University doctoral (PhD) dissertation abstract

Comparative Analysis of Hungarian and East German Agricultural Incomes and Productivity

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CONTENTS

1. Background of the research

The paper offers a comparative analysis of the Hungarian and the East German (New Federal States of Germany, NFS) agricultural incomes and productivity. In his choice of the research topic the author was inspired by his study period spent in Hohenheim University, Germany. In his third year of graduate studies he spent one academic term period there as an ERASMUS student taking lectures in the development of the German agriculture. On his return he prepared and presented a scientific paper at the Students' Scientific Conference and, in continuation, wrote his graduate degree thesis in the topic of the comparison of Hungarian and East German agriculture. These scientific experiences inspired him after graduation to further explore the topic, and develop it into a PhD doctoral research. In order to better elaborate on the methodological and country related issues of the research, he spent several months of DAAD and IAMO research scholarship in the Institute of Agricultural Development in Central and Eastern Europe; Institut für Agrarentwicklung in Mittel- und Osteuropa (IAMO), Halle, Germany under the supervision of Professor Dr. Heinrich Hockmann. On expiry of the scholarship period, Professor Dr. Heinrich Hockmann as co-supervisor continued to further support his doctoral research, which was initially and primarily supervised by Professor Dr. Gábor Szabó.

It is widely known that in the post-transition years the agricultural output of the majority of the Central and Eastern European countries drastically fell with many of them – like Hungary – being left behind the standards of the pre-transition period even to our days. Agricultural transition in East Germany, on the contrary, is considered by several authors to be a success story (Sulyok, 2005; Thiele, 1998; Koester-Brooks, 1997 among others). One may ask what caused the differences of the agricultural development trends between countries with broadly similar historical backgrounds. The author assumes that investigations of the question may lead to useful findings and practical conclusions. Related literature in the topic, however, is poor, only few of them undertake to focus on the analysis of the characteristics of the agriculture in Hungary and in the New Federal States (Darabos et al., 2003). Although different aspects of the transition in Hungary and in the former GDR (German Democratic Republic) have well been researched by several

Hungarian and foreign authors (Kissné 1995, 1997, 1998; Kiss, 2002; Heinrich, 1993; Koester-Brooks, 1997; Koester, 1999, 2007; Thiele, 1998; Roethe-Lissitsa, 2005 among other), to the best knowledge of the author no comprehensive comparative study of their agriculture has so far been prepared. Having reviewed the existing literature, the author concludes that there is an apparent need for income analysis, for the analysis of the impact of subsidies on income trends and for the investigation of the issue of productivity. For this reason, in his dissertation he aims to highlight these points primarily.

The author aspires to answer the following questions:
(1) What are the main characteristics of the agricultural transition in Hungary and in the New Federal States of Germany; what are the country-specific traits of their agricultural development after the transition?
(2) What trends can be identified in the agricultural incomes and in the partial productivity indices; what was the role of subsidies in shaping the income trends?
(3) What trends of total factor productivity (TFP) can be observed, and what are the main sources of its growth?

It is widely agreed that the course of development in the Eastern Federal States of Germany differed in many respect from that of the rest of the transition countries of the early 90s. One of the most marked differences is that none of the latter implemented (succeeded to implement) reforms under the umbrella of the Common Agricultural Policy; non of them was provided with the size of financial support the Eastern Federal States and their agriculture and rural areas were from German governmental and European Union resources. The author assumes, however, that despite the differences, his *comparative analysis* of the Hungarian and East German agriculture will lead to valuable conclusions that may enrich the existing literature on the transition processes and may contribute to their better understanding. Furthermore, now, 20 years after the regime change it is quite clear that transformation, the establishment of "well operating" market economies has proved to be a longer process than it was foreseen in the early 90s. Experiences accumulated during the past twenty years have modified the views on the

economic concept of transition, which makes the revision of most of the ideas of the early 90s inevitable. All this indicates that the initial problem is still with us.

In his choice of the topic and in the definition of the research objectives the author was led by considerations delineated above.

2. Research objectives, Databases and Methods

The relationship between the objectives, methods and databases of the research is demonstrated by Table 1.

Table 1: Research objectives, methods and databases

Objectives	Methods	Databases
1. Analysis of the major characteristics of transition and of agricultural development after the change of the regime	• Literature research • Statistical database research	• KSH, Statistisches Bundesamt, Eurostat database
2. Analysis of the income situation and partial productivity indices	• Comparative economic analysis • Index-calculations	• EAA and FADN database
3. Analyses of the total factor productivity (TFP) and its changes	• Index-calculations • Data Envelopment Analysis (DEA) • Stochastic Frontier Analysis (SFA)	• EAA and FADN database

Source: Author's own illustration

The first objective, the analysis of the major characteristics of the transition, is by nature based on and supported by literature research and statistical analysis. Literature research involves the study of relevant national and international journals, books, dissertation papers, working and discussion materials, and internet resources. Comparative studies as a rule require a high degree of data consistency, which is in some extent not easy to achieve. The requirement of data comparability, however, was not always met before the

late 90s, which in certain issues led the author to shorten the time span of his research. A further difficulty to cope with was that instead of two distinct countries, one country and five federal states of another country were to be compared. Data of reliable quality and composition to base the comparative analysis on became available for researchers only when relevant informational systems – Economic Accounts for Agriculture (EAA) and Farm Accountancy Data Network (FADN) – within the EU harmonization processes had been developed.

In his research the author relies on data of the late 80s and early 90s published by the Hungarian (KSH) and German statistical offices (Statistisches Bundesamt) and – in certain cases – on relevant data by international organizations/researchers and from internet resources.

The second objective, the analysis of the income situation and partial productivity indices is supported by data gained from the Economic Accounts for Agriculture and Farm Accountancy Data Network database. *In terms of methodology,* this involves comparative income analysis and the calculation and comparison of partial productivity indices.

The third objective is targeted at total factor productivity analysis. For TFP analysis *three types of methodology* are commonly used: index calculation, Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA). The latter two methods require the modelling of the production technology by appropriate mathematical approaches (econometric approach for SFA, and linear programming for DEA). The estimation of the production technology then allows the defining of the changes of the total factor productivity and their sources. Literature specifies three factors of TFP change (TFPC): technological change (TCH), technical efficiency change (TEC) and scale efficiency change (SEC).

The above three factors of TFP change can be defined as follows: *technological change* refers to any change in the production process related to time that results: (1) the

improvement of production volume (or quality) without (or with reducing) the number of production factors involved being changed; (2) the reduction of the number of production factors involved without the volume (or with improving the quality) of the products being changed (Andrássy, 1998). *Technical efficiency*[1] is defined as the ratio of actual and potential output at given technical and input levels. Beside technical efficiency and technological change as driving forces, scale efficiency – the level of approximation to the optimum of production scales under given conditions – can also have an impact on productivity change.

In his total factor analysis of Hungarian agriculture, the author applies a model which adds a fourth one to the three factors described above, that of the farm-specific factor expressing unobserved heterogeneity (HET) which makes the estimation of the production function more precise. The neglect of the farm-specific factor may lead to the over sizing of potential output which, in turn, may entail the reduction of the calculated value of technical efficiency and, in final issue, may lead to biases in the judgment of production potential.

