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Institutions, Policy Reforms and Efficiency in New Member States from Central and Eastern Europe

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Abstract

This paper investigates determinants of agricultural sector efficiency in ten new member states (NMS-10) of the European Union (EU) from Central and Eastern European countries by the non-parametric method Data Envelopment Analysis (DEA) and the panel data analysis. The agricultural sector efficiency varies between the NMS-10. We have found positive and significant association of the agricultural sector efficiency with the natural agricultural factor endowments, average farm size, farm specialization, small-scale farms, and the EU integration process. The foreign direct investments have an ambiguous affect, while the nominal assistance rate is not found significant. Reform and institutional developments and liberalization are associated with the agricultural sector efficiency positively, and vice versa infrastructure development and agricultural policy reforms, which have caused job flows and agricultural employment adjustments. The urban-rural income gap with job flows and agricultural labour adjustments have caused the agricultural sector efficiency positively.

Keywords: agricultural efficiency, institutions, policy reforms

JEL codes: C14, C23, Q12

1 INTRODUCTION

During the last two decades the most advanced Central and Eastern European countries (CEECs) have undergone institutional and economic reforms, transformation and adjustments to the European Union (EU) and operation in the single market. They have become the new member states (NMS) of the enlarged EU. These processes have induced greater opportunities in more competitive market environment.

LERMAN (2000) and MACOURS and SWINNEN (2002) argue different transformation and efficiency changes in agriculture of transition CEECs. SWINNEN (2009) explained the diversification of farm structures by economic mechanisms, which are influenced by initial conditions and reform policies, and the rapid globalization of food supply chains. This has following by the inflows of foreign direct investments (FDIs) (e.g. DRIES and SWINNEN 2004).

This paper focuses on agricultural sector efficiency in the NMS from the CEECs, which is measured by the non-parametric method Data Envelopment Analysis (DEA). Efficiency analyses are numerous, but inter-country comparisons are rare (e.g. LISSITSA et al. 2007). The novelty of the paper is in the in-depth analysis of the recent agricultural efficiency in the NMS, which is explained by a combination of factors, which caused differences in agricultural performances over time and between the NMS: (1) impact of initial conditions, institutional and reform policies and infrastructure variables on agricultural performance, (2) impact of transition and reform progresses on agricultural performance (3) impact of the relative natural agricultural factor endowments on agricultural performance, (4) impact of farm size and farm structures on agricultural performance, (5) impact of farm specialization on agricultural performance, (6) impact of FDI on agricultural performance, (7) impact of urban-rural income gap on agricultural performance, (8) impact of adjustment and integration into the single market on agricultural performance, and (9) impact of market-price distortions on agricultural performance. We develop and test the hypotheses based on our estimated regressions.

The rest of the paper is organized as follows. First, we present a brief literature review. Second, we describe our hypothesis on the nature of agricultural efficiency. Third, we present DEA methodology and data used. Fourth, we investigate the determinants of agricultural efficiency in the NMS from the CEECs. We find that the agricultural efficiency is determined by the transition process, institutional and policy reforms and by the integration into the EU. The diversity in farm structures in terms of farm size and farm specialization are an important determinant of agricultural efficiency, which has also important causalities with initial conditions and reform policies (SWINNEN 2009). Small-scale farm structures are found to be efficient. The urban-rural income gap is not found to be significant. Moreover, there might be also some market imperfections, which limit the labour flows from rural to urban areas such as the price differential and availability of housing and similar living conditions in urban areas. Finally, we derive main conclusions and policy implications.

2 BRIEF LITERATURE REVIEW

A body of theoretical and empirical literature has developed on transformation of CEECs agriculture and on integration of the NMS into the EU. The evolution and development of farm structures in transition followed by institutional and agricultural

policy reforms and market liberalisation have been analysed by several studies (e.g. LERMAN 2000, ROZELLE and SWINNEN 2004, SWINNEN 2009). They find a diversity of farm size and organizational structures inside and between the countries related to the evolution of the initial conditions, the reform processes in the transition and farm specialization.

