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AGRICULTURE LABOR FORCE IN SLOVAKIA AND ITS MEASUREMENT

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Introduction

The political and economic changes that took place in the 1990s significantly influenced the Slovak agro-industrial sector. The move from centrally planned to market oriented economy brought a new entrepreneurial environment and the whole sector passed through a complicated transformation process. During the former socialist period, the Slovakian farms operated under a soft budget constraint with direct intervention of the state. The quantity of output, particularly in cereals, became the major goal of production. Quality and economic efficiency played secondary roles, at the best.

Slovak agriculture followed a similar pattern of development as the other CEE countries. Land tenure and the role of state support to agriculture were among the first targets of this process. Generous subsidies for large-scale farms were reduced or removed and this contributed to a sharp reduction of agricultural production and a significant worsening of the financial results of this sector. An important accompanying measure of the transformation process was linked to significant change in employment. This sector, known previously as a buffer for redundant the labour force, responded quickly and a large proportion of it was pushed out of the sector.

Discussion on agriculture in Slovakia, as well as in all CEE and other candidate countries, have now a new dimension with their involvement in the EU enlargement and particularly in view of the EU common agricultural policy (CAP) and its extension to the future member countries. To this end assessment of current and future production potential and competitiveness of agriculture in individual candidate countries is in the forefront of the policy debate. Productivity of labor in agriculture and farmers' income level became one of the core topics in economic and political debates on the national and European scene. New production quotas and the CAP subsidy scheme proposed for candidate countries make this topic even more sensitive. There is no doubt that detailed and scientifically justified methodology for measuring productivity and competitiveness of agriculture is an urgent economic and political task.

In this paper we present basic information on recent production and productivity development in Slovak agriculture, complemented with some methodological discussion on productivity measures and productivity comparisons among group of producers, regions or countries. Our methodological approach to productivity calculation and comparison is illustrated for eight Slovak administrative regions.

The agricultural sector and recent production results

The Slovak agricultural output dropped significantly over the transitional period. Between 1990 and 2001 its level declined to about 54 %, see table 1. Employment in the agriculture sector showed constant decline over the whole period 1970-2001. Total employment in Slovak agriculture in 1970 was over 450 thousand; by 1980, it decreased to 331 thousand, in 1990 it reached 294 thousand.

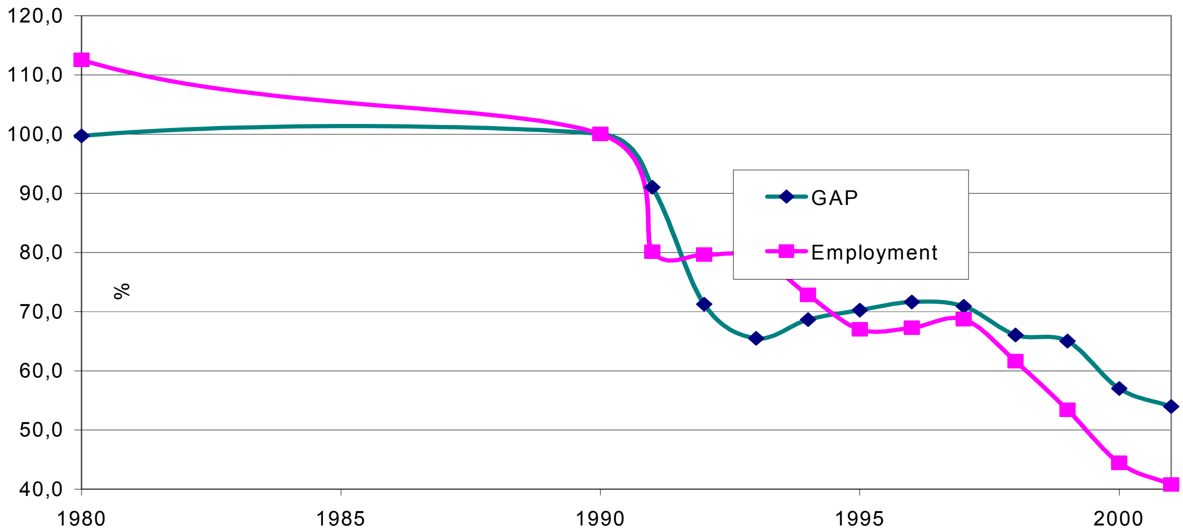
Table 1. Agricultural production, land and labor, 1970-2001

