and factor price equalisation imply that $A_r = A$, which makes the interpretation of $F_r = AT_r$ straightforward: 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 endowment of factor f in region/country r. With factor price equalisation, free trade and identical homothetic preferences across region/countries, region/country c's consumption vector must be proportional to the total world consumption:

$$D_r = s_r D_w \tag{4}$$

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

$$AD_r = s_r AD_w = s_r AY_w = s_r V_w \tag{5}$$

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

$$F_r \equiv AT_r = V_r - s_r V_w \tag{6}$$

The left hand side of equation (6) 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 (6) captures the consumption/demand and is often referred to as the predicted factor content of trade. For factor f the equation (6) can be rewritten as:

$$F_{fr} = V_{fr} - s_r V_{fw} \tag{7}$$

Equation (7) 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 region/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.

3 Previous studies

Two strands of trade literature contribute to a better understanding of factor content of agricultural trade in CEE. In section 3.1 we summarise the key literature findings from the factor content studies and relative endowment models. Given that there is no literature on factor content of agricultural trade in CEE, in section 3.2 we review the key literature findings from general trade literature on CEE.

3.1 Factor content of trade

In this section we summarise the key findings from previous empirical trade studies and discuss their implications for the present study. *Leontief* (1954) provides one of the first attempts to examine the HO theory empirically.[2] *Leontief* found that the U.S. (the most capital-abundant country in the world by any criteria) exported labour-intensive commodities and imported capital-intensive commodities, in contradiction with HO theory.[3] Hence, Leontief Paradox undermined the validity of the HO theorem, which predicted that trade patterns would be based on countries' comparative advantage in certain factors of production (such as capital and labour).

The Leontief Paradox has generated a huge literature in the subsequent years. Empirically, the HOV theorem has frequently been rejected for US and other developed economies in favour of statistical hypotheses such as a zero correlation between factor endowments and trade patterns (see *Davis* and *Weinstein* 2001 for an overview). The widespread view of nineties was well summarised by *Leamer* and *Levinsohn*'s (1995) appraisal of the empirical performance of factor endowment theories: *'It is more convenient to estimate the speed of arbitrage rather than test if the arbitrage is perfect and instantaneous'.*

Theoretically, *Leontief*'s methodology has been criticised along many lines (see e.g. *Schott* 2003 for an overview). In the context of factor content of agricultural goods' trade one of the main objections to *Leontief*'s methodology might be that *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) 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.

Summarising findings from the previous studies we may draw several conclusions important for the present study. First, as the *Leontief*'s original study itself, most of the factor content studies to date have been applied to developed countries, because

[2] Although, the *Leontief*'s attempt cannot be classified as a formal test of the HOV theorem, he provides one of the first attempts to examine the HO theory empirically.

[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 %.

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. The works by *Schluter* and *Lee* (1978) and *Lee*, *Wills* and *Schluter* (1988) are among the few exceptions. 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 study attempts to address all three issues of the previous studies. First, this study 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 Relative factor intensities in the CEE trade

A general finding of the existing CEE literature is that factor content of the CEE trade has been changing since the beginning of transition (e.g. *World Bank* 2005). Both, merchandise exports and imports are more skilled labour and capital intensive in 2003 than they were in 1996. Specialisation in many CEE countries is becoming more skilled labour and capital intensive (*Landesmann* and *Stehrer* 2002, *Woerz* 2003). *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.

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

has comparative advantage in labour intensive industries.

Worz (2005) studies 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.[4]

A significant feature of CEE's trade integration into the European and world markets was a rapid growth of IIT. At the beginning of transition IIT trade of CEEs and EU15 was in the range of 20-50 percent 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) (*Fidrmuc*, 2005). *Janda* and *Munich* (2004) note that the Czech industries with high share of IIT employ high percentage of low-educated labour. On the other hand, industries with low share of IIT employ low percentage of low-educated labour and are mainly net importers. Czech imports correspond to higher technology goods whose production requires a large share of capital and a highly educated labour. The scarcity of capital in the Czech Republic could be considered as a reason for high net imports in these industries.

Ferto (2005) is one of the few studies investigating IIT in agriculture. He examines the relationship between the factor endowment and the pattern of intra-industry trade with agricultural products. *Ferto* distinguishes between horizontal and vertical product differentiation. For the trade between Hungary and EU countries vertical product differentiation is find 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 EU15 implies that there are adjustment costs related to reallocation of factors of production during integration of CEE into the EU.

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 intra-industry trade (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 and comparing 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.

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

4 Production technology and relative factor endowment in CEE

In this section we present the empirical evidence of farming sector and agricultural trade in CEE. In particular, we examine two key drivers of agricultural trade: (i) relative factor endowment; and (ii) differences in production technology.[5] In section 3.4 we summarise the key findings of the CEEs' relative comparative advantages, which allow us to derive the empirical hypothesis. As usual, we begin with introducing the data we use.

4.1 Data

In the empirical analysis of factor content of trade we use data for 2004. The agricultural trade data is extracted from the COMEXT trade data base *Eurostat* (2007) and GTAP 7 data base. The COMEXT data base provides data for Member States of the European Union 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 U.S.A., 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 like CN, SITC Rev2, SITC Rev3 etc).

In addition to the bilateral trade flows, the GTAP Data Base provides national input-output flows in CEE and data for macroeconomic variables such as consumption, GDP, etc. The advantage of the GTAP Data Base compared to EU member countries' trade in the COMEXT Data Base is that it is a global data base representing the world economy.

The TFP estimates are based on a two year (2004 and 2005) firm-level panel data from the Farm Accountancy Data Network (FADN). The annual sample of FADN covers approximately 80.000 agricultural farms. In 2004 they represented a population of about 5.000.000 farms in the 25 Member States, covering approximately 90% of the total utilised agricultural area (UAA) and accounting for more than 90% of the total agricultural production of the EU. In the present study we make use of a panel data for 8 CEE economies covering two years - 2004 and 2005. The unbalanced panel contains 37416 observations: 34851 for IF and 2565 for CF. In the sample 827 CF farms and 10012 IF are represented in both years. Although, the CF amount only to 6.86% of the total number of farms in our sample, they cultivate almost half of the total UAA in CEE.

In order to reveal sectoral differences in production, trade and demand, we disaggregate agricultural sector in eight sub-sectors, which are summarised in Table 8

[5] Other often studied sources of comparative advantage are tastes, size (with increasing returns), market structure (with imperfect competition), location (with trade costs), and initial conditions (agglomeration).

in the Annex. In order to account for international differences in production and demand, we disaggregate CEE into eight countries (Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia).

