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The Role of Climate Change, Employment, Government Expenditure, and Imports on the Value of Agricultural Production in Romania

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Abstract. *Agricultural production is important for ensuring food security, supporting many activities of society and building strong trade economy of a country, but can be slightly influenced by numerous factors. Even if exists a lot of studies that analyze the influencing factors of agricultural production in terms of value, investments, climate change, credits, costs of energy and more, in the literature can be observed a research gap regarding the relation between emissions or mean weekly hours actually worked per employed person and value of agricultural production. The identified gap in the specialty literature was covered in this paper. The present paper aims to analyze a series of factors that influence the value of agricultural production, like: climate change, employment, government expenditure and imports, after discussing the theoretical framework about the subject. The methodological approach is based on using several linear regressions, tested with the EViews software. One of the main findings indicates the existence of relationships between both the change of imports and the change of emissions with the value of agricultural production in Romania during 1995-2021. Also, another result indicates a negative influence of temperature change on the value of agricultural production, showing once again that climate change does negatively impact agricultural output and, thus, the sustainable development of Romania. This study could be used further by policy makers to understand on which drivers should act on in developing sustainable policies for Romanian agriculture.*

Keywords: gross production value, agriculture, linear regression, correlation matrix, influencing factors, sustainable development, change.

Introduction

Agriculture plays a key part in achieving local sustainable development, by ensuring food security and safety, environmental protection, waste reduction, economic development, and improving the wellbeing of people who activate or not in this sector. (FAO, 2022).

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In 2021, the European Union held an agricultural area of 162.90 million hectares, of which arable land represented 98.86 million hectares. In Romania, in 2021, the agricultural area was 13.07 million hectares, of which land arable 8.53 million hectares, representing approximately 8.62% of total arable land at EU level (FAO, 2022). In 2020, according to the National Institute of Statistics' data (NSI, 2022), 2,8 million farms were registered in Romania, of which 53.89% smaller than 1 hectare (ha), 36.28% between 1 and less than 5 ha, 5.67% between 5 ha and less than 10 ha, 3.21% between 10 ha and less than 50 ha, and 0.96% with 50 ha and more. 54% of very small farms detain almost 5% of the Romanian agricultural land, while the almost 1% farms with over 50 ha had over 54% of agricultural land (NSI, 2022). From these, only 1.93% of the Romanian farms had legal personalities. In the meantime, the management was carried out by mostly elderly people, 61.31% persons being of 55 years old or more, of which 57.98% of them have had only practical farm experience, without any type of agricultural training. Although the age of farmers may not be a crucial factor in farm management according to Stępień et al., (2022), their level of education and training can significantly enhance their willingness to adopt new agricultural practices, as highlighted by Kilpatrick (2000). This aspect is particularly relevant in meeting the demands of sustainable development and other environmentally conscious models, such as the circular economy.

Additionally, several studies (Ciornei et al., 2023; Ngobeni & Muchopa, 2022; Popescu et al., 2022; Bahşi & Çetin, 2020; Kadanali & Emine, 2020) emphasized as well the impact of various indicators on achieving sustainable development in agriculture, and on improving the well-being of farmers, such as public and private investments, trade, climate change drivers, and others.

Taking all of these factors into account and the highest proportion of its population engaged in agricultural activities and the largest portion of its land dedicated to farming Romania stands out as one of the nation's most reliant on agriculture in Europe (Drăcea & Ciobanu, 2019).

The purpose of the paper is to assess the impact of emissions from agriculture, temperature, employment, government expenditure, and imports on the value of agricultural production in Romania between 1995 and 2021. We used the simple and multiple linear regression analyses to test the research hypotheses by using the EViews 11 software (Startz, 2024), which allows for statistical and econometric data processing.

The paper starts by providing a brief overview on the scientific literature at international and Romanian level. The next section presents the methodology, including the research hypotheses. Forward, the findings are presented and discussed in connection with previous literature, suggesting ways of raising the agricultural production in terms of value. Finally, the concluding remarks highlights the main findings and the recommendations for improving the value of agricultural production in Romania.