Year	Production		Land		Labor	
	bln SK*	% to 1990	1000 ha	% to 1990	persons	% to 1990
1970	67147	84,93	2628	107,35	451400	153,33
1980	78810	99,68	2477	101,18	331300	112,53
1990	79064	100,00	2448	100,00	294400	100,00
1991	71948	91,00	2449	100,04	235900	80,13
1992	56326	71,24	2447	99,96	234400	79,62
1993	51775	65,48	2446	99,92	233400	79,28
1994	54284	68,66	2446	99,92	214400	72,83
1995	55530	70,23	2446	99,92	197200	66,98
1996	56634	71,63	2444	99,84	198000	67,26
1997	56047	70,89	2445	99,88	202300	68,72
1998	52220	66,05	2444	99,84	181400	61,62
1999	51412	65,03	2442	99,75	157200	53,40
2000	45068	57,00	2441	99,71	130800	44,43
2001	42650	53,94	2440	99,67	120000	40,76

Source: Statistical yearbook, 2001, Bratislava *1995 prices

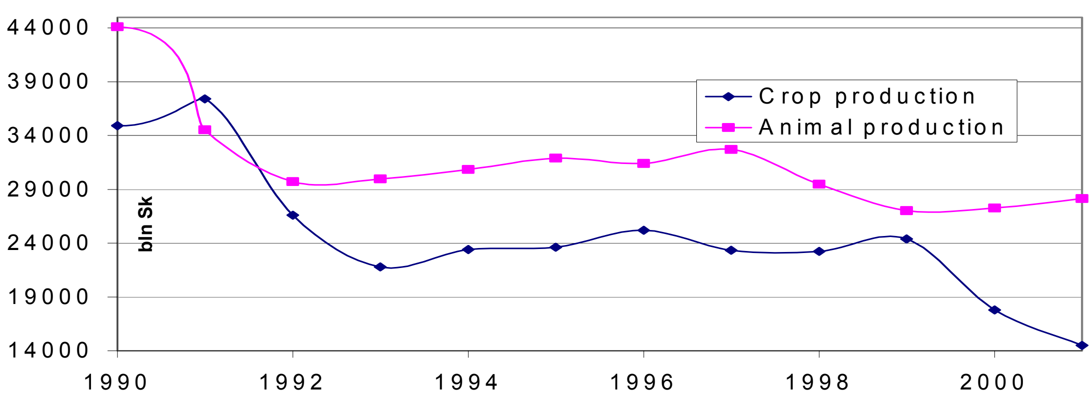
There was a particularly sharp decline in employment over last decade and its level in 2001 was 120 thousands worker. Between 1980 and 2001, the overall reduction in the labor force in Slovak agriculture was 60%, see figure 1. Additionally to systematic decrease in production and employment, there was also other important adjustments taking place within the agricultural sector. After the political changes and release of the market mechanism, agricultural producers changed significantly their production schemes toward more efficient and market oriented activities. The share of crop production, which under the previous regimes was artificially maintained at around 60% of total agricultural production, decreased.

Figure 1. Agricultural production and labor development in Slovakia,1990=100%



The livestock sector, after the initial shocking reduction in 1990-93, has revitalized its production structures and improved significantly its economic performance. A move from the mix-type farms to more specialized commercial units became pivotal in this process. The new position of the livestock sector is reflected in a changed pattern of Slovak agriculture. A previous "60 to 40%" bias toward crop production has been reversed to reciprocal pattern with some "60 to 40%" in favor of livestock. However, both sub-sectors reduced their production, compared to the pre-revolutionary period; in the case of crop production the decrease between 1990 and 2000 was about 60%; in livestock more than 36%.

