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DEVELOPMENTS IN THE INCOME SITUATION OF THE AGRICULTURAL SECTOR IN THE SELECTED EU MEMBER STATES

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ABSTRACT. The objective of this research is to provide a case study in the field of ambitious agricultural and rural development programmes of four neighbouring EU member states, namely Czechia, Italy, Hungary, Austria. The efficient agricultural production and compensation for employees strengthen the income conditions of the rural population in the selected countries, which can give insights into the impact of rural population support for a sustainable and competitive agricultural sector for other countries. The traditional developing trends of their agricultural sectors and food production with similar agricultural economic features make the comparison of these countries possible. This analysis focuses on the main economic indicators of agricultural income by emphasizing correlations among GDP growth, agricultural gross value added, compensation payments, wages and salaries, annual working units, food production per capita, agricultural emissions, rural population, nitrogen use, GDP in purchasing power parity per capita and arable land use based on principal component analysis with varimax rotation and principal component scores for describing the reasons of economic differences among the analysed countries represented on a two-dimensional map based on their Principal Component Scores at the economic development level by multisided overviews of regional economics, agricultural development and environmental conservation. The main conclusion is that rural population was able to increase income (compensation payments, wages and salaries) in the four Member States during the period from 2010 to 2018. Czechia with the highest average land use concentration got the best indicator of the gross factor income per annual working unit. In 2010, the gross factor income in Czechia was three times higher than that of Austria and higher than that of

Italy. By the end of 2018 Czechia achieved a considerable production growth of 35.5% but the increase of its gross factor income was even more spectacular, twice as high compared to Italy and 2.5 times higher compared to Austria. Compensation for employees and salaries and wages played the most important role in keeping the rural population in its original places accompanied by sustainable development.

***JEL Classification*:** Q1, Q18, Q26

***Keywords*:** annual working unit, food production, gross value added, Hungary, rural development.

Introduction

The study aims to analyse the main economic indicators of Czechia, Italy, Hungary and Austria in the period of 2010-2018 including GDP growth, agricultural gross value added, compensation for employees, wages and salaries, annual working units, food production per capita, agricultural emissions, rural population, nitrogen fertilisers, GDP in purchasing power parity per capita and the arable land use. The analysis was based on the database of the Eurostat and FAOSTAT and also references relevant to the topic. The literature review overviews the main economic concepts related to the objectives of this paper.

Different economic variables are analysed in order to clarify the reasons for increasing factor income in the context of agricultural gross value added, compensations, and wages and salaries. Furthermore, the number of annual working units (AWU) can have an impact on the factor income development of agricultural employees and farmers. Also, the size of rural population can be influenced by the income situation of employees based on compensations, factor income and purchasing power parity.

Pearson correlation matrix of the economic variables was applied to identify the strongest correlations (higher than 0.5) among the variables under study. Also, the principal component analysis (PCA) was carried out on the basis of Pearson correlation matrix of the economic variables and the principal component scores were calculated by a simple linear regression.

This paper sets out five hypotheses:

1. Compensation for employees (Compens3) and increasing wages and salaries (WageSal4) are the key indicators to keep rural population (RuralPopul9) in rural areas.
2. There is a close relationship between compensation for employees (Compens3) and increasing wages and salaries (WageSal4).
3. Agricultural gross value added (AgrGVA2) is closely related to the development (increasing or decreasing) of per capita food production (FoodProdCap7) and per capita GDP in purchasing power parity (GDPinPPP11).
4. Gross factor income (FactIncome6) has strong correlations with GDP growth (GDPgrowth1), compensation for employees (Compens3), wages and salaries (WageSal4), the number of annual agricultural labour units (NumAWU5) and the agricultural gross value added (AgrGVA2).
5. Agricultural carbon dioxide equivalent emissions (AgrEmission8) are closely related to land use (AraLand12) and nitrogen use (NitrUse10).

1. Literature review

The processes occurring before the economic transition, especially the setting up of the two-tier banking system in 1987, laid the foundation for a successful and effective central bank. This paper highlights major changes in key pieces of legislation between 1987 and 2013. As a conclusion, the National Bank of Hungary has been successfully integrated into the European System of Central Banks, and its history may serve as a blueprint for countries still in the accession period.

Lentner et al. (2018) have emphasized the importance of the consistent fixed banking and financial activities in strengthening performance in order to create strong competitiveness for their economies. Other experts highlighted the role of risk management including the relevance of identification of risk sources both for large, and small and medium-sized enterprises (SMEs). The economic and financial risk sources in SMEs of the V4 (Visegrád Group: Czech Republic, Hungary, Poland and Slovakia) and Serbia has been investigated in the context of the business environment, even in the agricultural sector (Oláh et al., 2019; Zsarnóczai & Zéman, 2019).