The choice of methodology to be used for total factor productivity analyses is always influenced by the availability and precision of data. Since data in this area are scarce, the research methodology was chosen so that it provides for the highest level of efficiency of information collection.

The data acquired allowed for completing the following calculations:

1. The comparison of the agricultural TFP indices in Hungary and in the New Federal States of Germany in years 1998-2007. For this index calculation methods were applied based on aggregate data from the EAA;

2. The decomposition of TFP sources in the German agriculture. For this Data Envelopment Analysis was applied using the data of the regional accounts of the German Economic Accounts for Agriculture in years 1991-2007;

[1] Technical efficiency , by Farrel's (1957) output-oriented definition

3. The decomposition of TFP sources in the Hungarian agriculture. For this data gained from the Farm Accountancy Data Network for years 2001-2007 were used and a special type of Stochastic Frontier Analysis was applied to tackle unobserved heterogeneity.

The index calculations were completed by using the multilaterally consistent Törnquist index. For Data Envelopment Analysis calculations the "DEAP" program was applied (Coelli, 2005). Stochastic Frontier Analysis was based on a model developed by Alvarez et al. (Alvarez et al., 2003, 2004); for the estimation of the model the "Limdep" program was applied (Green, 2008).

3. Research results and conclusions

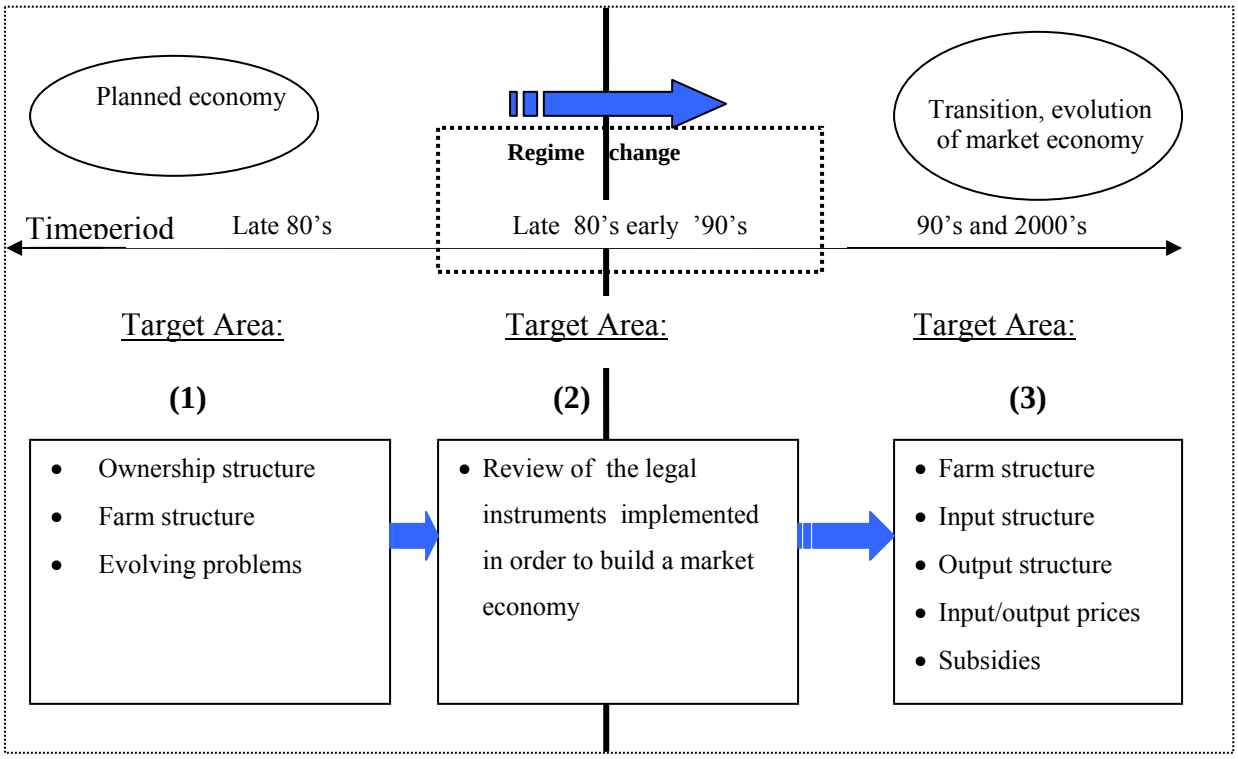
The results are discussed in order of research objectives. Chapter 3.1 discusses the characteristics of the agricultural transition; Chapter 3.2 presents the results of the comparison of agricultural incomes and partial productivity indices; Chapter 3.3 summarizes the conclusions drawn from the TFP analysis.

3.1. Main characteristics of agricultural transition

The timeframe of and the relationship between the areas examined under Objective 1 is demonstrated by Figure 1.

As shown in the figure, **the reference point for the first objective analysis** is *the agriculture of the 80s, since* it is inevitable to have a clear picture of the initial state of affairs in Hungarian and the former East German (GDR) agriculture before actual research analysis is started.

Figure 1: Timeframe of and the relationship between the areas examined under Objective 1



Source: Author's own illustration

The *bases* of the agricultural structure of the 80s both in Hungary and in the New Federal States (NFS) were laid in the late 1950s and early 1960s when the socialist type restructuring of agriculture was taking place. At that time there were both similarities and significant differences observed between Hungarian and GDR agriculture. *They were similar* in their being dominated by agricultural production cooperatives and state farms. In Hungary 70% of the utilized agricultural area was cultivated by production cooperatives, another 15% was worked by state farms.

The main differences can be summarized in that:

- Farms in the former East Germany were specialized and comparatively larger in size (production cooperatives and state farms with specifications in crop production and animal production);

- The proportion of small producers in Hungary was larger (responsible for 1/3 of total output);
- Land ownership in the former East Germany for larger part stayed with nominal private owners (this was merely a 'de jure' situation, the usage right was cooperatives hands);
- In Hungary significant reforms of economic management and coordination were implemented as early as in the mid 60s (side by side with the bureaucratic coordination, market coordination was also present and was given more and more importance), whereas in the GDR no cardinal reforms were implemented till the late 80s.

With all the differences, the late 80s found both Hungarian and former German agriculture in really bad shapes alike; low levels of productivity, outdated technology and poor international competitiveness were general.

The next section of the chapter compares the legal instruments implemented to tackle the process of agricultural transition in the two countries (Table 2).

Table 2: Legal foundations of agricultural market economies in Hungary and in the New Federal States

Target	**Action**	
	Hungary	**New Federal States**
Privatization of cooperatives' properties	Cooperative Laws	Agricultural Adjustment Act
Compensation/Restitution	Compensation Laws	Agricultural Adjustment Act Compensation and Just Satisfaction Act
Privatization of state property	Privatization Laws	Trust Law

Source: Author's own illustration

The analysis aims to investigate whether the applied legal instruments entailed substantial differences in the subsequent course of development of the two countries' agriculture.