Figure 2. Crop and animal production
in bln Sk (prices 1995)



Despite these important changes, agriculture has not in any significant way improved its economic performance. Many corporate farms, which still cultivate some 90% of agricultural land, thanks to governmental support, continued over the last decade in their "soft-budget" managerial policies. In particular, large-scale farms in submarginal climate and soil areas are heavily depending on direct state subsidies. Agriculture as a whole has experienced growing financial difficulties. In 2001, only 50 % of the farms reported some level of profit, even when subsidies are included.

Regional distribution of agricultural land, labor and production

The overall statistics on Slovak agriculture offer only limited information on the real situation in this sector. Despite the relatively small size of the country there are significant regional differences in agricultural land and employment distribution. There is still a significant but not transparent state subsidy policy. The evaluation of the economic performance of individual producers and regions is one of the most problematic topics in agricultural economics.

Table 2. Agricultural land, labor and production - regional distribution

Region	Land		Labor		Production		Ag.Land
	1000 ha	% SR	persons	% SR	bln Sk *	%SR	ha-worker
Bratislava	96	3.93	3621	4.10	3185	6.05	26.5
Trnava	294	12.04	13653	15.44	9667	18.35	21.5
Trencin	187	7.66	8665	9.80	5275	10.01	21.6
Nitra	470	19.25	17075	19.31	12721	24.15	27.5
Zilina	248	10.16	9621	10.88	4143	7.86	25.8
Bbystrica	420	17.21	13583	15.36	6474	12.29	30.9
Presov	387	15.85	12565	14.21	5505	10.45	30.8
Kosice	339	13.89	9633	10.90	5714	10.85	35.2

* Prices of 2000

Agricultural land represents in Slovakia 2.441 mil hectares, of which 1.567 mil (64,2%) is arable land with highly uneven regional distribution, see table 2. The largest share of agricultural land is located in the Nitra region and represents 19.25% of the Slovak total. The smallest region is Bratislava with less than 4% of the land. The distribution of the labor force also varies significantly. The highest share is also concentrated in region the Nitra with 19.3%; with 4% the smallest share was in Bratislava region. Gross agricultural production in these two regions also represents the largest and smallest regional output with 24% for Nitra and 6% for Bratislava region.

Production economics in measuring labor productivity

Significant differences among Slovak regions with respect to available natural resources, different production structures and access to state support in individual regions (producers, countries) complicate their mutual comparison. To compare their production performance, assuming that reliable data on production output (GAP) per unit of input could be used as a core concept and indicator of their average productivity. Numerically average productivity measure (APM) is calculated as GAP/(Sum of inputs). If labor productivity is considered, then

$$\mathbf{APM_{Labour} = GAP \,/\, Labor} \qquad (1)$$

where Labor could be expressed in physical terms (persons, expressed in full time equivalents, or and preferably in number of hours worked) and/or in terms of salaries used to compensate this resource. It should be underlined that APM-Labor indicator as expressed in (1) links the single input (Labor) to entire production output GAP without reflecting real complementarity and substitutionality effects among different resources. To reflect these aspects of productivity, some additional measures, particularly that of marginal productivity should be considered.

Let us consider the production function $\mathbf{y = f (F_1, F_2, \ldots, F_n)}$. The average productivity measure (APM) of resource $\mathbf{F_k}$ is calculated according (1) as

$$\mathbf{APM = y \,/\, F_k.}$$

The average production measure has limited information value and should be complemented with the marginal productivity measure (MPM) of resource $\mathbf{F_k}$ where MPM is defined as the first derivative of function **y** with respect to $\mathbf{F_k}$, or

$$\mathbf{MPM = dy/d\, F_k} \qquad (2)$$

In relation to the average and marginal productivities an analogy to average and instantaneous velocities. In a simplified case, if two production factors F1 and F2 are considered with linear production function

$$\mathbf{y = a + b_1{*}\, F_1 + b_2{*}\, F_2} \qquad (3)$$

then the average productivity measure of factor $\mathbf{F_1}$ would be

$$\mathbf{APM = (a + b_1{*}\, F_1 + b_2{*}\, F_2) \,/\, F_1 = b_1 + 1/\, F_1\, (a + b_2{*}\, F_2)} \qquad (4)$$

