Sigma convergence in Hungarian agriculture

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Abstract

The present paper provides an analysis of agricultural sigma convergence in four old Member States and in Hungary. The analysis was derived from the output and input data from the Economic Accounts for Agriculture between 1990-2005. The results obtained indicate significant convergence in the old Member States and Hungary. First of all this held true for incomes but the inputs do not reveal a perceptible pattern. However, in terms of outputs Hungary lags well behind the Old Member States, but the difference is not nearly as great for inputs. This can probably be explained by the fact that the rate of increase for inputs is higher than for producer prices, meaning the relative prices of agricultural output and input products (agricultural terms of trade) are increasing, which decelerates the convergence process. Even the improvement in efficiency can only partly compensate for these negative effects. The results of the analysis underline the importance of the number of employees of which the continual and significant decrease largely determines convergence itself and also its rate.

Key words

sigma convergence, EU, agriculture, income, indicators

Introduction

Economic growth and convergence are stimulating macroeconomic research fields. By analysing economic development the experts would like to answer fundamental questions such as the source of growth, what determines a country's growth rate and its pattern, and whether or not equalization among developed and less developed countries can be expected. The latter is a relevant question for interdependent countries or groups such as the EU Member States. Due to their common economic policy the Member States should become more interdependent. However, a result of constant EU enlargement is that differences among Member States regarding levels of development are increasing and it is becoming increasingly difficult to create a unique economic level. Initially the six founding ECC members had almost the same economic level but today the EU includes 27 Member States, having various levels of economic development. Therefore, it is an important question whether in such a heterogeneous community one can eventually expect differences in levels of development to disappear.

And all the factors mentioned above are even more relevant to agriculture. The Common Agricultural Policy is the most complicated and detailed EU regulatory system, and agriculture is also the main user of EU financial resources. Will the common regulation of agriculture facilitate more rapid convergence by new members, which includes Hungary?; and will this serve to eliminate differences among Member States, i.e., to convergence? Before analysing the question in more detail it is pertinent to overview convergence theories' chief characteristics and describe the definitions regarding the field's main elements.

Among convergence theories first came the **absolute convergence hypothesis** which was based on the neoclassical growth model, meaning the Solow model. In accordance with this hypothesis, poor developing countries are able to converge into the group of economi-

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cally developed countries. Due to decreasing marginal products, the growth rate in the less developed countries is larger than that of the more developed ones, which means that the poor countries are automatically lifted up, and that income differences are gradually erased.

However, the hypothesis of absolute convergence has not proven true in practice. The methods applied for empirically testing the model have been criticized. Friedman (Friedman, 1992) and Quah (Quah, 1993) emphasized that the convergence results obtained are statistically incorrect. (Major, 2001).

Following this came the **conditional convergence theory.** The theory's key idea is that the poor countries will not approach rich countries' development level (that is, to a certain level of development) but will grow at various equilibrium pathways. Each country has a characteristic long-term growth stage and trend, determined by the country's natural, economic and social conditions. The long-term equilibrium (i.e., the steady-state) of two or more countries is only uniform if all their parameters are identical (Ligeti, 2002.).

As mentioned above, the neoclassical model stipulates that the growth rate gradually decreases. As a country approaches a state of long-term equilibrium, the growth rate declines. However, this assumption seemed to contradict the observed facts so in the eighties a new development model was created. In contrast to the neoclassical theory's conclusions, the so-called endogenous growth theory predicted the continuation of the national income growth rate per capita in the various countries, meaning that the existing income differences will either increase or at least remain.

However, despite the new developments the most recent empirical work regarding the various countries' and regions' relative growth was not inspired by the new theories. Parallel to the endogenous trend a more sophisticated and precise analysis has also been published of which the empirical analyses are based on the old neoclassical model. The data support the conditional convergence, which relates particularly to the neoclassical model (Barro, 1997).

The literature of the last decade replaced the definition of absolute convergence with the designation of **σ convergence.** The main reason for this is that σ convergence is a more far-reaching definition than the absolute convergence hypothesis, and therefore includes it as a base case. This definition is more far-reaching than the absolute convergence hypothesis since in σ convergence the subject of the analysis is not all the countries in the world but can be any group of countries or any regions within a country. In accordance with this concept convergence means that the dispersion of the indicator analysed shows a declining tendency over time (Barro, 1992).

Both absolute and σ convergence analyse the convergence itself and its extent and do not deal with its rate. The definition indicating the speed of convergence is the **β convergence.** β convergence means that poor countries' growth rate is higher than that of the rich ones and thus the poor ones are able to converge. The number of β indicates the estimated speed or rate of convergence (Barro, 1992).

The two different convergence definitions are related to each other; meaning β convergence derives from σ convergence but the contrary does not hold true. For the "condensation" of the countries' cross-sectional data more rapid growth in the poor countries is indispensable. Thus β convergence is a prerequisite for σ convergence but it is not a sufficient condition.