Cardinal difference was found between Hungary and the New Federal States *in respect of their farm structures*. Land ownership in the New Federal States prior to the regime change belonged to private owners. (See paragraph above introducing the conditions of the 80s in the GDR.) This means that the privatization of the 90s in their case "simply" meant the restitution of the original ownership conditions with land use rights redelegated to the original owners or their descendents; this was a fairly simple way of privatization affecting 2/3 of the agricultural land area. Since in Germany large sizes of land properties had dominated back before World War II, the restitution of ownership rights, logically, resulted large sized privately owned land properties. In Hungary, however, the implementation of the compensation and cooperative laws allowed only very small sized land properties per owner. As a result, **in the New Federal States** a structure based on *large scale farms became dominant*, whereas **in Hungary** a *dual-pole farm structure* was established with large scale farms on the one pole and a large number of small farms on the other. The presence of the latter member of the dual structure in Hungary necessitated the introduction of specific governmental measures of different types. Firstly, because the large number of predominantly self supplying small farms makes the central statistical censuses and surveys as well as the preparation of a reliable agricultural report fairly complicated. Secondly, these small farms require special agricultural policy measures.

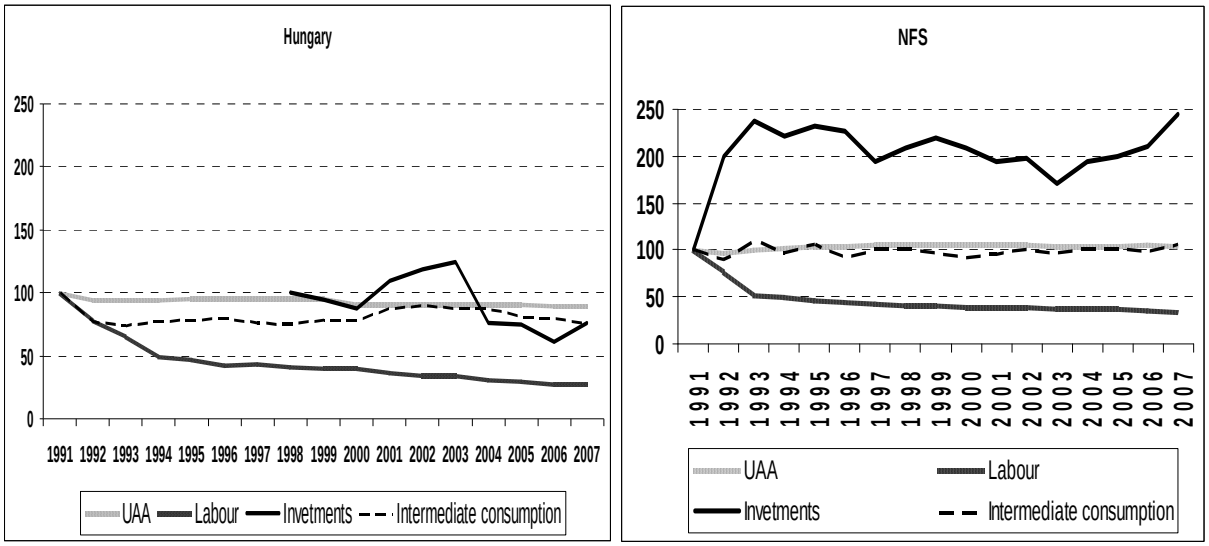
The section below examines the changes of agricultural input use and output production in the new structural conditions of the post-transition period.

The changes of the factors of agricultural production in Hungary and in the New Federal States show different patterns, changes in employment, though, are an exception (Figure 2).

Employment both in Hungary and in the New Federal States was significantly decreased, which largely contributed to the growth in productivity. The decrease of the employment, however, generated serious social problems in the rural areas. The seriousness of this problem may well be demonstrated by means of the following example: according to a survey carried out by the EU in 2006, among the 10 regions with the highest

unemployment rates in Europe, four were to be found in the new federal states. This is an indication that one of the most challenging responsibilities of agricultural and regional development is that of employment.

Figure 2: Agricultural input use



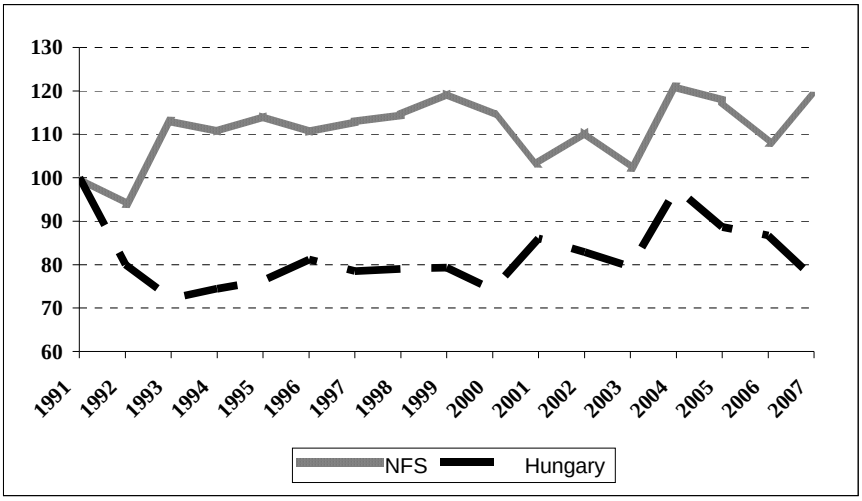
Source: Author's own calculation based on the database of Eurostat and the databases of the Hungarian Central Statistical Office (KSH)

As for other inputs, utilized agricultural area (UAA) size was changed at the smallest degree both in Hungary and in the New Federal States. The difference between the two countries in this respect is that in the New Federal States there happened a substantial reduction of UAA as early as 1990-1991 because very shortly after the regime change the marginal lands were set aside. Significant differences can be seen, though, in the investment schemes. Shortly after the political and economic change there was a dynamic growth in investments in the New Federal States, which was then consolidated at the same high level for the subsequent years. Reliable records of investments in Hungary before 1998 are not available, but investments were reported to sharply decrease in the early 90s (Kapronczai, 2006). No significant improvement was evidenced after 1998 either (except for the pre-accession years), while the period between 1998 and 2007 was characterized by fluctuations and fallbacks. *Livestock numbers significantly decreased in both countries.* Like UAA structure, the structure of animal farming in Hungary also had

a dual structure, while in the New Federal States the sector was dominated by large enterprises from the very beginning.

The new paragraph below is dealing with *agricultural output* patterns (Figure 3).

Figure 3: Agricultural output patterns, 1991=100%



Source: Author' own calculation based on the Eurostat database

The output of Hungarian agriculture substantially decreased after the political and economic transition, and in none of the years 1991-2007 did it reach the output level of the reference year 1991. The New Federal States, though, exceeded the output level of the same reference year in every year between 1991 and 2007, except only for year 1992.