4.2 Farm organisation and production technology

The *Ricardian* theory of international trade suggests that in order to exploit their comparative advantages, countries specialise in producing what they produce best. In other words, inter-industry differences in production technology determine the specialisation pattern of regions and countries.[6] Among other factors, the *Ricardian* gains from specialisation and trade depend on how big are inter-industry differences in production technology and how large are international (inter-regional) technological differences. Hence, in this section we explore both the relative and absolute technological differences in turn.[7]

In Western Europe, North America and other developed countries, where agricultural sector is dominated by relatively small and, compared to CEE, homogenous family farms input and output markets are functioning well and transaction costs of adjusting farm organisation are relatively low, the inter-regional and international variation in production technology is little affected by farm organisation (*Jensen* and *Meckling* 1976; *Pollak* 1985; *Schmitt* 1991, *Allen* and *Lueck* 1998). Hence, if farms can straightforwardly adjust their organisation and production structure according to changed market conditions, a given farm organisation little constrains firm specialisation. This is usually the case in developed market economies.

A distinctive difference of the CEE's agriculture is heterogeneity in farm organisation and significant market imperfections, which heavily affect farm production technology (*Swain* 1999; *World Bank* 1999; *Dale* and *Baldwin* 2000; *Rozelle* and *Swinnen* 2004; *Ciaian* and *Swinnen* 2006). As a result, because of often prohibitive farm reorganisation costs, the agricultural sector in the CEE transition countries is characterised by a dual farm structure (*Lerman et al* 2004; *Rozelle* and *Swinnen* 2004).[8] Some regions and countries are dominated by large corporate farms (CF), whereas in other regions and countries small individual farms (IF) cultivate most of

[6] In the present study the terms industries and activities are used as synonyms. Hence, inter-industry differences denote differences between agricultural activities, such as milk, grain, horticulture, etc.

[7] Generally, the production technology at firm level is determined by many factors (see e.g. *Jensen* and *Meckling* 1976). However, in the present study we particularly focus on farm organisation and deliberately abstract from other determinants of production technology.

[8] The dual farm structure is undoubtedly one of the specific features of agriculture in CEE. This holds with regard to the farm size – the CEE countries have both many small farms, which are often subsistence or part-time-oriented, and very large enterprises. The duality is also observed in farm size: IFs are relatively small and CFs are relatively big. In addition, land use fragmentation is another dual characteristic of the CEE's agriculture. Usually, the large holdings cultivate considerable lot sizes, while small IFs operate on very small and scattered plots, which often are too small and far away to efficiently use large machinery.

the land. These cross-country differences in the CEE farm organisation are summarised in Table 1, which reports percentage shares of land cultivated by IFs and their share in the total agricultural output. The last column of Table 1 reports the average farm size in hectares.

Table 1: Farm organisation and size in CEE in 2004

	IF share land %	IF share output %	Average farm size ha
Czech Republic	11.8	19.5	250.1
Estonia	63.5	48.9	119.6
Latvia	55.2	63.9	64.0
Lithuania	77.4	83.8	42.5
Hungary	36.2	47.5	53.2
Poland	94.5	96.2	15.8
Slovenia	99.9	99.9	12.7
Slovakia	10.8	13.6	535.5
CEE	56.16	59.16	136.68

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

The figures reported in Table 1 suggest sizeable differences in farm organisation across the CEE transition economies. According to columns 2 and 3, Slovenia and Poland have the highest share of IFs in both land use and in agricultural output. In contrast, Slovakia and the Czech Republic have the lowest share of IFs.

Table 1 confirms the evidence documented in the previous literature that the share of IFs is negatively and strongly correlated with the average farm land size (e.g. *Pollak* 1985; *Allen* and *Lueck* 1998). Countries with relatively high share of CFs (low share of IFs), e.g. the Czech Republic and Slovakia, have considerably larger farms than countries with high share of IFs (e.g. Slovenia and Poland). Given that cultivating 12 or 15 ha land, as in Slovenia and Poland, requires a considerably different technology than cultivating 535 ha land, as in Slovakia, both farm organisation and size co-determine the production technology in CEE.

Table 1 also suggests that, on average, the IF share in land use is lower than the IF share in output (compare columns 2 and 3). This can be explained by the fact that, on average, IFs tend to specialise in more labour intensive products, which are also more cost intensive and hence have a higher value per hectare of cultivated land and physical output unit compared to CFs. For example horticulture, the production of which is dominated by IFs, has a considerably higher value per output unit and the cultivated land hectare than cereals and oilseeds, the production of which is dominated by CFs.

In terms of farm specialisation and factor content of agricultural trade, the share

of IFs and CFs is important, if relative factor requirements in producing the same product are different between the two types of farms, i.e. they use different technologies. According to *Pollak* (1985) and *Allen* and *Lueck* (1998), one of the key distinctive differences in production technology between IFs and CFs is the relative labour and capital intensity. Indeed, several studies, which have evaluated the production technology of individual farms and corporate farms, have found significant differences in the relative labour/capital intensity (e.g. *Pollak* 1985; *Allen* and *Lueck* 1998). On average, IFs tend to use less capital compared to CFs, whereas CFs tend to use less labour compared to IFs in producing the same product.

According to *Pollak* (1985); *Allen* and *Lueck* (1998), These farm-type differences in labour/capital intensity are largely determined by differences in the relative factor costs and factor productivity. In terms of labour, usually, IFs face lower labour costs. Given that farmer is the residual income claimant, IFs do not suffer from moral hazard problem, which is an important issue in CFs (*Schmitt* 1991). This leads to higher labour productivity in IFs compared to CFs. On the other hand, labour productivity of IFs might be hindered by lack of labour specialisation, which reduces marginal product of labour. Most of the previous studies find the former effect is larger than the latter (*Pollak* 1985; *Allen* and *Lueck* 1998).

In terms of capital, usually IFs face higher per-unit capital costs. Because of missing collateral, IFs are more credit constrained than CFs, and in the presence of fixed capital transaction costs, IFs face higher per-unit capital costs than CFs. Moreover, capital productivity of IFs is often lower compared to CFs because of sub-optimal production scale and underemployment of fixed farm equipment and machinery (*Pollak* 1985; *Allen* and *Lueck* 1998). Hence, large CFs tend to have higher marginal productivity of capital than small IFs.

In order to gain the empirical evidence about farm-type productivity differences, we estimate Total Factor Productivity (TFP) for IF and CF. The TFP estimates are based on a two year (2004 and 2005) firm-level panel data from the FADN. The unbalanced panel contains 37416 observations for CF and IF. The distinction between IF and CF is done using variable A18 (organisational form), which is also provided for in the FADN data.