In accordance with the hypothesis of conditional convergence, β convergence applies to some countries in the sense that each country converges to its own long-term equilibrium and the convergence rate is in inverse ratio to the distance to the end state. However, conditional convergence does not state whether the long-term equilibriums of the various countries approach each other or not, meaning it does not say anything about σ convergence.

The international literature contains a wide range of papers on convergence. Among a few works referred to in this paper is Barro és Sala-i-Martin (1991, 1992) who analysed conditional convergence in 48 US states. Also mentioned is Bernard és Durlauf (1996) who dealt with the differences between cross sectional and time series convergence testing. Guetat és Serranito (2007) investigated both absolute and conditional convergence in southern African countries. Convergence in the 140 NUTS2 regions of the Community was analysed by Brasili és Gutierez (2004). Among the Hungarian authors we refer to papers by Major (2001) and Ligeti (2002) on convergence theory and dynamics as well as the paper by Dedák (2000) which discusses growth theoretical relationships in economic catching up.

Both the international and Hungarian literature focus on convergence at the national level rather than the various sectors, such as agriculture. Also mentioned in this paper is an analysis by Mukhereje and Kuroda (2003), on agricultural convergence in 14 states of India while McCunn and Huffman (2000) tested the effects of convergence research on the agricultural sector. Soares and Ronco (2000) investigated trends in agricultural income differences and profitability in terms of time in EU Member States while Ludena and his co-authors (2007) analysed convergence at sub-sector levels (crop, ruminants and non-ruminants production) and they also prepared forecasts.

Hungarian authors Borbély and Vanicsek (2001) dealt with the above mentioned research field and compared Hungary and the EU at the national and sectoral level regarding agriculture, industry, and services.

The above-mentioned papers and those listed in the References section sharply differ from each other regarding the type of analysis and the conclusions drawn. These differences can be identified as follows:

- On the basis of the convergence type, meaning from the definitions discussed above which are the focus of the analysis;
- By determining whether the analysis covers only the outputs or also the inputs.
- On the basis of the analysis is the total factor productivity, meaning any of the partial productivity indicators;
- By determining whether it refers to the whole agricultural sector or to some sub-sectors or to some groups of a sub-sector.

The present paper analyses σ convergence. On the basis of partial productivity indicators we endeavour to learn whether Hungarian agriculture (its total) is approaching the EU level and whether convergence is occurring more on the input side or on the output side?

Databases and methodology

The goal of this paper is to analyse Hungarian agricultural convergence and that of four Member States from the EU-15 (Austria, Denmark, France and Portugal).

In selecting the mentioned Member States agriculture's weight in the national economy was the determining factor as in each of the four countries agriculture accounts for 2-4%[2] of GDP. Moreover, agricultural activity or any of the production conditions are similar to those in Hungary. Among the determining factors for studying these countries were the product structure of Danish agricultural production, Austria's Accession date, Portugal's development level, and the diverse nature of French agriculture.

The convergence analysis is based on EUROSTAT data and included in the Economic Accounts for Agriculture (EAA)[3] which provides an overview of agricultural performance in the Member States. Since 1964 the Statistical Office of the European Union has regularly collected EAA data. The Hungarian EAA started in 1996 and was first published in 1998[4].

Starting with the *agricultural industry's output by deducting the various items of inputs*[5] the EAA arrives at the entrepreneurial income indicating the income of the non-paid labour, the income originating from land and from capital (Table 1).

Sigma convergence is the relationship between the output and input data from the countries studied provided the cross-sectional dispersion of the countries is declining over time. Testing the sigma convergence can be performed by estimating the following regression equation applied by McCunn and Huffman (2000):

$$\text{var (ln GDP/capita)} = \Phi_1 + \Phi_2 * t + \varepsilon_t$$

where, var (ln GDP/capita) is the GDP per capita variance; Φ_1 constant; Φ_2 regression coefficient; t time factor; ε_t white noise with zero expected value.

The sufficient condition for sigma convergence is that the regression coefficient (Φ_2) is negative and significantly different from zero, the latter tested by a t-test. The null and alternate hypotheses are the following:

H_0: $\Phi_2 = 0$

H_1: $\Phi_2 \neq 0$

The test statistic of hypothesis testing is: $t_t = \Phi_2 / S_{(\Phi2)}$. The significance level of the hypothesis testing is: $\alpha = 5\%$.

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[2] By considering the share of agriculture - in the narrowest sense, that is, ignoring the upward and downward processing, in GDP.

[3] EAA does not include the non-agricultural activity of agricultural organisations but it contains the agricultural activity of non-agricultural organisations.

[4] A detailed description of the database is provided in the publication of KSH entitled „Economic Accounts for Agriculture, 2006".

