AGRICULTURE AND MANUFACTURING SECTORS' IMPACT ON THE GROSS VALUE ADDED – A GRANGER CAUSALITY STUDY FOR EUROPEAN UNION AND ROMANIA

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Abstract: *The objective of the present research is to study the impact of the agriculture and manufacturing sectors on the Gross Value Added in the European Union and Romania, more precisely to see if this impact, which is evident, also takes the shape of a Granger causality. The analysis follows the Toda-Yamamoto procedure, because the variables are not stationary in their levels, and their elasticities have the same characteristic. The results are not the best, since most evaluations have been stopped because the vector autoregressive models have not been properly specified, according to the tests applied in this scope.*

Key words: *agriculture, manufacture, causality, impact, model*

JEL Classification: *Q19, O14*

Introduction

The gross value added is one of the measures that contribute to the formation of the Gross Domestic Product. The Eurostat definition (Eurostat, 2020) output value at basic prices less intermediate consumption valued at purchasers' prices. The breakdown of GVA according to the NACE Rev. 2 describes the contributions of various economic sectors to the formation of the indicator. *Agriculture, Forestry, Fisheries* and *Manufacturing* sectors have been selected for analysis in this paper, because of their importance in the national economies. The aim of the article is to state whether the contributions of these two sectors to the GVA, for Romania and European Union, can also be considered as a causality in Granger approach.

Literature review

Cai and Leung (2020) offer a perspective on the Gross Value Added, according to which this indicator represents a common measure of the economic performance for a given sector. Užar and Radojević (2019) develop on the contribution of agriculture in the formation of GVA in Serbia, they approach the 2008-2017 interval, the main analysis method applied by the authors is simple linear regression and the results outline the statistically significant influence of the agriculture. Sevcikova (2003) analyses the contribution of agriculture and food creation to Gross Value Added in Slovakia, compared with EU and CEFTA, outlining the decline of the impact, because of factors such as prices, and the actual output from agriculture. Siami-Namini (2017) studies the causal relationship between the GDP and economic sectors, including agriculture, for an interval of 25 years (1990 to 2014), the results achieved indicate that the value-added share of the agriculture has a rather non-favorable impact, while manufacturing is a positive factor. Tiffin and Irz (2006) have addressed the characteristics (that is, direction of causality between the Gross Domestic Product and the agriculture's VA per worker. The results, for developing countries, clearly outline the

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character of agriculture as independent (causal) variable in this relationship. Păunică et al. (2018) have used regression to study the impact of selected globalization indicators on the Gross Domestic Product for a panel of countries. The Granger causality has been used in the analysis of remittances' impact on the Gross Domestic Product and Final Consumption in EU member countries, by Păunică et al. (2019)

Gokmenoglu et. al. (2015) have employed Granger causality to study the causalities between a set of variables, including industrial production and GDP. Their results indicate no statistically significant coefficient that would describe any causality between the two variables. Yetiz and Özden (2017) have evaluated the relation of causality between GDP, agricultural, industrial and services sectors in the case of the Turkish economy, achieving a causality posed by agriculture on the Gross Domestic Product.

Thus, the results are mixed. This article aims to corroborate evidence from Romania and the European Union in order to substantiate the existence of a Granger causality between agriculture and manufacture GVA and the total GVA.

Research methodology

The following research hypotheses have been considered to describe the objectives of our research:

H1. Agriculture, forestry, fisheries causes, in Granger sense, the Gross Value Added in Romania and the European Union

H2. Manufacturing sector causes, in Granger sense, the Gross Value Added in Romania and the European Union

Given the relationship between the two variables, and the fact that they are susceptible to be non-stationary, the method chosen is the Toda-Yamamoto approach on Granger causality. Data are processed in EViews and the implementation of the method pursues the guidelines described in Giles (2011), namely:

a) test for stationarity/unit roots. This step aims to outline the maximum order of integration for each pair of variables. In the case in which the final stage of analysis is reached, this parameter will be used to modify the model used for actual testing. For this purpose, two tests are used:

- Augmented Dickey – Fuller (ADF). This test will be applied for a maximum of five lags, for the *Trend and intercept* option included in the test equation, the automatic lag selection is based on the Schwarz Info Criterion;

- Phillips - Perron (PP). The parameters of this test also specify the inclusion of *Trend and intercept* in the test equation, the chosen spectral estimation method is the default one – *Bartlett kernel*), and bandwidth is automatically selected on the basis of *Newey-West bandwidth*.

b) estimation of an unterstricted VAR model between the variables correlated with each hypothesis. The model is defined, at first, with 2 lags (the default setting), and then is updated according to the lag length criteria (the value specified by the most criteria is preferred, in the contrary situation, according to Chirilă and Chirilă (2017), the number of lags specified by the Schwarz Info Criterion will be used.