Kharlamova et al. (2018) declared that the development of technologies contributes to the increase of labour productivity, replacement of jobs by robots and automatic machines, which can further exacerbate social inequality. Kovacova et al. (2019) reviewed systematically the bankruptcy prediction models developed for the V4 with the emphasis on explanatory variables used in these models by using appropriate statistical methods and stated that the issue of bankruptcy predictions should be given priority to ensure sustainable economic development. A new bankruptcy prediction tool with higher sensitivity was proposed by Kliestik et al. (2018) by modelling local legal and business aspects. Peters et al. (2020) performed analyses regarding the relationship between product decision-making information systems, real-time big data analytics, and deep learning-enabled smart process planning. Estimates were made regarding networked, smart, and responsive devices by the application of the structural equation modelling technique (Kliestik et al., 2020a). Kliestik et al. (2020b) determined the existence of positive trend in earnings management and detected the change-point in its development for each Visegrad country.

The tradability of rural non-farm sector goods can have different implications. In a general equilibrium perspective, productivity gains in the agricultural sector have a negative impact on the tradable non-farm sector. This is because agricultural products, as well as rural non-farm non-tradable goods, have a relatively inelastic demand for labour, whereas tradable goods have a more elastic labour demand. If wages increase due to greater agricultural productivity, factories producing tradable goods, which are assumed to be operated by external producers, will move to avoid the higher wages (Lentner et al., 2019; Zsarnóczai & Zéman, 2019). Despite the fact Hungary is a small and open economy with limited natural resources the country has declared in its basic law a categorical prohibition on the application of genetically modified organisms (Popp et al., 2018).

In cases of the Baltic States the convergence of the absolute value of direct payments did not occur. This suggests that the dynamics of the amounts of direct payments do not correspond to the dynamics of agricultural output to full extent, thus creating the misalignment in the rates of growth. From this point of view, the lack of dynamics in the amounts of direct payments can create unfavourable economic conditions in the field of agriculture. Other authors focus on the importance of institutional investors to strengthen the economic prosperity of farms and their preferences at a regional level as well (Sadaf et al., 2019; Sapolaité et al., 2019; Vekic et al., 2020). Several authors have emphasized the importance and development of human labour resources at an international level and emphasized the collaboration among universities and enterprises in order to realise the strategic development of employees (Berková et al., 2019; Griffin & Coelhoso, 2019). Any country can develop its performance and high technology exports, but the skilled labour force is needed.

Indeed, the most profitable sectors, namely cereal and dairy farms, recorded a particularly strong increase in investments. The measure of dynamic efficiency can be used to analyse the performance of businesses in regards of inter-temporal optimization of the investment behaviour (Namiotko & Baležentis, 2017; Morris et al., 2017; Yang et al., 2017). Given the fact that the production of biogas from phytomass has become a strong pillar of „green electricity" output, but threat to soil fertility may endanger its stability (Maroušek et al., 2020a). It was revealed that feeding is the most promising alternative; however, additional energy inputs for potato waste steaming are advisable to break down trypsin inhibitors that naturally decrease protein digestibility (Maroušek et al., 2020b). Research and innovation are key incentive measures to improve the overall competitiveness of firms and countries too (Maroušek et al., 2015). After taking into account the size of the economies (GDP in market prices), the efficiency seems to be positively affected mainly by the development in large countries (Suess-Reyes & Fuetsch, 2016; Kocisova et al., 2018).

Some authors have focused on the strong relation between income and new technologies, which can cause income inequality in several unexpected ways in Europe. Robots and other automation technologies compete particularly with low-skill and routine jobs, while high-skill workers and capital owners mostly benefit from the productivity increases. Education is of key importance when it comes to people whose jobs are threatened by automation – to help unemployed workers to find new jobs as well as to prevent an increasing skill premium and/or job polarisation. It becomes extremely important in some national and regional markets (Bilan et al., 2020) and demands relevant solutions in programs of regional development (Akimova et al., 2020; Kostiukevych et al., 2020). Policy-makers should quickly focus on skills upgrades and on ways to reconcile technological innovation with welfare. There have been calls for action to enhance competitiveness, upgrade skills and reinforce equality of opportunities (Bubbico & Freytag, 2018; McFadden-Gorman, 2016). Also, they have noted that social transfers (pensions and unemployment benefits**)** were the main policy tool in developed countries for reducing income inequalities. However, in fact, programmes highly targeted at those in need were more efficient than transfers distributing income across the life-cycle of individuals. While family cash benefits for low-income groups were found to have a strong redistributive impact, some transfers, like disability benefits, increase the risk of creating poverty traps for beneficiaries (Bubbico & Freytag, 2018; Guzel et al., 2020), especially due to the impact of employment in informal sector (Mishchuk et al., 2020).

Other authors have declared that the contributions made to social security and taxes help to mitigate income inequality in all countries for which these data were available. The factor contribution of these redistributive measures on inequality was above 45 per cent for France, Italy and the UK. In European countries and the USA, employment status (differences between permanent and temporary employees, and between full-time and part-time employees, respectively) was the most important factor contributing to income inequality, with factor inequality shares ranging between 13.2 per cent (Italy) and 21.7 per cent (UK). In European countries, employment status was the most important factor contributing to the increase in labour income inequality (ILO, 2016) with appropriate consequences for state socio-economic development and well-being of the population (Mishchuk et al., 2018).