[5] From among the items to be deducted from the gross output neither the balance of taxes and subsidies on production nor the rents and the interests paid and received can be classified into the group of the inputs but in order to make it simple in the following the items to be deducted from the gross output are called inputs.

Table 1

Output and input categories in the Economic Accounts of Agriculture

Output of the agricultural industry				
Total intermediate consumption	Gross value added			
	Fixed capital consumption	Net value added		
		Balance of other taxes and subsidies on production	Factor income	
			Compensation of employees	Operating surplus/mixed income
				Balance of rents paid*, interest paid and received	Net entre-preneurial income

* rents and other real estate rental charges to be paid
Source: author's own figures prepared on the basis of the publication entitled "Economic Accounts for Agriculture, 2006"

One of the indicators most often applied in the convergence analysis is GDP per capita. Using available opportunities, in my research I performed not only the analysis of the agricultural outputs and inputs but also all the others on the basis of the Annual Work Units and Utilised Agricultural Area.

The analysis of the four selected countries covers the period from 1990 to 2005. For Hungary the data are only available from 1998 when the database started, meaning the applied time series are very short, and the results obtained should be taken with a measure of scepticism. For this reason the calculations are based on a twofold time frame: a long period for the four countries (1990-2005), and a shorter period when including Hungary, constituting five countries in all. By comparing the results obtained in the two versions conclusions can be drawn regarding Hungarian agricultural tendencies

In the next section the countries' performance will be presented briefly for output and input categories, with special emphasis on agricultural output per hectare and per capita, which partly determine the development of the other types of outputs. In the following we present the results of the convergence analyses.

Results and discussion

Between 1998 and 2005 Hungarian agricultural industry's output continued to increase, but nonetheless suffered some set-backs. The nominal value growth rate was 4.4%, but at the same time agricultural area continually decreased, in fact declining by 7 percent in seven years. Stemming from this the **output per hectare increased** from EUR 774 to EUR 1,045, meaning **by 35.1%** (Annex 1). The change was even more impressive if one considers **the agricultural output per capita, which increased from EUR 6,839 in 1998 to EUR 11,772 by 2005, totalling 72.1%** (Annex 2).

This can be explained by the 25% decrease in the number of agricultural employees. In terms of productivity, 2004 was an outstanding year with agricultural output per area increasing by 17.9% and the same per capita increasing by 23.8%. This sharp improvement was due to favourable weather conditions and to the transition to EU subsidy schemes, the latter's effect seen during the subsequent years.

Thanks to a bountiful supply of land, high livestock numbers, and sophisticated technology, **Danish** agriculture's output is impressive. Two thirds of agricultural products are sold abroad. Despite some market volatility, between 1990-2005 Danish agriculture was able to continually maintain its high output level which, in terms of efficiency, compared favourably with other European nations. Even in the worst year of 1999, the output reached **EUR 2,600, and in 2001 it almost reached EUR 3,400.** During the same 15-year period agricultural area decreased by less than 3%. Coupled with high productivity in terms of area, labour efficiency is also outstanding. The **output per capita, also remarkable by international standards, increased 1.5 fold, to EUR 11,9551**. These positive results are foremost due to a 40% decrease in agricultural employees.

Albeit at a moderate rate, French agriculture**'**s output continually increased between 1990 and 2005 (yearly by 0.8% on average). However, the 1992 agricultural reform temporarily hampered sectoral performance, but later the sector was able to adapt to the new policy. **During this period French agriculture's area productivity increased by 15.6 , from EUR 1,847 in 1990 to EUR 2,136 by 2005.** However, in this growth the 3% increase in area played little role. The increase in labour productivity was stronger than that of area productivity. Between 1990 and 2005 the number of employees decreased by 32.8% and **thus the output per hectare increased by 67.1% to EUR 67,052.**

During the last decade EU Accession had a decisive impact on **Austrian agriculture.** In the post-Accession era the most critical measures taken were those cancelling protection for producers and reducing agricultural prices to EU level, which was lower than the Austrian ones, which led to a significant decrease in gross incomes.

Despite significant direct payments, by 1999 Austrian agriculture's 1994 EUR 6,659 output decreased by more than 17% and it only started to grow slowly from 2000. If one looks at the whole period from 1990-2005, one sees that the output decrease was such (13.4%) that it exceeded the 5.6% area decrease. EU Accession led to more market-oriented regulation and resulted in a **decrease in area productivity, dropping from EUR 1,828 in 1990 to EUR 1,679 by 2005**. However, in terms of **output per capital** the situation is better because, thanks to a 30% decrease in employees, **productivity increased by almost 22% during the whole period analysed**.