The author in the following examines *input and output prices and the subsidization schemes of the transition years.* Following the monetary unification, producers prices in the former GDR between 1989 and 1991 dropped by approximately 2/3 (as a result of the 1:1 parity valuation of the East German Mark to the DM), which caused NFS farmers to cope with serious adjustment problems. This was eased by substantial transfers by the German government. There are only rough estimates of the volume and title of the sources known. From federal sources in years 1990-1995, agricultural subsidies of approximately 17.2 billion DM were made available to farmers in annually decreasing instalments. The highest in volume of the subsidization programs were the *adjustment*

and restructuring schemes having investment subsidies in their focus. In addition to this, further solid amounts of subsidies from the EU Structural Funds were also made available. The New Federal States had access to some 5.2 billion DM worth subsidization from this fund in years 1991-1993. No adequate data are available of the subsidizations **in Hungary** in the 90s. It is presumed that there was a drastic and sharp drop of the real value of subsidies in 1990-1992, and that real value growth of a moderate extent only happened in 1994, which stayed basically at that same level till as long as 2001. Following the EU accession of 2004, there has been a significant improvement in the volume of subsidies, their structure, however, has been changed so as to prioritize direct subsidization.

3.2. Analysis of agricultural incomes and partial productivity indices

The second objective set by the author is the analysis of agricultural incomes and partial productivity indices. For the analysis of the *agricultural incomes* data were collected from the Economic Accounts for Agriculture and from the Farm Accountancy Data Network. The comparisons rely on data available from EAA database for years 1998-2007 and on data available from FADN database for years 2004-2007.

The comparative analysis of the data of the **Economic Accounts for Agriculture** suggests that net income per hectare in the New Federal States exceeded Hungarian corresponding income data by an average of 18% between 1998 and 2003 and by 9% in years 2004-2007 (Table 3).

The differences in incomes are largely determined by the differences occurring in subsidies and in the compensation of employees. The comparison of the incomes, therefore, has also been *completed by a calculation when subsidies are disregarded and assumed costs of non-salaried labour are taken into account*. The base for calculating assumed non-salaried labour cost is the unit cost of paid labour.

Table 3: Comparison of incomes in Hungary and in the New Federal States based on data from Economic Accounts for Agriculture, New Federal States/Hungary

	1998-2003	**2004**	**2005**	**2006**	**2007**	**2004-2007**
Output at **producer price**	1.61	1.45	1.50	1.49	1.62	1.52
Subsidies on products	10.85	3.94	-0.07	0.00	-0.02	1.08
Gross output at **basic price**	1.82	1.59	1.40	1.41	1.56	1.49
(-) Intermediate consumption	1.68	1.38	1.48	1.53	1.60	1.50
Gross value added at basic price	2.06	1.94	1.26	1.20	1.50	1.48
(-) fixed capital consumption	2.43	2.11	2.08	2.05	1.93	2.04
Net value added at basic price	1.90	1.86	0.82	0.73	1.26	1.19
(+) balance of other subsidies and taxes on production	4.66	0.92	3.01	2.92	2.32	2.40
Factor Income	2.08	1.66	1.49	1.43	1.64	1.56
(-) Compensation of employees	2.59	2.05	1.87	1.82	1.58	1.82
Operating Surplus/Mixed Income	1.77	1.47	1.31	1.25	1.67	1.43
(+) Interest received	1.14	1.00	1.47	0.78	0.76	0.98
(-) Rents to be paid	4.27	3.91	3.33	2.96	2.54	3.11
(-) Interest paid	2.54	2.07	2.61	2.64	2.61	2.43
Net Entrepreneurial Income	1.18	1.10	0.92	0.88	1.43	1.09

Source: Author's own calculation based on the Eurostat database

The results of the analysis show that if agriculture were less subsidies in the New Federal States it would be making losses, whereas it would produce moderate profits in Hungary. By the calculations where non-salaried labour costs were observed, Hungarian agriculture made losses in every targeted year even by subsidization, whereas the New Federal States in the same years achieved profits on production. If non-salaried labour costs were observed but subsidies were left out of consideration, both Hungarian and NFS agriculture would be operating at losses, but the losses would be substantially higher in Hungary.

Table 4: Net entrepreneurial income per hectare trends in Hungary and in the New Federal States by observing assumed non-salaried labour costs, Euro/ha

	Subsidies included		**Subsidies excluded**	
	Hungary	New Federal States	Hungary	New Federal States
1998-2003	-250.9	96.6	-288.4	-208.0
2004	-195.7	179.6	-341.0	-150.3
2005	-227.1	142.7	-410.8	-192.7
2006	-173.3	140.9	-352.5	-209.7
2007	-192.3	295.4	-381.1	-56.5
2004-2007	-197.1	189.6	-371.3	-152.3

Source: Author's own calculation based on the Eurostat database

Results generated from the database of the **Farm Accountancy Data Network** evidence higher incomes in Hungary even by a lower level of subsidization (Table 5). They also show that incomes in Hungary would also be higher if the assumed costs of non-salaried labour were included.

Table 5: Comparison of agricultural incomes based on FADN data, 2004-2006, Euro/ha

	HU	**NBL**	**NBL/HU**
Total Output	1109,1	1461,4	1,3
(-) Intermediate consumption	785,0	1028,7	1,3
= Gross value added	324,1	432,7	1,3
(-) Depreciation	136,8	180,4	1,3
(+) Balance of current subsidies and taxes	199,5	356,4	1,8
= Farm net value added	386,7	608,8	1,6
(-) Total external factors	237,2	478,7	2,0
(+) Balance of subsidies and taxes on investments	10,2	4,2	0,4
= Net farm income	159,7	134,3	0,8

Source: Author's own calculation based on the Eurostat database

The income analysis was followed by *the comparison of partial productivity indices* based on the Economic Accounts for Agriculture database. The comparative calculations reveal that differences are the smallest when the agriculture' productivity levels of

intermediate consumption are compared. Land productivity between 1998 and 2003 was on average 1.6 times, and between 2004 and 2007 1.9 times higher in the New Federal States than in Hungary. The biggest difference between the two countries was found in their labour productivity. Although the gap has been reducing in the past years, it is still substantial (7.8-fold in favour of NFS) (Table 6).

Table 6: Partial productivity indices, New Federal States/Hungary

Year	Land productivity	Labour productivity	Productivity of intermediate consumption
1998-2003	1.59	8.55	1.24
2004	1.43	6.76	1.02
2005	2.04	6.84	1.02
2006	1.61	7.03	1.01
2007	2.51	10.72	1.17
2004-2007	1.90	7.84	1.06