Neither technological development nor social transfers can solve income inequality, therefore more jobs and workplaces are needed - either in urban or in rural areas - by stimulating the private investment activities of entrepreneurships, companies and corporations. Therefore, rural development is accompanied by the increasing income of rural populations, including annual working units (AWU) in the agricultural sector, by increasing wages and salaries per AWU, compensations for employees, agricultural gross value added and numbers of AWUs in order to follow the competitiveness conditions for domestic producers on national and international markets.

In the EU, improvements in energy efficiency appear to be a more feasible means of ensuring further reductions in GHG emissions. The energy-mix should also be adjusted to effectively reduce GHG emissions. Gains in energy efficiency are an important factor behind the mitigation of emissions. The EU agricultural policy (Common Agricultural Policy) is likely to stimulate agricultural production in the future, and structural changes might also appear. In any case, the analyses carried out indicate the scale and structural effects (Yan et al., 2017).

According to FAO (2017) competitiveness is most often measured by economic indicators, such as gross or net margins (often per unit of land), and comparing the performance of farms (or farming systems) based on these measures. Competitiveness and productivity are closely related: higher productivity can lead to a greater competitiveness of the enterprise (or sector) because more is produced of the same number of resources. This means that with all things being held equal, the cost of production per unit of output is lower and margins per unit of output are higher. Productivity is a necessary precondition for competitiveness. Competitiveness at the national level, resource endowments, technology, productivity, product features, fiscal and monetary management and finally trade policy are seen to be the most important factors that determine the competitiveness of an industry and/or business. All of the factors described above play an important role in the agriculture of Italy, Austria, Czech Republic and Hungary.

2. Methodological approach

Competitiveness at national level is based on a successful GDP growth (GDPgrowth1). The productivity at farm level is related to the agricultural gross value added (AgrGVA2). In addition to GDP growth and agricultural gross value added, compensation for employees (Compens3) can ensure the increasing gross factor income per AWU (FactIncome6) by taking in to consideration the number of AWU (NumAWU5) and the development of food production per capita (FoodProdCap7). The rural population (RuralPopul9) can boost agricultural production resulting in higher wages and salaries (WageSal4), and purchasing power parity per capita (GDPinPPP11) in parallel with increasing land use concentration (AraLand12). On the other hand, environmental conservation must be taken in to account to reduce agricultural emissions in CO2 equivalent (AgrEmission8) and nitrogen use (NitrUse10). Most of the above mentioned economic variables have strong or very strong correlations among themselves, therefore these variables have been selected for this research.

First, the Pearson Correlation matrix of the above-mentioned economic variables was studied to identify the strongest correlations (higher than 0.5) among the variables. In the second step, the Principal Component Analysis (PCA) was obtained on the Pearson Correlation matrix of the economic variables and Principal Component Scores were calculated by a simple linear regression. Countries are represented on a two-dimensional map based on their Principal Component Scores. Two 2-dimensional PCA maps were created regarding components 1 and 2 and components 1 and 3. The appearance of the countries studied in the four quadrants of the PCA map was based on the differences in their economic features.

During factor selection the primary goal is to maximize the variances of the principal components, resulting in an unrotated factor weight matrix. The factor weight shows the correlation between the original variable and the given factor, the value of which can vary between -1 and 1, similarly to the correlation coefficient. However, during factor selection, variables that have nothing to do with each other may be correlated with a particular factor, making interpretation impossible. Rotation could help to cope with this problem. Factor rotation means rotating the axes of a given factor so as to obtain a more interpretable factor solution (McCormick et al., 2017; IDRESC, 2020; Zagumny, 2001). During rotation only the explained variances of the factors change. In this study the orthogonal Varimax rotation method was applied, in which the axes are perpendicular to each other, obtaining uncorrelated factors, and the variance explained by the factors is maximized. Varimax rotation aims to simplify the factor matrix by maximizing the number of high-factor variables per factor, i.e., looking for either very strongly (positive / negative) correlated, or non-correlated variable-factor pairs. A Varimax rotation is more stable and better separates the factors compared to other procedures, which helps in the interpretation of the factors (McCormick et al., 2017; IDRESC, 2020). All calculations were carried out by SPSS (Statistical Program for Social Sciences).

3. Statistical analyses

The four countries can be researched by different economic variables as features in order to clarify reasons for increasing factor income concerning agricultural Gross Value Added, compensations and wages in four EU-member states. The question emerges of how the number of Annual Working Units (AWU) can have an impact on the factor income conditions of agricultural employees and farmers. Furthermore, the other issue is how the size of the rural population can be influenced by the income conditions of employees based on compensations, factor income and purchasing power parity. Also, agricultural emissions can decrease based on agricultural development by agricultural Gross Value Added. There are various common and interesting issues which can be understood by means of the research process.

Table 1 shows the abbreviations of the economic variables studied and their name and period for the selected four EU-member states (Czechia, Italy, Hungary and Austria). The economic variables are Gross Domestic Product, Gross Value Added, Compensation for employees, Wages and salaries, Total labour force input, Gross factor income, Food production variability per capita, Agricultural emissions, Rural population, Nutrient nitrogen use, GDP in Purchasing Power Parity per capita and Arable land.