The literature on farm and agricultural efficiency in the NMS and other transition countries is numerous (e.g. LISSITSA and ODENING 2005, BOKUSHEVA and HOCKMANN 2006, LISSITSA and BALMANN 2006, RUNGSURIYAWIBOON and LISSITSA 2007). However, the agricultural sector efficiency in association with relative agricultural factor abundance, institutions, regulations and reforms and market imperfections have been tested by a rare studies. Moreover, different studies estimating the efficiency of the various farm and agricultural structures yield mixed results according to their size, organizational structures, and farm specialization (MATHIJS and SWINNEN 2001, DAVIDOVA et al. 2003, GORTON and DAVIDOVA 2004, SWINNEN 2009).

The differential patterns between the CEECs have also been found concerning the inflows/outflows of labour into/out of agriculture and concerning farm labour absorption/shedding during transition (DRIES and SWINNEN 2002, SWINNEN et al. 2005, BOJNEC and DRIES 2005). However, in the most of the NMS from the CEECs, there has been a decline in official employment in agriculture, but with variations inside some countries by regions (SWINNEN 2009).

Farm restructuring and labour adjustment have contributed to the changing economies of scale in farm operations with possible imperfections in the emerging agricultural input, credit and output markets with associated transaction costs. GORTON and DAVIDOVA (2004) present a list of references of studies on farm and agricultural efficiency during the pre-accession to the EU. Both theoretical and empirical studies give mixed results concerning farm size and efficiency. However, at the same time, the smallest farms under certain environment can also be efficient (SWINNEN 2009). Small farm structures have also played an important social buffer role during transition. These positive causalities are also associated with the nature of the farm activity specialization crops versus livestock and other production.

3 DETERMINANTS OF AGRICULTURAL EFFICIENCY

To understand the agricultural sector efficiency pre- and post-EU accession, on the basis of the previous literature and empirical research we set out our hypotheses, which are tested in the empirical part of this paper. Agricultural efficiency depends on a combination of various factors such as technology used and relative factor abundance, institutional and policy reforms with input and output market environment, farm size and scale economies, organization and management, farm's specialization, and similar (GORTON and DAVIDOVA 2004, SWINNEN 2009).

The impact of technology used and relative factor abundance on performance are important ingredients of theory of production, efficiency, and of induced technological progress (COELLI et al. 2005, HAYAMI and RUTTAN 1985). MACOURS and SWINNEN (2002) argue the differential in the transition path dependence concerning labour-intensive versus land- or capital-intensive technologies in agriculture. In countries with labour-intensive technologies gains in technical efficiency were achieved by a shift from large-scale collective farming to small-scale individual farming, but with a

relative deterioration in scale efficiency. SWINNEN (2009) argues that the association between the farm efficiency and the labour/land ratio can be mixed depending on differential of farm and labour adjustment processes in labour-intensive versus capital- and land-intensive countries.

Institutional and policy reforms have induced changes in factor and output markets, which both are causing agricultural efficiency. Capital and output markets deregulation and liberalisation have opened a window of opportunities in purchases of inputs and in selling of outputs. However, at the same time there has been an increase in risk and uncertainty, which have been caused by institutional and policy reforms and by more competitive market conditions. Different institutional, land and other agricultural and macro-economic policy reforms have had important implications for farm and agricultural efficiency. We expect that the agricultural sector efficiency is in general positively associated with institutional and policy reforms as well as by improved market and other infrastructure development.

The improvements in infrastructure networks have contributed to faster transport with an expansion of market areas at falling cost of transport. The efficiency gains for farms and the agricultural sector are improvements for cheaper purchases of farm inputs, goods and services and advancements for more sales. LERMAN et al. (2004) argue that the increased competition and specialization accelerate the duality of agriculture in CEECs with the co-existence of the fewer large and numerous smaller farms.

Farm size and scale economies are an outcome of the evolution of the initial conditions and institutional and policy reforms. We somehow include duality of farm size structures by using average farm size and the share of smaller farms. SWINNEN (2009) argues the existence of the association between land use fragmentation and labour market constraints by the share of agriculture in employment. Particularly, a positive association between the share of land used by small farms and the share of labour employed in agriculture.