We apply the *Olley* and *Pakes* (1996) estimator, which allow to address the simultaneity and selection problems while estimating the production function parameters and firm-level productivity. The simultaneity problems are addressed by using investment to proxy for an unobserved time-varying productivity shock, and the selection problems are addressed by using survival probabilities. The *Olley* and *Pakes* estimator is implemented in STATA using command *opreg*.

The obtained TFP estimates by sector and farm type together with capital/labour ratio in farm output are reported in Table 2. The first column reports sectors. Columns $(K/L)_I$ and $(K/L)_C$ report capital/labour ratio in IF and CF output, respectively. TFP_I and TFP_C are TFP estimates for IF and CF, respectively. The last two columns - $(K/L)_I / (K/L)_C$ and TFP_I/TFP_C report the relative factor intensity

Table 2: TFP and capital/labour intensity in sectoral output by farm type in 2004

Sector	$(K/L)_I$	TFP_I	$(K/L)_C$	TFP_C	$\frac{(K/L)_I}{(K/L)_C}$	$\frac{TFP_I}{TFP_C}$
13	3789.7	0.6331	6266.2	0.8561	0.60	0.74
14	3433.2	0.7030	3651.6	0.7374	0.94	0.95
20	3173.6	0.7338	3350.3	0.7301	0.95	1.01
31	3417.6	0.7167	4192.2	0.7848	0.82	0.91
32	4003.6	0.5430	4175.6	0.7643	0.96	0.71
33	4872.9	1.0000	na	na	na	na
34	2246.1	0.8475	2654.8	0.6623	0.85	1.28
41	2543.7	0.7451	2731.0	0.6792	0.93	1.10
42	2500.4	0.7516	4445.2	0.8354	0.56	0.90
43	2200.0	0.8509	2261.2	0.5786	0.97	1.47
44	2311.4	0.7969	4049.8	0.7396	0.57	1.08
50	2950.3	0.7388	2974.0	0.7208	0.99	1.02
60	2355.8	0.7673	2734.0	0.6885	0.86	1.11
71	1751.8	0.8632	2483.9	0.5786	0.71	1.49
72	1983.4	0.8551	4619.3	0.8384	0.43	1.02
81	2383.2	0.7582	2628.6	0.6501	0.91	1.17
82	2575.2	0.7421	2826.2	0.7203	0.91	1.03

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, TFP_I, TFP_C-TFP estimates for IF and CF, respectively, $(K/L)_I / (K/L)_C$-relative factor intensity of IF compared to CF, TFP_I/TFP_C-TFP ratio.

of IF compared to CF and TFP ratio.

The results reported in Table 2 suggest a considerable inter-sectoral and farm-type variation in the capital/labour intensity in farm output. Generally, IF tend to be more productive than CF when the capital labour ratio is small (labour share is large). The opposite holds for CF. However, the capital labour ratio seems not to be the only determinant of farm TFP. For example, sectors 41 (dairying) and 14 (root crops and technical crops) have nearly the same capital/labour ratio in IF and CF output (0.93 and 0.94), but significant differences in farm-type TFP ratios (1.10 and 0.95). According to our estimates, in milk sector IF are more productive than CF, whereas the opposite holds for root and technical crops.

The relative factor intensity estimates reported in column $(K/L)_I / (K/L)_C$ suggest that in the CEE transition countries IFs tend to use more labour in all agricultural activities - the share of labour/capital ratio is higher for IFs in all activities. Column $(K/L)_I / (K/L)_C$ also suggests that farm-type technological differences are rather heterogenous across agricultural activities. The most sizeable technological

differences in terms of factor use are estimated for sector 72 (mixed livestock), where the relative capital labour content in IF output amounts only to 43% of CF output. Most of IF belonging to this category are weakly specialised semi-subsistance farms. In contrast, pig and poultry production is nearly equally capital intensive - IF output contains 2950.3 EUR capital per worker and CF output contains EUR capital per worker 2974.0. These results are broadly in line with previous literature on farm-type differences in production technology (e.g. *Pollak* 1985; *Allen* and *Lueck* 1998).

The *Ricardian* theory of international trade suggests that, in presence of market imperfections and significant transaction costs of adjusting farm organisation, technological differences would lead to different specialisation patterns between IF-dominated and CF-dominated regions, and hence magnify the cross-regional differences in factor content of agricultural output and trade: IF-dominated regions would specialise in labour intensive goods, whereas CF-dominated regions would specialise in capital intensive goods.

Hence, in the presence of market imperfections and prohibitive transaction costs of changing farm organisation, we would expect that countries with high share of IFs (Slovenia and Poland) would produce and export relatively labour intensive products and import products with relatively high capital content. In contrast, if all other conditions were equal, we would expect that countries with high share of CFs (Slovakia and Czech Republic) would produce and export relatively more capital intensive goods and import relatively more labour intensive goods.

4.3 Relative factor endowment

The HO theory of international trade suggests that in order to exploit their comparative endowment advantages countries should produce and export goods that utilise their abundant factor(s) of production and import products that utilise the countries' scarce factor(s).[9] In this section we examine differences in factor endowment across CEE. Indeed, several studies have found that differences in resources, rather than differences in technology (e.g. *Debaere* 2003), are among the most important determinants of country comparative advantage. Hence, we begin by examining the relative CEE's endowment with primary factors.[10]

First, we calculate the relative endowment with primary production factors comparing different factors. The standard approach of comparing the relative country endowments is to consider factor ratios, although there is no preferred combination of factors in forming these ratios. Table 3 reports absolute land and capital endowment for each CEE country. Land endowment is measured in hectares of agricultural land

[9] Although, similarities across countries can also promote trade. Indeed, volume of trade amongst 'similar' countries is greater than volume amongst 'very different' countries. Nevertheless, country 'differences' rather than 'similarities' are usually assumed as a more fundamental reason for trade.

[10] Generally, country endowment advantages capture many more variables than the three primary production factors. We focus on these three because the main focus of the present study is labour/capital and land endowment and content in agricultural goods.

per capita. Capital endowment is measured in thousands of Euros per agricultural worker. In addition to factor ratios, we also include a relative measure of agricultural labour force. Labour force is proxied by the share of agricultural employment in the total employment in 1990. We include this additional proxy for agricultural labour force for two reasons: (i) it is highly correlated with the unobservable agricultural labour endowment;[11] and (ii) it is highly exogenous, i.e. it is not determined by farm labour demand in 2004.[12] Moreover, those workers which worked in agriculture until the nineties 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 (*Csaki* and *Lerman* 1996).[13]

Table 3: 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.

