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AN ECONOMETRIC ANALYSIS OF THE ECONOMIC IMPACT ON CONSUMER PRICE INDICES

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Abstract. This study aims to test two models of multiple linear regression to determine the nature and size of the links between consumer price indices, indices of total consumer prices and indices indicating labor force, wage and labor costs. Following the application of the co-integration test, the association between the four and three macroeconomic variables was made through the cointegration equations for each model, respectively, which led to the use of the test of the vector error correction model. We believe that consumer price indices (CPI) are a way to measure inflation by covering monetary expenditure on goods and services intended for final consumption for all resident households, except institutional households, and the causal relations between wages and prices are difficult to identify, and the ability of wages to help predict future inflation is limited. Wages seem to be useful in assessing the current state of labor markets, but they are not necessarily enough to think about where the economy is going and inflation.

1. Introduction

In a market economy, the prices of goods and services can change at any time. Some prices go up, others go down. Inflation occurs when there is a generalized increase in the prices of goods and services, not just of specific items, which means that today you can buy with one euro less than you could buy yesterday. In other words, inflation reduces the value of currency over time.

The economy of any nation is a major concern for the government, the business community and the entire population. It is therefore important that different economic indicators are available to inform about the progress and state of the economy.

One of the indicators is the consumer price index, an indicator that must summarize the evolution between two periods of prices of all goods and services entering the consumption of the population. This index is calculated as a percentage ratio between the average current price index and the average index for the previous period (or other chosen periods of the reference year). Economic agents need the consumer price index to update debt, to (re)calculate wage rights, to reevaluate fixed assets. Magistrates ask the consumer price index to calculate the value of goods and services in civil cases or damages in criminal cases. Administrative-territorial units are interested in CPI for updating the prices of rents or other types of services provided. Members of the Advisory Committee for Civil Dialogue for Elderly People want to know how much inflation has increased (inflation rate), calculated by subtracting 100 from the annual consumer price index. Official statistics use CPI when calculating the real salary index, as a ratio between the net average nominal salary and the consumer price index, which shows us how much the purchasing power of the salary has increased.

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The real wage index is the ratio between the net nominal average earnings index and the general consumer price index. The real gain expresses the value of the goods and services that can be bought or used, respectively, with the average monthly net gain, over a certain period of time, usually one year, compared to another period, given the prices of goods and the tariffs of services.

The average monthly labor cost is the total (direct and indirect) expenditure incurred by the unit through work on average, per employee and obtained by reporting the annual labor costs to the average annual number of months in the reference period.

Therefore, the choice of the total consumer price index as an aggregate indicator of the size of the inflationary phenomenon is explained by its importance in the analysis of economic and social efficiency.

The succinct content of the article by sections is as follows: after the first introductory section, the second part is devoted to the study of literature, and the third part to the methodology, the, so that the results and discussions on the proposed analysis are represented in the fourth part, the end being the conclusions, the limits and the possible directions of the subsequent research.

2. Review of specialized literature

Econometric analysis of time series focuses on the statistical aspects of pattern building, with an emphasis on providing an understanding of key ideas and concepts in econometrics, instead of presenting a series of rigorous evidence. It explores how recent advances in time series analysis have impacted the development of a theory of dynamic econometrics, they have established an integrated approach to estimation and testing problems based on the maximum probability method and present a coherent selection of the strategy model.

This study, in addition to being a chronological series, was also used in forecasting data from non-stationary economic series.

The evolution of economies can lead to sudden changes caused by legislative changes, economic policy, major progress and political unrest. Macro-econometric models are a very imperfect tool for predicting this highly complicated and changing process. Ignoring these factors leads to a great discrepancy between theory and practice.

Many authors have studied the dependence of the consumer price index (CPI) on other variable economies and time series models [1-7]. Multiple regression models are often used to construct explanatory models for economic variables [8-11].

Falnita and Sipos [12] also propose a multiple regression model to explain CPI based on 7 independent variables (exchange rate, interest rate, production price, etc.). Other authors are working on inflation forecasting models.

Iyiola and Adetunji [13] studied the effect of monetary policy on consumer price indicators (inflation rate, gross domestic product, credit to the private sector, money in general, the net credit granted to the government and the consumer price index) and showed that there is a dependence between them by estimating the multiple regression model. The validity of the estimated model is verified by self-correlation testing and multicollinearity detection.