Table 1. Abbreviation and description of the economic variables investigated

Variable abbreviation	Variable name	Period	Source/database
GDPgrowth1	Gross Domestic Product	2010-2017	Eurostat: nama_10r_2gdp
AgrGVA2	Agricultural Gross Value Added	2010-2015	Eurostat: nama_10_a10
Compens3	Compensation for employees	2010-2018	Eurostat: nama_10_a10
WageSal4	Wages and salaries	2010-2018	Eurostat: nama_10_a10
NumAWU5	Total labour force input	2010-2018	Eurostat: aact_ali01
FactIncome6	Gross factor income per AWU	2010-2018	Eurostat
FoodProdCap7	Food production variability per capita	2010-2016	Eurostat
AgrEmission8	Agricultural emissions in CO2 equivalent	2010-2017	Eurostat
RuralPopul9	Rural population	2010-2018	Eurostat
NitrUse10	Nutrient nitrogen use	2010-2014	Eurostat
GDPinPPP11	GDP in Purchasing Power Parity per capita	2010-2018	Eurostat
AraLand12	Arable land	2010-2017	Eurostat

Source: AFI (Agricultural and Factor Income, 2017): DG Agriculture and Rural Development, Unit Farm Economics, European Union, 2018; EUROSTAT, 2019; FAOSTAT, 2019

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Table 1 shows abbreviation and description of the economic variables analysed to determine economic features of selected Member States of the EU.

Table 2 presents the economic variables of the four EU states. grouped into 3 blocks formed by PCA and presented in more detail in Table 6.

Table 2. Development of economic variables in Czechia, Italy, Hungary and Austria between 2010 and 2018, in percentage change (base =2010)

Economic variable	Block number	Czechia	Italy	Hungary	Austria
FactIncome6	Block 1*	35.5	**31**	**53.5**	**63.3**
FoodProdCap7		**49.5**	-11	-10	-25
NitrUse10		**37.6**	20.2	14	-0.2
AraLand12		-21	**-4.3**	**-1.6**	**-2.6**
GDPgrowth1	Block 2*	**22.3**	7.5	**26**	25
AgrGVA2		**71.6**	20	**57.6**	18
NumAWU5		-4	-3.2	-12	-8.2
AgrEmission8		**16.5**	-1	**15.5**	9.3
GDPinPPP11		**18**	-1.4	**26**	7.2
Compens3	Block 3*	30	27.5	31.2	48.5
WageSal4		30	27	35.3	50
RuralPopul9		-1.2	-7.4	-10	1.9

Source: AFI (Agricultural and factor income, 2017): DG Agriculture and Rural Development, Unit Farm Economics, European Union, 2018; EUROSTAT, 2019; FAOSTAT, 2019, *: Blocks derived from a Principal Component Analysis (Table 5) for more details. GDP per capita, US dollar current price, OECD, STAT before 1st February, 2020

Table 2 presents the change of economic variables in the selected Member States of the EU investigated in the period of 2010 and 2018. It can be seen from Table 2 that Czechia could have realised the highest level of the gross factor income per annual working unit for this ten-year period, because in this country the average land-use concentration was at the highest level in all of the EU-27. Therefore, the gross factor income was 9269 € in 2010, three times more than that of Austria and more than that of Italy. By the end of 2018 Czechia achieved considerable growth of 35.5%, but its gross factor income was even more noticeable, being twice that of Italy and 2.5 times that of Austria, which shows the important favourable results achieved in Czechia in this period.

The Table 3 shows the exact measure of gross factor income per annual working unit in 2010 and 2018 for the four countries.

Table 3. Factor income per AWU (NumAWU5) in four selected EU-member states in 2010 and 2018

Variable	Czechia	Italy	Hungary	Austria
FactIncome6 Gross in Euro, 2010	9,269	5,301	1,790	3,325
FactIncome6 Gross in Euro, 2018	12,563	6,955	2,748	5,430

Source: Authors1 own calculation, based on the SPSS in AFI (Agricultural and Factor Income, 2017): DG Agriculture and Rural Development, Unit Farm Economics, European Union, 2018; EUROSTAT, 2019 [nama_10r_2gdp], [nama_10_a10], [aact_ali01] and FAOSTAT, 2019.

Table 3 shows main data of two economic variables (FactIncome6 and NumAWU5) in 2010 and 2018 to emphasize the difference of incomes in the analysed countries.

It can be concluded that all these values are relevant to each studied EU-member state. Gross factor income is the largest in the case of Czechia, and the lowest in the case of Hungary. We can observe a significant increase in the gross factor income in all countries.

Table 4 shows the Pearson correlations among the 12 economic variables. A correlation coefficient exceeding the level of 0.800 can be considered very strong and is denoted by bold type. If the value is between 0.500 and 0.800, the correlation is strong, while under the level of 0.500 the correlation can be considered weak.