c) specification tests for the VAR model. By considering Hacker and Hatemi-J. (2003) and Giles (2011), all four tests are to be evaluated, and only models that pass the entire package will be considered for the next steps:

- AR roots test for stability. The values are analyzed in the *table* instrument;

- *VAR Residual Serial Correlation LM Tests.* The autocorrelation was tested for a maximum of lags indicated by the interface, that is 12 lags.;

- *Multivariate Normality Test,* the variant selected for the orthogonalization method is *Cholesky of covariance (Lutkepohl)*;

- *White Heteroskedasticity Test*, the option without cross terms.

When either stability or autocorrelation tests display improper errors, the lag length is updated by one unit, if the size of the dataset allows. But, if the model fails to pass one of the last two tests, the model is considered not properly specified in the sense of Granger causality testing.

d) the model that has passed all tests in the previous stage are updated, by inserting the additional number of lags corresponding to the maximum order of integration, as exogenous variables.

e) the Wald test for Granger causality is applied on the modified model.

All data have been extracted from the online database of the European Statistical Office – EUROSTAT.

The dataset selected is „*Gross value added and income by A*10 industry breakdowns [nama_10_a10]*”, of which the measures corresponding to the research hypotheses were drawn:

- *Value added, gross*;
- *Agriculture, forestry and fishing*
- *Manufacturing*.

The values for the three measures are expressed in *Current prices, million euro*, and the breakdown is made according to the NACE Rev. 2. The elasticities were obtained by applying natural logarithm to the original values.

Testing H1, European Union

Nominal values

The results of the unit root test applied on the variables that describe the first research hypothesis have led to the orders of integration specified in table no. 1.

Table 1. Orders of integration, H1 hypothesis, European Union, nominal values

Variable	ADF test	PP test
Gross Value Added (EGVA)	1	1
Agriculture, forestry and fishing (EAFF)	1	1
Maximum order of integration	1	

Source: author's representation of EViews results for ADF and PP tests

All tests converge on indicating that variables are non-stationary in their levels, but the first differences are stationary. Thus, the maximum order of integration is set to 1.

A VAR model is estimated next between *EGVA* and *EAFF*, with a single lag (as indicated by all lag length criteria). The model is stable, but there is serial correlation. When an additional lag is specified, all roots of characteristic polynomial are sub-unitary in module, however, the autocorrelation persists (at the same lag, 4, when tested against 12 lags). VAR(3) is not stable, as is VAR(4), VAR(5) and VAR(6). Given the criteria established for assessing the VAR models, in this case, the analysis methodology cannot proceed to the next step.

Elasticities

The unit root tests, like the previous case, lead to a maximum order of integration equal to 1. This means that, in the event of a reliable VAR model, an extra lag is to be added before testing for Granger causality.

Table 2. Orders of integration, H1 hypothesis, European Union, logarithm valuesthe

Variable	ADF test	PP test
Gross Value Added (LEGVA)	1	1
Agriculture, forestry and fishing (LEAFF)	1	1

Maximum order of integration	**1**

Source: author's representation of EViews results for ADF and PP tests

The lag length criteria indicate that the VAR is best specified with a single lag. The AR root test indicates a stable model, however there is autocorrelation in lag 4 out of 12. according to Giles (2011), the lag length is increased by one unit. VAR(2), even if stable, is characterized as non-usable due to autocorrelation. When further increasing the number of lags, the model becomes unstable up until 4 lags. VAR(5) is stable, but still affected by autocorrelation (lag 10 out of 12 tested). If the next two lags are added, in successive steps, the models are not stable. 7 remains the maximum possible number of lags possible under the number of observations included in the dataset.

Testing H1, Romania

Nominal values

Table no. 3 displays the orders of integration. While for the GVA, no stationarity was found until the 2nd difference was tested, the causal variable is stationary on the first difference, thus I(1), and the maximum order of integration is 2.

Table 3. Orders of integration, H1 hypothesis, Romania, nominal values

Variable	ADF test	PP test
Gross Value Added (RGVA)	**2**	**2**
Agriculture, forestry and fishing (RAFF)	**1**	**1**
Maximum order of integration	**2**	

Source: author's representation of EViews results for ADF and PP tests

The majority of the lag length criteria indicate 5 lags to be included in the VAR. When tested for stability, VAR(5), and then VAR(6) and VAR(7) are not stable. As the specification of Giles (2011) are considered in the scope of evaluating a model for specification, this VAR does not fulfil the criteria.

