Comparative analysis of the economic role of agriculture in the EU countries

Komparatívna analýza ekonomického postavenia poľnohospodárstva v krajinách Európskej únie

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Abstract: The role of agriculture within the frame of the enlarged EU is analysed in this paper. There is a requirement to perceive the tendency towards the downgrading of the status of agriculture in the national economy of the EU countries with the respect of the differences in the importance of agriculture mainly in the countries that are the new EU members. The role of agriculture is characterised by the following indices: share of the agricultural employees in the total employment, share of the added value of agriculture in the GDP, and index of the value added per one agricultural worker. These indices are the base for the construction of the "index of economic importance of the agriculture" which are the countries ranged by. A multidimensional classification of the countries was realised by the cluster analysis that divided the countries into three clusters accordingly to their similarity with regards to the importance of their agriculture in their national economy.

Key words: European Union countries, agriculture employment, share added value of agriculture in the Gross Domestic Product, Value added per one agricultural worker, cluster analysis

Abstrakt: V príspevku sa analyzuje postavenie poľnohospodárstva v rámci krajín rozšírenej Európskej únie. Tendenciu znižovaní postavenia poľnohospodárstva v rámci národného hospodárstva krajín EÚ je potrebné vnímať diferencovane vzhľadom na rozdielnosti v dôležitosti poľnohospodárstva obzvlášť v krajinách, ktoré sú novými členmi EÚ. Postavenie poľnohospodárstva je charakterizované prostredníctvom ukazovateľov – podiel zamestnaných v poľnohospodárstve na celkovej zamestnanosti, podiel pridanej hodnoty vytvorenej v poľnohospodárstve na hrubom domácom produkte a prostredníctvom ukazovateľa vytvorenej pridanej hodnoty na poľnohospodárskeho pracovníka. Na základe uvedených ukazovateľov je konštruovaný "index ekonomickej dôležitosti poľnohospodárstva", podľa ktorého sú krajiny usporiadané. Metódou zhlukovej analýzy je tiež uskutočnená viacrozmerná klasifikácia krajín na tri skupiny podobných si krajín z hľadiska dôležitosti poľnohospodárstva v ich národnom hospodárstve.

Kľúčové slová: krajiny Európskej Únie, podiel poľnohospodárstva na zamestnanosti, podiel poľnohospodárstva na hrubom domácom produkte, pridaná hodnota v poľnohospodárstve, zhluková analýza

INTRODUCTION

The phenomenon of the progressive downgrading of the economic role of agriculture in the developed countries is widely accepted, and moreover evident in the development analysis of the longer time horizon indices of the share of agriculture in both employment and GDP (Figure 1). However, historical background and geographical location of the individual EU countries determine to a large extent certain particularities of their agricultures, and thereby heterogeneity in their roles, and furthermore their defying the general tendencies towards globalisation with regards to the role of agriculture. It refers mainly to the new EU members, and therefore the issue of agriculture is in the EU now so widely discussed, even controversial.

It is highly problematic to determine an indicator for the measurement of the economic role of agriculture in the national economy, since a formulation of this task leads to the multidimensional classification of the countries from the point of view of several partial indicators, with the importance of proper choice and weight assignment of the individual indicators taking into account multifunctional character of agriculture. Human Development Index (HDI) for the annual classification and ranking of the countries all over the world has recently been playing a highly important role in the comparative studies of the level of the economic development. This index also considers transformation of multidimensional to monodimensional classification. Human Development Index (HDI) is calculated as a simple average of three indices: Live Expectancy Index, Education Index and Gross Domestic Product Index. Some critics of the Human Development Index, Halis Ekder (1994) share reservations about the normalisation of the individual HDI components. They point out the facts, that e.g. a change of maximum or minimum value of the index in the studied sample of countries will influence the Human Development Index.