Table 4. Pearson correlations of the economic variables

Variable	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	Ara Land12
GDPgrowth1 (V1)	0.46	**0.52**	**0.63**	**-0.73**	**0.75**	0.08	**0.88**	0.30	-0.24	**0.78**	-0.05
AgrGVA2 (V2)		-0.47	-0.40	-0.13	-0.23	**0.80**	**0.83**	-0.18	0.72	**0.83**	**-0.67**
Compens3 (V3)			**0.98**	-0.34	**0.85**	-0.49	0.09	**0.72**	**-0.77**	-0.13	0.33
WageSal4 (V4)				**-0.52**	**0.94**	**-0.53**	0.19	**0.60**	**-0.81**	0.02	0.42
NumAWU5 (V5)					**-0.79**	0.46	-0.50	0.28	**0.57**	**-0.66**	**-0.57**
FactIncome6 (V6)						**-0.57**	0.34	0.32	**-0.82**	0.29	**0.54**
FoodProdCap7 (V7)							**0.51**	0.16	**0.93**	0.35	**-0.97**
AgrEmission8 (V8)								0.14	0.25	**0.92**	-0.43
RuralPopul9 (V9)									-0.14	-0.25	-0.37
NitrUse10 (V10)										0.21	**-0.86**
GDPinPPP11 (V11)											-0.20

Source: Authors' own calculation based on AFI (Agricultural and Factor Income, 2017): DG Agriculture and Rural Development, Unit Farm Economics, European Union, 2018; significant correlations (p<0.05) were indicated with bold letters EUROSTAT, 2019 [nama_10r_2gdp], [nama_10_a10], [aact_ali01] and FAOSTAT, 2019

Table 4 demonstrates Pearson correlations of the economic variables calculated from the main statistical data of the selected Member States of the EU to describe the possible correlations among economic variables analysed. Table 4 indicates that GDP growth has a very strong correlation with Agricultural emissions. Agricultural gross value added has strong correlations with Food production per capita, Agricultural emissions and GDP in Purchasing Power Parity per capita. Compensation for employees has very strong correlations with Wages and salaries and Gross factor income. Wages and salaries have a very strong positive impact on Gross factor income and a strong negative impact on Nutrient nitrogen use. Gross factor income has a very strong negative influence on Nutrient nitrogen use. Food Production Capacity correlates strongly with Nutrition nitrogen in a positive way use but effects Arable land in a negative way. Agricultural emissions have a very strong positive connection with GDP in Purchasing Power Parity per capita while Nutrition nitrogen use has very strong negative correlations with AraLand12.

Table 5 shows the extracted Principal Components and their explained variance after a Varimax rotation. It can be seen from Table 5 that PCA (principal component analysis) established three components based on the economic variables studied.

Table 5. Variance explained by principal components

Principal	Initial Eigenvalues			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.63	46.92	46.92	4.51	37.54	37.54
2	4.22	35.19	82.10	4.06	33.86	71.41
3	2.15	17.89	100.00	3.43	28.60	100.00

Source: authors' own calculation.

Table 5 shows the extracted Principal Components and their explained variance after a Varimax rotation. It can be seen from Table 5 that PCA (Principal Component Analysis) established three components based on the economic variables studied. We have kept only those components which had eigenvalues over 1. Total Variance Explained for the principal components is 100.0% for all of three components, hence the statistical calculation is valid. Moreover, each component explained approximately one third of the total variance, which is satisfactory. It can also be seen that the first two components together explain 71.41% and the first and third component explain 66.14% of the total variance and can be used to represent the studied countries in two dimension with respect to the economic variables.

Each economic variable can be assigned to a component based on the highest component weight (Table 6). Hence, component-1 can be characterised by AraLand12, FoodProdCap7, NitrUse10, FactIncome6. Gross Factor Income and Arable land correlated negatively with the component while higher values of Food Production Capacity and Nutrition nitrogen use increase the value of component-1. Component-2 includes GDPinPPP11, AgrEmission8, GDPgrowth1, AgrGVA2 and NumAWU5. Only NumAWU5 correlates negatively with component-2 which means a decrease in the value of component-2 if NumAWU5 has higher values. Component-3 can be best described by RuralPopul9, Compens3 and WageSale4 (Table 6).

We can obtain the so called "scores" of the three components by applying a simple ordinal least square regression using the given component weights seen in Table 6. This means that instead of the original 12 economic variables we can use only these three components to study the relationships between the economic variables in the case of the 4 EU member states. The higher the value of the factor weight in absolute value, the more important a role the given variable plays in the interpretation of the factor, i.e. the meaning of the first factor (column) is most determined by the first variable (-0.991 in Table 6). In the rotated factor weight matrix (Table 6), we can see that the factor weights are in descending order in the table. This option makes it easier to interpret the factors, as it is easier to find the variables that best explain the factor (McCormick et al., 2017).

Table 6 shows the rotated component matrix and principal components. Numbers represent weights, which can be interpreted as correlations to the Principal Components. We associate each variable with a component if its weight is over 0.6. In case of a variable could belong to more than one component we relate the variable to the component with which it correlates the best. Component weights were used to calculate Principal Component scores which are linear combinations of the variables. Principal Component scores are very helpful to determine the economic differences among selected countries by taking the economic features into consideration.

Using the Principal Component scores, we can create two performance maps. Each map is a representation of the countries studied on a Cartesian coordinate system. Regarding the first map the first two components were used as the x- and y axes of the coordinate system while in case of the second map the first and the third component were used for the two axes of the coordinate system.