Literature review

The causality between climate change, employment, government expenditure, imports and the value of agricultural production at an international level and in Romania has been approached by several authors, as presented in the next two subsections. The value of agricultural production can be defined as a sum of all the natural resources that include livestock and crop products (Yakubu et al., 2022).

At the international level

The importance of the value of agricultural production in determining the state of agriculture was emphasized by Ngobeni and Muchopa (2022) for South Africa. Also, their paper explores the effect of government expenditures in agriculture, food import value, annual average rainfall, and population on the value of agricultural production in the period between 1983 and 2019 (Ngobeni & Muchopa, 2022). The authors (Ngobeni & Muchopa, 2022; Ngobeni, 2022) consider that the increasing government expenditure in agriculture will ensure that the sector produces sufficient research and enhances modern technologies for better production, especially through the investments in climate-smart agriculture research. Ngobeni (2022) concluded that investments in climate-smart research can develop and promote climate-friendly technologies, cutting carbon emissions and enhancing rainfall, thus improving agricultural efficiency.

According to Bahşi and Çetin (2020), in Turkey, the agricultural credits do not directly augment the value of agricultural production, but they serve as a vital resource for procuring inputs, for agricultural production increase, and for facilitating new investments in agriculture. Moreover, the authors (Bahşi & Çetin, 2020) consider that as agricultural credits become more readily accessible and are channeled into development programs, the utilization of these credits can significantly enhance agricultural production, thereby positively impacting the agricultural gross domestic product. However, Kadanali and Emine (2020), in their Turkish study identified that a unilateral causality relationship from agricultural loans to agricultural production existed, after testing the Granger causality test. For this reason, the authors (Kadanali & Emine, 2020) concluded that loan expansion can increase the well-being of farmers by increasing the number of accepted loans and increasing the facility to use of loans.

By carrying out descriptive statistics in Excel, Popescu et al. (2019) identified a different degree of efficiency in the use of agricultural land among the countries of European Union, due to a lot of factors including climate features regarding temperatures, the implementation of the Common Agricultural Policy in each country, etc.

Further, Pawlak (2016) analyzed the correlation between the value of production and costs of energy in agriculture in the period 2004 and 2014 and also the correlation between the value of agricultural production in fixed prices and energy inputs in the same period. The author's (Pawlak, 2016) results show a positive correlation between the value of production and costs of energy in agriculture, while the correlation between the value of agricultural production and energy inputs is negative.

In Turkey, agricultural production was positively influenced by the agricultural support programs, as a result of an econometric analysis performed by Işık and Bilgin (2016). When the effects of different supports are compared, looks like that the market price support bring a more efficient growing agricultural production than other type of supports (Işık & Bilgin, 2016).

At the level of Romania

In Romania, the number of employees in agriculture decreased with 30.2% in 2020 versus 2008 (Popescu et. al, 2022). Based on a complex methodology that include a fixed basis index, a regression equation, a calculation of the coefficient of determination, and Spearman's rank correlation coefficient performed by Popescu et. al (2022), the authors concluded that even if the number of employees in agriculture decreased, the agricultural production value increased because of: the reduction of employees was based on: aging and migration, the performance in agricultural production increased, the fluctuations in prices of agricultural products or because of intermediate consumption.

In another study, Popescu (2017) approached the contribution of agriculture in the Romania's gross domestic products through a regression and a correlation, using the indicators: "GDP at national level, GDP created in agriculture, the share of agriculture in Romania's GDP, the value of agricultural production, the value of vegetal production, the value of animal production and the value of agricultural services", between 2007 to 2016. From author's research (Popescu, 2017) resulted that an important relationship between GDP at national level and GDP created in agriculture existed, 42.70% of the variation Romania's GDP resulting from the variation of the GDP created in agriculture.

