LISTA LUCRĂRILOR CONSIDERATE RELEVANTE DE CĂTRE CANDIDAT

1. Gheorghe Popescu, **Micilă Mihai**, Nica, Elvira, Andrei Jean-Vasile (2018). The emergence of the effects and determinants of the energy paradigm changes on European Union economy. *Renewable and Sustainable Energy Reviews*, (81P1) pp. 768-774. ISSN 1364-0321. Articol ISI. IF_{2017}=1.670, $SRIR_{2017}$=3.127. https://doi.org/10.1016/j.rser.2017.08.055
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The emergence of the effects and determinants of the energy paradigm changes on European Union economy

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A B S T R A C T

Analyzing of the effects and the determinants of the energy paradigm changes on influencing the economic growth in European Union starts from the assumption that the economy is highly dependent of energy consumption in achieving of the economic growth and welfare for population. Consequently, the changes in the energy paradigm imply significant transformations in the production structures and their evolution. The aim of the paper is to present and evaluate the effects and determinants of the energy paradigm changes on assuring economic growth in European Union, by using the panel data approach and its subsequent techniques. In this respect, there was considered the evolution of nine economic variables across 30 countries, representing the EU member States during the examined period, plus Iceland and Norway, in order to revile direct and irrefutable connections among these variables in shaping the new energetic paradigm in European space. The results obtained during the research confirm that all nine variables are determinant and significant elements in shaping a new and proactive energy policy and it undoubtedly contribute in achieving of the sustainable economic development

1. Introduction

The possibility of changing the energy paradigm at the EU level represents a complex issue that has attracted particular attention. The attention paid to energy aspects is linked by the use of energy in the economic processes, the fluctuations of energy intensities of the national economies, the effects on the population welfare, amid worsening the dependence on energy imports, sometimes from sources affected by conflicts or political instability. In this vision, the energy and the new energy paradigm represents not just a major research topic in literature [1–3] and academia, it become a strategic goal, for policy makers, governments, and public administration structures. All these stakeholders are involved in a demarche of assurance of the energy independence and stability, having deferent significance and impacts on developing the new economic paradigm and in shaping of the new production structures. In contemporary economic developments, the energy tends to become a major politic, social and economic objective. The energy is considered to be among the most important vectors in assuring and promoting of sustainable economic development in actual capitalist societies. The role of energy in society is complex and often hard to be identified and clearly measured.

The energy and complementary aspects related to the energy sector tends to become in the near future a fundamental problem not only in European economic space, but also a factor in achieving of the politic stability and a key element in limiting of the climate change.

The analysis of the effects and determinants of the energy paradigm changes on influencing economic growth had faced numerous aspects in the literature [4,5]. By its essence, the energy represents a factor with significant influence towards the quality of life and social well-being, and ensures a smoothly run for the other economic components and structures as [6] noticed As [7] argues energy represents a vital input in every economic system in any time period. In recent studies [8–12]; is emphasized the importance of energy in assuring of the sustainable economic development and diversification of economic structures towards their transition to improved energy efficient processes. A recent study [13] investigates in a panel of twenty-five OECD countries for the period 1981–2007, a possible long-run relation between economic growth and oil consumption. Another research [14], using the same technique in case of some of OECD countries for a longer period (1980–2010) identifies significant effects of economic growth on oil demand. Another study [15] point out the positive relationship of energy consumption and gross fixed capital on

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economic growth

In the contemporary economic context, the national economies are generally dependent on traditional energy sources and rely on capitalizing on these sources in delivering consistent and long-term economic growth. Starting from this reality, contemporary economies have developed a specific energy paradigm [16,17], dependent on the exploitation and capitalization of classical sources of energy (coal, oil and natural gas). Nevertheless, the new environmental realities are urging the additional efforts to think of new sources and possibilities of sustaining the energy raw materials of the economy. The development of a sustainable energy policy however, has imposed an irreversible change from the fossil energy sources to renewable energies, in order to reduce the dependence on classic resources and to expand the possibilities of supply and the scientific research in the field. From this perspective, the examination of the emerging effects and the determinant factors involved in changing of the current energy paradigm on the economic growth in Romania and the EU represents an important analysis.

Generally, addressing the role of energy and its rational use towards the sustainable economic development in contemporary economies starts from classical economic theories [18,19]. These theories directly emphasize the aspects related to the production process, the incorporation of energy into the produced goods, and consider the energy as a production factor with special features. However, the energy is not just a production factor – it plays a complex social role. Considering the multidimensional nature of energy in contemporary economies, it exerts complex influences in economy and society; it represents a compulsory and constant element in determining of the economic growth, in modeling of the social system and the social consumption habits. Other researches [20–23] emphasize the importance of the availability of the energy and its influence in the production processes; other studies analyze the correlation between energy consumption and performances of the national economies [4,24].

Despite the current evolution of the European economies, and of a numerous and important technologic changes, massive investments, a new policy framework in the field and the changes of the European energy policy paradigm developments, the energy continues to be a most disputed topic in the field, which raises numerous approaches, solutions and academic debates.

As the global environmental situation tends to worsening, is manifested a growing interest in mitigation of the carbon emissions. In this respect, exists a large number of researches [18,20,23–25], regarding the interrelated aspects to energy structure, production, prices, taxation, consumption, very often in relationship with the economic growth and economic structure diversification. Investigating the causality relationship between energy consumption and Gross Domestic Product (GDP) and the co-movement in case of eighteen developing countries during 1975–2001, [48] reviles significant causality relationships between the considered variables.

The analysis of the energy paradigm transformations during the last period reviles mostly an un-convergent policy in the field, with significant challenges of the paradigm, which needs to be properly understood in the context of the new European energy policy transformations. Obviously, the increasing dependence of contemporary economies by energy consumption has triggered numerous inner mechanisms in sustaining an ever more difficult economic growth, accentuated by the supplying inconstancies. Defining a new energy paradigm, closer to the actual economic demands it should not be left exclusively to public authorities and institutions or to the stock market mechanism. In this context, it is necessary to increase the involvement of the existing national regulatory authorities in each Member State to oversee the implementation of specific energy policy instruments. On the other hand, the academia and the study groups are called upon to provide the scientific basis for the policy measures and to orient the system towards the best practice in the field, and, not least, the public opinion as a barometer in assessment of the energy policy functionality.

The study of the emergence of the effects and determinants of the energy paradigm changes on influencing economic growth in Europe has offered numerous valuable insights. [26] noted in his study that the increases in energy consumption during the years have determined dramatically changes in historical energy transitions. Also, [21] identifies the influences of the energy service usage and the changes in energy consumption behavior towards the economic developments.

Understanding of the role and the energy influence in assuring of the sustainable development in contemporary economies represents a great challenge in context of the new energy paradigm adjustments and approaches. The evolution of the energy paradigm defines, in a tight manner, the transformation of the contemporary economies and societies, being a fundamental instrument in achieving of the sustainable economic development. In contemporary economies, the energy represents more than a simple production factor - it had started to become a determinant instrument in shaping economic structures and policies, being in the same time instrument in political negotiations.

In this context, achieving of the sustainable economic development implies not only a rational use of energy, but also new and diversified sources of energy, stability in supplying and designing a new paradigm. Energy transformations during the economic processes contribute in increasing the value of the classical production outcomes, assuring perspectives in developing economic stability by achieving fulfillment of the economic policy goals. In a research conducted by [27], they discovered that 60% of Latin American and Caribbean countries develop a positive bidirectional long-run relationship between energy consumption, carbon dioxide emissions, and economic growth.

Staring from the assumption that the energy represents one of the determinant factors in promoting, diversification and achieving of a high economic development, but also a constraining element in this respect it is necessary to examine the effects and determinants of the energy paradigm changes on influencing economic growth. From this perspective, the main aim of the paper is to asses a possible existence of direct and irrefutable connections among considered variables employed in research in shaping the new energetic paradigm in Europe from an economic perspective, by using the panel data approach, using the specific data regarding thirtieth countries including the EU-28 member states plus Iceland and Norway.

2. Data series and preliminary results

In the current research, there are employed the latest available datasets on the Eurostat website for nine economic variables and thirty states regarding the importance of the energy and renewable energy particularly, towards the economic growth. In the table below are presented the data series considered in designing the research, the range of data availability, and the symbols used for designate each series (Table 1).

For the data considered above, Table 2 contains the descriptive statistics of the datasets considered in the paper. As the common range of data availability is 2004–2015 and the present work is based on the panel data approach, the considered period is set accordingly.

In case of Table 2, the results of the Jarque-Bera test reveal that the considered series are normally distributed, for a significance level of 1%.

3. Materials and methodology

In designing of the current research, the main instrument used in carrying out the analysis is the panel data methodology and its subsequent techniques. This method is employed with the aim of identifying the existence of a certain economic behavioral pattern among the considered economies, regarding the effects and determinants of the energy paradigm changes on influencing economic growth.

The choice of employing this methodology is based on its robustness and its high degree of applicability and it can be used in order to

Table 1
Variables description and data series availability.
Source: authors based on: Eurostat [54]

Symbol	Variable description	Data availability
e_dep	Energy dependence (%)	2000–2015
e_int	Energy intensity (kg of oil equivalent per 1 000 Euro of GDP)	1995–2015
e_pty	Energy productivity (Euro per kilogram of oil equivalent)	1995–2015
el_rs	Electricity generated from renewable sources (% of gross electricity consumption)	2004–2015
e_tax	Environmental tax revenues (Percentage of GDP)	1995–2015
hc_rw	Households final energy consumption originated from renewable sources	1999–2015
i_txe	Implicit tax rate on energy (EUR per tonne of oil equivalent)	2002–2015
pp_re	Primary production of renewable energy (ths. tonnes of oil equivalent)	2004–2015
sh_rec	Share of renewable energy in gross final energy consumption (%)	2004–2015

identify significant economic transformations in terms of variable significance and expression. In order to examine different correlations between the employed considered variables, a framework based on panel data analysis is proposed and designed. The research approach is following the methods of LLC designed by [28] and the panel unit root tests Fisher-ADF and Fisher-PP as in [29].

As presented in the Table 1, the data series are annual, with twelve years, ranging between 2004 and 2015. The starting moment is 2004, as beginning with this year starts the availability of data for the following variables: primary production of renewable energy, electricity generated from renewable sources, and share of renewable energy in gross final energy consumption, respectively. Some series of data start in 1995 (energy productivity, energy intensity, and environmental tax revenues), other in 1999 (households final energy consumption originated from renewable sources), 2000 (energy dependence), or in 2002 (implicit tax rate on energy).

From the availability of the data there may be observed that current the European framework to account for the aspects regarding the renewable energy was settled in 2004. However, for the present work, employing longer series of data could represent an advantage, but, considering the missing variables above named, it would have less point.

A common trend of the literature concerned in the analysis of various aspects in the field of energy, is represented by the using of the panel data approach and of its subsequent techniques, in order to identify and explain possible correlations and influences between specific variables.

As the latest developments in the literature in the field [19,22,30]; of energies analysis suggest, the endogeneity of the variables represents a hypothesis that should be considered with a high degree of probability. In conditions of a non-stationary and cointegrated panel with endogenous variables, an adequate econometric specification represents a basic requirement in order to ensure correct and unbiased estimations [31]. In application of cointegration techniques, considering of the Granger non-causality tests represents the essential tool, aimed to ascertain the error correction mechanism (ECM) and to explore the short and long-run relationships existent between the examined variables [32].

As it is shown by numerous studies in the field, [33–35] cointegration analysis represents the specific technique used to evidence the existence of a long-term relationship between the set of integrated variables, but not only time sufficient for accepting the causality hypothesis two econometric variables. In this context, the cointegration once proved, the loss of information in the long-run relationship between the variables induced through differencing is avoided by using of the ECM, which implies the further existence of a long-term relationship of equilibrium between the variables in question.

First, it is necessary to test for panel unit root. However, panel unit root does not represent a fundamental problem in panel data approach, particularly in cases of relatively short range of time series, as in the case of present paper.

The heterogeneity of specific parameters for each country-section induces inherent difficulties in testing for the stationarity of panel data; on the other hand, if the cross-sectional units are considered as independent, sometimes, it may not represent the proper approach. In order collect as much as possible from the virtuous and to avoid backward aspects of using of these tests, there were considered examination via the commonly used tests for panel unit root.

These tests represent either specific developments, either improvements of the time series unit root tests, adapted in an applicable form to the panel data environment. The former include [28], and [36] as LLC and IPS; and the latter refers to Fisher-type tests based on PP [37] and ADF tests [29] as (F-PP and F-ADF).

All the four tests employed in this research have the null hypothesis of a unit root in various forms including against the alternative of stationarity. Fundamentally, the form of the autoregressive model is [38]:

$$\Delta y_{it} = \rho y_{i,t-1} + \sum_{L=1}^{pi} \theta_{iL} \Delta y_{i,t-L} + \delta X'_{it} + \varepsilon_{it}, \tag{1}$$

Implementation of the LLC test consists on running separate ADF regressions for each country. The null hypothesis assumes the existence of a common unit root process, thereby ρ has the same value across countries, against the alternative hypothesis of stationarity.

In recent literature, IPS is considered as the most used unit root test in panel data approach, because it has a greater contribution in relaxing the restriction of homogeneity specific in case of the LLC test, also allowing for values of ρ_i, which in most cases may differ among

Table 2
The descriptive statistics of the datasets.
Source: authors' computations based on Eurostat data.

Variables	*e_dep*	*e_pty*	*e_tax*	*e_int*	*el_rs*	*hc_rw*	*i_txe*	*pp_re*	*sh_rec*
Mean	32.6	6.49	2.6	1.98	26.2	19.1	1.795	5.852	18.86
Median	52.8	6.8	2.48	1.47	17.4	16.1	1.725	2.811	14.30
Maximum	104.1	16.1	4.99	6.31	113.7	52.4	4.360	38.886	72.50
Minimum	− 740.1	1.60	1.44	0.62	0.0	0.0	0.764	0.000	0.10
Std. Dev.	122.21	2.92	0.62	1.14	25.7	13.9	0.706	6.899	16.63
Skewness	− 4.88	0.44	0.92	1.58	1.6	0.5	1.142	1.815	1.56
Kurtosis	26.6	2.8	4.07	5.34	5.0	2.2	4.695	6.449	5.08
J-B test	9757.8	12.0	67.2	231.1	209.1	25.9	121.1	375.0	211.1
Probability	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sum	11,705	2330	934	711	9390	6847	644	2101	6771
S.Sq. Dev.	5,347,031	3047	138	469	236,461	69,460	178	17,039	99,063
Obs.	359	359	359	359	359	359	359	359	359

countries. In this case, the testing procedure for IPS test is based on computation of the $\bar{t}$-statistic as the average of the ADF unit root test statistics, using the following (2) as in [39]:

$$\bar{t} = \frac{\sum_{i=1}^{N} t_{\rho i}}{N} \tag{2}$$

In (2), $t_{\rho i}$ designates the individual t-statistic in case of testing the null hypothesis represented by each country in the panel which follows a unit root process as $\rho_i = 0$ for all i. The alternative hypothesis in this case is described by [40]:

$$H_1: \begin{cases} \rho_i < 0, \text{ for} i = \overline{1, N_1} \\ \rho_i = 0, \text{ for} i = \overline{N_1 + 1, N} \end{cases}, \tag{3}$$

Also, for a functional version of the alternative hypothesis it is required that the fraction of stationary cross-sectional series to be nonzero, by following the condition that $\lim_{N\to\infty}(\frac{N_1}{N}) = \gamma$, $0 < \gamma < 1$. For ensure the consistency of unit root test, if the lag order is always zero ($\rho_i = 0$, for each i), IPS test provide simulated critical values of $\bar{t}$ for different number of time-length series T, and cross-sections, N.