The rapid globalization of food chains has caused new ways of marketing and the organization of exchange within the agro-food supply chains, including vertical coordination initiatives with the provision of farm assistance programs to the farms (WORLD BANK 2005). Market institutions are important for input and output markets, farm specialization and thus for farm and the agricultural sector efficiency.

Labour market constraints associated with the urban-rural income gap have been argued as a determinant for migration from rural to urban areas or to other countries, which has contributed to the growth of farming (MACOURS and SWINNEN 2008). We expect that the greater is the gap between the urban-rural incomes, the greater is the outflow of labour from rural areas, which fosters the labour outflow from agriculture improving the farm and agricultural efficiency. However, this labour flows depend on elasticity of demand for rural labour and on mobility in labour flows from rural to urban areas. If there are scarce jobs opportunities, there is little scope for out-migration from rural to urban areas (TODARO 1995).

The adjustment and entry of the NMS into the single market is expected to improve farm and the agricultural sector efficiency by better functioning of input and output

markets, improved quality and market integration into regional and international agro-food chains.

4 METHODOLOGY AND DATA

4.1 Methodology

To explain the nature and determinants of the agricultural sector efficiency, we focus on institutional and policy reforms, natural factor endowments, farm size, farm fragmentation, farm specialization, FDI, urban-rural GDP per capita gap, and the EU integration dummy.

We investigate the agricultural technical efficiencies of the NMS countries by employing DEA. Technical efficiency is the performance of a country as regard to the quantity produced in comparison to the quantities of inputs used. This performance can be input or output oriented and can satisfy constant returns to scale (CRS) or variable returns to scale (VRS) technologies. The input-oriented model measures the technical efficiency as the proportion of possible input decrease maintaining the same level of output while the output-oriented model estimates the technical inefficiency as the proportional potential increase of output using the same level of inputs. The technical scale efficiency is given by the ratio between two efficiency scores respectively estimated on a CRS and on a VRS technology. In our analysis we applied input oriented CRS technology.

DEA method, arising from the work of FARREL (1957), uses linear programming to calculate the production frontier with the best practices in the sample, and the distance of each farm from that frontier (FÄRE et al. 1994, BOJNEC and LATRUFFE 2009). A country on the frontier has an efficiency score of 1, while the further away a country from the frontier is situated, the lowest its efficiency score. The efficiency score in the presence of multiple inputs and output factors is defined as:

$$Efficiency = \frac{weighted\ sum\ of\ outputs}{weighted\ sum\ of\ inputs}$$

We assume that there are n countries (NMS-10) to be evaluated. Each country consumes varying amounts of m different inputs to produce s different outputs. Specifically, $country_i$ consumes amount x_{ji} of input j and produces amount y_{ki} of output k. We assume that $x_{ji} \geq 0$ and $y_{ki} \geq 0$ and further assume that each country has at least one positive input and one positive output value.

In the ratio form of DEA (Charnes, Cooper, and Rhodes CCR – construction) (CHARNES et al. 1978), the ratio of outputs to inputs is used to measure the relative efficiency, which is usually called productivity of the $country_i$ to be evaluated relative to the ratios of all of the other countries. The relative efficiency score of $country_p$ is obtained by solving the following model:

$$\max \quad \frac{\sum_{k=1}^{s} v_k y_{kp}}{\sum_{j=1}^{m} u_j x_{jp}}$$

$$\text{s.t} \quad \frac{\sum_{k=1}^{s} v_k y_{kl}}{\sum_{j=1}^{m} u_j x_{jl}} \leq 1 \ \forall l$$

$$v_k, u_j \geq 0 \ \forall k, j,$$

where $k = 1$ to s, $j = 1$ to m, $i = 1$ to n, y_{ki} = amount of output k produced by country i, x_{ji} = amount of input j utilized by country i, v_k = weight given to output k, and u_j = weight given to input j.