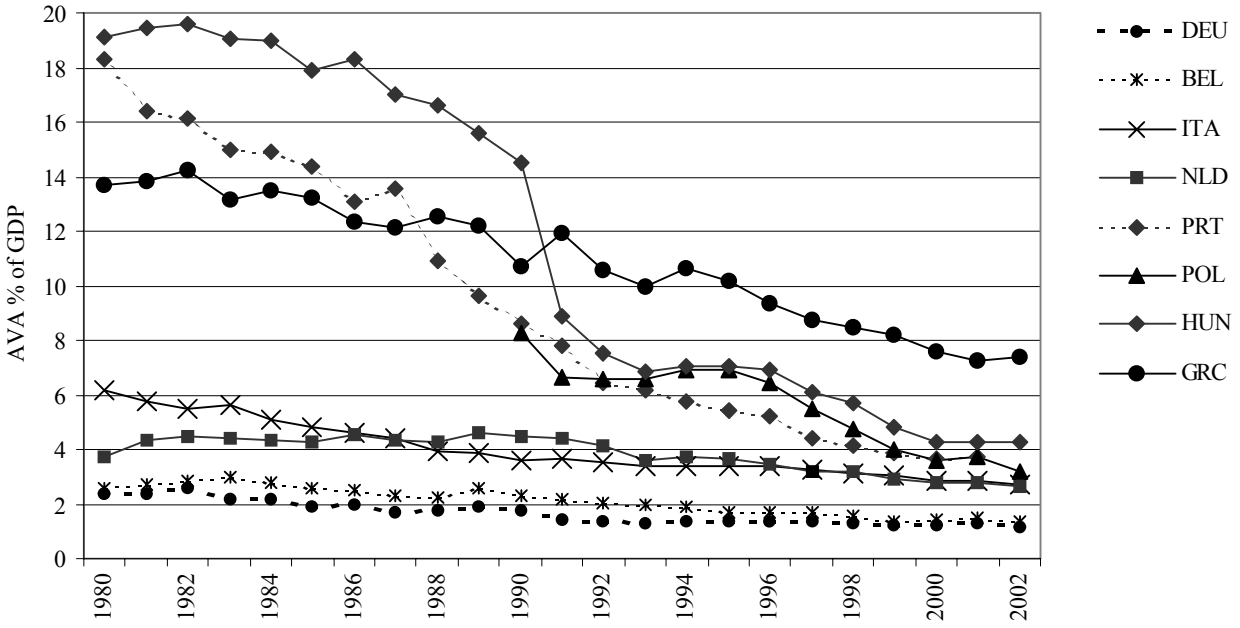

Figure 1. Agriculture Value Added % of GDP

However, the HDI is constructed as a rate of the relative comparison of the development level of the countries at a certain time. Absolute value of the index plays no significant role, as the whole analysis is based on the comparison of the country ladder rank position Human Development Report (2000, 2001, 2002, 2003).

Agricultural issues are extremely complicated. This paper narrows down the concept of the role of agriculture considering just the economic aspect without respects to the other roles of agriculture – first of all its role in the rural sustainable development. Comparative analysis of the EU countries from the point of view of the economic role of their agriculture is realised by numerous methodological approaches, one of which is an analogy to the calculation of the Human Development Index.

MATERIAL AND METHODS

The paper gives a comparative analysis of the economic role of agriculture in the 21 EU countries[1)], based on three indices:

– Agriculture Value Added (% of GDP) x_1
– Employment in Agriculture (% of total employment) x_2
– Agriculture Value Added per Worker (constant 1995 US$) x_3

Other data used for the analysis of the role of agriculture in the national economy are as follows: Gross Domestic Product per capita (GDP per capita in PPP, current international $), Gross Net Income (GNI) per capita, and Atlas method (current US$). World Bank database from the year 2002 served as a data resource. Four of the 25 EU countries (Cyprus, Malta, Ireland, Luxembourg) were not analysed because of not accessible complete data. Input data are given in the Table 1.