Dolca and Nicolov [14] present an econometric analysis of the relationship between net salary and consumer price index in which they analyze the calculation statistics for variables, the relationship between variables, the, it realizes the point cloud and applies the Fisher test and the Student test, estimates the parameters for the regression function and applies the homoscedasticity assumptions, as well as the Durbin-Watson test.

The procedure for testing a chronological dataset on CPI includes the OLS regression mounted by Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) which is used for

the case when calculating the unit root test [15], [16]. In his paper, Azimi [17], he tests whether the consumer price index (CPI) is generated from a stationary system. The statistical analysis of ADF and PP results in a lower statistical test value for CPI than the critical value at 0.05, this means that the CPI is not generated from a stationary process and follows the root of the unit at the level, but does not follow the root unit and is stationary at the first difference. Therefore, it rejects the null hypothesis in favor of the alternative.

CPI is generally used for three possible purposes, such as:

1. As an indication of the cost of living, that is, as a measure of the relative cost of living when faced with two different sets of prices for the same group of goods;

2 As a consumer deflator, that is, the price modification component for a breakdown of the value ratio into the price and quantity component;

3) As a measure of general inflation.

CPI forecasting is an important factor for any economy, as it is essential in economic planning for the future. Therefore, identifying a more accurate forecast model is a major contribution to the development of all countries. The European Central Bank report [18] documents the link between labor costs and price inflation in the euro area. Use of quarterly country and sector data for the first quarter of 1985-T1 2018, there is a close link between labor costs and price inflation in the four major euro area economies and in the three main sectors. The dynamic interaction between prices and wages varies over time and depends on the state of the economy and the shocks affecting the economy. The results show that labor costs are more likely to be shifted to price inflation with demand shocks than with supply shocks [19]. However, the change is systematically lower in periods of low inflation compared to periods of high inflation. From a theoretical perspective, the post-Keynesian view suggests that excessive gains over productivity increase price inflation. Instead, according to neoclassical theory, the causality between wages and inflation goes in the opposite direction.

Knotek and Saeed [20] show that for different payroll measures, the correlations between the wage index and the price index (inflation) are moderated at all opportunities, and the delays seem to have weakened in the last few decades. Recent evidence suggests that wage inflation has been influenced by price inflation. Similarly, Chang and Emery [21] find some evidence that price increases precede unit labor cost increases. In this respect, companies cannot change prices easily and therefore, if they decide to do so, the expected future costs must be taken into account. This means that prices could capture expected future wage movements.

Inflation recently returned to Romania, and the signs that this phenomenon will diminish are weak, despite the authorities' statements. Recent developments seem to indicate the possibility of a price-salary spiral, which will significantly contribute to the intensification of inflationary pressures.

3. Materials and Methods

The research approach followed in this article two stages: 1) testing of multiple linear regression models; 2) choosing and explaining the statistical-mathematical relationship and the influences between variables. The original econometric models presented here have passed rigorously through the stages of specification, parameterization, testing and decision (with emphasis on validation).

The data series has been tested using the Dickey Fuller test, the estimation of the parameters was made by the method of the smallest squares, following that in the final

models the obtaining of large values of the determination ratio (R2 quantifying the percentage by which the influence of the significant factors is explained, and adjusted R2 representing a corrected value of R2, a possible increase may sometimes be due to the number of variables in the model).

In the model were analyzed the t-Student tests (with null hypothesis H0: the coefficients are not significantly different from 0 and the alternative hypothesis H1: the coefficients are significantly different from 0), test F (verification if at least one coefficient is significantly different from 0, null hypothesis H0: all coefficients are not significantly different from 0 and H1: there is at least a different coefficient of 0), the Durbin-Watson test to test the self-correlation of model errors, the Jarque-Bera test to test whether or not model errors follow a normal distribution and the White test to check the homoscedasticity or heteroscedasticity of the economic model.

For the period 1999-2020, the following data series [18] were used: consumer price indices - monthly total consumer price index, monthly consumer food price index, and, monthly consumer price index of non-food goods and monthly consumer service price index, expressed as a percentage; Economic indicators - earnings indices, average annual labor cost.

The data were collected by the author from sources such as the National Institute of Statistics (insse.ro) – consumer price indices, real gain indices, average annual labor cost.