The figures reported in Table 3 suggest a substantial cross-country variation in endowment with primary production factors. According to Table 3, the most land abundant countries are Lithuania and Latvia with 0.76 and 0.71 hectare of agricultural land per capita, respectively. In contrast, the least land abundant country Slovenia has only 0.25 hectare of agricultural land per capita.

[11] 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.

[12] 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.

[13] Although, a certain share of them have left the rural regions, worker decision to leave is an endogenous process largely driven by wage differences and employment opportunities. Hence, the current agricultural employment share cannot be considered as a measure of exogenous comparative advantages.

Table 3 also suggests sizeable differences in the relative endowment with capital (column 3). The lowest ratio of capital per agricultural worker is in Lithuania (2929); the highest in Slovenia (6540). These capital endowment figures are in line with findings of previous studies that capital/labour ratio is increasing in GDP per capita (*Davis* and *Weinstein* 2001) - per capita 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 Table 3. The smallest agricultural employment share in 1990 was in Slovenia - 8.4%. This can be explained by the fact that Slovenia was (and still is) the most developed country (Yugoslav Republic) among all CEE economies in our sample. Also the Czech Republic and Slovakia are agricultural labour scarce countries compared to the rest of the CEE. The most farm labour abundant country is Poland, where in 1990 more than one quarter of all economically active workers were employed in agriculture.

Next, we calculate the relative factor abundance by comparing factor endowment shares with Gross Agricultural Output (GAO) shares among the CEE countries, as these estimated will be required for the HOV test. The relative factor abundance is defined as follows: if region/country r's endowment with factor f relative to 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. Both GAO and factor endowment shares are calculated with respect to the CEE, not the world endowment, as done usually in the literature. By selecting a homogenous group of CEE transition countries we hope to address the issue that all our sample countries rightly fit into the group - because they satisfy the HOV theoretical requirements and because their data are collected using the same or at least similar methodology. The obtained GAO and factor endowment shares by country are reported in Table 4.

The results reported in Table 4 allows us to assess the relative factor abundance/scarcity with respect to the rest of CEE. According to our estimates, the Czech Republic and Estonia are relatively abundant/rich 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. According to Table 4, Poland is relatively abundant/rich in labour and capital. Slovakia is relatively abundant in land and Slovenia is relatively abundant in labour bur relatively scarce in land and capital. These estimates are roughly in line with the factor endowment ratios reported in Table 3.

The relative factor endowment as a source of comparative advantage is particularly important when factor intensity differences are sizeable across sectors. Therefore, first we examine inter-sectoral technology differences in CEE. The inter-industry differences (differences between agricultural activities) in the relative labour intensity across CEE are plotted in Figure 1. Labour content in percent is on the vertical axis and the seven agricultural activities on the horizontal axis. Dots in the Figure represent the 8 CEE countries. The average values for each sector with the corresponding

Table 4: CEE country relative endowment with land, capital and labour

	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 and Eurostat (2008) data. Notes: GAO-Gross Agricultural Output.

standard deviations are reported next to the columns.

According to Figure 1, labour intensity is highly heterogenous across agricultural activities in CEE. For example, on average, the pig and poultry production (14.6% labour) is 2.4 times more labour extensive than horticulture (34.6%). Similarly, cereal and oilseed production (17.1% labour) requires almost two times less labour than permanent crops (33.9%). Hence, the inter-industry differences in the relative factor requirements reported in Figure 1 suggest potential gains from international specialisation in agricultural production and trade.

Based on figures reported in Table 3 and Figure 1, and the HO theory of international trade we can derive empirical hypothesis of predicted country specialisation. First, they suggest that land abundant countries, such as Latvia and Lithuania, would produce and export products with relatively high land content, and import products with relatively low land content. According to Table 3, Slovenia has the lowest land endowment per capita, which would suggest the opposite pattern of factor content of agricultural trade. Second, they suggest that 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 goods compared to 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 products. However, as we will see in the following sections, other things are not equal in agricultural production and trade conditions between (and within) the CEE transition economies.

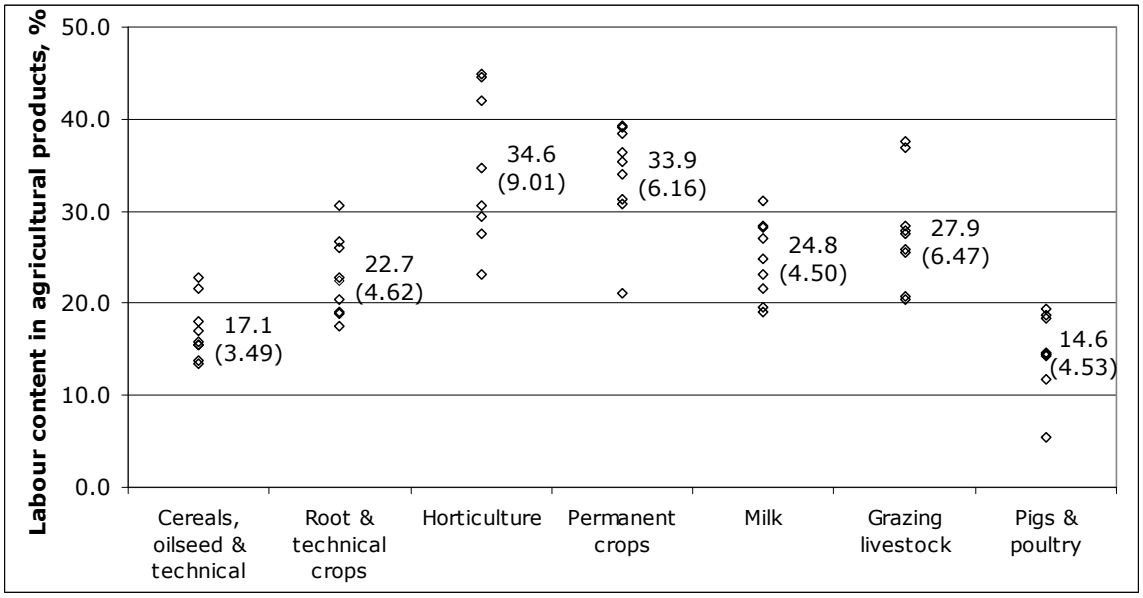

Figure 1: Labour content in agricultural goods at farm gate in CEE, 2004. Source: Authors' calculations based on FADN (2008) data.