The above problem is run n times in identifying the relative efficiency scores of all the NMS-10. Each country selects input and output weights that maximize its efficiency score. In general, a county is considered to be efficient if it obtains a score of 1 and a score of less than 1 implies that it is inefficient.

In the second step procedure we apply panel data analysis to explain the efficiency scores. There are some issues that we have to address when we estimate such panel data models including heteroskedasticity and the existence of autocorrelation. Contemporaneous correlation across panels may occur. To deal with the issues of contemporaneous correlation we apply the panel corrected standard error model (PCSE) which controls for heteroskedasticity and the AR(1) type of autocorrelation and contemporaneous correlation across panels (BECK and KATZ 1995, 1996).

4.2 Description of data and their sources

Agricultural natural factor endowment is expressed as the ratio between Annual Working Units (AWU) and Utilised Agricultural Area (UAA). The AWU/UAA shows how much labour pertains to a hectare of agricultural land. One AWU corresponds to the work performed by one person for an agricultural holding on a full-time basis or 1800 hours a year if national provisions does not state differently. The UAA describes the area used for farming in hectares. UAA does not contain unused agricultural land, woodland and land occupied by buildings, farmyards, tracks, ponds, and similar. The source for the AWU data is the Eurostat's Agricultural Labour Input Database, while the UAA data are coming from the FAO`s Land Database.

Average farm size is defined as the ratio UAA/total number of farms. Total number of farms refers to the total number of farms (in all size categories) operating in a region or a country. The source of these data is the Eurostat`s Structure of Agricultural Holdings Database.

Farm fragmentation is defined as the share (%) of farms, which are smaller than 5 hectares. This variable is associated with the number of farms by size categories. Practically, one can obtain these data by adding up the number of farms with less than 2 ha and those with 2-5 hectares and divide that by the total number of farms. Source of this data is the Eurostat`s Structure of Agricultural Holdings Database.

Farm specialisation is defined as the share (%) of crop output in total agricultural output. This indicator is the ratio between the crop output of a country, measured in million euro, and the total agricultural output of the same country, also measured in million euro. The ratio reveals whether a country is specialised in crops or animal production. Data is coming from the Eurostat`s Economic Accounts for Agriculture Database.

Foreign direct investment (FDI) is a component of a country's national financial accounts. The FDI is defined as an investment of foreign assets into domestic structures, equipment, and organizations, without including foreign investment into the stock markets. It is usually divided into two categories: FDI inflows and FDI outflows,

referring to the direct investment made at home or abroad, respectively. The indicator is measured in million USD at current prices, the source of data is the UNCTAD`s FDI Database.

Urban/rural GDP/capita is the classical GDP/capita indicator, which is combined with the OECD (1994, 2005) typology on rural areas. According to this latter typology, rural regions are classified into one of the three categories: predominantly rural (PR), intermediate (IR), and predominantly urban (PU) regions. The GDP/capita data in PPS/habitants were collected from the Eurostat`s Regional Agriculture Statistics for PU and PR regions in the NUTS3 level. Core data were weighted by the number of regional population in order to obtain country level data for 2000.

EU is a dummy, which describes the time of the NMS entering to the EU, equal one, and zero otherwise for the pre-accession period.

The status of institutional and agricultural policy reforms is measured as a total score of various reform indicators based on World Bank estimations. The World Bank evaluates the degree if institutional and agricultural policy reforms using several indicators on the following fields: price and market, land reform, agro-processing, rural finance and institutional reforms. The value of indicators' indices ranges from 1 (centrally planned economy) to 10 (completed market reforms). Unfortunately, these indices are not available for all NMS-10 in the sample of whole period in question, thus we use the value of 2001 to check to impact of initial status of agricultural policy reform on the technical efficiency.

In addition, we use the Nominal Rate of Assistance (*NRA*) to measure the agricultural supports based on World Bank project on the "Estimates of Distortions to Agricultural Incentives, 1955-2007".