More, Florea et al., (2021) used both the quantitative approach based on regression functions and correlation matrix) and the qualitative method based on SWOT analysis of the agriculture sector in Romania to identify that the area of organic farming, the average area per holding, the number of tractors and the outputs in agriculture were found positive relationships, while there was a negative relationship between the employees in agriculture, air pollutants, agriculture land, irrigation norm, agriculture training, and the outputs in agriculture.

Further, climate change in Romania was addressed by Ciornei et al. (2023), who pointed out its increasing evolution by more than 1.5 degrees Celsius in the period 1990-2021. According to Cofas et al. (2014) climate change impacts especially the agricultural sector, while Yakubu et al. (2022) calls attention to the fact that climate change needs to be researched as a supporting factor for the producers and other investors in agricultural and rural sectors in order to meet the sustainable development objectives.

Methodology

The research methodology was based on the analysis of factors that can influence the value of agricultural production in Romania, like: climate change drivers, employment, government expenditure and imports. The data is available on FAO (Food and Agriculture Organization of the United Nations, 2024). The selection of the analysis period, from 1965 to 2021, was determined by the accessibility of statistical data related to Romania and the data series used are annual. As presented in Table 1, the dependent variable taking into account is the value of agricultural production, while the independent variables considered are: greenhouse gas emissions from agriculture, temperature change, import value, government expenditure, and the employment mean weekly hours.

Table 1. Indicators of dependent and independent variables used in this research

Variable type	Variable name	Variable description	MU	Symbol
Dependent variable	Value of Agricultural Production - Gross Production Value (constant 2014-2016 thousand US$)	"This indicator is calculated as ratio between the total value of standard agricultural production or output and total used agricultural area" (FAO,2024).	1,000 USD	VAP
Independent variables	Emissions totals - IPCC Agriculture - Emissions (CO2eq) (AR5)	"Total greenhouse gas emissions from agriculture, including methane (CH4), nitrous oxide (N2O) and carbon dioxide (CO2) emissions." (FAO, 2024).	Kt (Kilotons)	EMS_DIF
	Government Expenditure in agriculture, forestry,	Data were collected annually through a questionnaire, which was developed in	million USD	GOV_EXP_DIF

Variable type	Variable name	Variable description	MU	Symbol
	fishing - Value US$, 2015 prices	partnership with the International Monetary Fund (IMF) (FAO, 2024).		
	Mean weekly hours actually worked per employed person in agriculture, forestry and fishing	"The indicator provides information on the mean hours worked per week by employed persons in all types of working time arrangements such as full-time and part-time in the agricultural sector." (FAO, 2024).	Hours/ employee	EMP_MWH
	Agricultural Products - Import Value Base Period Price	Value of agricultural imports (FAO, 2024).	1,000 USD	IMP_DIF
	Temperature change on land	"Statistics are available […] for annual mean temperature anomalies, i.e., temperature change with respect to a baseline climatology, corresponding to the period 1951–1980." (FAO, 2024).	°C	TEMP

Source: Authors' own contributions based on data available at FAO.org.

The methodological approach of this study is based on the regression analysis. Regression analysis is a statistical tool which help us to investigate the functional relationship between the value of a variable (dependent variable) and one or more predictor/exploratory variable (independent variables), and provide details about how accurate the independent variable predicts the dependent variable (Allen, 2004; Chatterjee & Hadi, 2013). According to Allen (2004), the main advantage of the regression analysis is that it represents a mathematical model that allow us to make clear the relative effect on a dependent variable of two or more independent variables. The limitations and gaps of linear regression are: to interpret a linear regression model as a causal relationship requires strong assumptions and can be challenging; a linear regression model is not simple, because exists hard rules that need to be taking into consideration; and in specification of a regression model is necessary to run the statistical testing. (Verbeek, 2017).