4.4 Putting the pieces pieces together: relative factor endowment and production technology

This section summarises the key findings from sections 4.2 and 4.3 of the relative factor endowment advantages and technology differences driven by differences in farm organisation and derives the empirical hypothesis, which will be tested in the following sections. Figure 2 maps out the agricultural labour endowment on the horizontal axis and the share of IFs is on the vertical axis. As in Table 3, the agricultural labour endowment is proxied by the share of agricultural employment in the total employment in the previous period.

The key findings are summarised in Figure 2, which positions countries according to their technology advantages driven by differences in farm organisation, and relative labour endowment advantages.[14] Those countries, which are located in the upper part of Figure 2 (Slovenia and Poland) have high share of labour intensive IFs, whereas those countries, which are located on the bottom (the Czech Republic and Slovakia) are dominated by labour extensive CFs. The most agricultural labour scarce countries are located on the left hand side in Figure 2 (the Czech Republic, Slovenia and Slovakia), whereas the most agricultural labour abundant countries

[14]Similar Figures can be drawn for the other two primary factors capital and land. Given country advantages in capital are inversely related to labour, they are not reported here for the sake of brevity.

(Poland) are located on the right hand side.

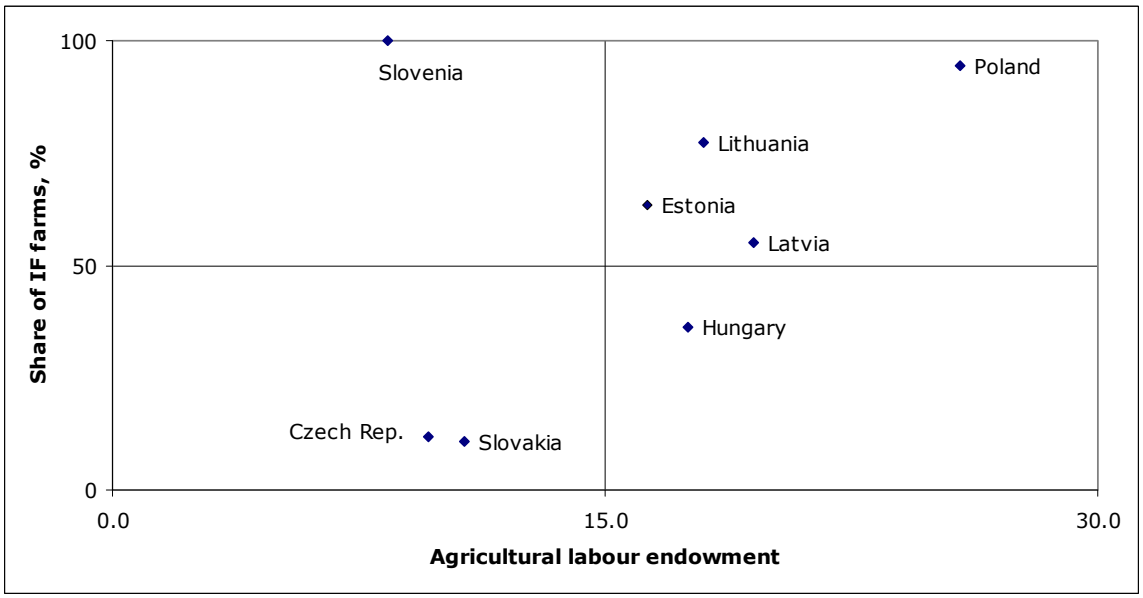

Figure 2: Comparative advantages of farm organisation and labour endowment

According to Figure 2, Poland has both technological and endowment advantages in labour intensive products. Compared to other CEE countries, the Czech Republic and Slovakia have strong technological disadvantages and some endowment disadvantages in labour intensive agricultural products. Slovenia has strong technological advantages and some endowment disadvantages in labour intensive products. The comparative advantages of Hungary are just the opposite of Slovenia. The remaining group of countries, the Baltic states, which are located in the central part of Figure 2, have slight labour endowment advantages, but do not have pronounced technological advantages/disadvantages in labour intensive agricultural industries.

Based on these findings, the Ricardian and HO theories of international trade suggest that agricultural exports of countries with comparative advantages in labour intensive products (e.g. Poland) would contain lower capital/labour ratio than agricultural exports of countries with comparative advantages in capital intensive products (e.g. Czech Republic and Slovakia). This is our empirical hypothesis, which we will examine in the following section.

5 Factor content of CEE agricultural trade: the hypothesis testing

In this section we estimate the factor content of agricultural trade in CEE. We also examine to what extent the CEE economies specialise in export of goods, according to their technological and factor endowment advantages identified in the previous sections. First, in section 5.1 we analyse the empirical hypothesis relating the relative country endowment and technology advantages to factor shares of the CEE-EU25 agricultural trade. In section 5.2 we test the HOV prediction formally for the intra-CEE agricultural trade. In section 5.3 we discuss the potential role of farm organisation in determining the pattern of agricultural trade and factor content of farm output.

5.1 Factor content of CEE-EU agricultural trade

In this section we estimate the factor content of CEE-EU25 agricultural trade. First, we analyse the agricultural exports from CEE to the rest of the world (most of which go to EU-25) and imports from the rest of the world (most of which originate from EU-25) to CEE. Second, we examine the factor content hypothesis relating the relative country endowment to factor content of agricultural trade. Given that the two groups of countries are rather heterogenous (i.e. new EU member states are very different from old EU member states), they violate the key underlying HOV assumptions, such as equal factor prices, identical technologies, etc. Hence, factor content of agricultural trade between these two groups of countries cannot be analysed in a standard HOV framework. In order to get around these issues, we process as follows: (i) we analyse factor content of the CEE-EU25 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 which factor price differences between the CEE and old EU member states play.

The disaggregated content of factor services of the gross agricultural trade flows are reported in Tables 5 and 6. In both Tables columns 2-4 report factor content in agricultural imports from EU-25 to CEE; and columns 5-7 report factor content in agricultural exports from CEE to EU-25. We use EU-25 factor intensities in production to obtain factor shares of CEE imports in Tables 5 and 6. This is a good approximation given the fact that most of the CEE trade is with EU (more than 75%). For exports we use factor intensities in production of CEE countries itself.[15] Given that agricultural trade is not balanced for all countries in our sample, the factor content is calculated per unit of exports and imports.

[15]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 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.

Table 5: 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.

The figures reported in Table 5 suggest some differences in factor ratios between exports and imports. On average, the CEE tend to have higher labour content relative to capital, and higher land content relative to capital and labour in exports as compared to imports. Comparing factor content between countries there is relatively small variation for imports. However, a stronger variation is observed for exports. Particularly, Poland and Slovenia have high labour/land ratio in exports, while the opposite holds for the Czech Republic and Slovakia. The Czech Republic, Hungary and Slovakia have low labour/capital ratio compared to other countries. Hungary, Slovenia, and Poland also have high capital/land ratio in exports.