In the first part of the analysis, there are calculated partial indices for the individual countries and for the considered indicators according to the methodology for calculation of the Human Development Index. (HDI), which consists of three partial components: Life Expectancy Index, Education Index, GDP Index. Our "Total Agricultural Index" (*TAI*) consists of three indices:

– Share of in GDP Index *(I1)*
– Share of the Employment in Agriculture in Total Employment Index (*I2*)
– Agriculture Productivity Index (calculated from the Indicator of the Agriculture Value Added per Worker) (*I3)*

TAI Index is formulated as a "deficiency rate" (or "surfeit rate") of the country in the entire three individual fields – Agriculture Value Added – % of GDP (x_1), Employment in Agriculture of Total Employment (x_2), Agriculture Value Added per Worker (x_3). Considering "surfeit" or "excess" it is reasonable to give attention to the distance that is for the country necessary to cover to reach what is recommended as "covetable direction or aim". Thus $\boldsymbol{I}_{ij}$ is defined as a "surfeit rate" for the country j with reference to the variable x_i as

[1] Belgium (BEL), France (FRA), Denmark (DEN), Netherlands (NLD), United Kingdom (GBR), Sweden (SWE), Germany (DEU), Austria (AU), Finland (FIN), Italy (ITA), Slovenia (SVN), Spain (ESP), Czech Republic (CZE), Hungary (HUN), Slovak Republic (SVK), Portugal, (PRT), Estonia (EST), Latvia (LVA), Poland (POL), Greece (GRC), Lithuania (LTU)

Table 1. Data sources and quantification of coefficients for countries by indicators

Country	AVA per worker[1]	Index 3 (I3)[2]	AVA % of GDP	Index 1 (I1)[3]	AgrEmp % TEMP[4]	Index 2 (I2)[5]	Average Index I1, I2[6]	GDP per capita[7]	GNI per capita[8]	Total Agric. Index (TAI)[9]	Rank I1, I2[10]	Rank TAI[11]
LTU – Lithuania	3 417.29	0.973	7.091	0.959	16.3	0.842	0.900	10 320	3 670	0.925	2	1
GRC – Greece	13 850.21	0.809	7.356	1.000	16.0	0.825	0.912	18 720	11 660	0.878	1	2
POL – Poland	1 725.29	1.000	3.162	0.343	19.1	1.000	0.672	10 560	4 570	0.781	4	3
LVA – Latvia	2 893.95	0.982	4.688	0.582	15.0	0.768	0.675	9 210	3 480	0.777	3	4
EST – Estonia	3 612.51	0.970	5.450	0.702	6.9	0.311	0.506	12 260	4 190	0.661	6	5
PRT – Portugal	7 629.76	0.907	3.700	0.428	12.7	0.638	0.533	18 280	10 720	0.658	5	6
SVK – Slovak Republic	4 004.15	0.964	4.158	0.499	6.1	0.266	0.382	12 840	3 970	0.576	9	7
HUN – Hungary	6 325.65	0.928	4.300	0.522	6.2	0.271	0.396	13 400	5 290	0.573	8	8
CZE – Czech Republic	6 458.30	0.926	3.790	0.442	4.8	0.192	0.317	15 780	5 480	0.520	11	9
ESP – Spain	22 580.04	0.672	3.388	0.379	6.4	0.282	0.331	21 460	14 580	0.444	10	10
SVN – Slovenia	39 171.80	0.411	3.109	0.335	9.8	0.475	0.405	18 540	10 370	0.407	7	11
ITA – Italy	27 654.20	0.592	2.735	0.277	5.3	0.220	0.249	26 430	19 080	0.363	13	12
FIN – Finland	42 157.47	0.364	3.426	0.385	5.6	0.237	0.311	26 190	23 890	0.329	12	13
AUT – Austria	34 440.38	0.485	2.249	0.201	5.7	0.243	0.222	29 220	23 860	0.310	14	14
DEU – Germany	34 647.32	0.482	1.156	0.030	2.6	0.068	0.049	27 100	22 740	0.193	19	15
SWE – Sweden	40 892.71	0.384	1.805	0.131	2.3	0.051	0.091	26 050	25 970	0.188	18	16
GBR – United Kingdom	31 320.62	0.534	0.967	0.000	1.4	0.000	0.000	26 150	25 510	0.178	21	17
NLD – Netherlands	59 300.13	0.094	2.664	0.266	2.9	0.085	0.175	29 100	23 390	0.148	16	18
DNK – Denmark	65 263.86	0.000	2.567	0.250	3.3	0.107	0.179	30 940	30 260	0.119	15	19
FRA – France	60 468.19	0.075	2.675	0.267	1.6	0.011	0.139	26 920	22 240	0.118	17	20
BEL – Belgium	57 366.74	0.124	1.343	0.059	1.8	0.024	0.042	27 570	22 940	0.069	20	21