Marginal productivity measure of factor $\mathbf{F_1}$ for the same linear production function (3) is calculated as

$$\mathbf{MPM = d\, (a + b_1{*}\, F_1 + b_2{*}\, F_2)/d\, F_1 = b_1} \qquad (8)$$

An approximation for the marginal productivity measure (1) of factor $\mathbf{F_1}$ could be calculated as an output increase caused by incremental increase in volume of resource $\mathbf{F_1}$ used in production process. Formally it could be calculated as

$$\mathbf{MPM = (a + b_1 * (F_1 + 1) + b_2 * F_2) = y + b_1}$$

where $\mathbf{b_1}$ is the regression coefficient for factor $\mathbf{F_1}$ and value of coefficient $\mathbf{b_1}$ represents marginal productivity measure of input F1, *ceteris paribus*.

For frequently used Cobb-Douglas production function with the same two factors $\mathbf{F_1}$ and $\mathbf{F_2}$, where output $\mathbf{y}$ is defined as

$$\mathbf{y = c_1 * F_1^{\alpha} * F_2^{\beta}} \qquad \mathbf{(5)}$$

the average productivity of the first factor $\mathbf{F_1}$ (e.g. labor) would be

$$\mathbf{APM = (c_1 * F_1^{\alpha} * F_2^{\beta}) / F_1 = c_1 * F_1^{\alpha-1} * F_2^{\beta}} \qquad \mathbf{(7)}$$

Applying the same Cobb-Douglas production function and factor $\mathbf{F_1}$ we can obtain an expression for marginal productivity level as

$$\mathbf{MPM = d\,(c_1 * F_1^{\alpha} * F_2^{\beta}) / d\,F_1 = \alpha * c_1 * F_1^{\alpha-1} * F_2^{\beta}} \qquad \mathbf{(9)}$$

All the above-presented indicators support the definitions of average productivity and could be used as a parallel measure to reflect better the real economic and technological situation of the subjects under evaluation. The main shortcomings of the above indicators became apparent when the substitution effects among different and/or differently valued resources are considered (as it is with majority of transition countries where new technologies are applied with significant impact on employment level).

The last approach in the productivity study is based on the data envelopment analysis (DEA), see reference 1. The importance of this approach is given by the fact that it represents complex measure of an average productivity through information on partial productivities for individual production factors. Through DEA methodology, the concept of "productivity peers" could be derived and used for further and more detailed economic and policy analysis.

To arrive to this point it is needed to define a set of producers/countries/regions and their input and output parameters. Let $P_1, P_2, \ldots, P_n$ be the producers whose output characteristics are defined by vectors $Q_1, Q_2, \ldots, Q_n$ and input characteristics by vectors $X_1, X_2, \ldots, X_n$. The issue is now to examine the possibility to find such linear combination of possible production input-output schemes X^j such, that their combination offers the optimal solution, with regard to $\mathbf{R^k}$ to following problem:

$$\begin{aligned} &\textbf{Min } R^k \\ \textbf{s.t.} \quad &\textbf{Sum } zj * Q^j_i \geq Q_i^k \quad I=1, \ldots, m1 \\ &\textbf{Sum } zj * X^j_i - R^k * X^k \leq 0_I \quad I=1, \ldots, m2 \\ &zj \geq 0, \; 0 \leq R^k \leq 1 \end{aligned} \tag{10}$$

By solving series of tasks (10) we can obtain values R^k for k=1,…,n which serve as the complex efficiency measure for all compared subjects $P_1, P_2, \ldots, P_n$. The producers for which values $\mathbf{R^k} = 1$ generate the set of "efficiency leaders" among the peer group. All other producers are compared relatively to the efficiency level reached by this set of "efficiency leaders". The DEA methodological approach is well supported by linear programming techniques and a broad range of specific software products, see reference 2.