As [36] argues in the general case, in which $\rho_i \neq 0$ for a fraction cross-sections, IPS shows that a properly standardized $\bar{t}$ follows an asymptotic normal distribution [36].

Alike to IPS test, the F-ADF and F-PP tests allow for ρ_i to vary across cross-sections and, consequently, a fraction of individuals to have a unit root. In the general framework of the Granger non-causality tests, the individuals which are found to follow an integrated process of the same order, usually, of order one, $I(1)$, this relationship has to be tested for cointegration.

For testing the cointegration among series in this research is used [41] Kao test. Although this test was initially designed to be applies in a bi-variate context, [42] indicates that this test has a higher power in comparison with other competing tests, especially in homogenous panels and when, as in our case, the length of time series is relatively short. Basically [43], Kao test is a version of ADF test, carried out either on the residual (ε_{it}) of the auxiliary regression $\varepsilon_{it} = \rho\varepsilon_{it-1} + \nu_{it}$, either based on the augmented variant of the pooling specification in (4) as in [43]:

$$\varepsilon_{it} = \rho\varepsilon_{it-1} + \sum_{j=1}^{p} \lambda_j \Delta\varepsilon_{it-j} + \nu_{it} \tag{4}$$

Under the null of no cointegration, the augmented version is constructed upon the (5) [44]:

$$ADF = \frac{t_\rho + \frac{\sqrt{6N}\hat{\sigma}_v}{2\hat{\sigma}_{0v}}}{\sqrt{\frac{\hat{\sigma}_{0v}^2}{\hat{\sigma}_v^2}/+\frac{3\hat{\sigma}_v^2}{10\hat{\sigma}_{0v}^2}}} \sim N(0, 1), \tag{5}$$

Whereby $\hat{\sigma}_v^2$ is denoted the estimated variance and $\hat{\sigma}_{0v}^2$ represents the estimated long-run variance of the error term.

The basic assumption of the Kao test is that the value of ρ does not vary across the countries in the panel. As [45,46] propose in his research seven types of cointegration tests residual - based that relax this assumption, and allows for meaningful heterogeneity. All the Pedroni tests are based on the estimated residuals of panel regression described by: $\varepsilon_{it} = \rho_i\varepsilon_{it-1} + \nu_{it}$, under the null hypothesis of no cointegration, where $\rho_i = 1$.

The denomination of error correction term for the cointegration term is originated in the gradual correction of the deviation from the long-run equilibrium achieved via a series of partial short-run adjustments [39,40]. The model is specificated upon the following forms [2,17,39]:

$$\Delta edep_{i,t} = \alpha_i^{edep} + \beta_i^{edep} ECT_{i,t-1}^{edep} + \sum_{j=1}^{m} \delta_{ij}^{edep} \Delta edep_{i,t-j} + \sum_{s=1}^{q} \gamma_{1,is}^{edep} \Delta e\text{int}_{t-s} + \ldots + \sum_{s=1}^{v} \gamma_{9,is}^{edep} \Delta shrec_{t-v} + u_{it}$$

...

$$\Delta shrec_{i,s} = \alpha_i^{shrec} + \beta^{v} ECT_{i,t-1}^{shrec} + \sum_{j=1}^{m} \delta_{ij}^{shrec} \Delta edep_{i,t-j} + \sum_{s=1}^{q} \gamma_{1,is}^{shrect} \Delta e\text{int}_{t-s} + \ldots + \sum_{s=1}^{v} \gamma_{9,is}^{shrec} \Delta shrec_{t-v} + w_{it}$$

As a result of the correlation existent between the lagged endogenous variables and the error term, in specification of VEC models, it is necessary to be present an instrumental variable estimator. Consistent with the [39] approach, fixed effects are included into the model to remove the undetected heterogeneity of the within-dimension, whist inclusion of orthogonal deviations, alike to differences in the mean approach, is designed to remove the heterogeneity specific to between-dimension (panel members).

Following the [32] approach, the long-run causality is measured through the significance of *ECT* coefficients (or *beta* coefficients) using the standard t statistic, whilst the causality in short-run is evaluated by the joint-significance of lagged explanatory variables. In order to ensure the model stability, the *ECT* coefficient, which expresses the adjustment rate next to an exogenous shock, is assumed to be negative.

The option for using the panel VEC model approach in present study is based on its flexibility, which allows for using of heterogeneous panels and correction for both serial correlation and heteroskedasticity in standard errors. From the methodological point of view, it is noticeable that, in case of no significant evidence of cointegration, as the adequacy of EC models is limited for cases in which the series are integrated of order one, the EC terms are not included in the ECMs, and the standard Granger causality models are estimated without an EC term. In addition, in situations of no cointegration, the comparison of all the considered variables in the EC model has to be based upon their stationarity. Nevertheless, if added anyway, the literature indicates that they report insignificant results [43].

4. Results and discussion

As there has been presented in the literature review, a plenty of recent researches address different interrelations of the energy sector. Most of these scientific contributions regard the economic growth and energy taxation, examining the limits of energy taxation as a factor very specifically correlated to sustainable development, as the human aggression towards the environment represents an uncontestable reality. The first researches in the field were deployed from a national perspective, aimed mainly to compare results of VAR or OLS models for different countries [46–48].

However, in the first studies conducted in the framework of panel data approach, the used datasets account for reduced number of countries, often divided into groups, upon the economic development, geographical placement, or other criteria. Grouping based on various criteria represented the factor that leaded to homogenous characteristics within the respective groups. As presented in the previous paragraph, employing of the panel data approach allows just for control of heterogeneity. Despite the homogeneity of the policy, settings across the European Union countries, regarding the level of development still stand important disparities.

Our panel consists of the 30 countries, representing the European Union member states in 2015 plus Iceland and Norway. Other countries also adhered to the framework of reporting to Eurostat, but the availability of data concerning them is usually limited at less than five years. Yet, these data regard the candidate countries, which are following the specific roadmap in order to ensure the improvement domestic energy balances as a provision for joining the European Union.

Choosing to use the Eurostat data is based on their compatibility along the panel countries. From the econometric point of view, that ensures the variables compatibility across the considered countries.

Table 3
Panel unit root tests.

Variable	LLC		IPS		ADF-Fisher Chi-square		PP-Fisher Chi-square	
	Level	Differenced	Level	Differenced	Level	Differenced	Level	Differenced
e_dep	– 4.2***	– 17.18***	– 0.29	– 13.98***	58.4	267.2***	66.7	366.7***
e_int	– 4.68***	– 15.76***	1.10	– 9.66***	53.6	193.7***	69.9	256.7***
e_pty	– 1.22	– 15.04***	3.70	– 9.52***	36.94	199.39***	38.13	274.135***
el_rs	10.44	– 9.07***	11.58	– 6.69***	19.17	159.24***	23.03	179.19***
e_tax	– 5.49***	– 10.7***	– 0.81	– 6.35***	70.61	143.9***	83.53**	179.1***
hc_rw	– 1.75**	– 14.74***	2.96	– 9.42***	37.11	203.4***	44.65	264.75***
i_txe	– 0.646	– 14.87***	1.99	– 9.6***	58.38	195.46***	76.2	302.13***
pp_re	1.23	–15.23***	5.25	– 10.02***	28.39	209.7***	35.81	261.22***
sh_rec	1.96	– 11.46***	7.13	– 7.3***	17.62	158.35***	40.08	211.57***

Notes: Lag length determined upon the modified Schwartz Info Criterion.
Probabilities for the LLC and IPS tests are computed assuming asymptotic normality. Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution.
All tests equations include individual constant term („fixed effects").
Differenced refers to series resulted from first-difference.
***, **, * indicates the rejection of the null hypothesis at 1%, 5%, and 10% levels of significance (one tailed test).

The figures resulted from running of the panel unit root tests are presented in the Table 3.

From the above data, it is obviously that, in general, the cross-sectional units and the cross-sections are integrated of order one. Only the using of the LLC test reported a significant part (though, a minority) of the cross-sections to be stationary, for various levels of significance. The results of the pairwise Granger non-causality tests for the considered variables are presented in Table 4; consistent with the approach described in [32], the running of the cointegration test is performed considering, both variables as the dependent variable.

The results in the Table 4 suggest that, in majority of the cases, exist a biunivocal significant relationship of Granger causality between the considered datasets. According to these results, the *energy dependence* represents a causal variable for *energy productivity*; *electricity generated from renewable sources*, *primary production of renewable energy* and is caused by all these variables, plus *share of renewable energy in gross final energy consumption.*

The *energy intensity* is in a biunivocal causal variable with *electricity generated from renewable sources* and *share of renewable energy in gross final energy consumption*, and is caused by *energy productivity*.

Besides, the *energy productivity* represents a causal variable for *electricity generated from renewable sources* and *share of renewable energy in gross final energy consumption*, and is in a biunivocal cause relationship with *energy dependence.*

The *electricity generated from renewable sources* represents a causal variable for *households final energy consumption originated from renewable sources*, is in a biunivocal cause relationship with *energy dependence, energy intensity*, and *primary production of renewable energy* and is caused by *share of renewable energy in gross final energy consumption*.

Despite the series of researches aimed to highlight the importance of taxation for economic growth and social welfare, based on the available data may be observed that, in fact, the *environmental tax revenues* does not cause any of the considered variables. This may be considered consistent to the resultative specific-character of this variable. Interestingly, this variable is caused only by *households final energy consumption originated from renewable sources*, which may represent a proof for the effectiveness of the specific policies put in place by the appropriate authorities.

Besides the *environmental tax revenues,* the *households final energy consumption originated from renewable sources* represents a causal variable for *electricity generated from renewable sources* and *primary production of renewable energy,* is in a biunivocal relationship of causality with *implicit tax rate on energy* and causes *electricity generated from renewable sources* and share *of renewable energy in gross final energy consumption.*

The *primary production of renewable energy* is also in a biunivocal relationship of causality with both *electricity generated from renewable sources* and *energy dependence*, causes *implicit tax rate on energy* and is caused by *share of renewable energy in gross final energy consumption.*

The *share of renewable energy in gross final energy consumption* also causes *energy dependence, electricity generated from renewable sources* and *households final energy consumption originated from renewable sources*; it is in a biunivocal relationship of causality with *energy intensity,* and is caused by *energy productivity.*

The results of the pairwise Granger causality may suggest that the variables are in a relationship of contegration. In order to ensure a double-check of this relationship of cointegration the authors considered to examine the partial correlation between the considered variables. The results are presented in the Table 5.

Table 4
The results of the pairwise Granger causality tests.

Variable	*e_dep*	*e_int*	*e_pty*	*el_rs*	*e_tax*	*hc_rw*	*i_txe*	*pp_re*	*sh_rec*
e_dep	–	1.18	15.94***	4.57***	0.20	1.27	1.55	6.16***	1.68
e_int	0.96	–	1.25	5.97***	1.29	1.56	0.68	0.22	6.36***
e_pty	1.57**	3.51**	–	9.24***	1.84	0.54	2.01	4.43	2.73*
el_rs	3.78**	6.02***	0.51	–	0.53	3.05**	0.12	8.52***	1.64
e_tax	1.37	0.059	0.13	1.01	–	1.82	1.30	0.20	0.46
hc_rw	0.42	1.79	2.19	1.48	3.45**	–	3.13**	3.26**	1.13
i_txe	1.94	1.88	1.65	0.01	0.69	3.45**	–	2.01	1.13
pp_re	4.08**	0.027	1.53	3.67**	0.64	0.52	2.87**	–	0.15
sh_rec	5.34***	4.35**	1.23	3.20**	0.90	6.78***	0.20	9.38***	–

Notes: In the first columns, the explanatory variable in the cointegrating relation; in the headings, the dependent variable.
***, **, * Indicates rejection of the null hypothesis of no cointegration at the at the 1%, 5%, and 10% levels of significance.

Table 5
Results of partial correlation analysis.

Correlation	*e_dep*	*e_int*	*e_pty*	*el_rs*	*e_tax*	*hc_rw*	*i_txe*	*pp_re*
e_int	0.086							
e_pty	− 0.234***	− 0.854***						
el_rs	− 0.583***	0.042	0.134**					
e_tax	− 0.074	− 0.185***	0.235***	− 0.047				
hc_rw	0.003	0.280***	− 0.374***	0.156***	0.141***			
i_txe	− 0.152***	0.265***	− 0.194***	0.193***	− 0.120**	0.369***		
pp_re	− 0.179***	− 0.306***	0.304***	0.279***	− 0.210***	− 0.126**	− 0.0004	
sh_rec	− 0.556***	0.230***	− 0.071	0.922***	− 0.070	0.266	0.291***	0.212***

***, **, * indicates the significance of *t*-statistic at 1%, 5%, and 10% levels, respectively.

Table 6
Results of Pedroni and Kao panel cointegration tests.

Test statistic	Subgroup 1		Subgroup 2		Subgroup 3	
	Statistic	Weighted-stat	Statistic	Weighted-stat	Statistic	Weighted-stat
Panel *v*-Statistic	− 2.579	− 4.507	− 2.241	− 4.063	− 2.527	− 4.853
Panel *rho*-Statistic	6.053	5.755	5.912	6.544	5.570	6.546
Panel *PP*-Statistic	− 4.772***	− 10.855***	− 8.014***	− 5.200***	− 9.273***	− 10.358***
Panel *ADF*-Statistic	− 3.731***	− 6.747***	− 5.582***	− 2.984***	− 6.861***	− 4.779***
Group *rho*-Statistic	8.143	–	8.581	–	8.699	–
Group *PP*-Statistic	− 15.96***	–	− 12.692***	–	− 16.338***	–
Group *ADF*-Statistic	− 6.346***	–	− 4.377***	–	− 5.151***	–
Kao test	*ADF t*-Stat		− 4.082***	ρ = − 0.120 (− 3.842)***		

Notes: Lag length determined upon the modified Hannan-Quinn Criterion.
All tests equations include individual constant term ("fixed effects").
For the coefficient ρ afferent to the Kao test *t-Stat* value in parenthesis.
***, **, * indicates the rejection of the null hypothesis of no cointegration at the 1%, 5%, and 10% levels of significance (one-tailed test).

In the Table 6 are presented the results reported from Pedroni and Kao panel tests for cointegration, with the remark that the conducting of the Pedroni test is adapted to the Eviews software package specific that supports maximum seven cointegrated series. Therefore, considering the results of the partial correlation analysis, which indicate a significant and high value of the correlation coefficients between *share of renewable energy in gross final energy consumption* and *electricity generated from renewable sources*, and respectively, between *energy productivity* and *energy dependence*, there was considered three subgroups.

In this respect, every subgroup contains one of the two correlated variables, as follows: subgroup one (*energy productivity* and *energy generated from renewable sources*), subgroup two (*energy dependence* and *share of renewable energy in gross final energy consumption*), and subgroup three (*energy dependence* and *energy generated from renewable sources*), plus the other six remaining variables respectively.