Portugal joined the EU in 1986, and between 1990 and 2005 the impact of EU Accession was pronounced as Accession meant generous subsidies for the backward agricultural sector, and prompted significant technical improvement plus increasing investment. Between 1990 and 2005 agricultural output continually increased. This, coupled with a a drastic drop in the number of employees, meant **output per capita grew two fold (by 136.8).** Portuguese agriculture was thus able to maintain or even increase the level of production by halving the amount of labour used. This was mainly due to the above-mentioned technical improvement **Area productivity also increased too,** albeit at a more moderate extent. **During the 15 years in question area productivity grew from EUR 1,521 to 1,693.**

When one surveys agricultural output traits in the four old Member States and Hungary, one observes a few common and general tendencies. Between 1990 and 2005 the output of agricultural products increased in all the countries apart from Austria. At the same time the agricultural area slightly decreased in each country and so, other than in Austria, the agricultural output per hectare increased. As for area productivity among the five countries, Denmark is in the best position, followed by France and then Austria and Portugal and finally by Hungary.

In each country the number of employees decreased more significantly than the agricultural area, meaning the output per capita increased more rapidly in all Member States, even including Austria. On the basis of output per capita the Members States' order of ranking mirrors area productivity. It is also worthwhile to compare the average annual growth rate of the above indicator. On the basis of the output per capita the Member States' ranking in terms of productivity level already attained is just the opposite. At 7.0% annually, Hungary's growth rate places firsts, followed by Portugal at 5.9%, France at 3.4%, and Denmark at 2.9%. As mentioned in the Introduction, this is also supported by the absolute convergence hypothesis, meaning the growth rate of the less developed countries is higher than that of the developed ones, thus enabling them to converge.
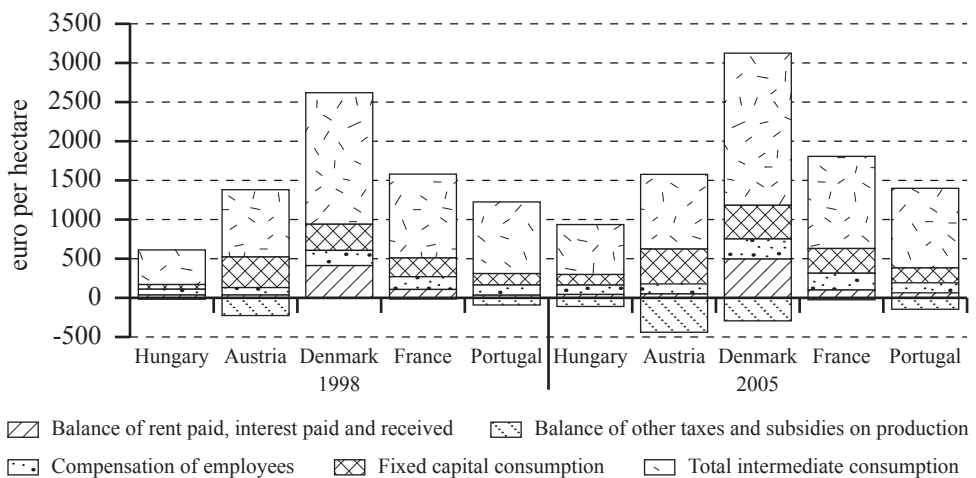

Figure 1: **Inputs per hectare in the investigated countries (1998, 2005)**
Source: author's own calculations based on EUROSTAT database.

At first in EAA the total intermediate consumption, accounting for the largest part in the inputs, is deducted from the output. This element of the input per hectare varies significantly from country to country (Figures 1-2); in France it is double and in Denmark more than triple the typical value for Hungarian agriculture. Its ratio to the output is the largest in Denmark, meaning 67.0 % while in the other four countries it is between 56-61%. Other than in Portugal, where it is stagnating, the ratio of the total intermediate consumption increased in each of the countries, meaning it accounts for a larger and larger part in the output and the share of the remaining part, indicating that the gross value added is gradually decreasing.

Due to the high and increasing rate of total intermediate consumption, the gross value added per hectare decreased during the period investigated in Denmark, France and Austria while in Portugal and Hungary it increased, but at a lower rate than the output. Apart from Austria, the gross value added per capita increased in each of the Member States.