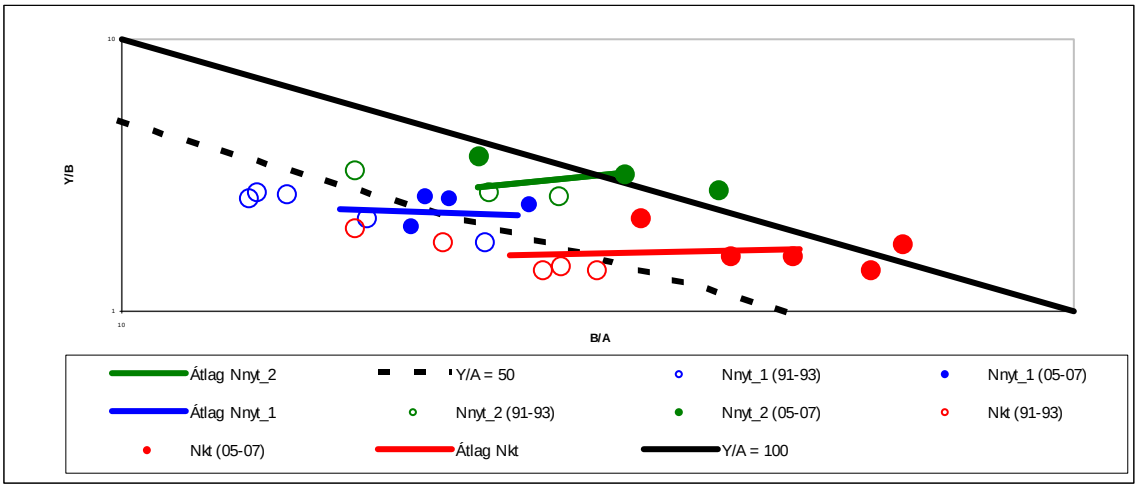
Source: Author's own calculation based on the Eurostat database

The significant differences between labour productivity indices may due to differences of applied technology levels, which, in turn, call attention to the details of the technological improvement that was taking place in the New Federal States during the transition process. For this reason, the author completed further investigations into the components of labour productivity of the NFS. Labour productivity can be viewed as the product of output/unit area (Y/B) and UAA/unit labour (B/A) from which the character of the technological development can be deducted (see Figure 4). In order to provide basis for comparison making, Figure 4 showing the decomposition of labour productivity into its components completed by the addition of corresponding data from the Western Federal States as well. Agricultural production in the "city-states" of Bremen, Hamburg and Berlin is of negligible importance, so they are not included in the investigations. For transparency reasons, the Western Federal States have been structured into two groups with one incorporating three federal states with the highest productivity levels (Nordhein-Westfallen, Niedersachsen, Schlesswig-Holstein) – to be practically considered as benchmark states –, and another with the remaining five states (Rheinland-Pflaz, Baden-Württember, Hessen, Bayern, Saarland). Bullets in the figure represent the federal states: in red colour for the Eastern states, in blue for the smaller size group of the Western

states (WFS_1) with lower productivity levels, and in green for the second group of Western states (WFS_2). The averages of years 1991-1993 are represented by empty circles, whereas filled circles show the averages of years 2005-2007. The broken line indicates labour productivity of 50 thousand Euro/hectare, the bold black line demonstrates 100 thousand Euro/hectare. Along the lines productivity levels are equal.

From the distribution of the empty circles it can be concluded that the labour productivity of the New Federal States and that of the Western states of the first group was nearly identical in years as early as 1991-1993. It is also clear, though, that land productivity in the Western states is in almost every case higher, which is an indication of their more intensive production technologies.

Figure 4: Decomposition of labour productivity



Source: Author's own calculation based on the Eurostat database

One can draw useful conclusions from the averages above on the volume and character of the technological development of the target groups. The length of the lines between the averages of years 1991-1993 (different colour empty circles) and those of years 2005-2007 (circles filled with different colours) is an indication of the volume of technological development, while their position is an indication of its character. The red line connecting the New Federal States is clearly the longest, which demonstrates that the volume of technological development in these states was higher than in their Western counterparts.

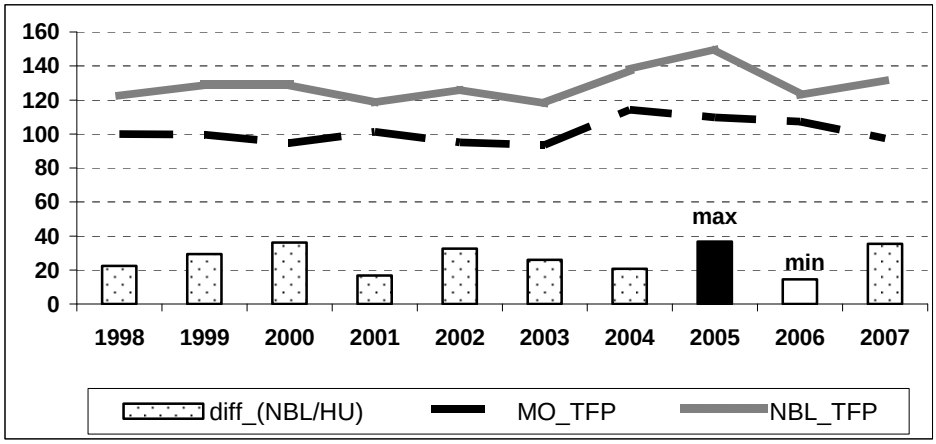
The clue to the definition of the character of the development is this: positions closer to axis Y refer to land saving intensive technologies, whereas positions close to axis X refer to labour saving capital-intensive technologies. The figure suggests that *the New Federal States in the target period were characterised by labour saving technological developments.*

3.3. Analysis of total factor productivity and its sources

The third objective set by the author is the analysis of total factor productivity and its sources. By total factor productivity the ratio of output and input is meant. As indicated in point 2., TFP analysis uses three types of methodology to be described below. The first two calculations rely on data gained from EAA database and on its regional accounts. Output in both cases means gross production in terms of production price, while inputs incorporate utilized agricultural area, annual labour unit, intermediate consumption and fixed capital consumption. The third calculation used data accessed from Hungarian FADN database. In this case output means agricultural output; inputs incorporate utilized agricultural area, annual labour unit, intermediate consumption and fixed assets. Current year prices in every case are deflated by price-indices.

The data for the **comparative analysis of the total factor productivity** of Hungary and of the New Federal States were accessed from the database of Economic Accounts for Agriculture for years 1998-2007. In his calculations the author applied the index-number method. *The results of the analysis show that TFP* in the New Federal States in target years *averaged by nearly 27% higher* than in Hungary. (See Figure 5) The bars in Figure 5 are to illustrate the differences between TFP levels. It can be seen that no significant changes have been identified in years 1998-2007. The lowest and the highest end points are 2005 and 2006, respectively.

Figure 5: Comparison of total factor productivity changes
in Hungary and in the New Federal States

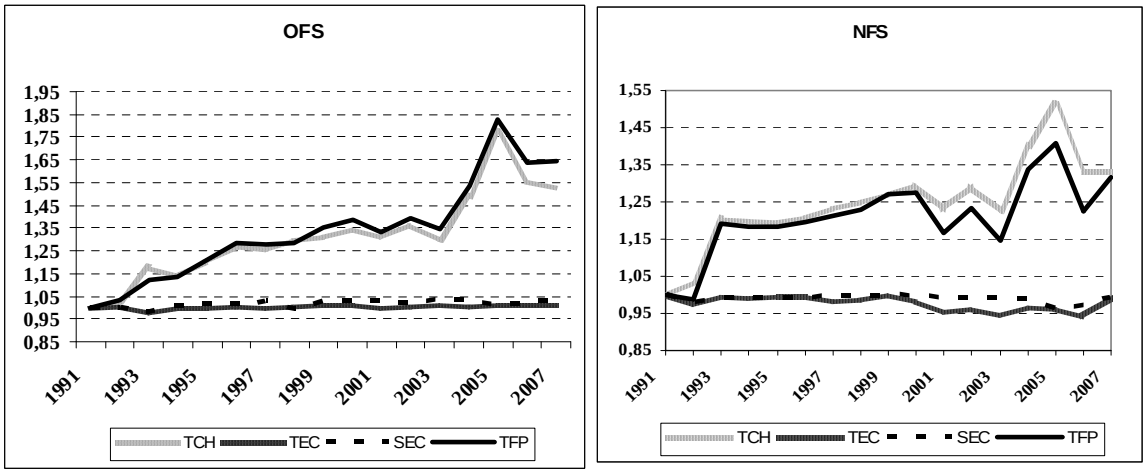


Source: Author's own calculation based on the Eurostat database

The section below is dealing with the identification of the sources of TFP growth.