Elasticities

After analysing the results of the unit root tests, the same values are found as in the previous case, the actual values of the Romanian variables

Table 4. Orders of integration, H1 hypothesis, Romania, logarithm values

Variable	ADF test	PP test
Gross Value Added (LRGVA)	**2**	**2**
Agriculture, forestry and fishing (LRAFF)	**1**	**1**
Maximum order of integration	**2**	

Source: author's representation of EViews results for ADF and PP tests

As the research methodology demands, the next step involves the definition of a Vector Autoregressive model between the variables and its configuration according to the lag length criteria, which indicate an optimum of five lags out of a maximum five. The model satisfies the first two conditions – stability and no correlation, the residuals are multivariate normal, but the heteroskedasticity test cannot be applied.

If the modified Wald test is applied, it indicates Granger causality, but in the reverse way than the research hypothesis, however, the impossibility to apply the test for heteroskedasticity is preventing the validation.

Unlike the results of Užar and Radojević (2019), which used linear regression, the analysis by Granger causality with the described parameters failed to reach any statistically significant results, in all cases.

Testing H2, European Union
Nominal values

The application of the two-unit root tests led to the following orders of integration, for the variables corresponding to the second research hypothesis:

Table 5. Orders of integration, H2 hypothesis, European Union, nominal values

Variable	ADF test	PP test
Gross Value Added (EGVA)	**1**	**1**
Manufacturing (EMAN)	**1**	**1**
Maximum order of integration	**1**	

Source: author's representation of EViews results for ADF and PP tests

Both tests indicated that the variables are I(1). The VAR model designed between *EGVA* and *EMAN* is designed with a single lag, as specified by the lag length criteria. The stability test displays roots only within the unit interval. However, when tested in the first 12 lags, autocorrelation occurs for lags 4, 7, and 9-12. After updating to 1…2 lag length, the new model has the same characteristics: stable, but there is serial correlation in residuals, and VAR(3) and VAR(4) have the same behaviour against the specification tests. The models with higher lag lengths are not stable. Because of their improper response to specification tests, the analysis for Granger causality cannot be pursued.

Elasticities

When tested for stationarity, the variables are stationary in their first difference, just like the nominal variables. Both PP and ADF tests have confirmed these conclusions.

Table *6*. Orders of integration, H1 hypothesis, European Union, logarithm values

Variable	ADF test	PP test
Gross Value Added (LEGVA)	**1**	**1**
Manufacturing (LEAM)	**1**	**1**
Maximum order of integration	**1**	

Source: author's representation of EViews results for ADF and PP tests

By estimating the VAR model required in the next stage, it has been confirmed that its optimum lag length is 1…1, from a maximum of 5 tested. The initial model responds well to the stability test, but autocorrelation occurs in the residuals for the 11th and 12th lag (a maximum of 12 lags have been tested), the same observations occur for VAR(2), VAR(3), VAR(4), VAR(5), while VAR(6) and VAR(7) are not stable. Therefore, the evaluation of Granger causality cannot be done under the current conditions.

Testing H2, Romania
Nominal values

The maximum order of integration is actually given by the *RGVA* variable, which is stationary only at the second difference. The same orders of integration were offered by the two tests.

Table 7. Orders of integration, H2 hypothesis, Romania, nominal values

Variable	ADF test	PP test
Gross Value Added (RGVA)	**2**	**2**
Manufacturing (RMAN)	**1**	**1**
Maximum order of integration	**2**	

Source: author's representation of EViews results for ADF and PP tests

As the methodology requires, the next step involved the creation of a VAR model, which was estimated initially with the number of 4 lags, but neither this model, nor the ones with an extended lag length (up to and including 7) are stable. Following Giles (2011), a model which is not stable will not be used for testing.

Elasticities

It can be observed, from table no. 8, that the orders of integration for the Romanian variables, either nominal or elasticities, are the same across the four cases tested.

Table 8. Orders of integration, H1 hypothesis, Romania, logarithm values

Variable	ADF test	PP test
Gross Value Added (LRGVA)	**2**	**2**
Agriculture, forestry and fishing (LRMAN)	**1**	**1**
Maximum order of integration	**2**	

Source: author's representation of EViews results for ADF and PP tests

The lag length criteria lead to a VAR model with only one lag, and it behaves like the other models. For one up to three lags, the model's residual are serially correlated, while VAR(4) is not stable. The models with more lags are not stable.

Conclusions

The analysis for Granger causality between the variables selected failed to return statistically significant results. The models had similar behaviours, with some of them not passing even the stability or autocorrelation tests. Perhaps the behaviour of the time series analysed generated those problems, therefore the author will consider analyse the correlation with variables by using other methods. Given the results emphasized in the literature review section, future analyses might lead to more significant results.

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