The fix capital consumption is deducted from the gross value added and then the net value added is obtained. The value of fixed capital consumption is larger in the countries having a high technical level in agriculture, such as Denmark, France and Austria, while in Portugal and Hungary it is characteristically low.
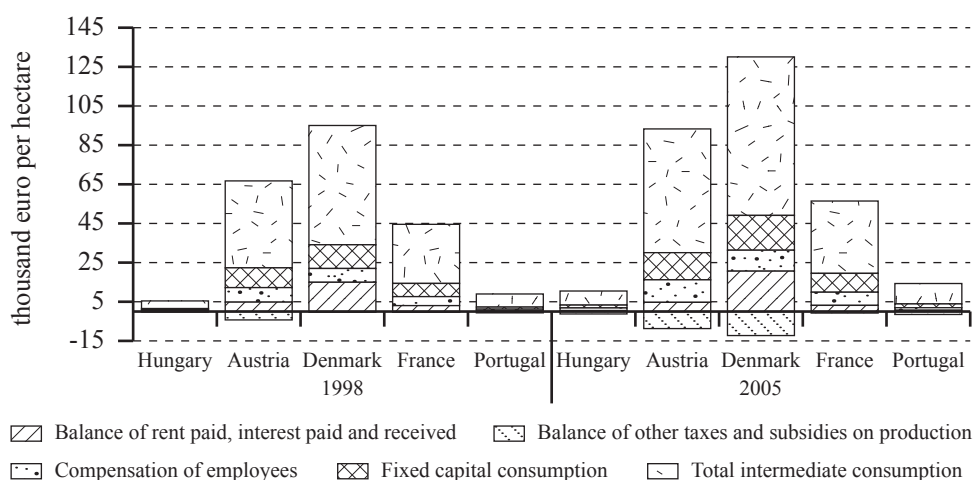

Figure 2: **Inputs per capita in the investigated countries (1998, 2005)**
Source: author's own calculations based on EUROSTAT database.

Only in Hungary did the **net value added** remaining after the deduction of the fixed capital consumption per hectare increase while in Portugal it stagnated and in the other Member States it was in decline. The net value added per capita was in decline in Denmark and Austria; in France, Portugal and Hungary it grew.

The net value added is modified by the **balance of other production taxes and subsidies.** In each of the the countries studied the balance of other production taxes and subsidies is positive (the amount of the subsidies exceeded that of taxes on production), and thus increased the income[6]. Therefore, in each case the net value added exceeded the factor

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[6]   In the figure the balance of the taxes and subsidies is a negative value, contrasting with the several modifying items – if the amount of the subsidies exceeds that of the taxes – increases the output and does not decrease it.

income. For subsidies the amount and rate of increase were remarkable in Austria, but it also rose sharply in Denmark and Hungary during the observed period (1998–2005).

Thanks to the positive balance of production taxes and subsidies the rate of increase for **factor income** per hectare was higher in Hungary and Portugal than that of net value added, while in Austria and Denmark it was stable. In France no significant effect could be identified. In every country the net value added was positive.

In Hungary and France **compensation for employees** accounted for 10-11% and in Austria, Denmark and Portugal for 7-9% of the output. These slight differences can be explained by higher wages and lower labour input in the developed countries and by the large number of employees and lower wages in the less developed countries. Other than Portugal, the ratio of labour input to output increased in every country.

The **operating surplus/mixed income** per area, obtained by deducting compensation for employees, was on the increase in Hungary and Portugal while in the other three countries it continually decreased. Due to fewer employees, the operating surplus/mixed income per capita increased in each of the studied Member States.

The values of the balance of rents paid, interest paid and received vary significantly for each country. In Austria it surpassed Hungary's by 20%, while in Denmark it was eleven times higher.

The final element for EAA output is the **net entrepreneurial income**. Due to various setbacks, in Denmark the net entrepreneurial income continually and sharply declined. In the other three old Member States the income differences continually grew more equal, due to slowly decreasing French and Austrian agricultural output as well as to increasing Portuguese income. In Hungary the net entrepreneurial income per hectare decreased between 1998 and 2003 and then in 2004 started to increase, and in 2005 continued to do so. Except for Denmark, the net entrepreneurial income per capita grew in all Member States.

The next section focuses on methodology and there the convergence analysis results will be presented. In the four countries the 1990-2005 calculations indicate convergence across agricultural outputs, gross value added and factor income and **operating surplus/mixed income**. In the four cases, the signs of Φ_2 coefficient (Table 2, column 1) were negative and significant, meaning that the **cross sectional dispersion decreased over time in the above outputs**, and the differences of the Member States decreased over time. The coefficient's absolute value t starting from the output to the net entrepreneurial income had an increasing trend, meaning the dispersion extent was declining at a larger and larger rate.

When Hungary was included in the studied period from 1998-2005, convergence was less apparent. Apart from entrepreneurial income, the value of coefficient Φ_2 was always negative and convergence significant only in agricultural output. The reason for this is that during the entire investigative period Hungarian agriculture's output per hectare increased but this increase was not consequent. Other than for output, the 2005 annual data in the various income categories exceeded that of 1998 but up to 2003 a decreasing or stagnating tendency was observed and only in 2004 was a positive change apparent in the time series. From this date it started to increase (Figure 3). However, if one considers the entire period, one observes that the dispersion declined more sharply, and during the seven-year period the absolute values of Φ_2 coefficient surpassed those of the values calculated for the period 1990-2005.