From the Table 6, there might be observed mixed results leading to different conclusions. However, the null hypothesis of no cointegration is rejected in majority of cases. As stated in the above paragraph, Pedroni considers that in cases of *rho* and *pp* tests exists a bias to under-reject the hypothesis no cointegration, especially in the case of small samples. In our case, it is possible one may observe that, for all the considered cases, for the *rho* test is accepted the null hypothesis, whereas, for the *pp*-test the results are opposite. In addition, considering the result reported by the Kao test, besides the results of the pairwise non-causality Granger tests, the inclusion of the EC term in the VEC model is suitable. The estimation for the VEC model, using GMM method, consistent with the approach of Arellano-Bover are presented in the Table 7.

The significant results in the estimated α_i (Error-Correction-Term) highlight different situations of the considered variables. Therefore, the negative values tending towards zero indicate that the long-term adjustment process is slow; this is the case for the *energy intensity* and *electricity generated from renewable sources*. *Primary production of renewable energy* the acts as variable that tend to overshoot the economic equilibrium of the system. In case of *share of renewable energy in gross final energy consumption*, the positive coefficient expresses that the action of this variable is toward a deflection of the considered system from the long-run equilibrium path.

Table 7
Estimation of error-correction-term in the vector error-correction model.

Variables	ECT coefficients (*t*-statistic)	Speed of adjustment (*t*-statistic)	Lag coefficient (*t*-statistic)	*F*-statistic
e_tax	1.000	− 0.002 (− 1.150)	0.161 (2.878) ***	2.639**
e_int	− 0.069 (− 4.926) ***	− 0.124 (− 2.155) ***	0.005 (2.575) ***	5.271***
el_rs	− 0.098 (− 0.576) ***	− 0.005 (− 0.522)	0.010 (0.654)	9.458***
ppre	− 2.263 (− 8.361) ***	− 0.025 (− 8.365) ***	− 0.042 (− 1.045)	11.357***
sh_rec	0.739 (2.657)***	− 0.007 (− 1.371)	− 0.015 (− 0.527)	3.535***

Notes: Lag length: 1, 1.
***, **, * indicates the significance at the 1%, 5%, and 10% levels of significance.

5. Conclusions

During the recent years, many studies have focused on the different connections between energy and energy consumption and different economic aspects. However these researches, previously conducted have taken into consideration just direct connections between these aspects, without establishing future influences on the economic development. In the introduced approach, the measuring of the effects and determinants of the energy paradigm changes on influencing economic growth in European Union is carried out by employing of the panel data approach and its subsequent techniques in a panel investigating the interrelated evolution of nine economic variables within 30 European countries, (EU-28 in 2015, plus Iceland and Norway).

One of the major challenges in contemporary economies is represented by the transformation of the current energy paradigm which implies a proper approach in the field, as it is remarked in literature [49–53] in connection with complementary issues in the field (environmental performance, environment protection, sustainable development and EU institutions).

The analysis of the variables employed in the research reviles multi-objective combinations and inter-correlations among countries and variables. In this context, the emergence of the effects and determinants of the energy paradigm changes on influencing economic growth in European Union represents a determinant research topic in literature by its main implication in designing the new energy paradigm.

Referring to the speed of adjustment, the results express the significant influence of *energy intensity* and *primary production of renewable energy*. Considering the significance of the lagged explanatory variables, which expresses the causal effect in short-term, the results indicate important evidence in favor of variables *environmental tax revenues* and *primary production of renewable energy*. It is remarkable that the latter variable takes significant values for all the aspects in the VEC model, despite the reduced and various shares of renewable energies in total consumption, in most of the considered countries. This situation may be interpreted in connection with the important investments and production capacities in the field of renewable energies deployed especially in some European countries, aiming to comply with the Kyoto Protocol provisions.

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Transformations of the Romanian agricultural paradigm under domestic economic policy reforms: An analysis during 1960–2011

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ABSTRACT

The main aim of this paper is to investigate the transformations of the Romanian agricultural paradigm under the domestic economic policy reforms. An econometric approach is adopted by analyzing the evolution of Romanian agriculture between 1960 and 2011 from the perspective of its implications on residential land economy. This methodological choice relies on its high degree of applicability and its ability to reveal the massive transformation of the Romanian agricultural paradigm during the period under focus. Two regression models have been developed in the attempt to analyze the evolution of total value added and labor productivity in agriculture. The results obtained during the research confirm that Romanian agriculture exhibits determinant and significant elements able to trigger a massive change of paradigm.

1. Introduction

Transformations of the Romanian agricultural economic paradigm under the residential land policy reforms have imposed massive and irreversible adaptations to a new and better functional system. The domestic economy had to develop a new set of specific functional rules and redesign the whole agricultural economic system in order to converge toward the European Union (EU) agricultural model. Redesigning the agricultural sector in Romania was a long and exhausting process, much longer than in the case of former ex-socialist economies, which continues to persist in a structural transition to achieve the performance of the EU agricultural model.

As it is remarked in literature, (Vasile et al., 2011), the main goal of restructuring Romanian agriculture follows the old requirements in the field regarding the transformation and modernization of the agricultural sector and food industry in order to achieve high levels of sectorial competitiveness and a great contribution in generating gross valued added and sustainable economic growth (Vasile et al., 2011).

In the former socialist countries, such as Romania, agriculture has represented and it continues to represent a major economic branch with significant and direct influences on economic development and population welfare. Romanian agriculture has experienced dramatic transformations in the last fifty years, moving from the socialist centralized production system to the free market economy exigencies, where the production has to fulfill a complex and new sets of requirements in order to determine its own share of market. The adjustment within the Romanian economy — including the agricultural sector — of the EU convergence requirements and mechanisms to the new policy reality (Andrei and Alecu, 2016; Drăgan and Drăgoi, 2013; Andrei and Darvasi, 2012) has imposed a change in consumption patterns (Sima and Gheorghe, 2015), as well as the cross-sectional sustainability evaluation (Popescu et al., 2017) in order to understand the necessity of sectorial transformations of the Romanian agricultural economic paradigm under the residential land policy reforms and estimate whether Romanian agriculture is on the right path.

Accession to the European Union has also imposed massive changes and a new agricultural paradigm in Romanian economy. All the transformations of the Romanian agricultural economic paradigm under the domestic land policy reforms has triggered an intense process of reforming and reassembling the rural communities on new considerations and principles, with agriculture emphasizing its multifunctional role and getting closer to the EU agricultural model.

In this context, agriculture continues to be considered a vital component, with an enormous influence on the whole society. As Ogen (2007) argues, agriculture has had a major multiplier effect on all economic sectors, being both consumer and supplier for a wide range of products. Therefore, agriculture has stopped being just a support for the majority of the economic branches as it has been considered so far and it becomes a more sensitive sector with major influences on residential land economies. Moreover, the land evinces its own symbolism inherent in Romanian economy and the tradition of the rural population. As Wolford et al. (2013) notice in their study, the land represents not only

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a production mean but it also materializes the ground on which the state produces and reproduces itself.

As scholarly studies argue (Ciutacu et al., 2015; Andrei and Gheorghe, 2014), after massive transformations and subsequent reforms, Romanian agricultural paradigm is still confined within traditional exploitation forms and structures and continues to raise numerous problems regarding its performances.

Starting from the assumption that agriculture assures a wide range of activities acting as a provider of raw materials, a warrantor of food safety or as a source of livelihood for the rural communities, the Romanian agricultural production system has been massively transformed during the years, in terms of the land use paradigms, productivity and operating systems.

In this context, like the other former socialist countries, Romania is facing numerous problems in fulfilling the criteria of a well-functioning and highly competitive market economy, and the agricultural sector makes no exception. As Romanian scholars postulate (Ciutacu et al., 2015; Popescu et al., 2017; Done et al., 2012; Tudorel et al., 2011; Ion, 2011), the residential land agricultural system was often the priority for the national economy even after the collapse of the whole system.

The transition to the market economy and adoption of agricultural reform measures have generated massive controversies involving, on the one hand, a deep fragmentation of agricultural land ownership, and on the other hand, the emergence of the large farms owning high tech equipment, leading to a clearly polarised Romanian agricultural economy with volatile results. Thus the transformations that took place have contributed to reducing the performance of the agricultural sector, making it most of the times, as noted in literature, a safety net for a more numerous rural population.

Starting from the premise that agriculture represents, at least in the Romanian case, a major economic branch, encompassing connotations that exceed the food safety approach, and becomes a highly dependent economic variable in the general picture of economic development, we deem important to analyze the land use paradigm changes and their correlation with the agricultural performance by measuring the value added evolution in Romanian agriculture.

This research is developed along two main lines of investigation. The first concerns the transformations of the Romanian agricultural paradigm under the policy reforms, by surveying several variables, as follows: the contribution of the agricultural sector to the main economic indicators (its share in the Gross Domestic Product (GDP), its share in the Gross Value Added (GVA)), the effort made in order to modernize the agricultural sector as a result of the investments allotted to the sector (the share of agricultural investments in total capital investments and the share of agriculture in fixed capital), the contribution of the sector to enhancing product value which results into increased exports (share of agriculture in exports), and finally the importance of the agricultural sector to mobilizing the labor force in rural areas by examining the evolution of the share of population working in agriculture.

By means of econometric analysis, the second line of research aims to investigate the evolution of value added in Romanian agriculture during 1960–2011, from the perspective of its implications on the rural communities and on the residential land economy as a whole. In this context, the research objectives were centered upon: the econometric methods to analyze the influence of eleven dependent variables and their contribution to generating agricultural value added in Romania and the use of the ADF and Phillips-Peron (PP) tests to develop two regression models for modeling the evolution of value added in Romanian agriculture.

2. Transformations of the Romanian agricultural paradigm under the domestic policy reforms

Analyzing the transformations of the Romanian agricultural economic paradigm engendered by the residential land policy reforms implies a delicate effort to understand the subtle sectorial operating mechanisms under the economic pressure and it requires paying thorough attention to the evolution of some of the most determinant and specific indicators considered in the analysis.

Achieving the standards of a free market and high competitive economy has imposed great economic transformations which have affected all the Romanian economic system. In this context, agriculture, as a basic economic branch had to adapt to the new conditions in the field. The evolution and transformations of the Romanian agricultural paradigm is the main result of the long and ineffective reforms' process and policy approaches occurring throughout a long period of time. Despite the fact that Romanian agriculture has been the subject of numerous economic reforms during the years, it continues to hold important shares in economic development.

Valuing the domestic land agricultural potential has determined numerous and massive transformations of the Romanian agricultural paradigm in order to achieve a highly competitive economy. These transformations are visible through the evolution of the most commonly used economic indicators such as the share of agriculture in generating GDP and GVA, which proves that agriculture holds a determinant economic position.

As presented in Fig. 1, despite the fact that the share of agriculture in GDP and GVA is decreasing, the values highlight the trend of the Romanian economy to become a free market economy, where agriculture plays a modest role in creating value added and GDP. If in 1990, at the outset of the transition period, agriculture held a share of 21.82% in GDP and 23.75% share in GVA, in 2011, the share decreased by 3.3 times in GDP and 3.17 times in GVA. This decrease of this sector's share to the major economic indicators as GDP and GVA does not mean a reduction in its importance within national economy, but rather a sectoral adjustment, necessary in the context of achieving the exigencies of the free market economy and convergence with the European agricultural model. This evolution proves that Romanian economy tends to overcome its main agricultural character and

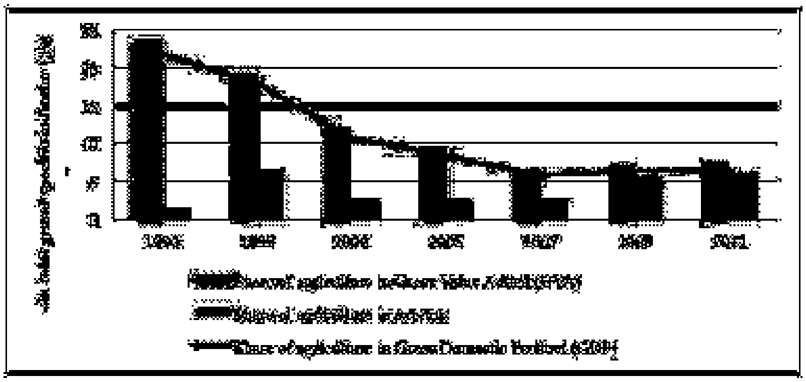

Fig. 1. Importance of the Romanian agriculture Evolution by main economic indicators, 1990–2011.
Source: author's own calculus on INS (2017a,b).

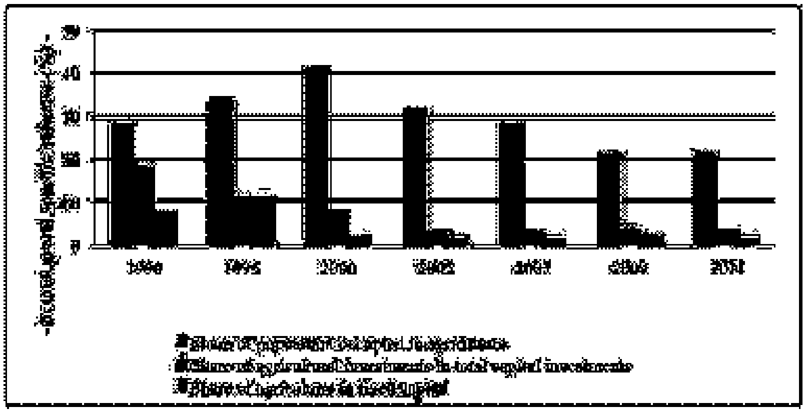

Fig. 2. Importance of Romanian agriculture in mobilizing investments and labor force, 1990–2011.
Source: author's own calculus on INS (2017a,b).

becomes more operational and market oriented, relying on the premise that the other economic sectors have increased their contribution to GDP. According to many scholars in the field (Nowak, 2016 Bożek, 2016; Swinnen and Ciaian, 2008), the ex-socialist European states have registered massive restructurations of the agricultural sectors. However, in the case of Romanian agriculture (Ciutacu et al., 2015) there are still significant gaps within the European agricultural model, as illustrated by the share of agriculture in Gross Domestic Product (GDP) and in Gross Value Added (GVA) which is often over the European average.Furthermore, as highlighted in Fig. 2, the share of agricultural investments in total capital investments and in capital fix diminished dramatically.

As shown in Fig. 2, during the period under focus, Romanian agriculture experienced massive decreases in sectorial investments. Romanian agriculture was decapitalized and transformed in a subsistence instrument for the rural population. The lack of interest in agricultural investments was intensified by the uncertain ownership of agricultural land and by land fragmentation which made almost impossible sustainable exploitations. If in 1990 the share of agricultural investments in total capital investments were about 18.11% and 7.81% in fix capital, twenty-one years later, the levels of these indicators were dramatically low, respectively 4.84 times lower than 1990 in the case of capital investments and 5.42 times lower in the case of fixed capital. Against this background, the share of workforce in agriculture increased during the analyzed period, and agriculture continued to support an important segment of rural population. The low extent of agricultural investments occurred as a result of numerous and various causes. The massive restructuring of the sector through the land ownership transfer to small owners together with the lack of financial feasibility significantly contributed to agricultural decapitalization. In addition, the questionable ownership of agricultural lands and the lack of fixed capital of the new properties intensified the process. As it was argued in previous studies (Ciutacu et al., 2015), Romanian agriculture was among the most decapitalized sectors in the EU agricultural model.

One of the major factors that led to the lack of investments in the agricultural field is the land use paradigm and ownership. The existence of a mass state land ownership was one of the characteristics of the socialist economy by 1989.