All the analyses presented in this paper have been performed in EViews (Startz, 2024), from hypotheses testing, such as stationarity, autocorrelation, and data distribution, to "Regression" module and model validity tests. All factors that were introduced in the econometric models passed the check of the hypotheses necessary for regressions validity. When data stationarity, autocorrelation, and normal distribution were tested, it was visible that three of the variables (emissions, import value and government expenditure) did not meet these prerequisite requirements of applying the regression model at the first level. So, it was necessary to transform the data by applying the first difference, after which the stationarity was found and the information have been interpreted as change from one year to another, and their symbol has a "DIF" mention. The stationarity at their first difference represents the change from one time period to the next one (Burke & Hunter, 2005). The variables considered for the models were selected only if the collinearity coefficient was less than 0.5, where statistical significance was registered.

Based on the approaches of different factors that influence the value of agricultural production presented in the literature review section, we intend to test the following hypotheses in this paper:

H1. The emissions from agriculture have a statistically positive significance in impacting the value of agricultural production in Romania during 1995-2021, as the agricultural activities have used

more intensive practices which increased the emissions for rising, finally, the agricultural production value.
H2. Both temperature changes and imports in agriculture have a statistically negative significance in impacting the value of agricultural production in Romania during 1995-2021, as increases of temperature, and of imports could affect the agricultural yield and prices, thus, the value of agricultural production.
H3. Government expenditure in agriculture influences positively the value of agricultural production as other authors (Ngobeni & Muchopa, 2022; Ngobeni, 2022) demonstrated in their research.
H4. Although Popescu et al. (2022) previously found that the agricultural production value increased even if the number of employees in agriculture decreased, the second hypothesis of this study was that the mean weekly hours worked per employee would positively influence the value of agricultural production. Our approach was based on the fact that the mean weekly hours worked per employee is a better indicator of the role of employment in impacting the agricultural production value, as it considers the labor productivity.

Results and discussions

The results of the descriptive statistics for the indicators from Romania previously presented in the methodology section and used in the regression are presented in Table 2.

Table 2. Descriptive statistics

	VAP	EMS_DIF	TEMP	IMP_DIF	GOV_EXP_DIF	EMP_MWH
Mean	15,995,984	-143.3264	1.152074	232,277.4	42.29100	35.37519
Median	16,144,985	-161.9428	1.335000	156,651.0	-46.18500	35.22000
Maximum	18,763,285	847.6070	2.266000	180,7131.	581.9200	38.22000
Minimum	13,281,429	-1,525.525	-0.424000	-695,811.0	-503.3700	31.30000
Std. Dev.	1,436,628.	549.5033	0.774392	687,229.6	339.8380	1.846311
Skewness	-0.113042	-0.364051	-0.392516	0.717363	0.111684	-0.157243
Kurtosis	2.840424	2.938172	2.315109	2.741878	1.755796	2.228642
Jarque-Bera	0.086151	0.578452	1.221022	2.302154	1.331614	0.780631
Probability	0.957839	0.748843	0.543073	0.316296	0.513859	0.676843
Sum	4.32E+08	-3,726.486	31.10600	603,9213.	845.8200	955.1300
Sum Sq. Dev.	5.37E+13	7,548,847.	15.59177	1.18E+13	219,4308.	88.63047
Observations	27	26	27	26	20	27

Source: Results generated in EViews by the authors' data processing, 2024.

The descriptive statistics shows both the trend of analyzed variables and the normality of distribution of data. Thus, all variables presented in Table 2 were normally distributed, as Jarque-Bera, Skewness, and Kurtosis tests indicate these aspects.

In terms of statistics, the value of agricultural production in Romania – VAP – reached an average of 1,599,5984 thousand USD in 1995-2021 time frame, with a maximum of 18,763,285 in 2004, the year when Romania registered the most of maximum absolute values of the monthly amount of precipitation from November (The National Meteorological Administration, 2021) and a minimum of 13,281,429 in 2007. 2007 is the most recent year with high absolute maximum temperatures in July, most above 35ºC (The National Meteorological Administration, 2022). 2007 it was also considered as one of the driest years in Romania according to Ardeleanu (2007).