Turning to the analysis of values shares of factor services in the gross trade flows in CEE (Table 6), we note that the results differ from factor contents in trade calculated in quantities and reported in Table 5. The figures reported in Table 6 suggest significant differences in factor content between exports and imports. In both exports and imports the largest factor share represents capital, which on average accounts for 58.5% and 49.1% of export and imports value, respectively. The agricultural imports from the CEE countries have higher labour content than exports (45.8% and 39.5%), whereas agricultural exports from CEE contain more capital value 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 import (export) value. In contrast to the results reported in Table 5, where we account only for relative factor quantities, in Table 6, where we account for both relative factor quantities and factor prices, the relative share of capital/labour and capital/land and labour/land is higher in exports than in imports. This can be attributed to factor price differences between CEE and trading partners

(mostly old EU members states). 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.

Table 6: 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.

According to Table 6, the variation of factor content in imports is rather small across the CEE countries. Similar to Table 5, 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 good exports in Estonia, Lithuania and Poland.

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.

5.2 Factor content of intra-CEE agricultural trade

In this section we examine the factor content hypothesis for the intra-CEE agricultural trade, i.e. we analyse agricultural trade from each CEE country to the rest of the CEE and vice versa. Given that countries within the CEE group are rather homogenous (because of their common past and similar initial conditions), the key underlying HOV assumptions, such as equal factor prices, identical technologies, are roughly

satisfied in the data. Hence, factor content of agricultural trade within the CEE group can be analysed using the HOV framework.

In order to test the HOV hypothesis, we rewrite equation (7) as a difference between the observed factor content of agricultural trade and the predicted factor content of agricultural trade. The obtained equation (8) provides the theoretical hypothesis for testing the HOV.

$$HO_{fr} \equiv F_{fr} - (V_{fr} - s_r V_{fw}) = 0 \tag{8}$$

According to (*Davis* and *Weinstein* 2001), equation (8) can be estimated either as a world version or country pair version. Most of previous studies have employed the world version (e.g. *Bowen*, *Leamer* and *Sveikauskus* 1987; *Trefler* 1995). Yet the country pair version have several methodological advantages of assessing the success of HOV. On the one hand, one does not have to employ and construct endowment data for the world as a whole. More specifically, the world endowment number is wrong as soon as countries are missing, or as soon as the data for a particular country are unreliable. On the other hand, and more importantly, it can be shown that the two-country version only requires that the specific HOV assumptions hold for the two countries considered (*Brecher* and *Choudri* 1988). As soon as the assumptions of HOV do not hold for the world as a whole, relying on world endowments is not correct.

In the present study we adopt a hybrid approach of the world and country pair versions for estimating equation (8). More precisely, we reformulate HOV for a smaller group of countries (yet larger than two).[16] This allows us to avoid constructing and employing endowment data for the whole world, which at a reasonable confidence level is not available for all agricultural activities and all world countries. In addition, by selecting a homogenous group of CEE transition countries we hope to address the issue that all our sample countries rightly fit into the group - because they satisfy the HOV theoretical requirements and because their data are collected using the same or at least similar methodology.

We test the HO hypothesis using a sing test and rank test. Sign test asks whether the sign of measured factor content of trade, F_{fr}, is the same as that of predicted factor content of trade, $V_{fr} - s_r V_{fw}$. A strength of the sign test is that large outliers are unlikely to affect the results. The major weakness, of course, is that countries with small predicted factor content of trade may have many sign errors without it indicating a major problem for the theory. Rank test puts a little more structure on the data by asking whether countries that are predicted to be large exporters/importers of a factor are measured to do so.

In order to perform the sign and rank test of the HOV hypothesis, we use equation (8). Given that agricultural trade is not balanced in any our sample countries, we

[16] Our group of countries include 8 CEEs: Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia.

calculate the observed factor content of agricultural trade and the predicted factor content of agricultural trade per unit of trade flow. The obtained HOV test results are reported in Table 7. The left columns for each factor report sign test results and the right columns for each factor report rank test results. In the column 'rank' the first number indicates rank according to the observed factor content of agricultural trade, the second number - according to the predicted. The smaller the difference between the two numbers, the better is satisfied HO prediction. For example, the Czech Republic satisfies HO sign test for labour and capital, but fails for land. The labour rank according to the observed factor content is 8, according to the predicted - 7. Hence, based on the both test results, the HO prediction is largely satisfied for the Czech Republic's content of land in trade. The last row and last column reports the average match in percent between the predicted and observed factor content of agricultural trade for each factor (bottom row) and each country (last two columns).

Table 7: HOV test results for the net agricultural trade in CEE

	Labour		Land		Capital		Average, %	
	sign	rank	sign	rank	sign	rank	sign	rank
Czech Republic	yes	8/7	no	7/5	yes	8/7	66.6	83.3
Estonia	yes	5/5	yes	5/4	no	5/4	66.6	91.7
Hungary	no	2/8	no	1/6	yes	2/8	33.3	29.2
Lithuania	yes	3/3	yes	3/1	yes	3/2	100	87.5
Latvia	yes	6/4	no	6/3	yes	6/3	66.6	66.6
Poland	yes	1/1	no	2/8	yes	1/1	66.6	75.0
Slovakia	no	4/6	yes	4/2	yes	4/6	66.6	75.0
Slovenia	no	7/2	yes	8/7	yes	7/5	66.6	66.6
Factor average, %	62.5	75.0	50.0	65.6	87.5	73.4	66.5	71.9

Source: Authors' calculations based on equation (8). Notes: HO test are based on input value in one unit of net agricultural trade in 2004. The unweighted averages are calculated as a percentage of theoretically maximum score.

According to the sign test results reported in Table 7, the HOV prediction is most often satisfied in the capital content of agricultural trade (7 out of 8 countries or 87.5 %). The sign test performs relatively poorly for land - only four CEE countries (50%) match the predicted import/export flows of land with the observed import/export flows of land. One way how to interpret these results are transaction costs and market imperfections, which are considerably higher for agricultural land than capital (*Ciaian* and *Swinnen* 2006, 2007). The relatively poor HOV performance for land is also confirmed by the rank test - it has the highest average rank deviation. The rank test performance is considerably higher for both labour and capital (75.0% and 73.4%).

In the case of labour, three countries match the predicted and measured ranks exactly - Estonia, Lithuania and Poland. Moreover, Polish trade of agricultural goods also fits perfectly the predicted capital content with the observed.