The transformation of the Romanian agriculture according to the new economic paradigm of a free market and well competitive economy imposed a massive land transfer from state ownership to private ownership, by virtue of two main instruments: land privatization and land sale. Fig. 3 illustrates the evolution of the land property transfer via privatization and via market mechanism, respectively. As it was argued in Constatin et al. (2015), Romania's land ownership and land consolidation were subjected to an unstructured agricultural policy. Land privatization in Romania was a vehemently debated subject, as the rural population continues to see land as the most relevant topic of ownership.

As (Constantin et al., 2017) argue the restoration of the initial peasant land ownership rights determined the rapid dissolution of the state agricultural exploitation structures and consequently a rapid decrease in the sectorial productivity. From this perspective, the state land privatization engendered the deepening of the gap between the Romanian and the European agricultural model. As a proactive measure in aggregating the agricultural land, the agricultural land sales significantly increased especially after 2002.

As illustrated in Fig. 3, the agricultural land sales in Romania, between 1999 and 2003, could be perceived as a direct reaction and as an attempt to understand the new trends to adapt the free market principles in agriculture. If in 1999 a total of 26904 ha intracommunity land was sold and almost twice (43,977 ha) extra-community land, the land sales increased by 2.4 times in the case of intracommunity land and 7.7 times in the case of extra-community land in 2003. The evolution of agricultural land sales in Romania, between 1999 and 2003 proves that the agricultural paradigm has been oriented to private land ownership. The agricultural paradigm has been switched from the state based land ownership to private land ownership. The instant effect is reflected by the distribution of the individual farm holdings (% in UAA). As Petrescu-Mag et al. (2017) notice, the Romanian land reform effects were particularly negative in the early years. These measures directly contributed to the increased uncertainty of the land ownership and the massive collapse of agricultural production.

Valorization of the Romanian domestic land agricultural potential is strictly connected to the evolution and the structure of agricultural holdings. The evolution of individual agricultural holdings could be understood as a basic marker in analyzing the transformations of the Romanian agricultural paradigm taking into consideration the fact that agricultural holdings are basic vectors in valuing the agricultural potential. Fig. 5 below illustrates the distribution of the individual agricultural holding as a share of UAA in Romania between 2002 and 2010 Fig. 4.

The distribution of the individual farm holdings as% in UAA in Romania between 2002 and 2010 exhibits a significant agricultural paradigm change. The determinant structure is represented by the farms owning between 1–5 ha of cropland area which accounted for 26.3% in UAA in Romania in 2002 and 26.3% in 2010. The large farms extending over 100 ha amounted to 3.4% of the cropland area in 2002 and 5.7% agricultural area in 2010. This situation reveals a steady trend in agriculture which continues to consolidate Romanian agriculture and its convergence to the European agricultural model. As Andrei and Aleca (2016) state, the evolution of agricultural holdings is closely dependent on the political system and public agricultural policy measures taken and only occasionally depends on external measurements.

Increasing the agricultural potential valuing has imposed redesigning the previous residential land agricultural production structures and the convergence to the European model. In this context the distribution of the individual farm holdings has managed to set a new

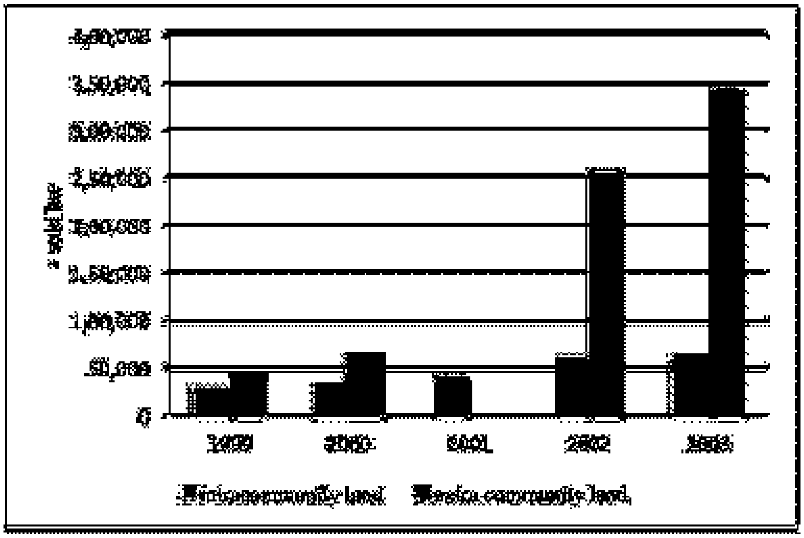

Fig. 3. Evolution of agricultural land sales in Romania, 1999–2003.
Source: authors based on Csaki and Helger (2005).

trend in achieving a well functional agricultural economy in Romania. The new Romanian agricultural paradigm entails a polarised agricultural economy and a massive gap between small and big industrial holdings.

Agriculture continues to represent a basic economic branch in Romanian economy and against this background, the analysis and understanding of the sectorial performance is highly valuable. Therefore, the second part of this paper is concerned with the issue of measuring the Romanian agricultural performance during the transition period.

3. Measuring the Romanian agricultural performance from the socialist paradigm to EU agricultural model convergence achievements, 1990–2011

In order to carry out the second objective of this research, respectively to measure the Romanian agricultural performance throughout the analyzed period, there have been employed the latest data sets available on FAOSTAT regarding Romanian agriculture (FAOSTAT, 2016). Despite the fact that some studies as (Paluna et al., 2013; Cong and Brady, 2012; Tudorel et al., 2011) have already been carried out in the field, the current research extends the variables used in constructing the model and it also employs two tests to determine the order of integration variables.

Table 1 contains the names of variables, the corresponding data series besides their time period availability, and the symbols for each series. Moreover, for all the series afferent to the variables defined in Table 1 the main statistical features are highlighted, based on characteristic measurements. The data series were plotted in Figs.5 and 6

Using these results allows the proper observation of the sub-periods with different turns of development in the Romanian agriculture. Considering Fig. 5 for the variables *FERT*, *FERTH*, it may be observed the maximal levels achieved in 1985, diminutions up to 1990, and a certain stationarity beginning with this year.

The evolution of the variables *TRA* and *TRAH* is similar, except that, starting with 1990, there occurs an obviously sharp increase in the trend. In the same figure, @PCA(AVPC) denotes the evolution of the average annual cereal production per 1 ha in the period 1961–2009 in comparison with the production in 1961. From the plot, we may observe a stationarity up to 1990 (naturally linked from the agricultural point of view to 1989), and large amplitude of variations beginning with this year.

Similarly, the developments of variables in Fig. 6 show different patterns of evolution up to 1990, on the one hand, and from this moment up to now, on the other hand. Thereby, the different turns in the evolution of the considered variables before and after 1989 have led us to consider this year as dividing the two sub-periods in analyzing the value added produced by the Romanian agriculture, as this year represented also a turning point in the social and economic evolution of the country.

For the considered variables, Table 1 presents the annual change rates and the annual average rate of change for each period considered, both in comparison with the first year of time-horizon, as it is specified in the table header. The graphical representations and descriptive statistics allow for the first clues to be identified regarding the existence of different sub-periods for the 1961–2009 time horizon, through the main features of evolution in the variables on the overall time horizon and

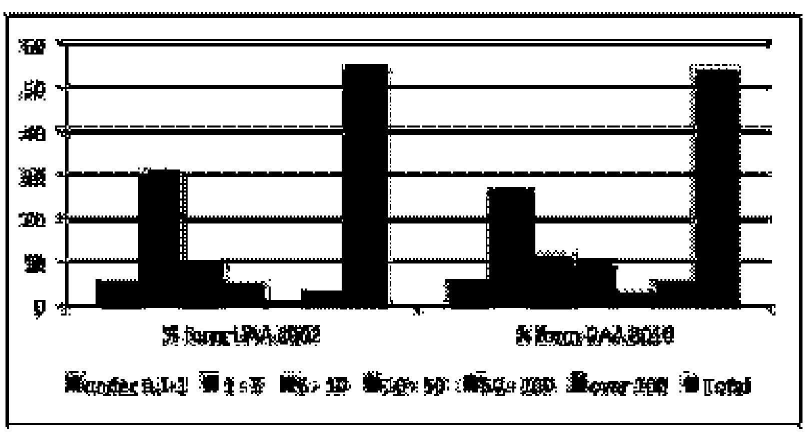

Fig. 4. Distribution of the individual farm holdings (% in UAA) in Romania, 2002–2010.
Source: authors based on INS (2017a).

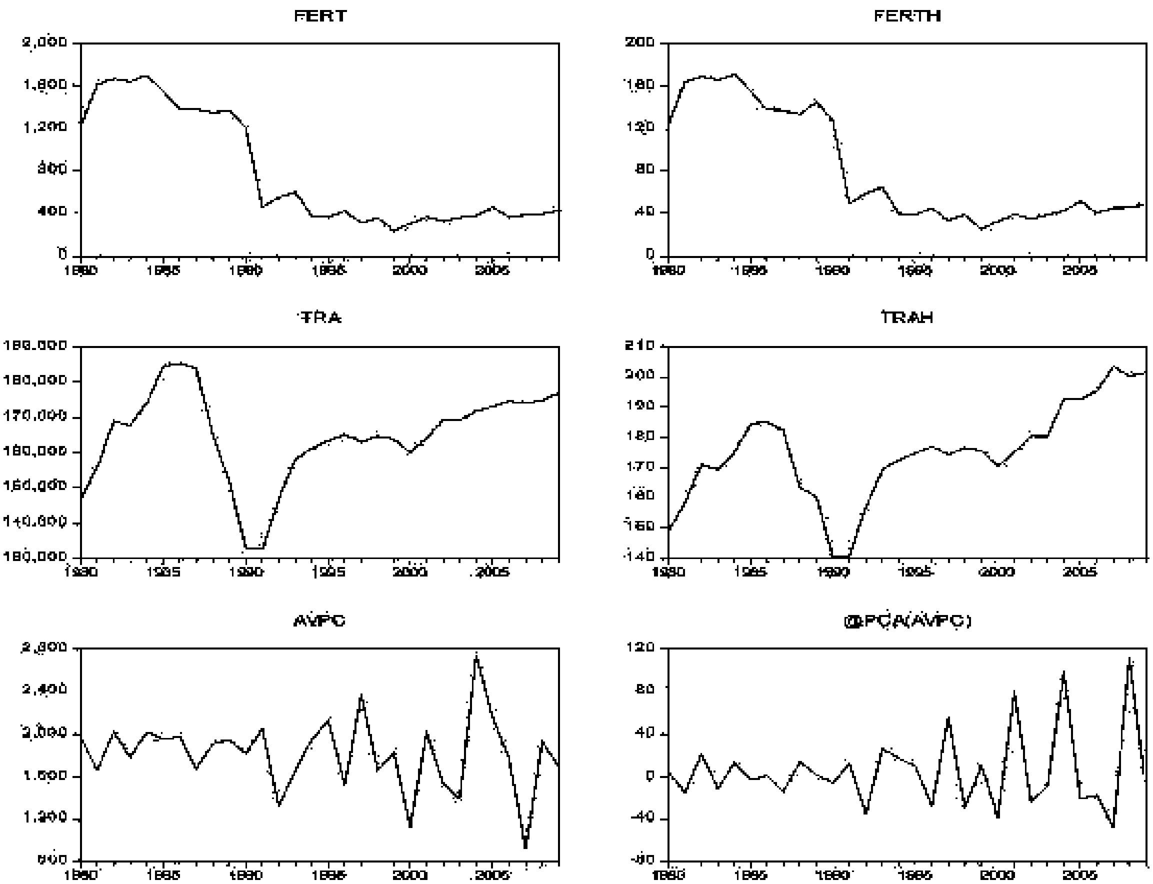

Fig. 5. The evolution of the FERT, FERTH, TR, TRH, AVPC and annual% change of AVPC variables in Romania, 1961–2009.
Source: authors' own computation based on FAOSTAT (2016).

respectively, each sub-period considered separately.

3.1. Material and method

Due to the data time-series feature (Table 2), it is necessary to observe if the considered data series are stationary. To this aim, the ADF and Phillips-Perron (PP) tests have been employed, as they allow us to determine the order of integration variables defined in Table 2. In order to apply the ADF test the methodological procedures described in Gujarati (2004) and Greene (2011) have been adopted. The Phillips-Perron (PP) test is based on estimating non-augmented DF test equations Phillips and Perron (1988). Using the PP tests in the present research takes into account that, over the ADF tests, the PP tests are robust to general forms of heteroskedasticity in the error term u_t. The figures of the test are presented in Appendix B.

In the paper, the acceptance of the null hypothesis is taken by comparison of computed absolute value of the tests statistics with MacKinnon critical p-values. According to this test, under the null, the computed absolute value of the test (based on the data series) is lower than the critical (absolute) p-value, in which case the time series is nonstationary.

The results for the variables considered within the model after applying the above presented procedure for the stationarity analysis are presented in Appendix A and Appendix B, and the summary is presented in Table 3.

As it may be observed, there are very important similarities between

Table 1
Variable names and data series for Romanian agricultureconsidered in the research, 1961-2011.
Source: authors' own computation based on FAOSTAT (2016)

Symbol	Variable name	Time period availability of the data series
$AVVA_{2000}$	The added value per worker in agriculture (USD – constant 2000 prices)	1950–2011
VA_{2000}	The total added value in agriculture (USD – yr. 2000 prices)	1950–2011
ARABLE	The surface of arable land	1961–2009
FERT	The total consumption of chemical fertilizers (tones)	1961–2009
CPVAL	Average value of cereal production (Net production value in constant 2004–2006 Intl. USD/ha)	1961–2009
FERTH	Consumption of fertilizers per hectare (Kg per ha of arable land)	1961–2009
TRA	Total number of agriculture tractors	1961–2009
TRAH	Number of tractors per 100 ha of arable land	1961–2009
POP	Total economically active population in agriculture (ths. persons)	1950–2011
Z	Technical endowment of labor in agriculture (Gross Capital Stock (constant 2005 prices – in ths. USD/person)	1950–2007
AVPC	Average cereal production per hectare (kg/ha)	1961–2009

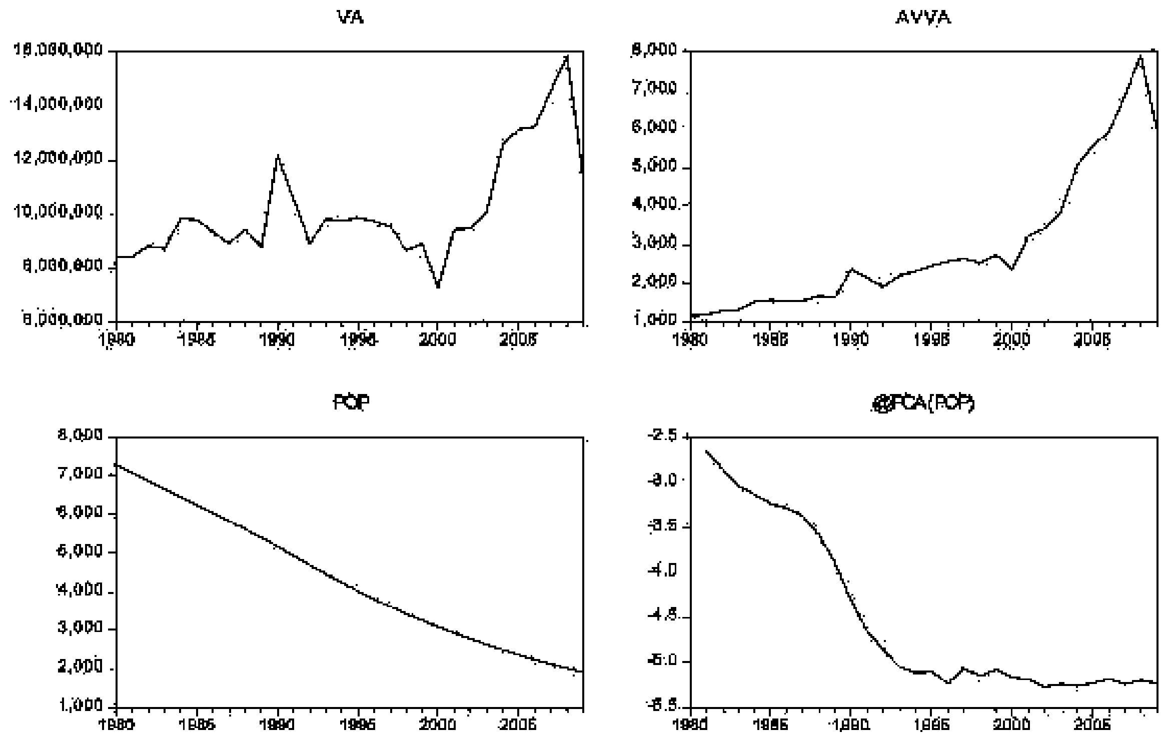

Fig. 6. The evolution of the VA, AVVA, POP and annual% change of POP variables during 1950–2011 in Romania.
Source: authors' own computation based on FAOSTAT (2016).