Labor productivity in agriculture - Results and discussion

Land and labor average productivity measures are the most frequently used and it is easy to compare and rank the measures of individual producers/regions/countries. Similarly we can calculate these measures over given time period to compare the dynamics in productivity development. The average labor productivity measure, calculated according (1) as a share of gross agricultural output per worker (in absolute values as well as in relative terms as % to 1990 level) is shown in Table 3.

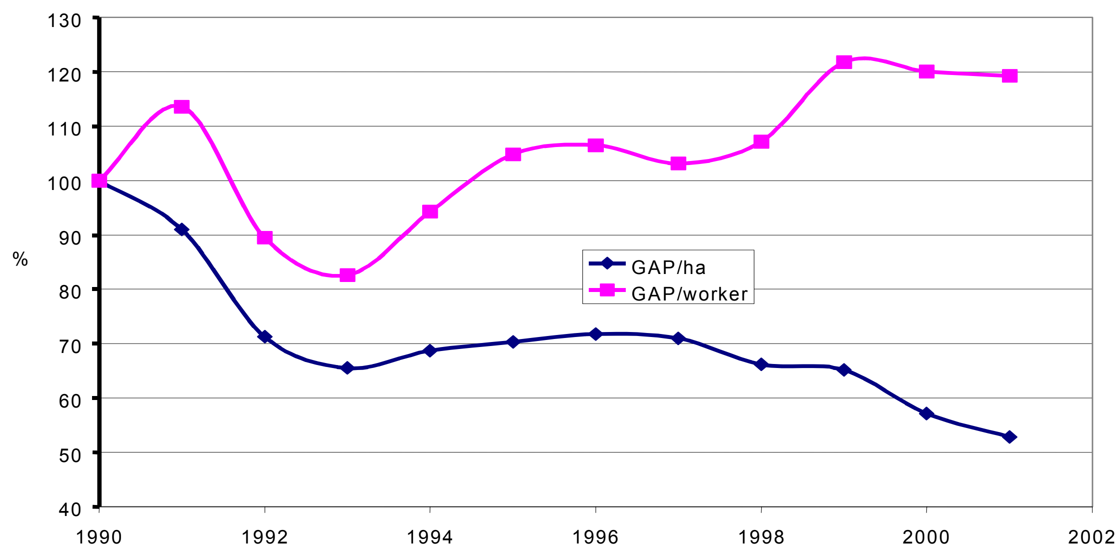
Table 3. Land and labor productivity, 1970-2001

Year	Agricultural production per			
	hectare Sk	worker 1,000 Sk	hectare as % to 1990 level	worker as % to 1990 level
1970	25551	149	79.1	55.4
1980	31817	238	98.5	88.6
1990	32297	269	100.0	100.0
1991	29379	305	91.0	113.6
1992	23018	240	71.3	89.5
1993	21167	222	65.5	82.6
1994	22193	253	68.7	94.3
1995	22702	282	70.3	104.9
1996	23173	286	71.7	106.5
1997	22923	277	71.0	103.2
1998	21367	288	66.2	107.2
1999	21053	327	65.2	121.8
2000	18463	345	57.2	120.0
2001	17480	355	52.9	119.3

The long-term average land productivity and labor productivity shown significantly different development tendencies. On the one hand, there was a decreasing average productivity of land over the last decade, while, on the other hand, there was a small increase in average labor productivity, see figure 4. The average productivity of labor rose from 149 thousands Sk per farm worker in 1970 to 238 thousands Sk in 1980, 269 thousands Sk in 1990 and 355 thousands in Sk per worker in 2001 (in constant prices 1995). Labor productivity in terms of per worker output increased between 1990 and 2000 about 20%. This positive development, however, reflects more decreasing employment rather than better economic performance in agriculture sector.