To identify a viable regression model, several scenarios were tested, having as endogenous variables the indicators of total consumer prices and exogenous variables either the indicators of monetary expenditure on goods and services for final consumption, or the earnings and the average annual cost of labor. The main steps were: choosing dependent and independent variables, testing the data series stationary, their stationing, estimating parameters, testing model hypotheses and interpreting results.

The dependent variables, CPI and independent variables, consumer price indices of food, consumer price indices for non-food goods, consumer service price indices, consumer service prices indices, were taken into account, income indices, average cost of labor and number of employees. (Table no. 1)

Table 1. Regression equations and notations used for variables

d_cpi_total = c(1) + c(2)·d_cpi_food + c(3)·d_cpi_non_food_goods + c(4)·d_cpi_services		
Indicator	Name of data series	Notation in the regression equation
CPI	cpi_total	d_cpi_total
Food consumption price	cpi_food	d_cpi_food
Good non-food consumption price	cpi_non_food_goods	d_cpi_non_food_goods
Price consumer services	cpi_services	d_cpi_services
d_cpi_total = c(1) + c(2)·d_wages + c(3)·d_labor_costs + c(4)·d_employees		
Earnings	cpi_total	d_cpi_total
Average labor cost wages	wages	d_wages
Number of employees labor_costs	labor_costs	d_labor_costs

4. Results and discussions

The first proposed regression model combines four variables, one dependent - the total consumer price index (CPI) and three independent - the consumer price index for food (cpi_food), non-food consumer price index (cpi_non_food_goods) and consumer service price index (cpi_services). To test the stationary, the Dickey-Fuller test was used for all four variables. (Table no. 2).

Table 2. Testing the stationarity - Dickey-Fuller (cpi_total, cpi_food, cpi_non_food_goods, cpi_services)

Variable		CPI	cpi_food	cpi_non_food_goods	cpi_services
t-Statistic		-2.258529	-8.018339	-3.555796	-3.412525
p-Value		0.1865	0.0000	0.0074	0.0114
Test critical values	1% level	-3.455289	-3.456514	-3.456730	-3.456730
	5% level	-2.872413	-2.872950	-2.873045	-2.873045
	10% level	-2.572638	-2.572925	-2.572976	-2.572976

For the CPI variable, the t-Statistics value is higher than the critical value for 1%, 5% and 10%, and the associated probability (p value) is higher than 5%, so the null hypothesis is accepted - the series has a unitary root (it is non-stationary).

The cpi_food series is stationary for all 3 levels of significance: 1%, 5%, 10%. The statistical value of -8.018339 is lower than the critical value for any level of significance presented. The null hypothesis is rejected and the associated value p = 0 confirms this.

For the cpi_non_food_goods variable the value t-Statistic is -3.555796, and the probability p associated with it is 0.0074. Thus, the cpi_nfg series is non-stationary for a significance level of 1%, but stationary for 5% and 10%.

For the cpi_services variable the value t-Statistic is -3.412525, and the probability p associated with it is 0.0114. Thus, the cpi_s series is non-stationary for a significance level of 1%, but stationary for 5% and 10%.

The non-stationary series were stationary making the difference, in the case of the CPI variable once (first order of integration), after which the cpi_non_food_goods series were tested in the same way, cpi_services (newly generated series were named d_cpi_total, d_cpi_non_food_goods). (Table no. 3)

Table 3. Testing the stationarity - Dickey-Fuller (d_ cpi_total, d_cpi_nfg, d_cpi_s)

Variable		CPI	cpi_non_food_goods	cpi_services
t-Statistic		-9.634819	-8.453494	-5.662300
p-Value		0.0000	0.0000	0.0000
Test critical values	1% level	-3.456514	-3.456514	-3.456514
	5% level	-2.872950	-2.872950	-2.872950
	10% level	-2.572925	-2.572925	-2.572925

For each of the variables tested, t-Statistic is lower than t-critical, p-Associated value < 0.05, so the null hypothesis is rejected and the alternative hypothesis is accepted, so the series has no unitary roots, so they are stationary. The multiple linear regression specifying the final econometric model is as follows (Equation 1):

$$d\_cpi\_total = c(1) + c(2)d\_cpi\_food + c(3)d\_cpi\_non\_food\_good + c(4)d\_cpi\_services \quad (1)$$

The parameters of the regression equation were estimated by the method of the smallest squares. (Table no. 4).