For analysing the sources of TFP growth in the New Federal States in years 1991-2007 the method of Data Envelopment Analysis was used (Figure 6). The results of the analysis indicate high rates of TFP development. The decomposition of TFP changes suggests that growth was to largest extent generated by technological development. Taking the dynamic investments that were taking place in the reference period into account, this finding meets the preliminary expectations of the author. Other sources of TFP growth – technical efficiency and returns to scale – have not been found to play significant impact on TFP growth, their low impact levels, though, may just as well be the consequence of the use of aggregated data in the calculations. (Farm level data may have led to larger differences.)

Figure 6: Changes of total factor productivity and their sources in German agriculture



Source: Author' own calculation based on the Eurostat database

For analyzing the TFP changes and their sources in Hungary, the method of Stochastic Frontier Analysis was applied. Due to data availability constraints, the period of 2001-2007 was analyzed. As the first step of the method, production function (frontier) estimation was accomplished. The summary of estimated data can be seen in Table 7 below. In TFP calculation production frontier parameters are considered to provide only interim results, their analysis, however, may lead to important assumptions.

The results of the estimation were processed according to four aspects: (1) the impact of inefficiency in relation to statistical noise, (2) the impact of production factors on output; (3) the importance of technological change; (4) the impact of unobserved components on inputs. For estimation purposes, the variables were divided by their geometric means, hence the first order coefficients can be interpreted as output elasticities evaluated at the geometric mean of the sample.

The impact of inefficiency in relation to statistical noise was examined with the parameter λ , where λ is the ratio of σ_u and σ_v; λ values higher than 1 indicate that the impact of technical inefficiency is higher than that of the statistical noise. *In the present case λ=3.04, and is significant at a level of 1%, which supports that inefficiency has a significant impact on Hungarian agriculture.*

Table 7: Parameter estimates

Parameters	Coefficients	Parameters	Coefficients
Means for random parameters		**Second order effects**	
α_0	0.307688***	α_{tt}	-0.00810**
α_t	0.014143***	α_{ta}	-.01292***
α_a	0.136097***	α_{tb}	0.00696
α_b	0.103161***	α_{tk}	-0.01181
α_k	0.081702***	α_{tv}	0.01445***
α_v	0.711642***	α_{aa}	0.11961***
Coefficients of unobservable factor		α_{bb}	0.10312***
α_{0m}	-0.17527***	α_{kk}	0.04914***
α_{tm}	-0.00082	α_{vv}	0.12680***
α_{am}	-0.02263***	α_{ab}	-0.08495***
α_{bm}	0.015462***	α_{ak}	0.02729***
α_{km}	-0.05848***	α_{av}	-0.07685***
α_{vm}	0.092443***	α_{bk}	-0.00046
α_{mm}	0.007669	α_{bv}	0.00462
		α_{kv}	-.06737***
Variance and asymmetry parameters			
σ_u	0,473	σ	0,497***
σ_v	0,156	λ	3,036***

Source: Author's estimates based on FADN data from AKI
(Note: ***, **, * denote significance levels at 1%, 5% and 10%, respectively)

The analysis *of the input impact on output* reveals that it is intermediate input (α_v) that has the highest degree of output elasticity (71%). (This is in line with the cost structure of the Farm Accountancy Data Network sample holdings. Intermediate consumption is responsible for 70% of total costs.) Differences of small degree are observed between labour (α_a =13,6%), utilized agricultural area (α_b =10,3%) and capital (α_k =8,17%) output elasticities.

Variable "t" (time) applied in the model allows to determine *technological change* which in this case refers to the shift of the production function. Technological development over the target period was found positive ($\alpha_t > 0$), with an average of nearly 1.4% for the length of seven years. The rate of growth, however, was decreasing, $\alpha_{tt} < 0$. The technological development was found labour saving ($\alpha_{ta} < 0$) and intermediate input usind ($\alpha_{tv} > 0$).

The *unobserved farm specific component (m_i^*)* proved to have different affects on the production elasticities: it negatively affects the production elasticity of labour (α_{am}) and capital (α_{km}), while has a positive effect on land and intermediate consumption. There has no significant relationship been found between technological change and the unobserved component. Since the exact character of the unobserved component is not known, it is not possible to provide its detailed interpretation either. *However, the significant values imply that omitting this component from the production frontier may well lead to misinterpretation of the technology parameters and the inefficiency effect.*

The parameter estimates allow defining total factor productivity change and its sources (Table 8). **The calculations reveal fluctuations of TFP in Hungary in the target period.** The change was the biggest in years 2003-2004, which is basically due to weather effects. Apart from this sharp change, the period was characterized by a tendency of growth.

Table 8: Changes of total factor productivity and their sources in Hungarian agriculture, 2001=100%

	TFP	SEC	TCH	TEC	HET
2002	100.7%	100.2%	103.8%	97.0%	99.8%
2003	96.6%	100.5%	107.1%	89.9%	99.8%
2004	117.5%	100.1%	108.9%	108.1%	99.7%
2005	109.4%	100.1%	109.9%	99.7%	99.7%
2006	109.3%	100.1%	110.1%	99.5%	99.6%
2007	107.1%	100.0%	109.5%	98.1%	99.7%
Average annual growth rate	**1.1%**	**0.0%**	**1.5%**	**-0.3%**	**0.0%**

Source: Author's estimates based on FADN data from AKI

The decomposition of the sources of the changes casts light on the significance of two basic factors: technological change (TCH) and technical efficiency (TEC). Other sources of TFP change – scale efficiency and the unobserved farm specific component – have not been found to have a significant impact. The growth of TFP is clearly due to *technological development*. The rate of technological development was the highest in

years 2002 (3.8%) and 2003 (3.1%) (There was a significant growth in agricultural investments in the pre-accession years as compared to the years before.), then it began to fall (with rates of 1.7%, 1% and 0.1% in years 2004 and 2005 and 2006, respectively), and turned to the negative in 2007 (-06%). In agriculture three types of technological change are differentiated: biological, mechanical and organizational. Biological technological change is primarily generated by higher volumes or better quality of intermediate consumption; mechanical technological change involves better machinery and equipment use; organizational technological change refers to the application of enhanced organizational principles. There is a very strong relation observed between technological development and fixed assets growth with a correlation coefficient of 0.95 over the target period. This might be an indication that technological development is principally the result of enhanced technical standards. Further on, the calculations revealed that the primary driving forces of productivity growth are investments. Investments, in turn, are to a large extent geared by subsidization: the most significant improvements in fixed assets happened in years 2002 and 2003, when the volume of investment subsidies was the highest, which is a proof of the decisive impact of investments on TFP growth.