The above presented productivity measures offer various conclusions and scenarios on the future development of agriculture in Slovakia as well as in other CEEC agriculture. However, in the case of Slovakia, under the current market and policy environment, there is no economic

Figure 4. Average productivity of land and labor, Slovakia, 1990=100 %



reason to expect a recovery of agricultural output to its pre-transition levels, when growth rates and output were maintained at artificially high levels by the central planning system and massive state support. The very fact that the decline in agricultural has stopped may indicate that Slovak agriculture has stabilized at a new equilibrium, indicating what we are able to produce under the open market environment in conformity with market conditions. Struggling for higher labor productivity, one cannot rely on increased production parameters only.

The heterogeneous picture of Slovak agriculture is seen not only from its over all dynamics and time series on productivity development for the country as a whole, but it should also be ~~is~~ seen also from its regional breakdown. There are high differences in average labor productivity indicators calculated for individual regions, see table 4. Production per farmer in Bratislava region highly dominates across the country. In 2000 it reached 879 thousand Sk per worker, in Zilina region it was only 438 thousand Sk per worker. Comparing to the Slovak average, Bratislava region represents 148% and Zilina only 72% of this level.

Table 4. Average productivity of agricultural land and labor - regional indicators

Region	Productivity in 1000 Sk		Productivity as % to SR		Ag land in	
	hectar	farmer	1 ha	1 worker	ha per farmer	% SR
Bratislava	33	880	154	148	27	96
Nitra	27	745	125	125	28	100
Trnava	33	708	152	119	22	78
Trencin	28	609	131	102	22	78
SR	22	596	100	100	28	100
Kosice	17	593	78	100	35	127
Bbystrica	15	477	71	80	31	112
Presov	14	438	66	74	31	112
Zilina	17	431	77	72	26	93

SR= Slovak Republic

In order to analyze the productivity concept deeper and to simplify its comparison among different economic structures, we used additional calculations and comparisons based on two production functions introduced earlier. The output GAP was defined through explanatory variables Land and Labor. At first we used the linear multiple regression function (3). Applying this function we obtained the following results

GAP = -663.283 – 14. 196 * Land + 1.048 * Labor R-multiple = 0.885 $R^2 = 0.783$

To compare and to check these results we used also the Cobb-Douglas production function (5), for which we derived the following parameters

GAP = 0,8169 * Land ^ (-0,439) * Labor^1,233 R-multiple = 0,856, $R^2 = 0{,}733$.

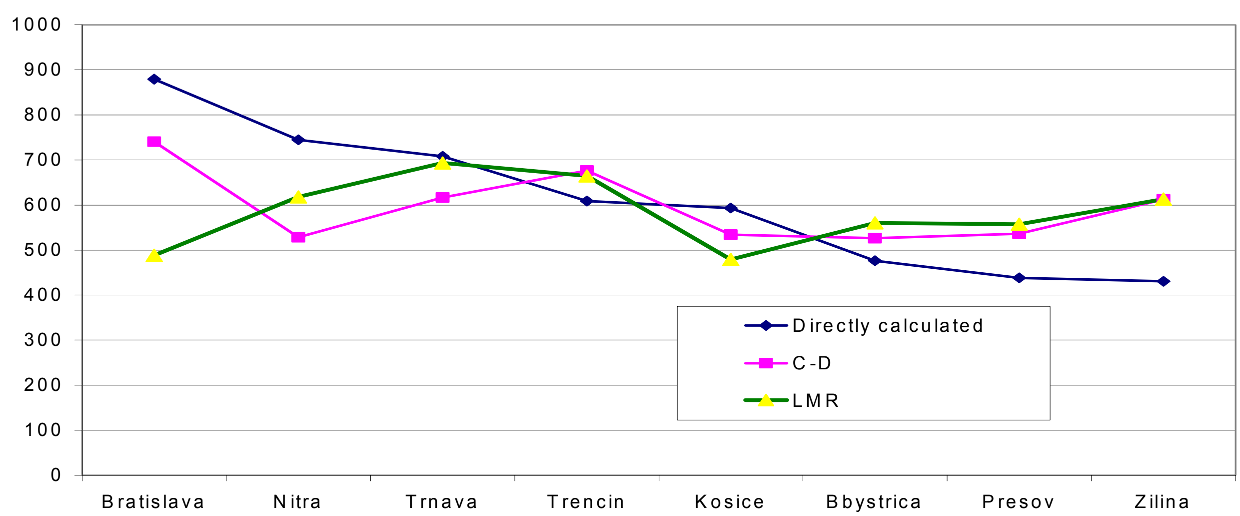
Application of both production functions offers interesting and useful results. The theoretical-expected values of GAP derived through both of these functions according expressions (3) and (5) are compared with their empirical-observed counterpart in Table 5.