Turning to country-specific results, we note that the least rank deviation is estimated for Estonia. However, the factor content of Estonian agricultural trade fails sign test for capital. Lithuania performs the best in terms of both rank and sign tests - it satisfied all three sign tests and the average average rank deviation is only 1.00, which is the second lowest in our sample (after Estonia). We estimate the largest deviations between the predicted and observed labour, land and capital content for Hungary, which fails sign test for two out of three factors and the average rank deviation is 5.67, which is the highest in our sample.

In addition, we also assess the HO prediction with respect to factor content in total trade (not per unit). This alternative evaluation allows us to assess the magnitude of deviations across factors. In terms of magnitudes of the predicted and observed factor content of agricultural trade, the HOV test results suggest significant discrepancies between the predicted and observed factor content of agricultural trade in CEE. For example, the Czech Republic and Slovenia export considerably more labour and slightly more land than suggested by the relative factor endowment. In contrast, the Czech Republic and Slovenia export more capital, than would be optimal from the HO perspective. Estonia and Latvia export all three primary factors more than the HOV theorem suggests. Lithuania and Slovakia export too much land but import too much labour and capital. Hungary imports more labour, land and capital than country's endowment would suggest. Poland imports too much land and labour, whereas export too much capital.

Finally, we also perform the HO sign and rank tests for factor quantities of agricultural trade. The alternative test results yield similar results. Therefore, we do not repeat the results presented above for factor value of agricultural trade.

5.3 The role of farm organisation

Summarising findings from the previous two sections we may conclude that the measured factor content of imported and exported agricultural goods is rather similar in CEE. Second, the CEE transition countries only weakly specialise their international trade in agricultural goods according to their comparative advantages in primary factor endowment.

In this section we provide a first attempt to explain these peculiarities observed in the CEE agricultural trade. In particular, we aim at assessing the role of market imperfections and transaction costs. Given that neither market imperfections nor transaction costs are observable, we need to account for them indirectly. Moreover, our sample size (eight observations) does not allow to perform a formal testing of the role of market imperfections and transaction costs.

In order to get around these issues, we adopt a qualitative analysis approach to in-

vestigate the potential role of farm organisation in factor content of agricultural trade. More precisely, in order to examine the relationship between farm organisation and factor content of agricultural trade, in Figures 3 and 4 we plot the share of land used by IF (x axis) relative to the ratio of labour/capital in trade to labour/capital endowments (y axis). Our null hypothesis is that farm organisation is fully endogenous and hence does not affect the factor content of agricultural trade.

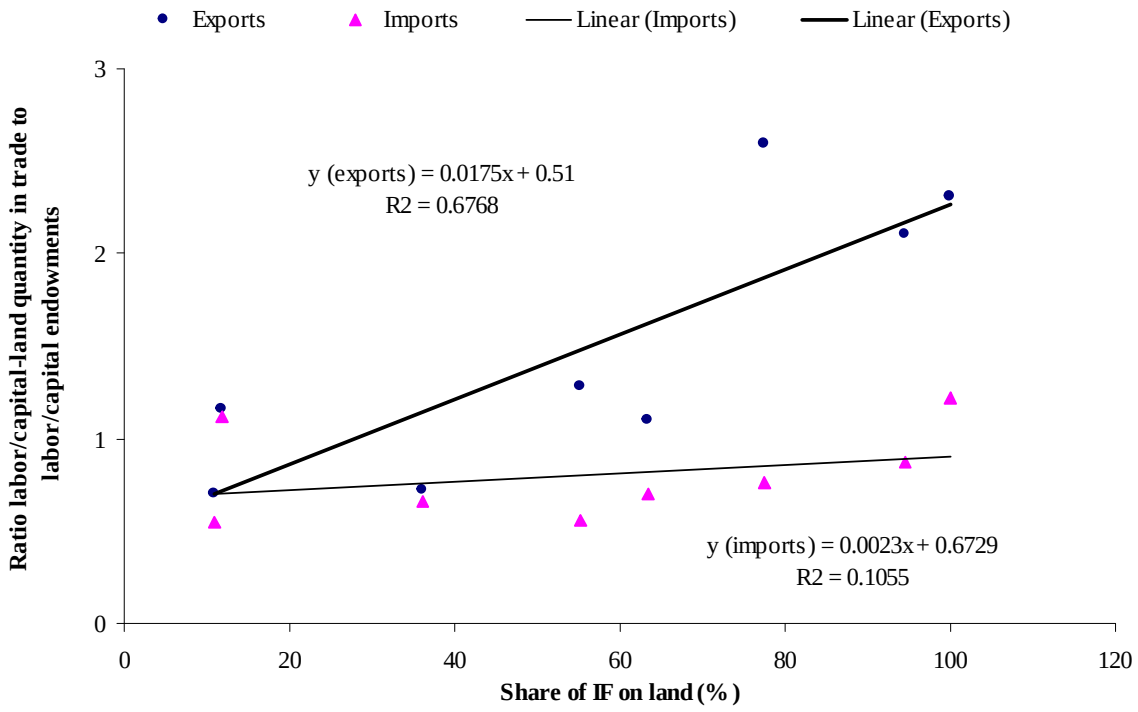

Figure 3: Farm structure and ratio labour/capital quantity in trade to labour/capital endowments in 2004

Figures 3 and 4 show how farm organisation affects the factor content of agricultural trade in CEE. In Figure 3 the ratio of labour to capital content in exports and imports is represented in quantities, whereas in Figure 4 it is in values (costs). In other words, the difference is that Figure and 4 takes into consideration differences in input quantities and input prices in exports and imports whereas Figure 3 accounts only for differences in input quantities in exports and imports in CEE.

The results reported in Figures 3 and 4 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. Hence, farm structure co-determines the type of products (in terms of labour/capital intensity) CEE countries export and import. Higher share of IFs in land use implies higher share of labour content of exports and imports. The sign for exports is in line with our expectations.