Convergence across countries based on output per hectare

Output per hectare	1990-2005			1998-2005		
	Φ_2 (1)	Significance of Φ_2 (2)	Φ_1 (3)	Φ_2 (4)	Significance of Φ_2 (5)	Φ_1 (6)
Output of the agricultural industry	-0.00293	significant	0.10738	-0.01305	significant	0.25166
Gross value added	-0.00326	significant	0.09647	-0.01517	insignificant	0.28785
Net value added	0.00260	insignificant	0.07871	-0.01124	insignificant	0.27903
Factor income	-0.00382	significant	0.06663	-0.01647	insignificant	0.26775
Operating surplus/ mixed income	-0.00768	significant	0.11847	-0.01689	insignificant	0.35518
Net entrepreneurial income	0.39238	significant	-1.39022	0.33440	insignificant	1.38671

Source: author's own calculations based on EUROSTAT database.

In the EU-15 Member States and in Hungary, the net entrepreneurial income analysed tended to diverge, but in the latter case the coefficient was not significant.

The convergence process is indicated by the fact that Hungarian area productivity is approaching that of the other countries investigated. In 1998 Hungarian output data accounted for only 34-38% of the average of the four old Member States studied but in 2005 they accounted for 45-66% (Annex 3).

The analyses carried out on the basis of income per capita further proved the presence of convergence. In the old Member States and in the group including Hungary, coefficient Φ_2 was negative for all income types with the exception of net entrepreneurial income. In almost every case this proved significant, except for the operating surplus calculated for the period of 1998-2005 (Table 3). Moreover, the absolute value of Φ_2 was always higher than the per hectare data. There was also insignificant divergence for net entrepreneurial income.

In 1998 the Hungarian agricultural sector's output per capita accounted for only 14-16% on average in the investigated countries, while in 2005 it reached 20-27%. Due to Hungarian agriculture's low labour productivity these ratios lagged behind the per area data.

The output data (except for agricultural output) depend on the "earlier" output data and on the modifying items. The output data influence each other while the inputs do not. It is pertinent to overview the outputs regarding the input elements' convergence during the investigated period.

For the 1990-2005 period calculations were performed based on the four countries' data and the per hectare data showed showed convergence for fixed capital consumption, compensation for employees, interests and rents, but also divergence for total intermediate consumption, and taxes and subsidies balance, but the coefficient's value was insignificant. However, the sigma convergence analysis for the shorter period indicated significant convergence for fixed capital consumption and for compensation for employees.

Table 3

Convergence across countries based on output per capita

Output per capita	1990-2005			1998-2005		
	Φ_2	Significance of Φ_2	Φ_1	Φ_2	Significance of Φ_2	Φ_1
	(1)	(2)	(3)	(4)	(5)	(6)
Output of the agricultural industry	-0.01211	significant	0.94928	-0.05486	significant	1.34976
Gross value added	-0.02289	significant	1.06474	-0.06391	significant	1.45309
Net value added	-0.02087	significant	1.04272	-0.06087	significant	1.37862
Factor income	-0.03106	significant	0.97827	-0.06640	significant	1.31793
Operating surplus/ mixed income	-0.05187	significant	1.17892	-0.07746	insignificant	1.46095
Net entrepreneurial income	0.62477	insignificant	-1.90512	0.64632	insignificant	1.99623

Source: author's own calculations based on EUROSTAT database.

Compared to 1998-2005, the coefficient's absolute value indicating dispersion decrease was lagging behind in the longer period. This shows that **the inputs' equalization was not as typical in the four countries as** for the group of studied countries that included Hungary.

Table 4

Convergence across countries based on input per hectare

Input per hectare	1990-2005			1998-2005		
	Φ_2	Significance of Φ_2	Φ_1	Φ_2	Significance of Φ_2	Φ_1
	(1)	(2)	(3)	(4)	(5)	(6)
Total intermediate consumption	0.00063	insignificant	0.09460	-0.01221	significant	0.24494
Fixed capital consumption	-0.00013	insignificant	0.18028	-0.03282	significant	0.52001
Compensation of employees	-0.00284	insignificant	0.14448	-0.00295	significant	0.14638
Balance of other taxes and subsidies on production	0.16547	insignificant	2.02917	0.18871	insignificant	2.57868
Balance of rents paid, interest paid and received	-0.00913	insignificant	1.48200	-0.02608	insignificant	1.32201

Source: author's own calculations based on EUROSTAT database.

In 1998 Hungary reached 24-48% of the average for the four countries investigated, while in 2005 it reached 36-123% (Annex 3). The 123% high value is due to the adaptation of EU subsidy schemes causing the tax and subsidy balance to grow sharply. Apart from this Hungarian agricultural input attained 36-60% of that of the EU. In both years the ratios for inputs per hectare exceeded the output data.

As for data per capita, the 1998-2005 values correspond with those calculated for area productivity; meaning these are observable regarding total intermediate consumption, fixed capital consumption and compensation for employees (Table 5). In all three cases the absolute values of coefficient Φ_2 exceeded the Table 4 values. In the research that didn't include Hungary divergence generally occurred, and there was a clear decrease in dispersion regarding total intermediate consumption.