Interestingly, 2004 was the year with the maximum value of value of agricultural production as it was the case with the highest employee mean weekly hours in Romania in the analyzed time frame.

In the analyzed period (1995-2021), the value of emissions from agriculture – EMS – reached an average of 16,740.28 kilotons with a maximum of 19,678.88 in 1995 and a minimum of 14,580.74 in 2012, while the change of agriculture emissions from a year to another – EMS_DIF –reached an average of -143.3264 kilotons in Romania in 1995–2021 period.

The value of mean weekly hours worked per employee – EMP_MWH – reached an average of 35.37519 mean weekly hours actually worked per employed person in agriculture, forestry and fishing in 1995–2021 period, with a maximum of 38.22 in 2004 and a minimum of 31.3 in 1995. The year 1995 is the year in which the highest value of emissions was registered and also the year with the lowest mean of employee working hours.

Temperature on land – TEMP – registered an average of 1.152074°C in the period of 1995-2021, with a maximum of 2.266000°C in 2018, and a minimum of -0.424000°C in 1996.

The change of the government expenditure in agriculture, forestry and fishing– presented an average of 1,387.945 in 2001-2021 period, with a maximum of 2,370.07 million USD in 2008, and a minimum value of 511.87million USD in 2002, while the change of the government expenditure from a year to another – GOV_EXP_DIF registered an average of 42.29 million USD from 2001 to 2021

Regarding the change of imports – IMP – from 1995 to 2021 the reached average was 378,8513thousand USD, with a maximum of 7,859,096 thousand USD in 2020, and a minimum of 892,754 thousand USD in 1997, in the same time (1995-2021) the change of imports from a year to another – IMP_DIF – registered an average of 232,277.4 thousand USD

The results of the correlation matrix are presented in Table 3.

Table 3. Correlation matrix

Correlation Probability	VAP	TEMP	GOV_EXP_DIF	IMP_DIF	EMS_DIF	EMP_MWH
VAP	1.000000 -----					
TEMP	0.251827 0.2051	1.000000 -----				
GOV_EXP_DIF	0.200795 0.3960	-0.278680 0.2341	1.000000 -----			
IMP_DIF	-0.449664 0.0212	0.275131 0.1737	0.224185 0.3420	1.000000 -----		
EMS_DIF	0.445146 0.0227	0.094779 0.6451	0.096367 0.6861	-0.060085 0.7706	1.000000 -----	
EMP_MWH	-0.093316 0.6434	-0.453265 0.0176	0.087367 0.7142	-0.252290 0.2137	-0.035686 0.8626	1.000000 -----

Source: Results generated in EViews by the authors' data processing, 2024.

The correlation matrix indicated the existence of relationships of the change of imports, and the change of emissions with the value of agricultural production in Romania during 1995-2021. Also, it seems like there was a correlation between mean weekly hours of work and temperature during the same time frame.

The results of the multiple linear regressions are presented in Table 4.

Table 4. Findings of the influencing factors of value of agricultural production

Dependent variable – Value of Agricultural Production - Gross Production Value (VAP)			
	Model 1	Model 2	Model 3
EMS_DIF	1,185.326***		1,054.244**
TEMP	-798,181.2**		-1,079,370*
IMP_DIF	-0.872382**	-1.057932**	-0.972201**
GOV_EXP_DIF		1,437.923 (p=0.14)	816.8596 (p=0.37)
EMP_MWH	-356,632.6**		-419,874.3*
C	29,961,418***	1,6345,503***	32,635,219***
R-squared	0.513000	0.299972	0.554964
Prob (F-statistic)	0.003344	0.048248	0.029442
Durbin-Watson	1.915324	1.545173	1.824696

Note: *** p-value <0.01; ** p-value <0.05; * p-value <0.10

Source: Results generated in EViews by the authors' data processing, 2024.