However, we are also interesting for the role of the *transition and reform progresses* in explaining of technical efficiency. Our dataset includes indices produced by the EBRD (2008) Dataset. The EBRD assesses progress in transition through a set of transition indicators. These have been used to track reform developments in all transition countries of operations since the beginning of transition. Progress is measured against the standards of industrialised market economies, while recognising that there is neither a "pure" market economy nor a unique end-point for transition. Assessments are made in nine areas: large scale privatisation, small scale privatisation, governance and enterprise restructuring, price liberalisation, trade and foreign exchange system, competition policy, banking reform and interest rate liberalisation, securities markets and non-bank financial institutions, and infrastructure. The measurement scale for the indicators ranges from 1 to 4+, where 1 represents little or no change from a rigid centrally planned economy and 4+ represents the standards of an industrialised market economy. These variables are introduced as additional control explanatory variables to investigate the stability and consistency of the findings explained in the previous section for the baseline model. Namely, during the analysed years most of the NMS-10 were completing transitional reforms and restructurings, and adjusting for the EU membership and for competition on the enlarged EU markets.

Table 1 presents the summary statistics of the explanatory variables for the NMS-10. The comparisons of the minimum and maximum values confirm different factor

endowments, farm specialization, agricultural structures, and agricultural market supports between the analysed NMS-10. The size of FDIs might be also biased to the country size.

Table 1: Summary statistics of explanatory variables for NMS-10, average 2001-2006

Variable	Obs	Mean	Std. Dev.	Min	Max
Factor endowment	60	0.10	0.05	0.03	0.21
Farm specialisation	60	0.51	0.07	0.38	0.73
Average farm size	60	18.6	23.6	3.1	88.3
Farm fragmentation	60	0.71	0.19	0.42	0.98
Foreign direct investment	60	3508.2	3797.3	132.0	19591.0
NRA	60	0.320	0.210	-0.103	0.920

According to the natural agricultural factor endowment, which is measured as labour intensity per agricultural area, Slovenia, Romania, Poland, and Bulgaria experienced the highest AWU per UAA (Table 2). Farm specialization defined as the share (%) of crop output in total agricultural output is close to 0.5: 0.41 in Estonia and 0.65 in Romania, with the outlier Bulgaria with the share closer to one. Average farm size (UAA per farm) varies considerably between the NMS-10 from 3.3 ha in Romania to 83.6 ha in the Czech Republic. The latter experiences the lower farm fragmentation (% of farms smaller than 5 hectares), which varies considerably between the NMS-10 from 18.0% in the Czech Republic to 96.4% in Bulgaria. Differences in FDIs indicate the openness of the NMS-10 for FDI inflows and the size of the country. The NRA varies considerably between the NMS-10 from 3.6% in Bulgaria up to 61.4% in the neighbouring Romania.

Table 2: Summary statistics of explanatory variables, average 2001-2006

	Factor endowment	Farm specialisation	Average farm size	Farm fragmentation	Foreign direct investment	NRA
Bulgaria						
Mean	0.135	0.964	4.6	0.964	3142.8	0.036
Std. Dev.	0.017	0.012	0.8	0.012	2557.6	0.109
Czech R.						
Mean	0.037	0.552	83.6	0.180	6365.7	0.289
Std. Dev.	0.002	0.043	3.5	0.279	3289.3	0.052
Estonia						
Mean	0.056	0.411	23.7	0.494	1240.3	0.245
Std. Dev.	0.014	0.027	7.8	0.052	977.5	0.079
Hungary						
Mean	0.098	0.535	6.2	0.888	4801.6	0.292
Std. Dev.	0.011	0.049	0.3	0.001	2328.2	0.116
Latvia						
Mean	0.084	0.501	12.2	0.497	617.3	0.349
Std. Dev.	0.010	0.034	1.4	0.033	560.6	0.167
Lithuania						
Mean	0.063	0.512	9.6	0.593	833.7	0.334
Std. Dev.	0.005	0.036	1.8	0.100	573.7	0.131
Poland						
Mean	0.141	0.492	6.5	0.672	9551.8	0.205
Std. Dev.	0.004	0.019	0.7	0.042	5959.4	0.186
Romania						
Mean	0.185	0.647	3.3	0.928	4796.7	0.614
Std. Dev.	0.015	0.050	0.1	0.027	4051.3	0.154
Slovakia						
Mean	0.054	0.468	30.1	0.912	3006.2	0.259
Std. Dev.	0.005	0.040	2.2	0.018	1200.6	0.056
Slovenia						
Mean	0.191	0.482	6.3	0.580	725.4	0.582
Std. Dev.	0.015	0.032	0.01	0.017	477.5	0.261