(1) Agriculture Value Added (% of GDP), (2) Index I3, (3) Agriculture Value Added per Worker (constant 1995 US$), (4) Employment in Agriculture (% of total Employment), (5) Index I2, (6) Average of Indices I1 and I2, (7) GDP per Capita (PPP US$), (8) GNI per capita, (9) Average of indices I1, I2 and I3, (10) Ranking countries by average C1 and C2, (11) Ranking countries by Total Index of Agriculture

$$I_{ij} = \frac{\max_k \{x_{ik}\} - x_{ij}}{\max_k \{x_{ik}\} - \min_k \{x_{ik}\}}$$

where:
$i = 1, 2, 3$ index of indicators
$j = 1, 2, ... n$ index of the country

The indices are recalculated such as each country j surfeit/deficiency indicator $\boldsymbol{I_{ij}}$ $i = 1, 2, 3$, lies within the range 0–1. Average deficiency index I_j for the country j from the above-mentioned indicators is defined as a simple non-weighted average of $\boldsymbol{I_{ij}}$.

$$TAI = I_j = \frac{1}{3}\sum_{i=1}^{3} I_{ij}$$

Considering the character of the third indicator – Agriculture Value Added per Worker, with covetable higher values, index (*I3)* for it is composed as

$$I_{ij}^{*} = (1 - I_{ij})$$

Surfeit is interpretable, in the Total Agricultural Index (TAI) of the country *j,* as an excess (above-average) role of agriculture in the country, connected with the lower productivity of this sector. The ranking of countries is calculated on the base of the mean of the first two indices **I1** and **I2,** plus the calculation of TAI index, with the lowest ranking of those countries where the agriculture still plays an important role from the point of view of its share in employment, as well as its share in GDP, with incorporation of the lower productivity of this sector.

Multidimensional classification of the countries by the three above-mentioned indicators concurrently (Agriculture Value Added per Worker – x_1, Employment in Agriculture – % of Total Employment – x_2, GNI per capita – x_3) is stated in the next part of this paper, with cluster analysis as a methodological tool of multidimensional classification.

The general task for cluster analysis can be formulated as follows: Consider set n of objects and each of them is characterized by p attributes. The results of the measurements create n of p-term vectors $x_1, x_2, ..., x_n$, set of all observation is created by a matrix $X = \{x_1, x_2, ..., x_n\}$. The task of the cluster analysis resides in the decomposition of the set X to the set $S = \{S_1, S_2, ..., S_m\}$, where m is the number of clusters of objects x_i. The number of clusters can range from 1 to m.

As it figures from the definition of the cluster analysis, the notions "similarity" or "dissimilarity" are determining for the creation of the clusters, with the measure of their similarity as the formulation of the clusters. The similarity of the object can be measured by various means, the most frequent one is the Euclid distance, which can be expressed as follows:

$$d_1(X_i, X_j) = \sqrt{\sum_{k=1}^{p} (x_{ik} - x_{jk})^2}$$

where x_{ik} is the value of the k-th variable of the i-th object, and x_{jk} is the value of the k-th valuable of the j-th object. This measure can be also found in the form of the power of two and in the form of an absolute value.