The R-squared test indicates the validity of all tested values, with better valid values for the first and third models, meaning that the independent variables considered in these two models explains better the independent variable. Also, the values of the Prob (F-statistic) in all 3 models suggest that all three models are statistically significant. Further, the Durbin-Watson test suggest that all three models are valid as its value is near 2.

The findings suggest that all independent variables considered in the three models, except the change of the government expenditure, were statistically significant in impacting the value of agricultural statistics.

Thus, the change in emissions from agriculture positively impacts the value of agricultural production, the first hypothesis being validated. This means that, if the change of emissions from one year to the next increases by 1 Kt, the value of agricultural production increases as well by around 1,185.326 or 1,054.244 thousand US$, depending of the model. This finding suggest that Romania still needs to adopt policies for decupling the economic output in agriculture of emissions in agriculture. So, we recommend retesting in the future this relationship for a macro view of the climate change-agriculture type of relationship, bearing in mind that future studies should focus as well on the drivers of prices, and other influencing factors of both emissions and value of agricultural production.

The temperature change negatively impacts the value of agricultural production, the second hypothesis being validated. This means that, if the temperature change increases by 1°C, the value of agricultural production decreases by around -798,181.2 or -1,079,370 thousand US$. This finding indicates the need of tackling the effects of climate change through environmental-friendly policies, such as restoring degraded land area, protecting areas at risk of environmental degradation, and reducing the emissions in all economic activities.

The imports change negatively impacts the value of agricultural production, this fact conducting also to the second hypothesis validity. This means that, if the imports change increases by 1000 USD, the value of agricultural production decrease by around 0.872382, 1.057932 or 0.972201 depending on the model.

The government expenditure change positively impacts the value of agricultural production. This means that, if the change in government expenditure increased with 1 million USD, the value of agricultural production increase by around 1,437.923 or 816.8596 thousand US$. However, the change it is not statistically significant at 5% and we cannot conclude the third hypothesis. Also, future studies should retest this relationship for Romanian indicators considering more yearly data, as now the starting year of reporting data on government expenditure was 2001.

The mean of working hours weekly registered by an employee negatively impact the value of agricultural production. In other words, if the mean weekly hours worked by an employee increases with an hour, the value of agricultural production decreased with 356,632.6 or 419,874.3 thousand US$. In this case, the forth hypothesis it was not confirmed. In this case, future studies should analyze the quality of work, as well as other aspects which might influence the performance of workers in agriculture, and their impact on the value of agricultural production.

Finally, future research could take into consideration other variables which might influence the agricultural production value, such as the production yield, the structure of production, the prices of inputs and agricultural products, and other possible influencing factors.

Conclusion

The contribution of the study to the literature can be expressed in several directions, because the paper has explored a wide large of factors that can influence the value of agricultural production, an important indicator for developing sustainably the Romanian agriculture. From our paper stand out that the influence of the factors considered in our analysis on the value of agricultural production is high (R = 0.55).

This study is one of the few research that examine the relationship between the total emissions in agriculture or the mean weekly hours worked by an employee and the agricultural production value. As from our knowledge, the impact of labor productivity and emissions on the value of agricultural production has not been tested in Romania between 1995 and 2021. Thus, the findings suggest that the yearly change of emissions impacts positively the value of agricultural production, while the temperature change, the yearly change of imports, and the labor productivity impact negatively the dependent variable.

Except the general limitation and gaps exposed in methodology section, regarding the linear regression, it must be also noticed that another limit of the present paper is related to the data series availability, the analyzed period being from 1995-2021 or 2001-2021 in case of government expenditure.

In conclusion, future studies should focus on considering more variables in the models for a longer time frame, while the policy makers and the Romanian farmers should pay more attention to the drivers of agricultural production value for improving the sustainable development of their farms and of the agricultural sector.

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