Table 5. Summary results on agricultural production and labor productivity in 1000 Sk per worker

	Directly calculated		C-D		LMR	
Region	GAP	ALP	MPM	ALP	MPM	ALP
Bratislava	3185	880	-0.325	740	1.048	488
Nitra	12721	745	-0.232	529	1.048	618
Trnava	9667	708	-0.271	617	1.048	694
Trencin	5275	609	-0.297	677	1.048	665
Kosice	5714	593	-0.235	534	1.048	479
Bbystrica	6474	477	-0.231	526	1.048	560
Presov	5505	438	-0.236	536	1.048	558
Zilina	4143	431	-0.269	612	1.048	613

The graphical illustration of these results is shown on Figure 5.

Figure 5. Average labor productivity measures



In case of Bratislava, the originally calculated average productivity measure for labor was 880 thousand Sk per worker. In case of linear multiple production function the APM was calculated as 488 thousand Sk and through Cobb-Douglas function it is 740 thousand SK per worker. The highest differences among the average productivity measures are observed for the regions of Bratislava and Nitra.

The general conclusions on production and productivity measures enable us to compare any region or producer across the country and to compare its actual economics results with those theoretically expected. Through reliable and internationally comparable data it would be possible to compare the results of agriculture sector in regions and countries with different structure and scope of natural and economic resources. As found through DEA methodology and shown in table 6, there are three productivity leaders among the Slovak regions, namely Bratislava, Trnava and Nitra. On the other hand, there are five regions significantly lagging behind with their productivity parameters. For example, Zilina region reached only 52% of the production output compared with those of "productivity leaders".

Table 6. Peers structure for the Slovak regions calculated on DEA approach

Peers	Bra	Tr	Tn	Ni	Zi	Bb	Pr	Ko	R
Bra	1,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**1,00**
Tr	0,00	1,00	0,00	0,00	0,00	0,00	0,00	0,00	**1,00**
Tn	**0,68**	**0,32**	0,00	0,00	0,00	0,00	0,00	0,00	0,85
Ni	0,00	0,00	0,00	1,00	0,00	0,00	0,00	0,00	**1,00**
Zi	**0,88**	**0,07**	0,00	**0,05**	0,00	0,00	0,00	0,00	0,52
Bb	**0,66**	0,00	0,00	**0,34**	0,00	0,00	0,00	0,00	0,61
Pr	**0,76**	0,00	0,00	**0,24**	0,00	0,00	0,00	0,00	0,55
Ko	**0,73**	0,00	0,00	**0,27**	0,00	0,00	0,00	0,00	0,75

Value R^k could be interpreted in "productivity" terms also in reciprocal way. The $1/R^k$ values of what would be in relative terms output of the k-th producers if its productivity level would reach those of its best peers. In case of Zilina region its output with "good performance" should be almost doubled and reach 191% of the current level. However, despite importance of the above methodologies it is important that the main features of productivity tendencies are confirmed through different approaches, namely through the three differently calculated values of average labor productivity, marginal productivity and DEA approach.

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