The third part of the analysis is concentrated on the exploration of the relationship between the indicators of the role of agriculture in the economy. Power functions in the following form are used:

$$y_j = b_o \times x_j^{b_1}$$

where:
y_j, x_j are in the order values of the dependent and independent variables of j-country
b_o, b_1 are the parameters of the functions. The parameters are estimated by using the Single Least Square Methods.

RESULTS AND DISCUSSION

The Index of the Share of Agriculture Value Added in the GDP (I1) and the Index of the Share of Agriculture Employees in the Total Employment (I2) for all 21 countries with accessible data is given in the first part of the analysis. The lowest value of the Share of Agriculture Value Added in the GDP are found in the United Kingdom (0.967%), the highest value of this index can be found in Greece (7.356%). The Index of the Agriculture Employees is again the lowest in the United Kingdom (1.4%), the highest one is evident in Poland (19%). Coefficients I1 a I2 were calculated by the above-mentioned methodology (Table 1), and the average index is calculated from them. This average index serves as a base for the ranking of the countries by the importance of their agriculture in decreasing order (Table 1). According to this classification of the countries, the most important economic role has the agriculture in Greece (1), Lithuania (2), Latvia (3), Poland (4), Portugal (5), and Estonia (6). The countries with the lowest share of agriculture in the total employment and the GDP were – United Kingdom (21), Belgium (20), Germany (19), Sweden (18), France (17), Netherlands (16), and Denmark (15). The other countries (including the Slovak Republic – 9) create the "middle group". The Index of the Agriculture Value Added per Employee (I3) is attached to the first two ones. This index reflects certain level of a labour productivity in the given sector, and with regards to its character it is calculated by the inverse relation, i.e. the higher its value, the lower labour productivity in agriculture of the given sector. The countries are ranged by the average index calculated from entire three indices – Total Agriculture Index (TAI), Table 1. The ranking of the countries was not substantially changed. The first group is created by the countries with a higher share of agriculture in the employment and the GDP, though a lower labour productivity: Lithuania (1), Greece (2), Poland (3), Latvia (4) Estonia (5), and Portugal (6). The countries with a lower share of agriculture in the employment and the GDP alongside with a higher labour productivity rank last: Belgium (21), France (20), Denmark (19), Netherlands (18), GBR (17), Sweden (16), and Germany (15). The other countries (in-

cluding the Slovak Republic – 7) create the "middle group".

The multidimensional classification of the countries into the three groups of countries similar from the point of view of entire three indicators realized by the method of cluster analysis did not bring significantly different results, and thus it confirmed the possibility of using the Total Index in agriculture for the mutual comparison of the countries. The three clusters of the countries were created, as can be seen in the Figure 2. The progression of the clustering is shown by the dendrogram (Figure 3).

Classification of the countries:

Cluster 1: LTU, GRC, POL, LVA, PRT (5 Members)
Cluster 2: EST, SVK, HUN, CZE (4 Members)
Cluster 3: ESP, SVN, ITA, FIN, AUT, DEU, SWE, GBR, NLD, DNK, FRA, BEL (12 Members)