Table 6. Rotated component matrix and principal component eights

	Principal Component		
Variables	1	2	3
AraLand12	**-0.991**	-0.125	-0.054
FoodProdCap7	**0.957**	0.256	-0.133
NitrUse10	**0.886**	0.064	-0.460
FactIncome6	**-0.631**	0.455	0.628
GDPinPPP11	0.084	**0.983**	-0.162
AgrEmission8	0.302	**0.937**	0.173
GDPgrowth1	-0.088	**0.875**	0.476
AgrGVA2	0.598	**0.743**	-0.299
NumAWU5	0.671	**-0.739**	-0.049
RuralPopul9	0.335	-0.130	**0.933**
Compens3	-0.392	0.049	**0.919**
WageSal4	-0.492	0.204	**0.846**

Source: authors' own calculation based on AFI (Agricultural and Factor Income, 2017): DG Agriculture and Rural Development, Unit Farm Economics, European Union, 2018; EUROSTAT, 2019 [nama_10r_2gdp], [nama_10_a10], [aact_ali01] and FAOSTAT, 2019 negative weights were indicated with italic.

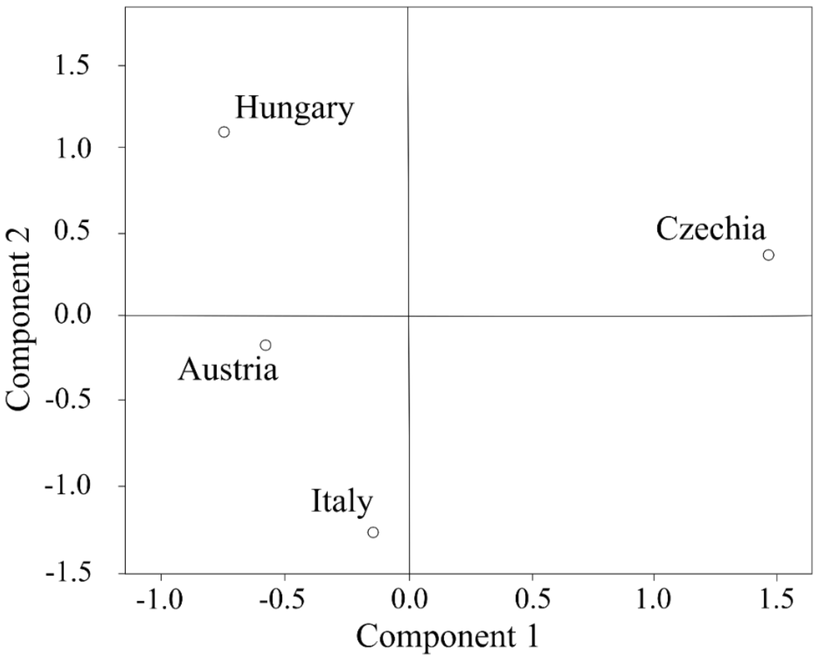

Figure 1. PCA map of the countries using component-1 and component-2
Source: Authors' own calculation based on AFI (Agricultural and Factor Income, 2017): DG Agriculture and Rural Development, Unit Farm Economics, European Union, 2018; EUROSTAT, 2019 [nama_10r_2gdp], [nama_10_a10], [aact_ali01] and FAOSTAT, 2019.

Figure 1 indicating the result of the PCA Component-1 and 2 can be interpreted according to Table 6. Figure 1 represents countries with respect to component-1 and 2. The positive values of component-1 means higher Food Production Capacity and Nutrient nitrogen use and lower Gross factor income and Arable land. The negative values of component-1 can be interpreted in an opposite way. Therefore, we can conclude that Czechia had higher values of Gross factor income and Nutrient nitrogen use, and on the contrary, Austria, Italy and Hungary have lower values of Gross Factor Income and Nutrient nitrogen use and higher values of Arable land and Gross factor income between 2010 and 2018. On the other hand, the second component separates Hungary and Czechia from Austria and Italy. The reason behind this is that Hungary and Czechia had greater changes in Agricultural GVA and in Agricultural emissions (AgrEmission8) and also in GDP and GDP in purchasing power per capita, while Austria and Italy had much lower changes in these economic variables (Table1).

These patterns can also be seen in the Table 1. The first quadrant contains Czechia where the food production per capita (FoodProdCap7) increased by 49.5%, stimulating an increase in Nutrient nitrogen use (NitrUse10) of 37.6%. Therefore, the agricultural gross value added (AgrGVA2) increased by 71.6% with power purchase parity (GDPinPPP11) increasing by 18% even agricultural producers accompanying with GDPgrowth1 22.3% based on the increase in agricultural production, while agricultural emissions (AgrEmission8) also increased by 16.5%. On the contrary, FactIncome6 in Czechia increased moderately by 35.5% compared to the increase in Hungary of 53.5% and Austria of 63.3%, which was accompanied by a decrease in the number of NumAWU5 (annual working units) of 4% and of the Arable land measure (AraLand12) of 21%. Naturally, in Czechia the land use concentration can be realised by a smaller number of AWUs and less Arable land because the forestry areas increased.