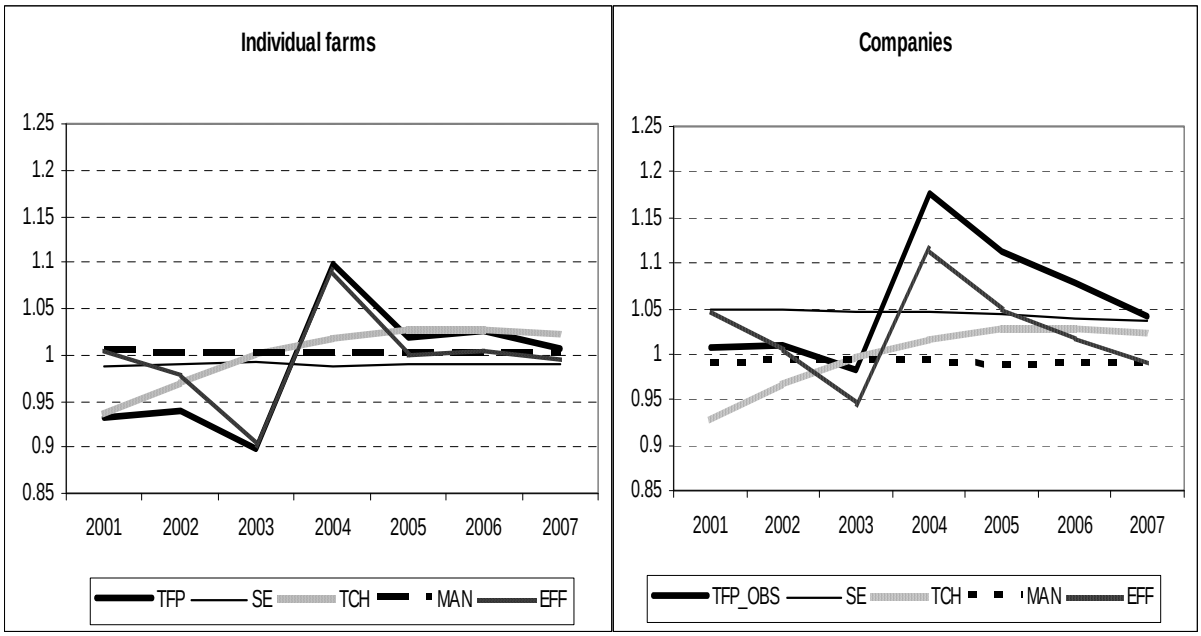
Beside technological development, technical efficiency was also found to have a significant impact on TFP growth. The analysis reveals that the effect of climatic factors is transmitted to Total Factor Productivity through technical efficiency. If the climatic situation is favourable, the gap between the best run and the less well run farms is smaller; although if the situation becomes less favourable, the gap becomes greater, i.e. the technical efficiency of these last mentioned farms decreases. The factors of technical efficiency are hot topics of scientific discussions, and no consensus has so far been reached concerning its theoretical and methodological background. Many claim that the most critical component of technical efficiency is managerial competency. In this light, the results of the analysis allow to arrive at the conclusion – which may well be logically supported by practical examples – that even farmers with modest managerial capacities can improve their performance potentials if the climatic conditions are supportive, and will fail to do so if the conditions are adverse. *This is an indication that agro-political*

strategies in support of technical efficiency improvement will not only facilitate production enhancement, but will improve performance stability as well.

Returning back to the point of the impact of technical efficiency on TFP, it was found that the fluctuations of efficiency level reached their highest points in years 2003 and 2004, and were due to actual fluctuations of weather. Except for this period, data evidence a tendency of stagnation or slight decrease of technical efficiency for the rest of the target years. In other words, within the period analysed the farms did not pick up on average, they even fell behind from the potential output. This tendency is highly undesirable, especially because Hungarian agriculture is known to have significant potentials of technical efficiency growth. Technical efficiency scored an average of 72% by the calculations. This suggests that with better utilization of technology potentials, Hungarian agricultural could theoretically improve its output levels by approximately 30% even without having to increase inputs.

In the case of Hungary, *TFP changes were also analyzed in relation to individual producers and companies.* When compared, companies were found to have slightly higher levels of total factor productivity in the reference period then individual farms did (Figure 7).

Figure 7: Total factor productivity and its sources by organizational forms



Source: Author's own calculations based on FADN data from AKI

Their higher scores can predominantly be attributed to their better levels of technical efficiency (TE). Other factors of TFP have not been found to be significantly different between the two organizational forms. As expected, scale effect (SE) proves to have higher importance with companies, but not high enough to significantly affect the difference between the performances of the two sectors.

4. New results

1. The author applied a new approach to the comparative analysis of the agricultural development in Hungary and in the New Federal States of Germany after the change of the regime pinpointing the key differences between them. He concludes that the major differences are expressed by: (1) the size of outputs, (2) farm structure, (3) the size of subsidies and (4) the size of inputs. He provides solid arguments in support of his allegation that the differences are the product of the disparities in the initial status quos and the legal foundations implemented in the process of the agricultural restructuring in the two target nations.

2. Relying on the income informational databases of the Economic Accounts for Agriculture (EAA) and Farm Accountancy Data Network (FADN) – organizations established after the change of the regime – the author concludes that: non-corrected EAA data reveal the advantage of the NFS net entrepreneurial income/hectare data over Hungarian, while FADN data reveal the advantage of Hungarian farm income data over NFS data. He also concludes that NFS agriculture would suffer more severe losses if subsidies were denied than their Hungarian counterpart would. Furthermore, if non-salaried labour costs were observed, Hungarian agriculture would be making losses even by subsidization, while the negation of subsidies would not significantly affect NFS agricultural incomes.

3. Relying on the partial productivity indices (land, labour and intermediate consumption productivity) by his calculations, the author proves that the use of production factors (labour, utilized agricultural area and intermediate consumption) in the NFS agriculture over the research period was more productive than in Hungarian agriculture. The biggest size difference between the two target groups was identified between their labour productivity indices. By the decomposition of labour productivity into its components, the author proves that the high standard of this index for the NFS is basically the result of the capital-intensive (labour saving) technological development that were taking place in the region in the transition period.

4. Using the method of multilaterally consistent index calculation, the author concludes that the total factor productivity level of the agriculture of the New Federal States in years 1998-2007 averaged by 27% higher than that of Hungary.

5. By decomposing the sources of total factor productivity growth with Data Envelopment Analysis, the author proves that the critical driving force of agricultural TFP growth in the New Federal States was technological development; other factors of TFP growth – technical efficiency and scale efficiency – were not found to have played significant roles.

6. To tackle the biases resulting from sample heterogeneity, the author applies a special type of Stochastic Frontier Analysis for the decomposition of the sources of total factor productivity growth of the Hungarian agriculture. The results of the model calculations reveal that the changes of TFP in years 2001-2007 were predominantly determined by technological improvement and technical efficiency change, the former producing positive while the latter producing negative effects. The author points out that the correlation ratio between technological change and investment subsidies is 0.95, which is an indication of the high importance of investment subsidies in TFP growth.