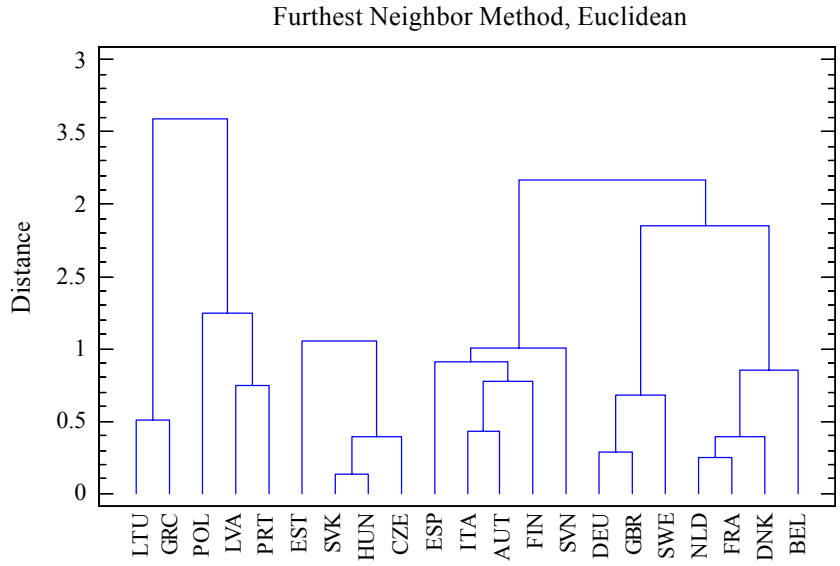

Figure 2. Dendrogram

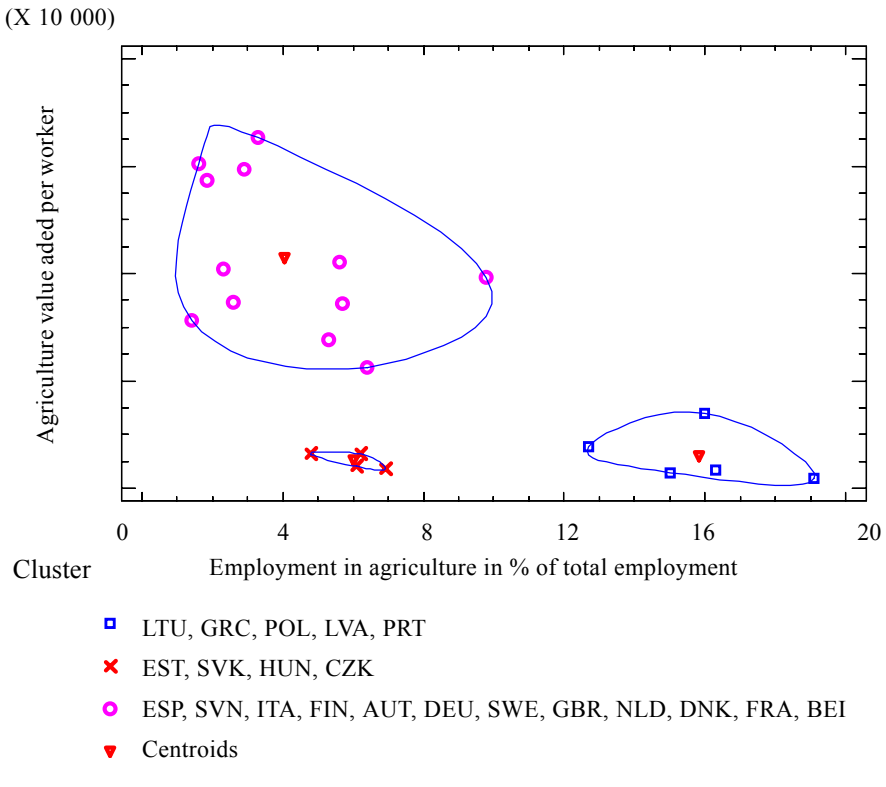

Figure 3. Classification of the countries into three groups

Centroids

Cluster	AVA % GDP	EMP % AG	AVA per work
1	5.19947	15.82	5 903.3
2	4.42455	6.0	5 100.15
3	2.34032	4.06083	42 938.6

Accordingly to the centroids the clusters can be characterized as follows:

Cluster 1: the countries on the low level of the agriculture development – a high share of employment in the agriculture (15.8%), a high share of agriculture value added in the GDP (5.2%), and low labour productivity (5 900 US$) per worker.

Cluster 2: the countries on the relatively low level of agriculture development – a distinctly lower share of employment in agriculture (6%), a relatively high share of the agriculture value added in the GDP (4.4%), and even lower labour productivity in agriculture per worker than in the first cluster (5 100 US$).

Cluster 3: the countries on the high level of the agriculture development and low position of agriculture in the national economy, with a typical slightly lower share of employment in agriculture comparing with the second cluster (4%), a lower share of the agriculture value added in the GDP (2.3%), and high labour productivity per worker (app. 43 000 US$).