Table 2
Annual change rate (Y%Δ) and the yearly average rate of change (aY%) during the considered time periods.
Source: authors' own computation based FAOSTAT (2016)

Symbol		1961–2009	1961–1989	1990–2009
AVVA 2000*	Y%Δ	415.19	40.22	153.07
	aY%	5.62	3.44	6.72
VA 2000*	Y%Δ	34.77	4.35	−7.04
	aY%	1.00	0.43	−0.36
ARABLE	Y%Δ	−10.50	−4.01	−6.99
	aY%	−0.29	−0.14	−0.37
AVPC	Y%Δ	57.11	80.42	−6.55
	aY%	0.93	2.06	−0.69
CPVAL	Y%Δ	56.02	79.33	−6.79
	aY%	0.91	2.03	−0.69
FERT	Y%Δ	29.05	317.32	−64.55
	aY%	0.64	5.05	−5.70
FERTH	Y%Δ	44.70	334.75	−62.21
	aY%	0.93	5.20	−5.35
POP*	Y%Δ	−73.54	−25.55	−63.27
	aY%	−4.37	−2.91	−5.09
TRA	Y%Δ	240.39	192.00	33.05
	aY%	3.11	3.76	0.77
TRAH	Y%Δ	251.60	204.20	43.09
	aY%	3.40	3.91	1.14
Z**	Y%Δ	223.22	54.42	106.81
	aY%	3.99	4.44	4.12

Data availability: *1950–2009; **1950–2007.

the results obtained by using the two tests, such as: the series $AVVA_{2000}$, VA_{2000}, *ARABLE*, *FERT* and *FERTH* (both for the whole period 1961–2009 and for the considered sub-period, 1961–1989) are first-order integrated variables.

Both ADF and PP tests, conducted for the *AVPC* and *CPVAL* variables for the whole time horizon evidenced with 1% significance level a first-order integration $I(1)$ process for the series as such (models (1) and (4)), and the stationarity of the series, considering either fixed effects (models (2) and (5)) either fixed effects and trend, respectively (models (3) and (6)). On the other hand, the same tests on these series

Table 3
ADF and PP tests summary.

Data series	ADF test	PP test
AVVA 2000		
	I(1) for (1), (2) and (3)	I(1) for (4), (5) and (6)
VA 2000		
	I(1) for (1), (2) and (3)	I(1) for (4), (5) and (6)
ARABLE		
	I(1) for (1), (2) and (3)	I(1) for (4), (5) and (6)
AVPC (1961–2009)	I(0) for (2) and (3)	I(0) for (5) and (6)
	I(1) for (1)	I(1) for (4)
AVPC (1961–1989)	I(0) for (3)	I(0) for (6)
	I(1) for (1) and (2)	I(1) for (4) and (5)
CPVAL (1961–2009)	I(0) for (2) and (3)	I(0) for (5) and (6)
	I(1) for (1)	I(1) for (4)
CPVAL (1961–1989)	I(0) for (3)	I(0) for (6)
	I(1) for (1) and (2)	I(1) for (4) and (5)
FERT (1961–2009)		
	I(1) for (1), (2) and (3)	I(1) for (4), (5) and (6)
FERT (1961–1989)		
	I(1) for (1), (2) and (3)	I(1) for (4), (5) and (6)
FERTH (1961–2009)		
	I(1) for (1), (2) and (3)	I(1) for (4), (5) and (6)
FERTH (1961–1989)		
	I(1) for (1), (2) and (3)	I(1) for (4), (5) and (6)
POP (1950–2009)	I(0) for (1)	I(0) for (4) and (5)
TRA (1961–2009)		
	I(1) for (1), (2) and (3)	I(1) for (4), (5) and (6)
TRA (1961–1989)		I(0) for (5) and (6)
	I(1) for (1)	I(1) for (4)
TRAH (1961–2009)		
	I(1) for (1), (2) and (3)	I(1) for (4), (5) and (6)
TRAH (1961–1989)		I(0) for (5) and (6)
	I(1) for (1) and (2)	I(1) for (4)
Z		I(0) for (5) and (6)
	I(2) for (1), (2) and (3)	I(2) for (4)

conducted for sub-period 1961–1989 evidenced a $I(1)$ process in the case of series as such, or with fixed effects (models (1), (2), respectively (4) and (5)) and a $I(0)$ process in the case of applying the analysis models considering fixed effects and stochastic trend (models (3) and (6)). All these date lead to the conclusion that these series may be considered stationary in trend.

For the series *TRA* and *TRAH*, considered on the whole time horizon both tests reported first order integration $I(1)$ processes for all six analysis models. For the sub-period 1961–1989, the PP test reported a $I(1)$ process for the both series as such, and $I(0)$ processes, considering either fixed effects (model (5)) or fixed effects and trend (model (6)). For the same sub-period, the ADF test highlighted an $I(1)$ process with neither fixed effects nor trend for the series *TRA*, and an $I(1)$ process for the series such as and, respectively with fixed effects for the series *TRAH*.

The technical endowment of labor (*Z*), according to ADF test is, with 1% significance level, a $I(2)$ process; at the same time, according to the PP test, the same series is $I(2)$ according to the random walk model, but it is stationary considering models (5) and (6).

Both ADF and PP tests evidenced, with 1% significance level that, according to the models (1) and (4), the series *POP* is stationary; the result is maintained for the PP test in the case of analysis with fixed effects.

3.2. Results and discussion

The regression model proposed attempts at analyzing the evolution of total value added and of labor productivity in agriculture, as a result of specific influence factors. Due to the different order of cointegration of the variables, there were considered the following alternative models:

$$\log(IVA_{2000}) = \beta_0 + \beta_1 \log(IARABLE) + \beta_2 \log(IFERT) + \beta_3 \log(ITRA) + \beta_4 \log(IPOP) + \beta_5 \log(IZ) + \beta_6 \log(ICPVAL) \quad \text{(M1)}$$

$$\log(IAVVA_{2000}) = \beta_0 + \beta_1 \log(IFERTH) + \beta_2 \log(ITRAH) + \beta_3 \log(IPOP) + \beta_4 \log(IZ) + \beta_5 \log(IAVPC) \quad \text{(M2)}$$

whereby I *variable* there has been denoted the dynamics (YoY) of the considered variable. The results are presented in the Tables 4 and 5 respectively.

The parameters estimations were performed using different combinations of variables described in Table 1. The explained variables of the regression models are the logarithm of the index of the total gross value added in agriculture, and the logarithm of the gross value added per 1 worker index respectively, both expressed in the year 2000 prices (log (IVA_{2000}) and log ($IAVVA_{2000}$)). The estimation of the models has been done by employing the OLS method.

Table 4
M1 Dependent Variable: log(IVA_{2000}).

Variable	Period		
	1961–2008	1961–1989	1990–2008
Constant	−0.085 (−0.738)	0.465 (4.544)**	1.436 (1.540)
log(IARABLE)	−0.561 (−0.460)	−0.818 (−2.758)	−3.576 (−2.182)*
log(IFERT)	0.157 (1.901)***	0.315 (7.723)**	0.221 (2.483)**
log(ITRA)	−0.812 (−1.838)***	−1.429 (−8.394)**	−0.975 (−1.511)
log(IPOP)	−1.440 (0.507)	17.818 (5.590)**	29.869 (1.513)
log(IZ)	1.277 (1.104)	2.532 (10.328)*	3.961 (1.374)
log(ICPVAL)	0.205 (3.236)*	0.465 (19.418)*	0.198 (3.175)*
Adjusted-R^2	0.251	0.996	0.517
AIC	−1.494	−6.884	−1.533
SIC	−1.158	−6.731	−1.186
F-statistic	2.453***	83.799**	4.034**

Note: the values in brackets are the t-statistics.
* Significant at 1% significance level.
** Significant at 5% significance level.
*** Significant at 10% significance level. F-statistics is reported to test for the joint significance of the coefficients.

Table 5
M2 Dependent Variable: log($IAVVA_{2000}$).

Variable	Period		
	1961–2008	1990–2008	1961–1989
Constant	−0.075 (−0.667)	1.194 (1.085)	0.192 (2.201)
log(IFERTH)	0.168 (2.095)**	0.236 (2.246)**	0.365 (4.324)**
log(ITRAH)	−0.747 (−1.765)***	−0.643 (−0.843)	−0.978 (−5.143)**
log(IPOP)	−2.672 (−1.283)	22.874 (0.963)	7.510 (3.049)***
log(IZ)	0.936 (0.891)	2.734 (0.810)	1.945 (5.338)**
log(IAVPC)	0.228 (3.428)**	0.232 (2.964)**	0.465 (8.204)*
Adjusted-R^2	0.283	0.319	0.906
AIC	−1.549	−1.218	−4.963
SIC	1.261	−0.921	−4.832
F-statistic	3.048**	2.59**	16.407**

Note: the values in brackets are the t-statistics.
* Significant at 1% significance level.
** Significant at 5% significance level.
*** Significant at 10% significance level. F-statistics is reported to test for the joint significance of the coefficients.

Despite the difficulties induced by the models specification in direct interpretation of the results, they indicate that, during the overall considered period, the dynamics of the total value added in agriculture has been affected by the surface of arable land, but it has been positively influenced by the change in the fertilizers and in the average value of cereal production (12–15). The results in Table 5 show similar influences upon the dynamics of the labor productivity in agriculture, taking into account the exception that model M2 has considered the average cereal production per hectare, instead of average value of cereal production (M1).

4. Conclusions

The results of this research suggest that the variables used in modeling the evolution of value added and labor productivity in Romanian agriculture have been correctly chosen and they have significant impact on the calculations.

Analyzing the sectorial transformation by employing the main economic indicators, such as the contribution of agriculture to the Gross Domestic Product and Gross Value Added, create a holistic image of the Romanian agriculture on its path to modernization. Agriculture continues to represent for Romania a determinant economic branch of great importance, notably impacting upon the rural communities. Despite the last evolutions in the field, Romanian economy could be considered an agricultural economy, taking into consideration the resources mobilized in this sector.

Assessing the considered sub-periods, there may be observed that between 1961 and 1989, the use of fertilizers, labor, fixed assets, as well as the average value of cereal production significantly influenced the total value added of the sector. Moreover, the influence of the number of tractors is noteworthy; even the results show a negative relationship; this may be interpreted in the context of the sharp decrease in their number between 1985 and 1990, when the total value added increased, despite this diminution.

The change in consumption of fertilizers and in the average cereal production per hectare directly impacted on the labor productivity in the sector. In the period 1990–2008, the fertilizers and the average value of cereal production played a positive role upon the total value added in agriculture, whereas the surface of arable land reported a significant negative influence. Furthermore, the consumption of fertilizers per one hectare of arable land and average cereal production per hectare exerted a positive influence on the dynamics of labor productivity in Romanian agriculture.

The analysis of the transformations of the Romanian agricultural economic paradigm under the residential land policy reforms reveals that the Romanian agriculture is on the right path to achieve competitiveness. All sectorial transformations of Romanian agriculture, the design of the new paradigm under the conspicuous domestic policy reforms, as well as the intense and irreversible process of reforming and reassembling the rural economy on the new basis bring Romanian agriculture closer to the EU agricultural model and paradigm.

Annex A. ADF test for the variables considered within the model.