7. The author concludes that the analysis of FADN data for years 2001-2007 has not revealed significant differences between the TFP levels of Hungarian individual farms and agricultural companies.

5. Results for practical utilisation

Chapter One, which examines the characteristic features of agricultural development and the impact of the implemented measures on development, offers useful information for researchers, members of interest groups and chambers, and political decision makers. Information gained from the research results may support them in their preparation of future development plans. The dissertation and related literature can be a useful pool of information for lecturers, researchers and motivated students, especially for those of them, who are interested to explore the area of agricultural development.

Research results on the impact of subsidies and unsalaried labour costs on the incomes, as introduced in *Chapter Two,* offer useful information for those who are interested in the issues of agricultural competitiveness and social political questions regarding rural areas.

Chapter three, which concerns the analysis of TFP change and its sources, have both theoretical and practical feasibilities. The methods discussed in the theoretical section of the chapter can be adapted in comparative analyses both at macro and micro levels. At the macro level they can support the analyses of the impacts of economic political decisions; at micro level, executive and consultancy staff members may find them useful in their work. The exploration of the sources of TFP facilitates the better focusing of economic political decisions, and improves the efficiency of feedback on the impact of the implemented decisions. These methods have not yet been commonly introduced in Hungary, thus the research can play an important role in calling attention to this lack. Results of the empirical data analysis may be further utilized by organizations handling or using databases on the performance of Hungarian agriculture (Hungarian Central Statistical Office, Ministry of Agriculture and Rural Development or farmer's unions).

6. List of author's publications in the research topic

In foreign language scientific journals:

1. Baráth L. (2007): Die Entwicklung der Landwirtschaft in Ungarn und den neuen Bundesländern Deutschlands. In: Jahrbuch der ÖGA-Band 17. Facultas Verlag. Wien. 13 s. ISBN 978-3-7089-0400-9 ISSN:1815-1027 13-25.

In Hungarian language scientific journals with foreign language abstracts:

2. **Baráth L.** (2006): Hatékonysági mutatók változása a német mezőgazdaságban az 1990-es évektől napjainkig. (Changes of efficiency indicators in the German agriculture from 1990 to our time) In: Agrártudományi Közlemények (Acta Agraria Debreceniensis) 2006/20. Debreceni Egyetem. Debrecen. HU-ISSN: 1587-1282. 15-23.
3. **Baráth L.** (2008): A mezőgazdasági jövedelmek alakulása Magyarországon és Németország új tartományaiban. (Agricultural incomes in Hungary and in the New Federal States of Germany) In: Agrártudományi Közlemények (Acta Agraria Debreceniensis). 2008/29. Debreceni Egyetem. Debrecen. Hu-ISSN: 1587-1282. 15-29.
4. **Baráth, L. – Hockmann, H. – Keszthelyi, Sz. – Szabó, G.** (2009): A teljes tényezős termelékenység változásának forrásai a magyar mezőgazdaságban (2001-2006). (Sources of total factor productivity changes in Hungarian agriculture. (2001-2006)) Statisztikai Szemle. 87. évf. 5. sz. 471-492.
5. **Baráth, L. – Szabó, G. (2010):** A német keleti tartományok és Magyarország mezőgazdasági jövedelem-helyzetének összehasonlító elemzése. (Comparative analysis of agricultural incomes in Hungary and in the New Federal States of Germany.) Gazdálkodás. 2010. 54. évf. 3. sz. 297-308.

In reviewed conference papers in foreign language:

5. **Baráth, L.** (2007): The effect of the subventions on the development of the agriculture in Hungary and the Neue Bundesländer of Germany. In: MACE Conference. Berlin. 17-18. 01. 2007. Internet: www.mace-events.org. 7 p.
6. **Baráth, L.** – Nagy, Zs. (2007): The main changes in Hungarian external trade after 2004. In: Agrarian Perspectives XVI. "European Trends in the Development of Agriculture and Rural Areas". Prague 17-19. 09. 2007. ISBN: 978-80-213-1675-1 CD-Rom 8 p.
7. **Baráth, L.** – Hockmann, H. (2009): An examination of technical efficiency and total factor productivity change in Hungarian agriculture, 2001-2006. In: IAMO Forum. 20 Years of Transition in Agriculture: What has been achieved? Where are we heading? Halle. 17-19. 06. 2009. CD-Rom. 21 p.

In reviewed conference papers in Hungarian language with foreign language abstracts:

9. **Baráth L.** – Nagy Zs. (2005): A német mezőgazdaság fejlődésének főbb tendenciái, különös tekintettel a keleti tartományokra. (Major tendencies of the development of agriculture in Germany, with a special view to the New Federal States) „Agrárgazdaság, Vidékfejlesztés, Agrárinformatika" c. Nemzetközi Konferencia (AVA 2). Debrecen, 2005. április 7-8. CD-Rom. 9 o.

10. **Baráth L.** – Nagy Zs. (2005): Magyarország és a keletnémet tartományok mezőgazdasági fejlődésének jellegzetességei a rendszerváltás utáni időszakban. (Characteristics of the development of agriculture in Hungary and in the New Federal States of Germany in the post-transition period) In: „Verseny Élesben" Európa- napi konferencia. Mosonmagyaróvár, 2005. május 5-6. CD-Rom. 8 o.

11. **Baráth L.** (2006): A tesztüzemi eredmények elemzése Magyarországon és a volt keletnémet tartományokban. (Analysis of Farm Accountancy Data Network data in Hungary and in the New Federal States of Germany) In: „Within the European Union" c. III. Nemzetközi Konferencia. Mosonmagyaróvár, 2006. április 6-7. CD-Rom. 8 o.

In reviewed conference papers in Hungarian language without foreign language abstracts:

12. **Baráth L.** – Nagy Zs. (2005): A mezőgazdaság fejlődésének főbb tendenciái Magyarországon és a keletnémet tartományokban. (Major tendencies of agricultural development in Hungary and in the New Federal States of Germany) In: XI. Ifjúsági Tudományos Fórum. Keszthely. 2005. 03. 24. CD-Rom. 6 o.
13. **Baráth L.** (2006): A mezőgazdasági termelés hatékonyságának vizsgálata Magyarországon és Németország keleti tartományiban. (Analysis of the efficiency of agricultural production in Hungary and in the New Federal States of Germany) In: „A magyar gazdaság versenyképessége" c. konferencia (Szerk.: Vig Zoltán). BMGE. Budapest. 2006. 06. 09. 45-54. ISBN: 963 420 859 2. 45-54.
14. **Baráth L.** (2007): A mezőgazdaságban képződött jövedelmek összehasonlítása az Európai Unió régi és újonnan csatlakozott tagállamai között. (Comparative analysis of the agricultural incomes in the old and the new member states of the European Union) In: „Merre tart a világgazdaság: Európa helyzete" c. konferencia (Szerk.: Vig Zoltán). BMGE. Budapest. 2007. 12. 7. 21-29. ISBN: 978 963 420 939 3. 21-29.