The third part is devoted to the estimation of the following relationships:

– Relationship between the Agriculture Value Added per Worker and Employment in Agriculture (Figure 4).
– Relationship between the Share of the Employment in the Agriculture in the Total Employment in the Gross National Income per capita (Figure 5).

The booth regression functions have a power form function, which can be used for the interpretation of the b_1 as an elasticity coefficient. From the first regression function $y = 10\ 1921.x^{-1.0872}$ (Coeff. of determination is 52.5%) it can be figured, that increasing (decreasing) of the Employment in Agriculture by the 1% leads to the decreasing (increasing) of the Agriculture Value Added per Worker by 1.0872% . From the second regression relationship, with the following form: $y = 5\ 682.9.x^{-0.7443}$ (R^2 = 52%), can be concluded, that increasing of the GNI per capita by 1% leads to the decreasing of the Employment in the Agriculture by 0.4%. Both figures 4 and 5 show the grouping of the EU countries into three groups, which are practically identical with the clusters of the countries obtained by the cluster analysis. On the base of a relatively low coefficient of determination, it can be concluded, that the historical background of each country, as well as other characteristics, from which geographical location is of high importance, significantly influence the position of agriculture in national economy. In accordance with the convergence tendencies it can be expected, that the EU countries will gradually become closer from the point of view of the share of agriculture in the total employment and the GDP, and the labour productivity, however certain specification will remain. It refers mainly to the new EU member countries, notably Poland, Lithuania, Latvia, but also the older member countries as Portugal and Greece, where just a gradual downgrade of the economic role of agriculture in their national economy can be expected.

CONCLUSION

The number of EU member states increased by ten on 1 May 2004. Agriculture plays a greater role in the most