Data series	By level	By first order difference	By second order difference	Integration order and the model
	-0.26 ($p=0$)	-4.23^{***} ($p=0$)	–	I(1) with constant (*M2*)
AVVA_2000 (1980–2009)	-1.86 ($p=0$)	-4.25^{**} ($p=0$)	–	I(1) with constant and trend (*M3*)
	–	-3.81^{***} ($p=0$)	–	I(1) (*M1*)
	-2.11($p=0$)	-5.61^{***} ($p=0$)	–	I(1) with constant (*M2*)
VA_2000 (1980–2009)	-2.62($p=0$)	-5.41^{***} ($p=0$)	–	I(1) with constant and trend (*M3*)
	-0.01 ($p=0$)	-5.66^{***} ($p=0$)	–	I(1) (*M1*)
	-0.46 ($p=0$)	-7.56^{***} ($p=0$)	–	I(1) with constant (*M2*)
ARABLE (1961–2009)	-1.92 ($p=0$)	-7.60^{***} ($p=0$)	–	I(1) with constant and trend (*M3*)
	-1.16 ($p=0$)	-7.51^{***} ($p=0$)	–	I(1)
	-5.00^{***} ($p=0$)	–	–	I(0) with constant (*M2*)
AVPC (1961–2009)	-5.69^{***} ($p=0$)	–	–	I(0) with constant and trend (*M3*)
	–	-7.37^{***} ($p=0$)	–	I(1)
	-1.85 ($p=0$)	-5.30^{***} ($p=2$)	–	I(1) with constant (*M2*)
AVPC (1961–1989)	-3.64^{**} ($p=0$)	–	–	I(0) with constant and trend (*M3*)
	–	-7.05^{***} ($p=0$)	–	I(1)
	-5.10^{***} ($p=0$)	–	–	I(0) with constant (*M2*)
CPVAL (1961–2009)	-5.31^{***} ($p=0$)	–	–	I(0) with constant and trend (*M3*)
	-0.08 ($p=0$)	-7.47^{***} ($p=2$)	–	I(1)
	-1.95 ($p=0$)	-5.50^{***} ($p=2$)	–	I(1) with constant (*M2*)
CPVAL (1961–1989)	-3.83^{**} ($p=0$)	–	–	I(0) with constant and trend (*M3*)
	–	-7.21^{***} ($p=0$)	–	–
	-1.21 ($p=0$)	-6.95^{***} ($p=0$)	–	I(1) with constant (*M2*)
FERT (1961–2009)	-1.36 ($p=0$)	-7.23^{***} ($p=0$)	–	I(1) with constant and trend (*M3*)
	-0.60 ($p=0$)	-7.02^{***} ($p=0$)	–	I(1) (*M1*)
	-0.98 ($p=0$)	-6.22^{***} ($p=0$)	–	I(1) with constant (*M2*)
FERT (1961–1989)	-1.54 ($p=0$)	-4.88^{***} ($p=0$)	–	I(1) with constant and trend (*M3*)
	–	-1.75^{*} ($p=0$)	–	I(1)
	-1.29 ($p=0$)	-7.06^{***} ($p=0$)	–	I(1) with constant (*M2*)
FERTH (1961–2009)	-1.41 ($p=0$)	-7.31^{***} ($p=0$)	–	I(1) with constant and trend (*M3*)
	-0.59 ($p=0$)	-7.13^{***} ($p=0$)	–	I(1)
	-0.93 ($p=0$)	-6.22^{***} ($p=0$)	–	I(1) with constant (*M2*)
FERTH (1961–1989)	-1.72 ($p=0$)	-4.82^{***} ($p=0$)	–	I(1) with constant and trend (*M3*)
	–	-5.61^{***} ($p=0$)	–	I(1) (*M1*)
	-1.73 ($p=3$)	–	–	–
POP (1980–2009)	-0.11 ($p=3$)	–	–	–
	-2.99^{***} ($p=4$)	–		I(0)
	-2.34 ($p=1$)	-3.62^{***} ($p=0$)	–	I(1) with constant (*M2*)
TRA (1961–2009)	-2.69 ($p=1$)	-3.76^{**} ($p=0$)	–	I(1) with constant and trend (*M3*)
	–	-3.38^{***} ($p=0$)	–	I(1)
	-1.82 ($p=6$)	-1.98 ($p=0$)	–	–
TRA (1961–1989)	-1.71 ($p=6$)	-2.55 ($p=0$)	–	–
	–	-1.99^{**} ($p=0$)	–	I(1)
	-2.38 ($p=0$)	-4.87^{***} ($p=0$)	–	I(1) with constant (*M2*)
TRAH (1961–2009)	-2.62 ($p=0$)	-5.02^{***} ($p=0$)	–	I(1) with constant and trend (*M3*)
	–	-4.32^{***} ($p=0$)	–	I(1)
	-1.71 ($p=6$)	-3.20^{**} ($p=0$)	–	I(1) with constant (*M2*)
TRAH (1961–1989)	-1.66 ($p=6$)	-1.97 ($p=5$)	–	–
	–	-2.73^{***} ($p=0$)	–	I(1)
	–	-1.02 ($p=6$)	-8.54^{***} ($p=0$)	I(2) with constant (*M2*)
Z (1980–2007)	–	-3.00 ($p=0$)	-8.37^{***} ($p=0$)	I(2) with constant and trend (*M3*)
	–	–	-8.52^{***} ($p=0$)	I(2)

***Significant at 1% significance level; **significant at 5% significance level; *significant at 10% significance level.

Annex B. Phillips-Perron test for the model variables.

Data series	By level	By first order difference	By second order difference	Integration order and the model
	−0.32 (f_0)	−4.44*** (f_6)	–	I(1) with constant (M5)
AVVA_2000 (1980–2009)	−1.87 (f_0)	−4.59*** (f_6)	–	I(1) with constant and trend (M6)
	–	−3.81*** (f_6)	–	I(1) (M4)
	−2.13 (f_0)	−5.67** (f_0)	–	I(1) with constant (M5)
VA_2000 (1980–2009)	−2.62 (f_0)	−5.47*** (f_6)	–	I(1) with constant and trend (M6)
	−0.01 (f_0)	−5.66*** (f_6)	–	I(1) (M4)
	−0.49 (f_0)	−7.53*** ((f_6)	–	I(1) with constant (M5)
ARABLE (1961–2009)	−1.94 (f_0)	−7.60*** (f_6)	–	I(1) with constant and trend (M6)
	−1.16 (f_0)	−7.37*** (f_6)	–	I(1)
	−6.46*** (f_5)	–	–	I(0) with constant (M5)
AVPC (1961–2009)	−5.95*** (f_6)	–	–	I(0) with constant and trend (M6)
	–	−10.26*** (f_6)	–	I(1)
	−1.88 (f_0)	−7.12*** (f_6)	–	I(1) with constant (M2)
AVPC (1961–1989)	−3.64** (f_0)	–	–	I(0) with constant and trend (M3)
	–	−7.05*** (f_6)	–	I(1)
	−6.36*** (f_5)	–	–	I(0) with constant (M2)
CPVAL (1961–2009)	−5.34*** (f_6)	–	–	I(0) with constant and trend (M3)
	−0.11 (f_5)	−10.51*** (f_2)	–	I(1)
	−2.00 (f_0)	−7.25*** (f_2)	–	I(1) with constant (M2)
CPVAL (1961–1989)	−3.83** (f_0)	–	–	I(0) with constant and trend (M3)
	–	−7.21*** (f_6)	–	–
	−1.21 (f_0)	−8.96*** (f_2)	–	I(1) with constant (M2)
FERT (1961–2009)	−1.37 (f_0)	−9.02*** (f_2)	–	I(1) with constant and trend (M3)
	−0.60 (f_0)	−7.02*** (f_6)	–	I(1) (M1)
	−1.01 (f_0)	−9.17*** (f_2)	–	I(1) with constant (M2)
FERT (1961–1989)	−1.55 (f_0)	−8.68*** (f_2)	–	I(1) with constant and trend (M3)
	–	−7.67*** (f_2)	–	I(1)
	−1.30 (f_0)	−9.07*** (f_2)	–	I(1) with constant (M2)
FERTH (1961–2009)	−1.42 (f_0)	−9.02*** (f_2)	–	I(1) with constant and trend (M3)
	−0.59 (f_0)	−7.13*** (f_6)	–	I(1)
	−0.96 (f_0)	−8.76*** (f_2)	–	I(1) with constant (M2)
FERTH (1961–1989)	−1.73 (f_0)	−6.22*** (f_6)	–	I(1) with constant and trend (M3)
	–	−5.61*** (f_6)	–	I(1) (M1)
	−4.41*** (f_6)	–	–	I(0) with constant (M2)
POP (1980–2009)	–	−2.42 (f_3)	–	–
	−21.45*** (f_4)	–		I(0)
	−2.35 (f_7)	−3.63*** (f_6)	–	I(1) with constant (M2)
TRA (1961–2009)	−2.75 (f_7)	−3.76** (f_0)	–	I(1) with constant and trend (M3)
	–	−3.38*** (f_6)	–	I(1)
	−2.74* (f_6)	–	–	I(0) with constant (M5)
TRA (1961–1989)	−10.39*** (f_7)	–	–	I(0) with constant and trend (M6)
	–	−1.99 ** (f_6)	–	I(1)
	−2.22 (f_0)	−4.88*** (f_6)	–	I(1) with constant (M2)
TRAH (1961–2009)	−2.62 (f_7)	−5.02*** (f_6)	–	I(1) with constant and trend (M3)
	–	−4.33 *** (f_0)	–	I(1)
	−4.96 *** (f_3)	–	–	I(1) with constant (M2)
TRAH (1961–1989)	−4.39*** (f_7)	–	–	–
	–	−2.73*** (f_6)	–	I(1)
	−5.61*** (f_2)	–	–	I(0 with constant (M2)
Z (1980–2007)	−28.62 *** (f_2)	–	–	I(0) with constant and trend (M3)
	–	–	−8.52*** (f_0)	I(2)

***Significant at 1% significance level; **significant at 5% significance level; *significant at 10% significance level

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RESEARCH ARTICLE

The impact and determinants of the energy paradigm on economic growth in European Union

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Abstract

Contemporary economies are strongly reliant on energy and analyzing the determining factors that trigger the changes in energy paradigm and their impact upon economic growth is a topical research subject. Our contention is that energy paradigm plays a major role in achieving the sustainable development of contemporary economies. In order to prove this the panel data methodology of research was employed, namely four panel unit root tests (LLC, IPS, F-ADF and F-PP) aiming to reveal the connections and relevance among 17 variables denoting energy influence on economic development. Moreover, it was introduced a specific indicator to express energy consumption per capita. Our findings extend the classical approach of the changes in energy paradigm and their impact upon economic growth and offer a comprehensive analysis which surpasses the practices and policy decisions in the field.

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Introduction

Energy is by far one of the most important vectors in promoting sustainable economic development in contemporary societies. During the years, energy in general, and particularly the energy market has experienced numerous and effective paradigm changes under the pressure of geopolitical and geostrategic threats and supply insecurity. But the diversification of energy supply sources, the promotion of renewables and also the possibility of the enterprises to access the energy exchange market have had a major contribution to the optimization of energy production and consumption. Providing secure energy supply implies the well-functioning of a network of factors including efficiency of energy market and a good intersection of energy production and demand in a fluid and highly competitive context.

Nowadays energy has been transformed into a veritable production factor [1], with a straight influence on the economic growth. The most of literature focus on the relationship between energy and different components of the environmental mechanism–(resource productivity, economic growth, greenhouse emissions related industry, CO2 emissions and complementary components) [2–3], there are new research trends dealing with the relevance of energy in achieving sustainable development and economic growth. In literature [4] has been highlighted a direct and significant influence of energy usage on economic growth on numerous countries surveyed, implicit from the perfective of GDP growth, welfare and resource productivity.

In another study [5] it is point out that economic growth and energy consumption self-influence each other and trigger on short and long run a causal relationship between their components, such as foreign direct investments, relative prices and the financial development of a country [5]. Moreover, the direct link between energy consumption and the income level was also debated by numerous surveys [6–8]. However, the connection between energy and the different components of the economic development is still approached in the literature [9–12] more theoretically rather than analytically.

Following the accelerated development of the production forces in the past century, the post-industrial era brings to attention an unprecedented environmental problem. The last decades have been marked by a series of evolutions in this field whose magnitude, based on the past experience, is expected to be amplified in the coming period. There has to be pointed out that these evolutions are concurrent with the requirements of the continuous economic development as the only known viable source for the unceasing increase of living standards in modern societies and the necessary improvement of the quality of life in traditional ones. In our opinion, the main criterion that should be used to divide the two types of society is represented by the accessible form of energy for the majority of the population.

The traditional societies are characterized by the extensive usage of solid fuels, especially wood, in areas that already experience serious environmental problems, affecting once more the fragile global equilibrium. Not least, some of these countries are denominated as having "emergent economies", with part of them in the top of the world production of goods, and the environmental effect of their industries is undeniable. As the development is fundamentally based on energy, the access to superior forms of energy (especially electric) for the traditional communities still may be accomplished by means of fossil fuels, confining resources and issuing emissions.

According to the Eurostat data [13], twelve countries in Europe (Slovenia, Croatia, Latvia, Hungary, Lithuania, Slovakia, Poland, the Czech Republic, Romania, Estonia, and Bulgaria) still have an energy intensity over 200 kilograms of oil equivalent (kgoe) per 1000 Euros of GDP.[13]

Analyzing the possibilities of carbon emissions reduction, Caiazza [14] underlines that there are two feasible solutions: the decrease in energy intensity and the improvement of consumption structure. Fundamentally, this development can be achieved by decreasing the share of energy production based on fossil fuels and correlatively increasing the renewable energies, that is, the fuel substitution effect and renewable energy penetration effect.

Many scholars have dealt with the impact of energy patterns on the different components of economic development in contemporary economies. Several examples are worth mentioning, starting with Kraft and Kraft [15] who studied the causal relationship between economic growth and energy consumption within the US economy, continuing with [16] who analyzed the same issue considering six Central American countries between 1980–2004 using a multivariate research framework, or Akinlo [17] considering eleven Sub-Saharan African countries by using the autoregressive distributed lag (ARDL), and Esso and Keho [18] who analyzed the causal link between energy consumption, carbon dioxide (CO_2) emissions, and economic growth in the case of 12 selected Sub-Saharan African countries.[18]

Taking into consideration all the above mentioned opinions, studies and differences, we argue that the causal relationship between energy paradigm evolution and economic growth requires an in-depth analysis from a specific perspective. Previous studies and reports have analyzed the correlation between energy consumption and economic growth [19–21] ignoring economic efficiency aspects. In an effort to complete the infield analysis and to properly understand the full economic effects of energy in contemporary economies, by using 17 variables, we aim to extend the current research by investigating the broader economic effects of energy production and taxation [22–23] in promoting sustainable economic development.

The novelty of this paper consists in the design of a specific indicator which expresses the energy consumption per capita and in the use of four panel unit root tests (LLC, IPS, F-ADF and F-PP) to reveal the connections and relevance of considered variables. Moreover, in all these cases the null hypothesis of a unit root is provided against the alternative of stationarity, and all the tests are adapted for the specific requirements of the panel data analysis. Also, the length of the data sets ensures the implementation of the tests and tools throughout the paper to be valid.

Data series and preliminary results

The latest datasets available on the Eurostat (2016) were employed, which allowed us to include Romania in the study among the other EU-28 countries. In addition, using indicators such as: energy intensity, energy productivity, energy dependence, and resource productivity, allowed the energy performance measuring in the economy. Table 1 presents the variables, the period of data availability, and the symbols employed for each series.

The descriptive statistics of the variables employed in the study is presented in Table 2. As the research is based on the panel data approach, there may be observed that the common period of data availability is 2004–2014. The study takes into consideration major aspects, such

Table 1. Description of the variables and data series.

Symbol	Description of the Variable	Time-period availability of the data
Egrs	Electricity generated from renewable sources (% of gross electricity consumption)	2004–2014
Edep	Energy dependence (%)	1990–2014
Eint	Energy intensity (kg of oil equivalent per 1 000 Euro of GDP)	2003–2014
Epty	Energy productivity (Euro per kilogram of oil equivalent)	1995–2014
Gdp	Real GDP per capita (Euro per inhabitant)	1995–2015
Gec_a	Gross inland energy consumption—all products	1990–2014
Gec_g	Gross inland energy consumption—gas	1990–2014
Gec_n	Gross inland energy consumption—nuclear	1990–2014
Gec_p	Gross inland energy consumption—petroleum	1990–2014
Gec_r	Gross inland energy consumption—renewable	1990–2014
Gec_s	Gross inland energy consumption—solid fuels	1990–2014
Gec_w	Gross inland energy consumption—waste	1990–2014
Pec	Primary energy consumption (mil. tonnes of oil equivalent)	1990–2014
Ppre	Primary production of renewable energy (tonnes of oil equivalent)	2003–2014
Rpty	Resource productivity (Euro per kilogram, chain linked volumes—2010)	2000–2015
Shrec	Share of renewable energy in fuel consumption of transport (%)	2004–2014
Shrft	Share of renewable energy in gross final energy consumption (%)	2004–2014

Source: authors based on EUROSTAT (2016).

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Table 2. The descriptive statistics of the employed variables.