Table 4. Parameters of the regression equation (1)

Dependent Variable: d_cpi_total				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
c	0.214733	0.207507	1.034823	0.3017
d_cpi_food	0.437995	0.004922	88.99603	0.0000
d_cpi_non_food_goods	0.462100	0.004039	114.3994	0.0000
d_cpi_services	0.099491	0.002298	43.29717	0.0000
R-squared	0.999966	Mean dependent var		179.5860
Adjusted R_squared	0.999965	S.D. dependent var		117.4656
S.E. of regression	0.692485	Akaike info criterion		2.118031
Sum squared resid	124.1995	Schwarz criterion		2.172360
Log likelihood	-274.5211	Hannan-Quinn criter.		2.139864
F-statistic	2512849	Durbin-Watson stat		0.357907
Prob(F-statistic)	0.000000			

The t-Student values for the parameters are calculated in the t-Statistics column. If the value Prob. $< 0,05$ rejects the null hypothesis: the parameters of the variables differ significantly from 0. Statistical analysis t shows:

• 0.05 Probabilities for cpi_food, d_cpi_non_food_goods and d_cpi_services, null hypothesis is rejected, alternative hypothesis is allowed, coefficients are significantly different from 0;

• The free term coefficient is not significant because the probability attached to the t-statistical test is much higher than the 5% significance threshold%.

The F-statistics for the proposed model has a value of F=2512849 with a probability $< 0,05$ and therefore it is accepted that the overall multiple linear regression model studied is valid.

The model passes the error self-correlation tests, according to Durbin-Watson (DW = 0.35), the normality of error distribution, according to Jarque-Bera (Skewness = -0.51; Kurtosis=4.08) and homoscedasticity, according to White (F_statistic = 36.29924), Prob F(3,259) = 0,0000). (Figure 1)

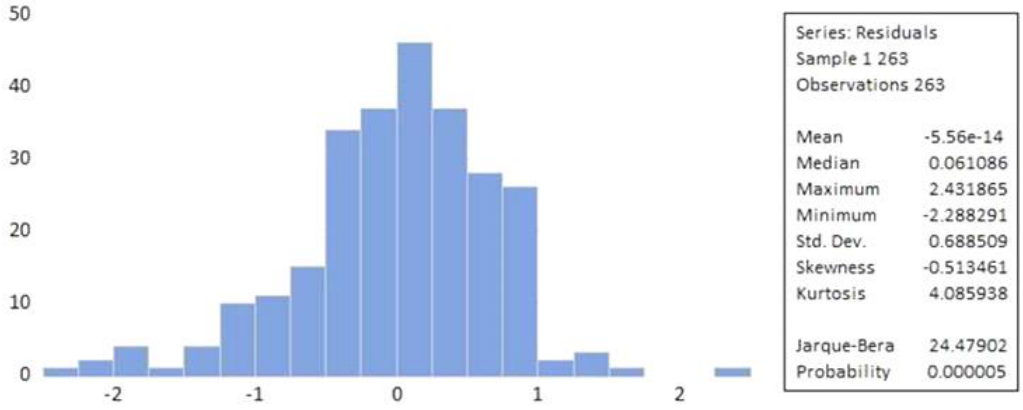

FIGURE 1. Jarque-Bera test for econometric model 1

The econometric model 1 parameterized as multiple regression is the following (Equation 2):

$$d\_cpi\_total = 0.214733 + 0.437995 d\_cpi\_food + 0.462100 d\_cpi\_non\_food\_good + \\ + 0.099491 d\_cpi\_services \quad (2)$$

The determination ratio (R2=99%) shows the percentage by which the influence of significant factors is explained. In other words, 99% of d_cpi_total variation is explained by d_cpi_food, d_cpi_non_food_goods, d_cpi_services. To counteract the mechanical growth of R2 due to the number of regression variables, the adjusted R is used, its value of 99% confirming the validity of the model.