Table 5

Convergence across countries based on input per capita

Input per capita	1990-2005			1998-2005		
	Φ_2 (1)	Significance of Φ_2 (2)	Φ_1 (3)	Φ_2 (4)	Significance of Φ_2 (5)	Φ_1 (6)
Total intermediate consumption	-0.00590	significant	0.89551	-0.04814	significant	1.28782
Fixed capital consumption	0.00799	insignificant	1.58317	-0.09439	significant	2.10808
Compensation of employees	0.01859	significant	0.62745	-0.01995	significant	1.04820
Balance of other taxes and subsidies on production	0.31235	insignificant	3.63619	0.86530	insignificant	2.52989
Balance of rents paid, interest paid and received	-0.00427	insignificant	3.09063	-0.08960	insignificant	3.27025

Source: own calculations based on EUROSTAT database

For one item coefficient Φ_2 revealed an output modification, and this occurred with the subsidy and tax balance for production, which was consequently positive, thus indicating convergence. The reason for this was that in several countries the amount of subsidies for production was greatly modified.

In terms of input per capita Hungarian agriculture also made rapid progress. In the first year of the period the ratio of 5-20% increased to 16-26%, which was still significantly below both the EU averages for input per hectare and input per capita. Regarding this indicator it is necessary to mention that the input level in the four investigated countries was higher than that in other EU countries, while the number of employees is relatively low and, therefore, the input per capita is extremely high. But in Hungary there is a high number of employees and thus the input per capita is relatively low and Hungary's ratio lags behind the inputs of the other countries studied. By comparing this ratio to the EU-25 average a more accurate picture is obtained; meaning the outputs per capita descend to the inputs; and all of these are lower than the values of area productivity.

Conclusions

Based on the research conducted we can first of all state that the output data converged not in the four country group, but also in the group including Hungary. This is particularly true for output per capita where the output per capita was more accentuated than per hectare. This indicates that in Hungarian agriculture **the driving force behind convergence tends to be fewer agricultural employees resulting in efficiency improvement rather than an increase in output level**. The sharp decline in the number of employees possibly contributes toward the equalization of performance differences For example, Austria experienced a decline in output but also a decline in the number of employees, but the latter occurred at a greater rate than with output. In this respect efficiency increased, reflecting tendencies in the other Member States, which were influenced by output increase and a lower decrease in the number of employees (at a lower rate than for output). **Owing to its high number of employees, Hungarian agriculture lags well behind, meaning the future holds major potential for improvement.**

For output data only the net entrepreneurial income differs from the trend. Because they differ according to Member States, rents plus interests paid and received meant net entrepreneurial income diverged in each case and in both periods.

The last two years of the period, meaning 2004 and 2005, are noteworthy when it comes to assessing the Hungarian sector's output. In these two years performance was much higher than before and this was due to favourable production conditions and to the adaptation of EU subsidy schemes.

Convergence for the inputs is less typical. The four countries studied attained greater convergence in output data through various inputs and structures, meaning that the **output data convergence cannot be attributed to a tendency similar for inputs**. When Hungary is included in the studied countries, sigma convergence is observable in fixed capital consumption and in compensation for employees. The reason for this is linked to the inputs as between 1998 and 2005 convergence in Hungarian agriculture was so pronounced that it drove down dispersion for the five countries in the observed group. **In terms of inputs Hungary is closer to the EU level than with outputs, which meshes with the above information. This hinders output data convergence,** and is why income convergence was less significant among the group of nations that included Hungary.

The input rate increase is greater than that for outputs, which is partially due to production factors and input prices and levels, all of which is connected to the terms of trade. In the Member States, and particularly so in Hungary, the relative prices of agricultural output and input products (agricultural terms of trade) is on the increase, which means the increase rate for the input prices exceeds the producer prices. All these contribute to rapid convergence for the inputs which **decelerates income equalization.**

Not only prices influence convergence but also by the relationship between output and the input volume, meaning by efficiency. Apart from Austria, the volume increase for outputs exceeded that of inputs in each country, which means that efficiency generally increased. Improvement in efficiency was greater in the less developed countries such as Portugal and Hungary than in France and Denmark. This shows that **efficiency improvement bolstered convergence in the less developed countries.** However, price effects were more influential

than the advantage derived from improved efficiency with the exception of Portugal where the efficiency improvement was larger.

In the Introduction it was mentioned that previously non-Hungarian authors had already carried out convergence analyses on EU agriculture, but here I will certainly not attempt to compare my results with theirs. On the one hand, the earlier research covered only the EU-15 and did not contain any information on Hungary. On the other hand, their methodology only permitted conclusions for the countries and not for specific groups of countries.