Hungary belongs to the second quadrant, where the FoodProdCap7 decreased by 10%, while the NitrUse10 increased by 14%; but also, FactIncome6 increased by 53.5% and AraLand12 only decreased fractionally, by 1.6%, compared to Czechia. Hungary is separated from Italy and Austria because the Agricultural gross value added (AgrGVA2) increased enormously by 57.6%, which contributed to a growth in the GDP of 26% and an increase in the Nutrient nitrogen use (NitrUse10) of 14% which was accompanied by an increase in Agricultural emissions (AgrEmission8) of 15.5% - the second highest after Czechia's 16.5%.

Austria and especially Italy belong to the third quadrant and are separated from Hungary and Czechia along component 2 due to GDPgrowth1, AgrGVA2, AgrEmission8 and GDPinPPP11. On one hand, the reason behind this is the decrease or a moderate increase in the previously mentioned variables. On the other hand, NumAWU5 has a negative correlation with component 2, indicating an increase or a moderate decrease in its value. Austria had the lowest increase in agricultural GVA of all four countries and had the highest-level increase of factor income per AWU. This shows that agricultural production in Austria was the most efficient and concentrated regarding inputs and labour productivity. Moreover, the increase in the compensation was the greatest in Austria, and because most of the compensation covered the developing consumption of fixed capital, agricultural development brought more prosperity for Austria than for the other countries. These income conditions could help to keep the rural population in their original places of residence and to increase this population in the inverse ratio to the rural population in other countries.

Hungary and Czechia saw a considerable increase in agricultural GVA by a large increase in agricultural emissions in CO_2 equivalent, causing enormous damage to the natural environment along with the risk of global warming. Even though Czechia used more nitrogen than the other three countries, the increase in factor income per AWU was only a little higher (35.5%) than that of Italy (31%). As a comparison, Austria and Hungary managed to increase the factor income by 63.3% and 53.5%.

However, Austria and Italy were separated from Czechia with respect to arable land and food production per capita. Arable land decreased moderately by 2.6% for Austria and 4.3% for Italy and food production per capita decreased by 25% for Austria and 11% for Italy. This means that in Italy and Austria food production per capita decreased, which could result in a decrease in the arable land used. Hence, agricultural value added also increased slightly, leading to a moderate GDP growth. However, the factor income of both countries could increase considerably as a consequence of the considerable amount of subsidy for farmers, which improved the consumption of fixed capital. In Austria, in spite of the decrease in nutrient nitrogen usage, agricultural emissions increased. The other three countries used a very high level of nitrogen, and only Italy managed to decrease its agricultural emissions.

Figure 2 represents countries with respect to component-1 and 3. The interpretation of component-1 is the same as previously discussed in connection with Figure 1. Austria, Hungary and Italy are separated from Czechia along component-1. The reason for this is that Austria, Italy and Hungary had an increasing trend in factor income per AWU and a decreasing trend in food production capacity compared to Czechia. The y-axis represents component-3, including three economic variables, namely compensation for employees (Compens3), wages and salaries (WageSale4) and rural population between 2010 and 2018. Positive values on component-3 indicate a great increase, while negative values mean a huge decrease in these economic variables. In Austria the compensation and wages and salaries increased enormously by 48.5% and 50%; therefore, the factor income could increase by 63.3%, which naturally resulted in an increase in the rural population by 1.9%. However, all other countries also increased compensation for employees and wages and salaries in the agricultural sector, but to a lesser extent, and the rural population decreased in these countries.

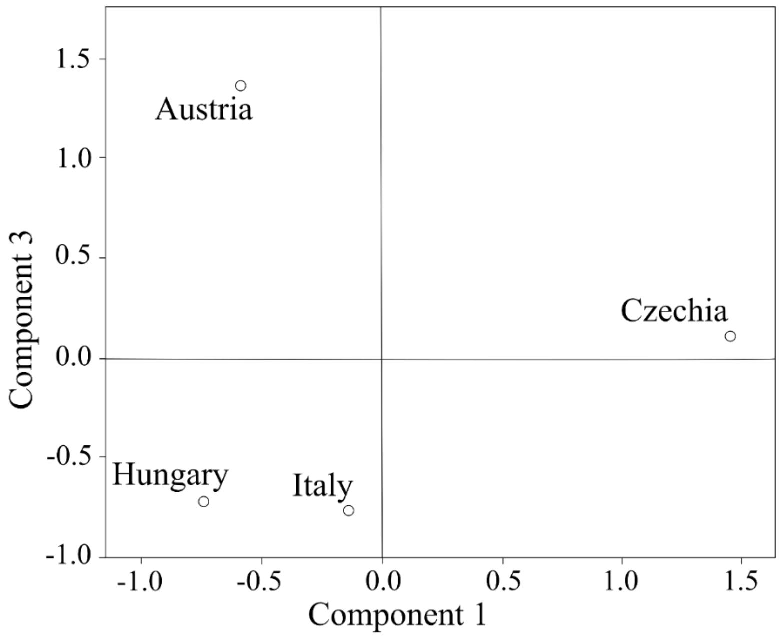

Figure 2. PCA map of the countries using component-1 and component-3
Source: Authors' own calculation based on the SPSS in AFI (Agricultural and Factor Income, 2017): DG Agriculture and Rural Development, Unit Farm Economics, European Union, 2018; EUROSTAT, 2019 [nama_10r_2gdp], [nama_10_a10], [aact_ali01] and FAOSTAT, 2019.