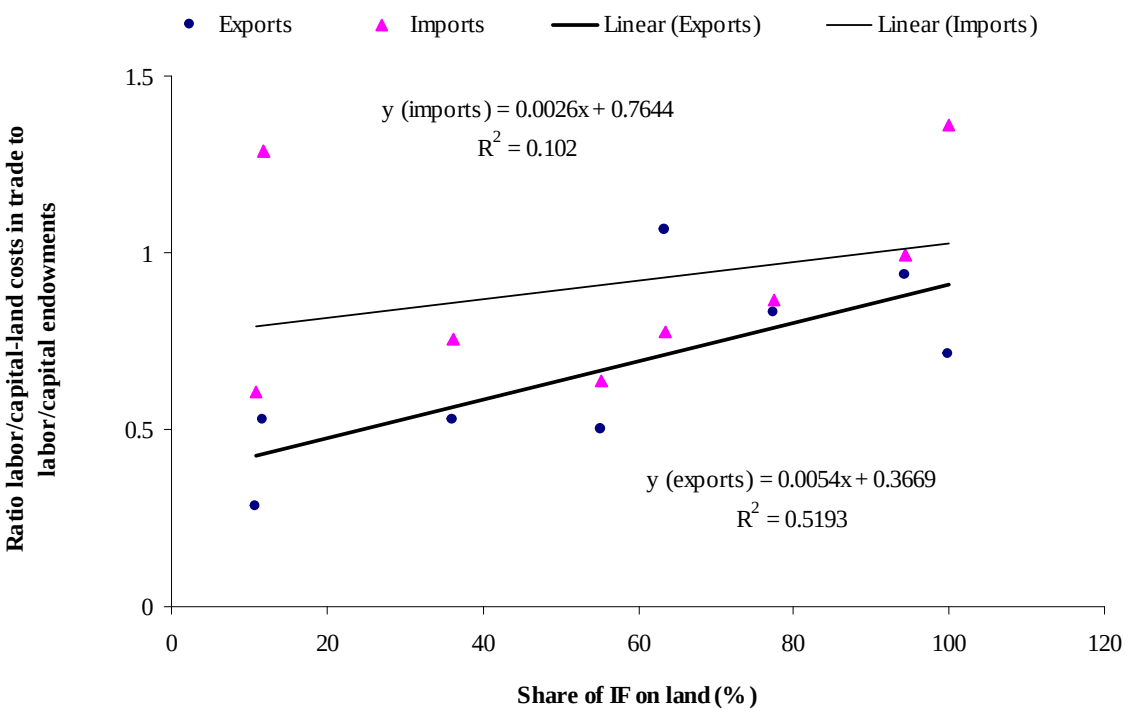

Figure 4: Farm structure and ratio labour/capital cots in trade to labour/capital endowments in 2004

In contrast, our theoretical hypothesis suggests the opposite sign for imports - countries with IF dominance would import more capital intensive products. However, our results for imports reported in Figures 3 and 4 do not confirm this hypothesis. The relationship for imports have the same sign as for exports, however, the correlation is not significant for imports. This might be due to the fact that imports are determined by other factors which we do not control for. For example, differences in consumers preferences, market size effects (through the number of available varieties to consumers) and other differences in consumer behaviour, which are neglected in the present study.

Generally, the relationship is considerably stronger for exports than for imports (for exports $R^2 = 0.68$ and 0.52, whereas for imports $R^2 = 0.11$ and 0.10). When represented in quantities (Figure 3), the correlation between farm structure and factor content of imports is approximately equally as correlation when imports are represented in values (Figure 4). For exports there is some difference between the two correlations. When taking into consideration only quantities, the correlation is somewhat stronger (Figure 3) than if accounting for both input quantities and input prices. This indicates that input price differences may hove some offsetting effect to farm organisation in determining the factor content of exports.

6 Conclusions and policy implications

The objective of the present paper was to examine factor content of the CEE transition country agricultural trade. In addition, the paper attempts to identify the potential role of transaction costs in farm organisation and sectoral re-specialisation, and market imperfections in determining agricultural specialisation and relative factor intensities of different CEE countries. The present paper is one of the first attempts in two respects: (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 the new EU member states for 2004 we identify significant differences in factor content of agricultural goods traded between different CEE countries and compared to old EU member states. At the country level our results suggest that factor content between exports and imports is rather similar in the CEE agricultural trade flows. In both exports and imports the largest factor share represents capital, which on average account for 49% of imported good good value and 59% of exported good value. These results are new and have not been reported for CEE in the literature before.

Performing the HOV sign and rank tests for the intra-CEE trade we found that from the relative factor endowment perspective the factor content of agricultural trade is suboptimal. According to the sign test results, the HOV prediction is most often satisfied in the capital content of agricultural trade (7 out of 8 countries or 87.5 %). The sign test performs relatively poorly for land - only four CEE countries (50%) match the predicted import/export flows of land with the observed import/export flows of land. One way how to interpret these results are transaction costs and market imperfections, which are considerably higher for agricultural land than capital (*Ciaian* and *Swinnen* 2006, 2007). The relatively poor HOV performance for land is also confirmed by the rank test - it has the highest average rank deviation. The rank test performance is considerably higher for both labour and capital (75.0% and 73.4%).

Analysing the potential role of transaction costs and market imperfections, we find some evidence that transaction costs and market imperfections may indeed co-determine sectoral specialisation and farm organisation, 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. Hence, farm structure co-determines the type of products (in terms of labour/capital intensity) CEE countries export and import. Higher share of IFs in land use implies higher share of labour content of exports and imports. However, these first results have to been verified econometrically, in order to be able to draw general conclusions about the relationship between factor content in production and trade, and transaction costs in farm organisation and sectoral respecialisation. Our results suggest that this is a promising avenue for future research and should be followed in future, when the re-

quired 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 other, depending on the cross-country variation in farm structure. For example, before Slovakia joined the EU, the government granted farmers investment subsidies for fruit production. However, such policy is not efficient in the context of Slovakia where CFs dominate the agricultural production and transaction costs of reorganising farm structure are considerable, because according to findings from section 4, CFs do not have competitive advantages in fruit production. 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 heterogenous in terms of farm organisation, the demand for protection will vary across countries particularly with liberalisation of markets with the EU accession. Countries with high share of CFs will demand protection for labour intensive products, whereas in 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.

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7 Appendix

Table 8: Sectoral classification based on FADN

Agricultural activities in this study		FADN classification of sub-sectors	
13	Cereals, oilseed and protein crops	13	Specialist cereals, oilseed, protein crops
14	Root crops and technical crops	141	Specialist root crops
		142	Cereals and root crops combined
		143	Specialist field vegetables
		144	Various field crops
20	Horticulture	201	Specialist market garden vegetables
		202	Specialist flowers and ornementals
		203	General market garden cropping
39	Permanent crops	31	Specialist vineyards
		32	Specialist fruit and citrus fruit
		33	Specialist olives
41	Milk	41	Specialist dairying
49	Grazing livestock	42	Specialist cattle-rearing and fattening
		43	Cattle-dairying, rearing and fattening
		44	Sheep, goats and other grazing livestock
50	Pigs and poultry	50	Specialist granivores (pigs and poultry)
89	Rest of agriculture	60-82	Rest of agricultural activities