5 ECONOMETRIC RESULTS

We present our empirical results on determinants of the agricultural sector efficiency in three steps. First, we focus on our baseline estimations. Second, we present the augmented model with the institutional and infrastructure variables. Finally, we check the role of urban-rural income gap.

5.1 The baseline estimations

In the baseline model the NMS-10 agricultural sector efficiency (Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia), which is expressed by DEA technical efficiency scores, is explained by

natural agricultural factor endowment, farm specialization, average farm size, farm fragmentation, and FDI. As we can see from regression (1) in Table 3, the average farm size and the smaller farms are positively and significantly associated with the agricultural efficiency, and vice versa FDI. In regression (2) in Table 3 we include additionally the EU dummy variable. It is positively and significantly associated with the agricultural sector efficiency. In this regression specification also the regression coefficient for the natural agricultural factor endowment variable become significant with a positive sign. The regression coefficient, which is pertained to the NRA variables in regression (3) in Table 3, is not found significant. Finally, regression (4) in Table 3, which includes additional explanatory variable for institutional and agricultural policy reforms reinforces the findings concerning a positive and significant association of the agricultural sector efficiency with the natural agricultural factor endowments, average farm size, the percentage of small-scale farms as a measure of farm fragmentation, and the EU dummy variable, but a negative and significant association with the FDI variable and the agricultural policy reforms. The regression coefficient for farm specialization is not found significant.

Table 3: Determinants of agricultural efficiency – the baseline model for NMS-10

	DEA technical efficiency scores			
	(1)	(2)	(3)	(4)
Factor endowment	0.374	0.710**	0.745*	0.748**
Farm specialisation	0.467	0.188	0.199	0.121
Average farm size	0.005***	0.005***	0.005***	0.005***
Farm fragmentation	1.073***	1.169***	1.164***	1.181***
Foreign direct investment	-0.009**	-0.015***	-0.015***	-0.015***
EU		0.110***	0.110***	0.097***
NRA			-0.017	
Agricultural policy reforms				-0.006***
Constant	-0.533***	-0.539***	-0.539***	-0.503***
N	60	60	60	60
R^2	0.7968	0.8389	0.8391	0.8435

Notes: * p<0.1; ** p<0.05; *** p<0.01. Parameters are estimated by the Prais-Winsten estimator. The z values are computed from standard errors that are corrected for heteroscedasticity and contemporaneous correlation of error terms across panels.

5.2 Models with reform and infrastructure variables

5.2.1 Principal component analysis

We expect that the agricultural sector efficiency is determined by reform and infrastructure variables in the analysed countries using EBRD (2008) indices. The focus is on the variables explaining in the areas of privatisation, liberalisation, and restructuring reforms, and infrastructure development. To estimate the impact of these variables on the agricultural sector performance, we first used a principal component analysis to reduce dimensionality and multicolinearity from a larger number of variables and to select the relevant common general components of variables.

The preliminary analysis based on the scree test criterion yields three principal components that account for 76.5% of the variance of the analysed reform and infrastructure variables. The first principal component has positive weight for each of the analysed variables, but each weight is rather low or less than 0.5 (Table 4). The higher positive weights are seen for securities markets and non-bank financial

institutions, telecommunications, and restructuring, and can be interpreted as an index of the reforms and institutional development. The second principal component has high positive weight for railways and positive weights also for each of the other analysed infrastructure variables, and a higher negative weight for small scale privatisation. The second principal component can be interpreted as an index of the level of railway infrastructure development. The third principal component has a high positive weight greater than 0.5 for large scale privatisation and close to 0.5 for price liberalisation, and can be interpreted as an index of liberalisation.