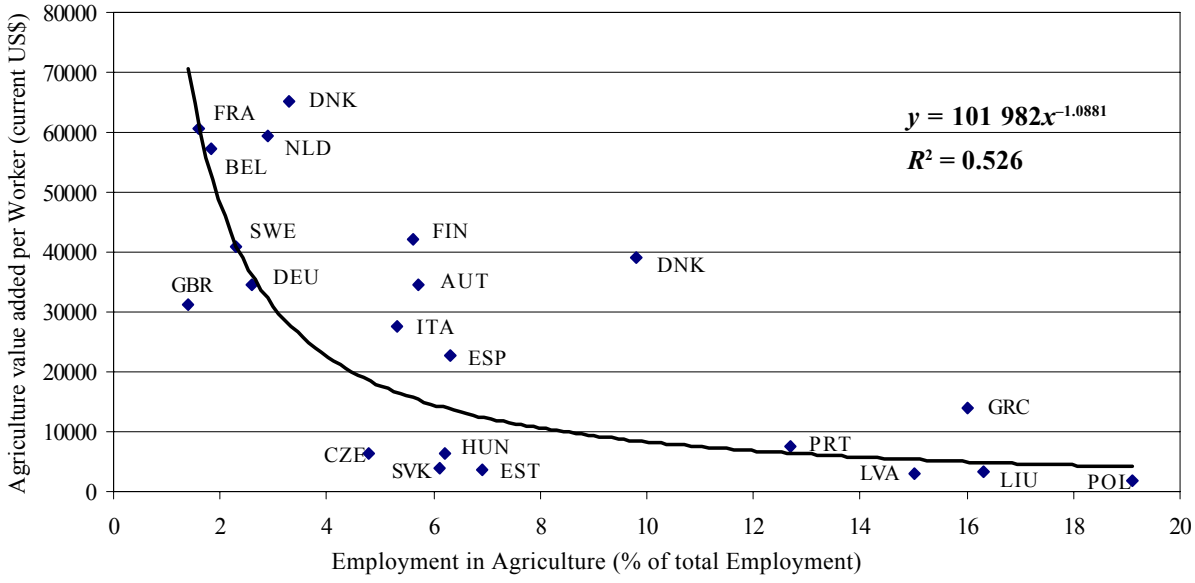

Figure 4. Agriculture Value Added per Worker versus Employment in Agriculture

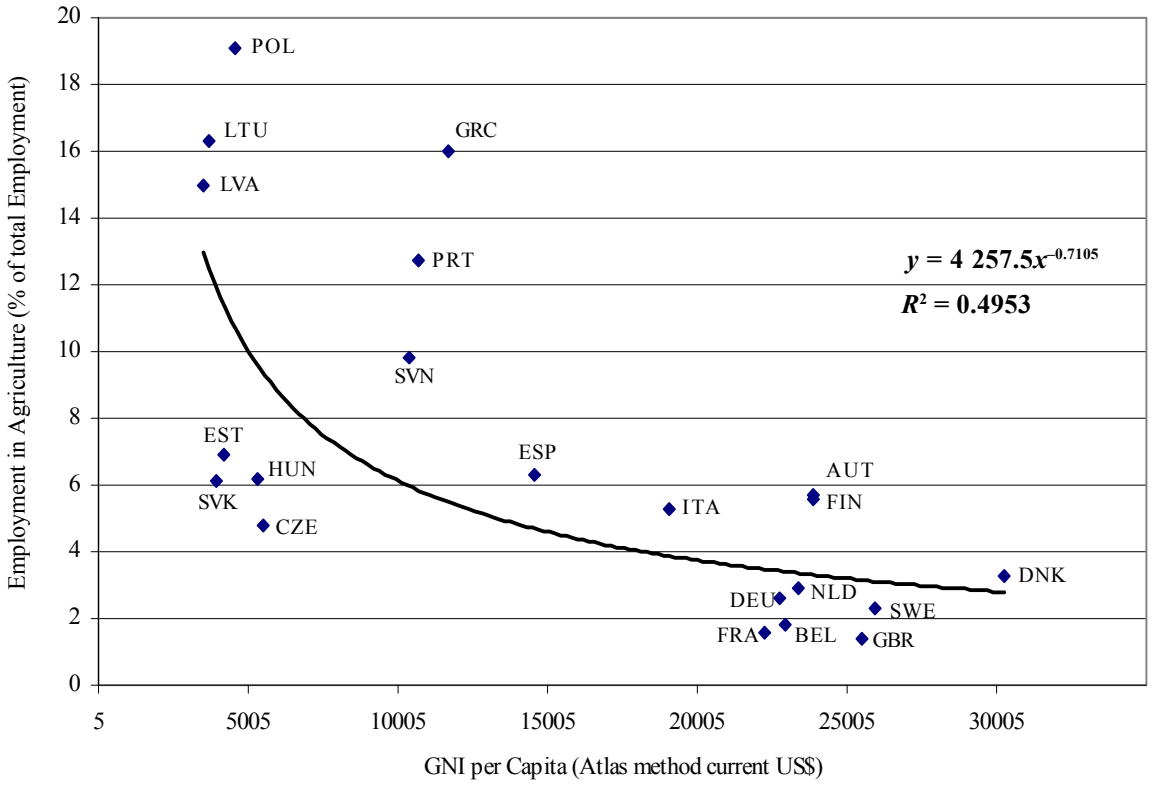

Figure 5. Employment in Agriculture versus GNI per Capita

of the new member states than in the EU-15. In EU-15 there is a higher level of employment in agricultural production in southern than in northern Europe. Employment in agriculture is falling overall. Employment in agriculture in the new member states is much higher than in the EU-15. Agricultural employment accounts for a higher proportion of total employment than the proportion of GDP accounted for by agricultural GVA in EU-15. Although share of agriculture in the contribution to GDP and to GNI varies from one new country to another, agriculture is socially and environmentally a sector of vital importance for all new member states. The statistical methods applied in the paper allow exact to describe and quantify similarities and dissimilarities of the EU member states from the agriculture point of view.

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