	Egrs	*Gdp*	*Gec a*	*Gec g*	*Gec n*	*Gec p*	*Gec r*	*Gec s*	*Gec w*	*Edep*	*Eint*	*Epty*	*Ppre*	*Pec*	*Rpty*	*Shrec*	*Shrft*
Mean	22.85	25.42	62.31	14.83	8.43	22.20	5.91	10.55	0.36	37.20	190.82	6.50	5.77	58.43	1.46	16.54	2.85
Median	16.10	22.60	28.43	4.41	1.01	9.90	2.78	3.88	0.12	54.30	146.80	6.80	2.51	26.90	1.18	12.40	2.10
Maximum	109.60	82.90	351.70	87.75	116.47	123.48	35.41	86.13	4.30	102.50	626.60	14.60	36.02	327.60	3.74	69.20	21.60
Minimum	0.00	3.90	0.87	0.00	0.00	0.87	0.00	0.00	0.00	-665.50	68.60	1.60	0.00	0.90	0.24	0.20	0.00
Std. Dev.	21.73	16.94	83.17	22.11	21.39	29.71	7.01	17.72	0.65	109.29	100.90	2.75	6.82	78.20	0.90	13.68	2.89
Skewness	1.73	1.27	1.92	1.90	4.12	1.78	1.66	2.78	3.89	-5.18	1.55	0.38	1.71	1.91	0.70	1.54	2.21
Kurtosis	6.48	4.70	5.76	5.45	20.01	5.04	5.42	10.43	20.84	29.97	5.69	2.62	5.76	5.66	2.59	5.63	12.28
J-B test	314.2	121.6	291.6	267.4	4660.1	219.5	220.2	1124.4	4938.3	10882.1	220.5	9.6	251.8	283.0	27.6	214.4	1378.1
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sum	7153.5	7956.4	19502.4	4641	2638	6949	1851	3304	113	11643	59728	2035	1806	18290	458	5177	893
S.Sq.Dev.	147361	89582	2157981	152482	142770	275386	15317	97954	132	3726745	3176527	2353	14499	1908075	250	58376	2603
Obs.	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313

Source: authors' own computations based on Table 2.

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as: energy consumption components, energy dependence and energy intensity, as well as energy efficiency, by using energy productivity and resources productivity.

Materials and methodology

The data employed in the current study refers to 29 countries, representing the European Union member states at this moment and Norway. As presented in Table 1, the series are annual, extended over 11 years, running between 2004 and 2014, representing the earliest data available for the *electricity generated from renewable sources*, *share of renewable energy in fuel consumption of transport*, and respectively, *share of renewable energy in gross final energy consumption*. Also, some of the data series start in 2003 (cases of *energy intensity* and *primary production of renewable energy*), or in 2000 (as those regarding *resource productivity*).

It is worth mentioning that the European framework to account for the energy issues, not only renewables, as in the case of *energy intensity* and *resource productivity*, was finally established in 2004. Nevertheless, the present research could benefit from the positive aspects of longer series of data, but, the missing variables named above represents a disadvantage.

In the literature [24], the population represents one of the variables emphasized as a major driving factor for energy consumption and taxation. Intuitively, this approach is correct–the energy consumption is expected to increase both with the number of population and with the prosperity of society, as the access to superior forms of energy represents a key aspect of the modern lifestyle. On the other hand, from the methodological point of view, it is appealing to consider that energy intensity may not represent a fair measure to rank the countries from the energy consumption point of view, as this indicator has two drawbacks:

1. first, it does not consider the population, apparently one of the driving factors in a country's total energy consumption; and,
2. instead, it takes into account only the GDP, which, usually, tends to decrease with the population and especially with the population growth rate.

Relying on these observations and starting from the available data, we tried to build an indicator in order to express the energy consumption per capita. In this respect, the total consumption of energy per inhabitant (*TE/P*) could be considered as a valid measurement in order to account for the population and it was computed using (1):

$$\frac{TE}{P} = \frac{TE}{GDP} \cdot \frac{GDP}{P}, \tag{1}$$

where *TE/GDP* accounts for the energy intensity and *GDP/P* represents GDP per capita. The results of this computation are presented in Table 3.

It may be observed that the classification of the countries according to the total consumption of energy per inhabitant leads to exactly the same results as the classification based on the energy intensity criterion. In our opinion, this result can be equivalent to the fact that energy intensity may express the level of development of a certain country regardless the number of population. Thus, the developed countries succeed in ensuring superior life conditions, concomitant to reduced consumption of energy. Also, for the considered panel of countries, this may represent a valid proof that the number of population does not affect the energy intensity, and, consequently, for the sample period, this variable does not affect the results of the research. This finding is consistent with other similar research results presented in the extant literature [25–27].

Another study [27] with closed conclusions outlines that the main factors that determine the emissions of CO2 are the growth in population and the increase in the general level of

Table 3. Average energy intensity and energy consumption per inhabitant.

Country	Energy intensity	Total energy consumption per inhabitant
Denmark	78.8	3.1
Ireland	87.6	3.4
Norway	92.2	3.6
Italy	109.4	4.3
Austria	114.5	4.5
United Kingdom	115.3	4.5
Luxembourg	117.8	4.6
Spain	126.4	5.0
Germany	128.1	5.0
Netherlands	131.9	5.2
Greece	132.3	5.2
France	132.8	5.2
Sweden	136.0	5.3
Portugal	140.9	5.5
Cyprus	142.9	5.6
Malta	143.2	5.6
Belgium	159.9	6.3
Finland	191.0	7.5
Slovenia	202.4	7.9
Croatia	207.6	8.1
Latvia	236.3	9.3
Hungary	253.6	9.9
Lithuania	274.2	10.8
Slovakia	279.3	11.0
Poland	282.5	11.1
Czech Republic	290.4	11.4
Romania	298.6	11.7
Estonia	377.1	14.8
Bulgaria	514.3	20.2

Source: authors based on EUROSTAT (2016).

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income: the evolution of revenues is granted to exert stronger pressures than the growth in population. Interestingly, within the population-effect, the main determinant is not the number but the affluence, whilst the income-effect evidence various evolutions across countries. [27]

Due to increasing interest in the CO2 emissions mitigation, as the global environmental situation tends to worsen, in the literature exists plenty of researches in the interrelated fields of energy production, consumption, taxation, structure, prices, etc., often times in close connection with the economic growth.

The latest evolutions in the analysis of various energy aspects imply using the panel data approach and its subsequent techniques, presented below, due to important econometric advantages: the considerable increase of the sample size, which allows for higher degrees of freedom, more reliable statistical tests, including increasing the power of cointegration ones; the heterogeneity between countries; the reduced collinearity between the considered variables.

In this framework, Granger causality tests represent the main tool in the application of cointegration techniques, in order to observe the error correction mechanism (ECM) and to examine the long and short-run relationships between the considered variables [28]. The underlying idea of employing the causality tests is based on Granger's [29] proof, according to which when the series are integrated of order one, $I(1)$, there might occur linear combinations by virtue of which the series become stationary without differencing.

The series of this type are considered cointegrated and in this context, the existence of a long-run relationship between the integrated variables is a task which is analyzed by using the cointegration analysis. If the cointegration is proved, the issue of differencing, represented by the loss of information on any long-run relationships between variables, is avoided through the ECM, employed to check whether there is any stationary linear combination of non-stationary variables, implying that a long-run equilibrium relationship holds between the variables.

The first step to be taken consists in panel unit root testing. The problem of the unit root is not a key issue in the panel data approach, especially where the length of the time series is relatively reduced, as in the case of the present research. Although testing for the stationarity of panel data is complicated by the inherent heterogeneity of country-section specific parameters, on the other hand, considering cross-sectional units as independent, sometimes, does not represent an appropriate approach.

In order to avoid as much as possible the backward and to best capture the virtuous aspects of employing these tests, we considered using four panel unit root tests, namely LLC [30], IPS [31], and, respectively Fisher-type tests based on ADF [32] and PP tests [33] (herein denoted as F-ADF and F-PP, respectively). All considered tests have, in various forms, the null hypothesis of a unit root (common, in the case of LLC or for some cross-sections, in the case of the last three) against the alternative of stationarity, and are adapted so as to deal with the requirements specific to the panel data environment. Basically, the autoregressive (AR) model has the form [16] (2):

$$\Delta y_{it} = \rho y_{i,t-1} + \sum_{L=1}^{p_i} \theta_{iL} \Delta y_{i,t-L} + \delta X'_{it} + \varepsilon_{it}, \tag{2}$$

where, by $i = \overline{1,N}$ are denoted the cross-sections, observed through the time length $t = \overline{1,T}$; p_i represents the lag order, allowed to vary among individuals, and is determined by means of the t-statistic of $\hat{\theta}_{iL}$ (under the null, ($\hat{\theta}_{iL} = 0$), these t-statistics are distributed $N(0,1)$, either if $\rho_i = 0$ or $\rho_i < 0$); X'_{it} are the exogenous variables of the model, containing fixed effects and, if necessary, individual trend; by ρ_i are denoted the AR coefficients; ε_{it} describes a stationary process. If $\rho_i < 1$, y_i is considered to be low trend-stationary; in case $\rho_i = 1$, then y_i is not stationary, that is, the series contains a unit root.

Although the LLC test is based upon running distinct augmented Dickey-Fuller (ADF) regressions for each individual, the null hypothesis assumes the existence of a unit root process that is common for all cross sections; that implies a value of ρ the same across sections, against the alternative of no unit root. Among the unit root tests for panel data IPS is the most used; it assume a relaxation in the restriction homogeneity as it is specified for the LLC test, allowing for a coefficient of $y_{i,t-1}$ which can vary among individuals, and putting forward a testing procedure based on the calculation of the $\overline{t}$-statistic as [24]:

$$\overline{t} = \frac{\sum_{i=1}^{N} t_{\rho i}}{N} \tag{3}$$

where, $t_{\rho i}$ represents the individual t-statistic for testing of the null hypothesis in each cross-section of the panel, assumed that every individual contains a unit root: $\rho_i = 0, (\forall) i = \overline{1,N}$.

The alternative is specified upon [34], [35]:

$$H_1 : \begin{cases} \rho_i < 0, \text{ for } i = \overline{1, N_1} \\ \rho_i = 0, \text{ for } i = \overline{N_1 + 1, N} \end{cases}, \tag{4}$$

namely, it requires that the fraction in the series which are stationary to be nonzero: $\lim_{N \to \infty} \left(\frac{N_1}{N}\right) = \gamma, 0 < \gamma < 1$. In case that the lag order is always zero ($p_i = 0, (\forall) i = \overline{1, N}$), IPS test stipulates simulated critical values for $\bar{t}$, provided for a different number of individuals N, and length in series.

Some researches in the literature [36] points out the underlying idea of such testing, based on the finding that a linear combination of two or more non-stationary series may be stationary. If this type of stationary linear combination exists, the non-stationary time series are said to be cointegrated. The stationary linear combination may be considered as a relationship of long-run equilibrium across the considered variables and it is called cointegrating equation.

In this research, it was opted to assess the cointegration among variables using Kao test for which Gutierrez [37] suggests that it has a higher power than other competing tests, especially in a homogenous panel and that, as in our case, the time series length is relatively short.

The Kao test is based either on a version of the ADF test on the residual (e_{it}) of the auxiliary regression $e_{it} = \rho e_{it-1} + v_{it}$, or on the augmented version of the pooled specification [24], [38]:

$$e_{it} = \rho e_{it-1} + \sum_{j=1}^{p} \lambda_j \Delta e_{it-j} + v_{it} \tag{5}$$

Under the null hypothesis of no cointegration, the augmented version of the test is constructed as follows [24]:

$$ADF = \frac{t_\rho + \frac{\sqrt{6N}\hat{\sigma}_v}{2\hat{\sigma}_{0v}}}{\sqrt{\frac{\hat{\sigma}_{0v}^2}{\hat{\sigma}_v^2} / + \frac{3\hat{\sigma}_v^2}{10\hat{\sigma}_{0v}^2}}} \sim N(0,1), \tag{6}$$

where $\hat{\sigma}_v^2$ is the estimated variance and $\hat{\sigma}_{0v}^2$ is the estimated long-run variance of the error term. Nevertheless, the Kao test is based on the assumption of a homogenous value of ρ across the cross-sections in the panel. Extant literature [39] suggests seven types of residual-based cointegration tests that support this assumption, allowing for considerable heterogeneity: panel *v*-statistic, panel *rho*-statistic, panel *ADF*-statistic, panel *PP*-statistic, group *rho*-statistic, group *ADF*-statistic and group *PP*-statistic.

More specifically, Pedroni [39] tests are based on the estimated residuals of the panel regression, $e_{it} = \rho_i e_{it-1} + v_{it}$, under the null of no cointegration, $\rho_i = 1$. Basically, the panel cointegration test is a test of unit roots in the estimated residuals of the panel. That is equivalent to the expectance of the stationarity of residuals in the case of a cointegrating relation.

Nevertheless, Pedroni [39] suggests that in cases like *rho* and *pp* tests there is a bias to under-reject the null in the case of small samples. The first set (panel tests) comprises four tests, based on pooling and averaging the test statistics for cointegration in the time series across the within-dimension of the panel; in addition, other four values of the same tests are computed as weighted statistics [39]. The second type (group tests) includes three tests based on pooling the residuals of the regression along the between-dimension of the panel. In the latter case, the limiting distributions are based on limits of piecewise numerator and denominator terms.

For both sets of Pedroni tests, the cointegrating relationship is estimated separately for each cross-section, followed by the pooling of the resulting residuals in order to run the panel tests.

The value of the test statistics is then computed as an average of the estimated coefficients corresponding to each cross-section. As a consequence, every test statistics balances the short-run specific dynamics of every member, the fixed individual effects and deterministic trends (within-dimension), as well as the slope coefficients (between-dimension) specific to every cross-section.

In order to evaluate the long-run relationship present between the nonstationary series that proved to be cointegrated from the specific tests presented above, it was used a vector error correction model (VECM) and consequent error correction term. In this situation, a VECM is a restricted autoregression vector (VAR) that may be estimated using a series of different techniques as: dynamics of fully modified OLS (DOLS/FMOLS) models [40], [41] the pooled mean group estimator (PMG) [42] Quasi Maximum Likelihood (QML), or Generalized Method of Moments (GMM).

This type of model involves the estimation of the long-run bi-variate relationship with the inclusion of a lead and lags of the differenced explanatory variable, providing better results than other competing techniques. The VEC has the cointegration relations embedded into the specification; as a result, it allows the long-run behavior of the endogenous variables only towards converge to their cointegrating relationships, whilst allowing for short-run adjustment dynamics. The cointegration term is denominated as error correction term (ECT), as the deviation from the long-term equilibrium is gradually corrected through a series of short-run partial adjustments. The GMM [39], [34] represents a suitable technique in the estimation of a panel VARs, using lags of the endogenous variables as instruments for computing unbiased and consistent estimates.

The model can be specified as follows (7):

$$\begin{aligned} \Delta E\mathrm{int}_{i,t} &= \alpha_i^{eint} + \beta_i^{eint} ECT_{i,t-1}^{eint} + \sum_{j=1}^{m} \delta_{ij}^{eint} \Delta E\mathrm{int}_{i,t-j} + \sum_{s=1}^{q} \gamma_{1,is}^{eint} \Delta Gec\_r_{t-s} + \ldots + \sum_{s=1}^{v} \gamma_{9,is}^{eint} \Delta Shrec_{t-v} + u_{it} \\ \ldots \\ \Delta Shrec_{i,t} &= \alpha_i^{shrec} + \beta^{v} ECT_{i,t-1}^{shrec} + \sum_{j=1}^{m} \delta_{ij}^{shrec} \Delta E\mathrm{int}_{i,t-j} + \sum_{s=1}^{q} \gamma_{1,is}^{shrect} \Delta Gec\_r_{t-s} + \ldots + \sum_{s=1}^{v} \gamma_{9,is}^{shrec} \Delta Shrec_{t-v} + w_{it} \end{aligned} \tag{7}$$

where $ECT_{i,t-1}^{eint,\ldots,shrec}$ are the lagged residuals, derived from the long-run cointegrating relationship; $\delta_{ij}^{eint,\ldots,shrec}$ and $\gamma_{1,\ldots,9}^{eint,\ldots,shrec}$ represent the coefficients of short-run adjustment, whereas u_{it} and w_{it} represent the disturbance terms, assumed to be uncorrelated and have zero mean.