Table 4: Principal components weighting factors for NMS-10

Reform	Component 1	Component 2	Component 3
Large scale privatisation	0.2242	-0.0622	0.5371
Small scale privatisation	0.2496	-0.4132	-0.2885
Enterprise restructuring	0.3565	-0.2384	-0.0721
Price liberalisation	0.1508	0.2527	0.4946
Competition policy	0.3267	-0.2742	0.0163
Banking reform & interest rate liberalisation	0.3495	-0.1146	0.0866
Securities markets & non-bank financial institutions	0.3712	0.0086	-0.2048
Overall	0.2852	0.4466	-0.0917
Telecommunications	0.3707	0.0865	-0.0006
Railways	0.0577	0.5087	-0.0501
Electricity	0.1936	0.0253	0.3957
Roads	0.1312	0.3503	-0.3549
Water	0.3069	0.1653	-0.1879
Cumulative proportion	0.451	0.621	0.765

Kaiser-Meyer-Olkin measure of sampling adequacy: 0.692.
Source: Own calculations based on EBRD dataset.

5.2.2 The panel estimations

Table 5: Determinants of agricultural efficiency: the augmented model with the institutional and infrastructure variables for NMS-10

	DEA technical efficiency scores (5)
Factor endowment	1.822***
Farm specialisation	0.551*
Average farm size	0.005***
Farm fragmentation	0.932***
Foreign direct investment	-0.011**
Reform component 1	0.018**
Reform component 2	-0.019**
Reform component 3	0.041***
Constant	-0.632***
N	60
R^2	0.8181

Notes: * p<0.1; ** p<0.05; *** p<0.01. Parameters are estimated by the Prais-Winsten estimator. The z values are computed from standard errors that are corrected for heteroscedasticity and contemporaneous correlation of error terms across panels.

To test the impact of transition and reform processes on the agricultural sector efficiency, we investigate this by the augmented baseline model with the additional institutional and infrastructure variables: reform components 1, 2 and 3 (Table 5). The size of the regression coefficient, which is pertained to the natural agricultural factor endowment variable has increased substantially and is now significant. The positive association with the farm specialization has become significant as well. The previous findings for the regression coefficients that are pertained to the average farm size and the percentage of small-scale farms (farm fragmentation) are reinforced. The farm efficiency is positively and significantly associated with the principal component 1 (index of the reforms and institutional development) and the principal component 3 (index of liberalisation), but negatively and significantly associated with the principal component 2 (index of the level of railway infrastructure development). This latter finding indicates that better infrastructure development provides opportunities for labour outflows from farms, which negatively affects the agricultural sector efficiency.

5.3 The role of urban-rural income gap

Table 6: Determinants of agricultural efficiency: the role of urban-rural income gap for NMS-6

	DEA technical efficiency scores				
	(6)	(7)	(8)	(9)	(10)
Factor endowment	-1.108	-1.179*	-0.515	-0.289	-0.593
Farm specialisation	1.024***	1.070***	0.686*	0.782**	0.742*
Average farm size	0.004***	0.004***	0.005***	0.005***	0.005***
Farm fragmentation	1.425***	1.342***	1.337***	1.380***	1.474***
Urban-rural income gap	-0.034	-0.047	-0.015	-0.025	0.430*
Foreign direct investment		-0.004	-0.010**	-0.009*	-0.007
EU			0.094**	0.092**	0.072*
NRA				-0.116	
Agricultural policy reforms					-0.032*
Constant	-0.999***	-0.918***	-0.812***	-0.906***	-0.960***
N	36	36	36	36	36
R2	0.8030	0.8063	0.8280	0.8380	0.8509

Notes: * p<0.1; ** p<0.05; *** p<0.01. Parameters are estimated by the Prais-Winsten estimator. The z values are computed from standard errors that are corrected for heteroscedasticity and contemporaneous correlation of error terms across panels.