At a 1% increase in cpi_food, d_cpi_total increases by 0.437995%, while the other variables remain constant. At a 1% increase in d_cpi_non_food_goods, d_cpi_total increases by 0.4621% (the most significant influence), while the other variables remain constant. At a 1% increase in d_cpi_services, d_cpi_total increases by 0.099491%, while the other variables remain constant. Therefore, the positive development of the three indices (in the sense of increasing the total consumer price index) measures changes in the price level of a weighted average market basket of consumer goods and services purchased by households. As the overall price level rises, each monetary unit buys fewer goods and services, from which we infer that inflation reflects a reduction in purchasing power per unit of money.

The econometric model 1 suggests an important link between the prices of all goods and services entering the consumption of the population between two periods. Thus, the three analyzed statistical indices expressing an increase in the cost of living (prices of goods and services) have a positive and strong impact on consumer prices (indices of consumer prices).

Consumer price indices aim to provide rapid information on fluctuations in the economic cycle in real terms.

The second proposed regression model links the consumer price index to three labor force indicators: earnings indices, average annual labor costs and the number of employees.

The Dickey-Fuller test for all four variables was used to test stationary results, the consumer price index was detailed in the previous model. For salary variables, labor costs and employees the value of t-Statistic is higher than the critical value, and the associated probability is greater than 5%, so the null hypothesis is accepted - the series has a unitary root (it is non-stationary). The series were stationary by differentiation, after which the new series generated (d_salaries, d_costs_labor and d_employees) were tested again. (Table no. 5)

Table 5. Stationarity testing - Dickey-Fuller test (wages, labor_costs, employees)

Variable		wages	labor_costs	employees
t-Statistic		1.092631	1.324252	-2.855499
p-Value		0.9962	0.9980	0.0651
Test critical values	1% level	-3.724070	-3.724070	-3.456514
	5% level	-2.986225	-2.986225	-2.872950
	10% level	-2.632604	-2.632604	-2.57292

The non-stationary series were stationary, making the difference a second time (the second integration order).

The multiple linear regression specifying the final econometric model is as follows (Equation 3):

$$d\_cpi\_total = c(1) + c(2) d\_wages + c(3) d\_labor\_costs + c(4) d\_employess \quad (3)$$

The parameters of the regression equation were estimated by the least squares method. (Table no. 6)

Table 6. Parameters of the regression equation 3

Dependent Variable: d_cpi_total				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
c	-18440.13	2924.766	-6.304822	0.0000
d_wages	-168.3648	60.44049	-2.785629	0.0105
d_labor_costs	5.210993	1.967979	2.647890	0.0144
d_employees	0.005671	0.000874	6.486952	0.0000
R-squared	0.771374	Mean dependent var		1307.110
Adjusted R_squared	0.741553	S.D. dependent var		3112.276
S.E. of regression	1582.209	Akaike info criterion		17.70699
Sum squared resid	57577875	Schwarz criterion		17.89896
Log likelihood	-235.0443	Hannan-Quinn criter.		17.76407
F-statistic	25.86696	Durbin-Watson stat		1.388803
Prob(F-statistic)	0.000000			

The t-Student values for the parameters are calculated in the t-Statistics column. If Prob. $< 0,05$ rejects the null hypothesis: the parameters of the variables differ significantly from 0. The analysis of statistics t shows that the probabilities for d_wages, d_labor_costs, d_employees are $< 0,05$, so the null hypothesis is rejected and the alternative hypothesis is admitted, the coefficients being significantly different from 0.

The F-statistics for the proposed model has a value of F=25,86696 with a probability $< 0,05$ and therefore it is accepted that the overall multiple linear regression model studied is valid.

The model passes the error self-correlation tests, according to Durbin-Watson (DW=1.38), the normality of error distribution, according to Jarque-Bera (Skewness=1.23; Kurtosis=7.81) and homoscedasticity, after White (F_statistic=1.83, attached probability =26%). (Figure 2)