Regarding this paper it is important to emphasize that the advantage stemming from aggregated investigation directed toward the entire agricultural level is that the results allow overall conclusions for convergence across countries. However, the disadvantage is that **it does not reflect national differences emerging from various production structures**.

However, as shown by Ludena (2007), the above point is potentially important since in the various agricultural sub-sectors (e.g. crop, ruminant and non-ruminant production) efficiency improvement and convergence trends differ. For example, this paper definitely shows that in sub-sectors such as crop production and non-ruminants convergence is greater than with ruminants where divergence is more prevalent. As with this paper, a lack of input and output data chiefly explains why little research is done at sub-sector levels.
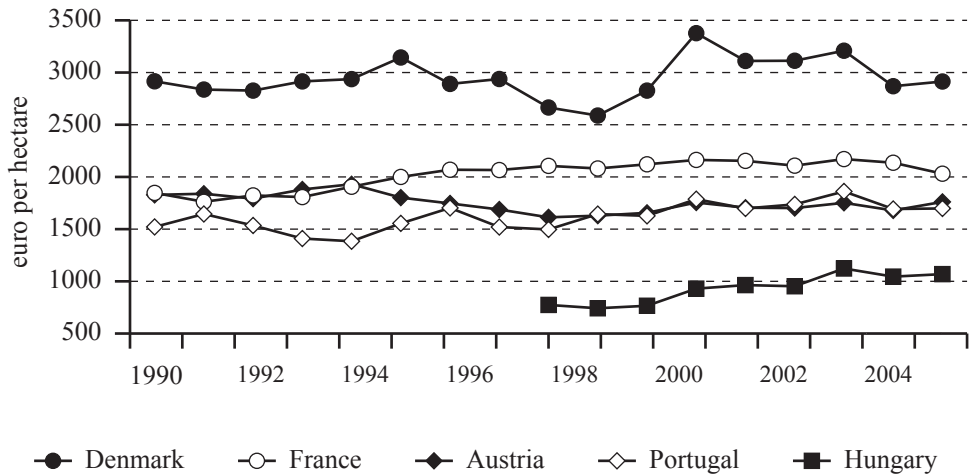
Annex 1:   **Output per hectare in the investigated countries (1990-2005)**
Source: author's own construction based on EUROSTAT database.
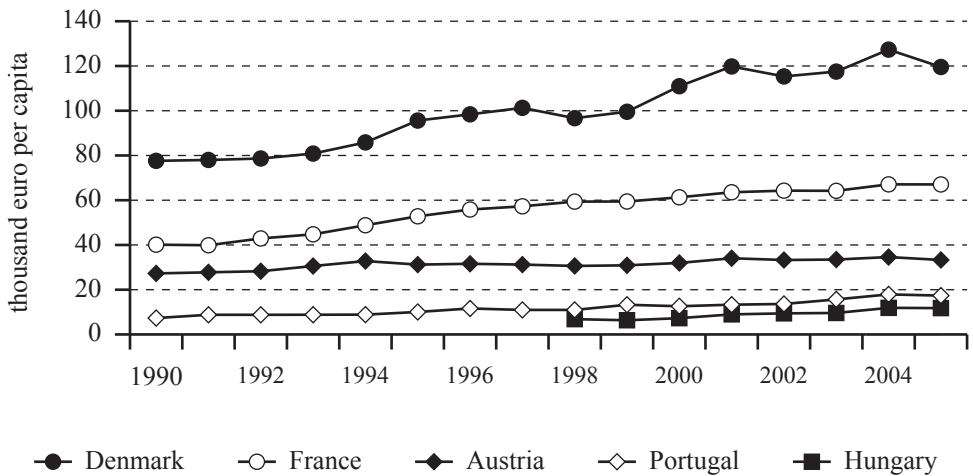
Annex 2:   **Output per capita in the investigated countries (1990-2005)**
Source: own construction based on EUROSTAT database.

Outputs and inputs of Hungarian agriculture in the percentage
of the average of the four EU countries (%)

Description	1998	2005	1998	2005
	Per hectare		Per capita	
Outputs				
Output of the agricultural industry	37.8	49.6	15.3	21.9
Gross value added	34.4	44.7	13.9	19.7
Net value added	38.0	46.7	15.4	20.6
Factor income	38.3	56.7	15.6	25.0
Operating surplus/mixed income	35.9	55.6	14.6	24.5
Net entrepreneurial income	37.1	61.9	15.0	27.3
Inputs				
Total intermediate consumption	40.8	53.4	16.6	23.5
Fixed capital consumption	24.0	41.0	9.5	17.7
Compensation of employees	47.6	59.4	19.3	26.2
Balance of other taxes and subsidies on production	44.2	123.3	4.5	24.1
Balance of rents paid, interest paid and received	31.2	36.2	12.7	16.0

Source: author's own calculations based on EUROSTAT database.

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