Figure 2 shows the result of the PCA, where component-1 and 3 are interpreted according to Table 6.

Hence, the third component is related to rural population, compensation for employees and wages and salaries. The positive values of component-3 indicate higher values for rural population, compensation and wages. The negative values of component-3 can be interpreted in an opposite way. Therefore, the rural population decreased the most in Italy and Hungary, by 7.4 and 10%, respectively, resulting in a separation from the other countries. Austria had the largest positive percentage change with respect to compensation (48.5%), wages and salaries (50%) and rural population (1.9%).

It can be stated that sometimes the considerable increase in compensation for employees and wages could result in a considerable decrease in the rural population, as occurred, for example in Hungary, where the population decreased. Moreover, in the case of Hungary the AWU decreased sharply by 12%, which caused a moderate decrease in the rural population. This means that in Hungary the decrease in employment in the agricultural sector stimulated the rural population to leave their original rural places of residence, which increased the factor income as a reason for the decrease in the AWU.

In Czechia and Italy, the rural population decreased to a lesser extent than in Hungary – which could also be the result of the decreasing employment and AWU in the agricultural sector; this resulted in an increase in the factor income per AWU to a lesser degree than that recorded in Austria and Hungary.

These conditions strengthened the very strong correlations between compensation and wages and salaries (by 0.980), between wages and salaries and factor income per AWU (by 0.935), and also between compensation for employees and factor income per AWU (by 0.846) (Table 1; EUROSTAT 2019; FAOSTAT 2019). The rural populations mostly depended on compensation and wages and salaries, and therefore rural population has a strong correlation with compensations (by 0.720) and with wages and salaries (by 0.598). This can also show that it is not the factor income per AWU which has the most influence on decreasing rural populations, but other two variables, namely compensation and salaries as direct incomes for AWU (Table 1; Table 2; Eurostat 2019; FAOSTAT 2019).

This study has its limitations as well. There are some limits of covering economic and social conditions because the statistical data cannot provide all the possibilities to analyse the economic processes. Also, the statistical analyses are based on the average calculation of database, therefore each country or region may differ from the average level of countries studied. The calculations of this paper can provide mainly average solutions for economic difficulties as each source of difficulties is located in a given country or region. Generally, speaking, there is no unified solution for solving economic difficulties to ensure sustainable development in rural areas.

This study focusses on very strong and strong correlations among the economic variables. In parallel with the increase of GDP growth and agricultural gross value added agricultural emission can also intensify, therefore the application of new advanced technology relevant to the environmental conservation is needed. Also, increasing compensation for employees can lead to rising wages and salaries, and gross factor income.

Innovation may lead to the reduction of income inequalities. Bubbico & Freytag (2018) also confirmed the correlations between new technological innovation and welfare. ILO (2016) highlighted that labour income inequality has increased in Europe recently (see more in AFI, 2017; EAFRD, 2020). Increasing food production capacity is accompanied by more efficient land-use concentration and rising nitrogen use. Tenorio et al. (2020) highlighted that in the last decade the Nitrogen (N) balance was smaller for maize crops following soybean compared to continuous maize. Despite the larger N balance (on an area basis), irrigated fields exhibited smaller yield-scaled N balance relative to rainfed fields (Beltrán-Esteve & Picazo-Tadeo, 2017).

If difficulties and economic issues in agriculture can be general unified solutions are needed to increase economic production efficiency in a sustainable way to avoid natural damages. Future research should concentrate on increasing production efficiency and land-use concentration by the introduction of advanced agricultural technology to ensure environmental conservation and avoid natural damages. Burja et al. (2020) emphasized that land grabbing in Romania has had a significant dimension compared to other Member States of the EU leading to an inadequate agrarian structure and adverse effects on the sustainable performance of agricultural holdings and the sustainable development of rural areas.

Conclusion

Based on the statistical analyses GDP growth has a very strong correlations with agricultural emissions, therefore research hypothesis related to this correlation tends to be confirmed. Also, agricultural gross value added has strong correlations with food production, agricultural emissions and purchasing power parity per capita. The compensation for employees also has very strong correlations with the development of wages and salaries accompanied by increasing gross factor income. On the other side increasing wages and salaries have a positive impact on gross factor income and a strong negative impact on nitrogen use, thus strong correlations can be confirmed in this case as well.

Expanding food production capacity has a positive impact on nitrogen use but a negative impact on land use change. A very strong positive correlation can be seen between agricultural emissions and purchasing power parity per capita, but a very strong negative correlation between nitrogen uses and land use change. Finally, it can be concluded that only two economic variables (compensation for employees, wages and salaries) played a considerable role in keeping rural population in its original places. Adequate livelihood can keep local population in rural areas. Finally, it can be concluded that all hypotheses tend to be supported.

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