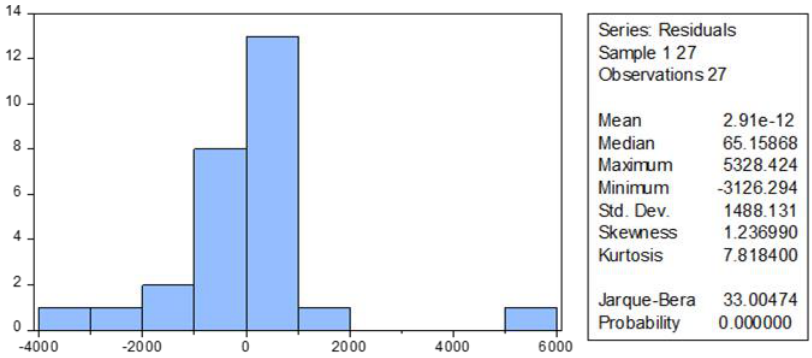

FIGURE 2. Jarque-Bera test for econometric model 2

The econometric model 2 parameterized as multiple regression is the following (Equation 4):

$$d\_cpi\_total = -18440.13 - 168.3648 d\_wages + 5.210993 d\_labor\_costs + 0.005671 d\_employess \quad (4)$$

The determination ratio (R2=77%) shows the percentage by which the influence of significant factors is explained. In other words, 77% of the d_cpi_total variation is explained by the variation of d_wages, d_labor_costs, d_employees. To counteract the mechanical growth of R2 due to the number of regression variables, the adjusted R is used, its value of 74% confirming the validity of the model.

At a 1% increase in d_wages, d_cpi_total drops by 168.36%, while the other variables remain constant. At a 1% increase in the force of d_cost_labor, d_cpi_total increases by 5.21% (most significant influence), given that the other variables remain constant. At a 1% increase in d_employees, d_cpi_total increases by 0.006%, while the other variables remain constant. The model confirms that the price growth rate decreased over the period studied despite the positive development of labor costs and the number of employees being obvious benefits for consumer prices. It is noted that the faster wages rise, the faster prices fall, even if the number of employees or the cost of labor increases.

In all the countries of the world, trade unions pursue the interests of their members, namely the increase in purchasing power. This is achieved primarily by increasing the level of wages. Any increase in wages leads to an increase in production costs and, consequently, to an increase in prices and, consequently, to inflation.

The increase in wage income influences the total consumer price index (CPI). Because employees have to pay higher prices for the goods and services they consume, minimum wage increases are automatically cancelled, being essentially useless if we are interested in the standard of living of employees.

The high value of the free term c indicates that factors that were not considered in the model construction have a significant impact on the evolution of the CPI. The negative value of the free term reveals that the variables not included in the econometric model have a negative effect on the evolution of CPI.

5. Conclusion

The results of the paper confirm that the consumer price index does not provide a complete picture of consumer behavior or the evolution of consumer prices and spending or labor indicators. Therefore, restricting the scope to urban consumers, especially in countries such as Romania, with rural population, self-consumption and large transfers of agricultural products from rural to urban areas, reduces the expressiveness of this indicator.

Correlation statistics suggest that economic growth in Romania is significantly correlated with CPI and independent variables in the study. The ADF root test results show that the time series data are not stationary at levels, but after changing the data in the first or second difference, they became stationary. The consequences of the co-integration test confirm that there is an association between the four and three macroeconomic variables for each long-term economic model. In the same order, this means that the selected variables follow a theory of randomness. Since a co-integration equation was found for each model, the test of the vector error correction model was used, the results show that there is a significant long-term causality.

The adequacy results of each model persist that the residues are homoscedastic, normally distributed, and there is a serial correlation between residues to confirm that the models are appropriate. Since almost all variables follow the random model, markets are more or less efficient and, under these conditions, more efficient, economic growth

in Romania could be improved if CPI and other variables are controlled in a significant routine. These results confirm the existence of important opportunities for the Romanian government to review its economic policy, in terms of consumer prices (CPI) and labor force. The results of the empirical studies offer the Romanian government and the political decision-makers some directions regarding the measurement of inflation in the sphere of consumption, the determination of the purchasing power of salaries and pensions, and, as well as wage negotiations between the main actors of social dialogue (government, trade unions, employers), calculation of real interest, substantiation of social policies, making international comparisons. Thus, price inflation has come to lead to wage inflation, price increases precede unit labor costs increases, and surplus earnings from productivity increase price inflation. Therefore, a healthier management of total expenditure for final consumption will lead to better economic growth.

Closely related to future research directions, there are also subjective limits, assumed by the author, regarding the typology, number or expression of indicators.

In the future, it is necessary to expand the research by adding quantitative variables. The next step could be represented by a model test and, implicitly, by a comparative analysis with other states at the same level of socio-economic development with Romania.

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Conflict of interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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