In our baseline model specification in regression (1) in Table 1, we replace the FDI variable with the urban-rural income gap variable, which is presented in regression (6) in Table 6. Due to missing data, the regressions in Table 6 are estimated for NMS-6 (Bulgaria, the Czech Republic, Hungary, Poland, Romania, and Slovakia). The regression coefficient pertaining to the average farm size remains similar as well as for the small-scale farms, which has increased. The increase is also seen for the farm specialization, which is now significant. On the contrary, the sign for the regression coefficients pertaining to the urban-rural income gap and the natural agricultural factor endowment have a negative sign, but are not significant. In regression (7) is included the FDI variable, which is insignificant, but the negative association pertaining to the natural agricultural factor endowment becomes significant, and vice versa, when the EU dummy variable, which is significant, is included in regression (8). When the NRA variable, which is insignificant, is included in the regression (9) specification, the results do not change considerably. This implies that the NRA has not had neither

direct nor indirect considerable affect on agricultural efficiency. Finally, there are some changes in regression (10), when instead of the NRA is used the variable for agricultural policy reforms, which has a slightly significant negative affect on the agricultural sector efficiency. The negative regression coefficient pertaining to the FDI variable becomes insignificant, but as a striking finding, the association between the agricultural sector efficiency and the urban-rural income gap becomes positive and significant. These results suggest that the institutional and agricultural policy reforms have caused agricultural efficiency negatively, but at the same time the urban-rural income gap with job flows and farm labour adjustments have caused agricultural efficiency positively.

6 CONCLUSIONS

We have investigated the agricultural sector efficiency, which is measured by the DEA technical efficiency scores. The differential in the agricultural sector efficiency by the analysed NMS-10 is explained by a combination of institutional and policy reform factors, technology and relative natural agricultural factor endowments, farm structures and scale economies that have evolved or emerged from the transition process, farm specialization, FDI, NRA, EU integration, and urban-rural income gap.

Our findings support some findings of empirical studies in agricultural and development economics. We have found a positive association between farm size and agricultural efficiency. Relative natural agricultural factor endowments are important for agricultural efficiency in a positive way. The affect of FDI on agricultural efficiency is ambiguous. This is consistent with the evidences that first, several FDI firms contracted many agro-food firms in these countries to gain the market access, and second, reflects some recent development in FDI outflows from the NMS. Consequently, in several cases FDIs are used to buy the local markets by closing down the former local agro-food firms and import products, which have caused negatively agricultural efficiency. Small-farm structures and farm specialization have caused the agricultural sector efficiency in a positive way. Large-scale farms in NMS are still mainly multi-product farms.

Special emphasis is on the institutional and infrastructure variables, the role of urban-rural income gap, and the EU accession. The EU accession variable covers the pre- and post-EU accession period, which has caused agricultural efficiency in a positive way. The single market provides development opportunities for greater agricultural efficiency within a new institutional and policy environment in an enlarged and more market competitive market structures with the globalization of food supply chains.

The mixed results are found on how institutional framework and policy reforms affect the relative agricultural sector efficiency. The results suggest a positive association of agricultural efficiency with institutional and reforms development and liberalisation, while a negative association with infrastructure development. Moreover, the association between the agricultural sector efficiency and agricultural policy reforms is found significantly negative. These results suggest that the agricultural sector efficiency has been determined by labour flows and employment adjustments at a farm and agricultural sector level. This finding is reinforced further, when in the regression are at the same time included the variables for the agricultural policy reforms and the urban-rural income gap suggesting that the institutional and agricultural policy reforms have caused agricultural efficiency negatively, but the urban-rural income gap with job

flows and farm labour adjustments have caused agricultural efficiency positively. However, mixed results for the urban-rural income gap can be also a consequence of the labour market mismatch, where urban demand is for different labour than is supply of rural job seekers. While good infrastructure may foster the people to leave rural areas and agriculture, there might be also some market imperfections, which limit the job flows from rural to urban areas such as the price differential and availability of housing and similar living conditions in urban areas.

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