The specification of these models must exhibit an instrumental variable estimator, due to the correlation between the lagged endogenous variables and the error term. The inclusion of fixed effects into the model is in line with Arellano and Bover's [34] approach, aimed at removing the unobserved heterogeneity, whereas the use of orthogonal deviations, which are similar to differences from the mean approach, removes the unobserved heterogeneity in the panel members.

According to Granger et al [28], the long-term causality is evaluated via the significance of the *beta* coefficients (that is, the coefficients of *ECT*) using the standard *t*-statistic, whereas the short-run causality is measured through the joint-significance of the lagged explanatory variables. The long-run causality examination by the significance of the *beta* coefficients is based on their determinant role within the long-run relationship in the cointegrating process.

Their values express the speed in elimination of the deviations from the long-run equilibrium, through changes in each variable; therefore, the process movement on the way described by the significance of the *ECT* coefficients is taken for granted as a permanent one. Bond (2002) considers that the Arellano-Bover [43] approach may have some advantages over other approaches to dynamic panel models. In addition, the *ECT* coefficient, that represents the speed of adjustment following an exogenous shock, is expected to be negative in order to ensure the stability of the model.

The choice of the panel VECM approach in this research relies on its flexibility, allowing the use of heterogeneous panels and correction for both heteroskedasticity standard errors and serial correlation. Methodologically, there has to be pointed out that, in the case of no consistent evidence of cointegration, as the applicability of ECM is limited for the situations when the series are $I(1)$, the ECT are not included in the EC models, and the standard Granger causality models are estimated without an ECT. Also, in cases of no cointegration, the inclusion of all the considered variables in the ECM has to be based on their stationarity. However, the literature suggests that, if added anyway, they report insignificant results [24].

Results and discussions

According to the literature review [1–2], [5], there are many recent contributions addressing various connections of the energy sector. Most of these researches are in the field of the economic growth and energy taxation [22], trying to assess the limits of energy taxation as a factor positively correlated with development, and, more specifically, to sustainable development, as the mankind aggression towards the planetary environment represents an incontestable reality. The first studies in this field were conducted from a local perspective, focused on a comparison between the results of VAR models for various countries.

Nevertheless [42] in the first studies launched in the panel data approach, the observations sets used to account for a small number of countries, sometimes divided into groups, considering their geography, economic development, or other criteria that led to homogenous characteristics of respective groups. To put it different, one of the key aspects of using the panel data approach is that they allow for heterogeneity control. It is known that European Union countries are homogeneous with regard to policy settings whereas there are important disparities when considering their development level. Nevertheless, [44] represents one of the most comprehensive studies that employed the multiple facets of the panel data approach.

Our panel consists of 29 cross-sections, represented by the European Union member countries at this moment, plus Norway. There are also other countries that adhered to the Eurostat report framework, but the data availability concerning them is usually limited to fewer than five years. However, these data refer to the candidate countries, which, in this respect are following the specific roadmap in order to ensure the improvement of their energy balance as a condition for joining the EU.

We have chosen to use the Eurostat data due to its compatibility across all the countries in the panel, which, from the econometric point of view, further ensures the compatibility between the variables across the considered countries. The results from the running of the panel unit root tests are presented in Table 4.

After checking for stationarity, the main finding is that, generally, the cross-sections and the cross-sections units are cointegrated of order one. Only the using of the LLC test reported a significant part (though, a minority) of the cross-sections to be stationary, for various levels of significance. Nevertheless, previous research [34], [45] pointed out that the results using of the IPS test are reasonably satisfactory and generally better than those obtained from running of the LLC test [45]. As a consequence, we take for granted the result that the series are cointegrated of order one, $I(1)$. The results of using the IPS tests are also largely confirmed by the results issued through employing the F-ADF and F-PP tests.

The significant results of the pairwise Granger causality tests for the considered dataset are presented in Table 5; as in [28], [35] we test for cointegration in both directions, with both variables acting as the dependent variable.

Table 4. Panel unit root tests.

Variable	LLC		IPS		ADF-Fisher Chi-square		PP-Fisher Chi-square	
	Level	Differenced	Level	Differenced	Level	Differenced	Level	Differenced
Egrs	11.12	-6.93***	12.95	-2.495***	7.178	100.98***	12.304	142.747***
Gdppc	-3.98***	-9.067***	-1.02	-3.49***	66.46	96.18***	117.99***	107.87***
Gec a	1.025	-20.46***	3.65	-10.835***	31.34	226.266***	43.14	359.156***
Gec g	1.779	-14.688***	3.592	-7.58***	21.474	165.981***	25.338	226.121***
Gec n	-3.56***	-7.418***	-0.78	-4.744***	38.782	84.051***	66.424***	178.853***
Gec p	-0.729	-15.059***	2.886	-7.648***	29.802	172.51***	32.188	243.737***
Gec r	-0.288	-14.951***	4.161	-7.581***	29.535	170.325***	54.537	244.763***
Gec s	-3.13***	-17.03***	0.873	-9.1***	50.625	19.752***	63.736	276.284***
Gec w	-1.305*	-9.639***	2.254	-4.347***	37.565	110.863***	42.588	178.677***
Ed	-1.541*	-18.785***	2.021	-10.910***	35.163	226.376***	66.946	355.114***
Ei	-3.57***	-14.254***	1.816	-6.972***	39.532	159.11***	66.756	242.913***
Epy	-1.266	-14.399***	3.299	-7.608***	32.732	169.646***	36.798	256.776***
Ppre	0.636	-15.141***	4.97	-7.691***	22.551	172.056***	38.929	253.275***
Pec	1.277	-20.691***	3.241	-11.892***	38.431	242.894***	48.411	352.796***
Rpy	-1.998**	-13.542***	1.905	-6.913***	36.884	157.994***	46.796	213.458***
Shrec	3.497	-11.015***	7.722	-5.493***	7.867	139.173***	12.284	193.040***
Shrft	0.414	-10.758***	3.356	-5.228***	35.491	131.696***	53.293	165.121***

Notes: Lag length determined upon the modified Hannan-Quinn Criteria. Probabilities for the LLC and IPS tests are computed assuming asymptotic normality. Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All tests equations include individual constant term („fixed effects"). *Differenced* refers to series resulted from first-difference.

***, **, * indicates the significance at 1, 5, and 10% levels (one tailed test).

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As we have already mentioned before, the extant literature and the statistical measurements (such as energy intensity) exhibit a bias for linking the GDP with the energy consumption. Despite these approaches, the results for the considered countries and in the outlined period express a decoupling of the two indicators.

These results suggest that variables *eint, gtec_r, gtec_p, edep, pec, ppre, rpty, epty egrs, shrec*, may be found in a cointegration relationship. As a consequence, we used the Pedroni tests, adapted to the specific Eviews software package, which supports at most seven cointegrated series: as a result, the series were split up into three subgroups, in order to be suitable to run a Pedroni test, as follows: the first subgroup, containing the series: *egrs, gec_p, gec_r, edep, eint, epty, ppre;* the second subgroup, consisting of the series *pec, rpty, shrec, edep, eint, ppre, gec_r*; and the third made up of the series: *pec, rpty, shrec, egrs, gec_p, gec_r*, and *epty*. This *triangular* approach was intended to ensure a double check for all the considered series. The results of Pedroni cointegration tests are presented in Table 6.

Analyzing Table 6, one may observe mixed results giving varying conclusions, but in the majority of cases the null hypothesis of no cointegration is rejected. Even when considering Pedroni's suggestion, according to which in cases like *rho* and *pp* tests there is a bias to under-reject the null in the case of small samples (see the previous paragraph), it is possible to observe that, in all considered cases for the *rho* test the null is rejected, whilst, for the *pp* test the results are opposed. Moreover, taking into account the result of the Kao test, as well as the results of the pairwise Granger causality tests, we consider the inclusion of the ECT in the VECM.

Table 5. The significant results of the pairwise Granger causality tests.

Variables	Egrs	Gdp	Gec a	Gec g	Gec n	Gec p	Gec r	Gec s	Gec w	Edep	Eint	Epty	Ppre	Pec	Rpty	Shrec	Shrft
Egrs	-						15.9***				3.2**	3.19**	14.67***				
Gdppc		-									4.32**	11.3***					
Gec a			-								4.79***	5.5***	28.4***	4.23**	4.28**		2.43†
Gec g				-	4.66**		28.0***	12.88***				2.53*	23.4***	8.43***	4.54**		
Gec n				7.29***	-	6.02***	7.63***		11.48***				7.42***	5.14***			
Gec p				8.64***	16.81***	-	32.97***		15.79***			2.74*	27.28***		5.87***		
Gec r	5.9***				2.56*		-			4.57**			3.26**				9.63***
Gec s	2.41†			6.30***	13.37***	10.23***	19.12***	-	8.60***		3.16**		18.62***	5.11***			
Gec w					14.52***	12.06***	10.70***		-				15.24***				
Edep	14.6***					3.41**	7.46***			-		16.98***	7.04***		4.38**		3.66**
Eint	5.57***										-						
Epty	13.19***						6.35***			2.36*		-	5.64***				
Ppre	4.54**				3.05**		4.63**			3.99**			-				9.77***
Pec	3.15**			13.9***	10.85***	12.15***	33.22***	6.54***	4.03**		4.46**	5.03***	27.85***	-	3.99**		
Rpty		3.57**				2.86*								2.57*	-		
Shrec							19.33***					8.27***	17.86***		2.85†	-	
Shrft				3.11**			5.29***				9.50***		4.51**				-

Notes: In the first columns, the explanatory variable in the cointegrating relation; the headings, the dependent variable.

***, **, † Indicates rejection of the null hypothesis of no cointegration at the at the 1, 5, and 10% levels of significance.

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Table 6. Results of Pedroni and Kao panel cointegration tests.

Test statistic	Subgroup 1		Subgroup 2		Subgroup 3	
	Statistic	Weighted-stat	Statistic	Weighted-stat	Statistic	Weighted-stat
Panel *v*-Statistic	-2.757	-3.931	-2.399	-4.280	-3.816	-4.502
Panel *rho*-Statistic	6.497	6.567	5.236	6.117	5.961	5.918
Panel *PP*-Statistic	-5.359***	-8.146***	-9.536***	-13.299***	-16.460***	-19.828***
Panel *ADF*-Statistic	-1.759**	-2.686***	-5.987***	-4.876***	-6.288***	-7.065***
Group *rho*-Statistic	9.076	-	8.223	-	8.091	-
Group *PP*-Statistic	-16.115***	-	-18.679***	-	-27.281***	-
Group *ADF*-Statistic	-2.377***	-	-6.632***	-	-9.520***	-
Kao test	*ADF t*-Stat		-4.082***	ρ = -0.304 (-6.812)***		

Notes: Lag length determined upon the modified Schwartz Info Criterion. All tests equations include individual constant term ("fixed effects"). For the coefficient ρ afferent to the Kao test *t-Stat* value in parenthesis.

***, **, * indicates the rejection of the null hypothesis of no cointegration at the 1, 5, and 10% levels of significance (one-tailed test).

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Table 7 presents the results from the GMM estimation of the VECM using the Arellano-Bover approach.

The significant results in the estimated ECT highlight various situations of the considered variables, as follows: values generally tending towards zero, which indicates that the long-term adjustment process is slow, as in the case of variables *edep*, *egrs*, *shrec*, and *epty*; in cases of *primary energy consumption* and *resource productivity* one can observed that the system has the tendency to overcome an important part of the disequilibrium in each period; in addition, there is a tendency to over-shoot the long-term equilibrium, namely in cases of *gross inland energy consumption*, for both considered types, petroleum and renewable energy; on the other hand, the positive values indicate the variables whose evolution disturbs the system from the long-run equilibrium, such as the *primary production of renewable energy* and, with a lower impact, the *energy generated from renewable sources*.

Table 7. Estimation of ECT in the Vector Error-Correction Model.

Variables	ECT coefficients (*t*-statistic)	Speed of adjustment (*t*-statistic)	Lag coefficient (*F*-statistic)
EINT	1.000	0.000162(0.833)	-1.151*
GEC_R	-5.315(-8.235)***	-0.0114(-1.274)	10.042***
GEC_P	-2.659(-20.593)***	0.215(17.964)***	29.894***
EDEP	-0.0056 (-2.721)***	0.67(3.688)**	5.275***
PEC	-0.596(-11.607)***	0.412 (15.948)***	41.810***
PPRE	2.988 (4.835)***	-0.0072 (-0.766)	9.704***
RPTY	-0.655(-2.285)***	-0.0054(-2.752)***	1.649*
EPTY	-0.179(2.176)**	-0.0176(-3.562)***	4.724**
EGRS	0.057(3.311)***	-0.085(-3.673)**	3.322**
SHREC	-0.117(-4.175)***	-0.0439(-2.467)***	0.407

Notes: Lag length: 1, 2.

***, **, * indicates the significance at the 1, 5, and 10% levels of significance.

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Regarding the short-run causal effect, the results indicate important evidence in favor of all the considered variables except for *shrec*, as evidenced by the significance of the lagged explanatory variables. The exception represents the share of renewable energy in total energy consumption, situation that can be explained by the reduced values within the series. As regards the speed of adjustment, the results presented in Table 7 provide evidence in favor of the significance of almost every considered variable within the process, except for *eint*, *gec_r*, and *ppre*. This situation can be explained also by the reduced share of renewable energies in total consumption, in most of the countries under analysis. The speed of adjustment for *gec_p*, *edep*, and *pec* is significantly and positively signaled, whereas they are negatively signaled in cases such as *ppre*, *rpty*, *epty*, *egrs*, and *shrec*.

Conclusions

As the environmental initiatives gain momentum, there can be observed a reverse movement of the developing countries that outrun the leading countries that relied in their development on using the fossil resources and now, due to their policy in favor of the global diminution of emissions, they prevent the developing countries from accessing their own resources and sentence them to perpetual underdevelopment. In this seemingly contradictory evolution, the production and consumption of energy, compliant with environmental requirements, represent the only viable key in order to ensure the sustainable development of society and economy. However, the issue does not regard only the countries mainly characterized by traditional societies.

The paper demonstrates that the increasing trends for energy demands in contemporary economies are obvious and it is necessary to improve both the energy paradigm and the measurements in order to optimize the efficiency. Most researches [46–50] in the field underline the relationship between the economic growth and energy as a positive factor correlated with sustainable development. We contend now that some change is necessary in the energy production and consumption paradigm, both at the European Union level and inland level, in order to achieve economic performance and become more environmentally friendly. It was argued that the factors that disturb the equilibrium of the system in the long run are the primary production of renewable energy and, with a lower magnitude, the energy generated by renewable sources.

The findings of this study should be considered in the light of its limitations, for instance the fact that our panel consists of only 29 cross-sections, represented by the European Union member countries at this moment, and Norway. We contend that it will be easier to start a debate regarding the role of energy paradigm changes on economic growth while there is a capacity to understand the evolution of technological gains and innovation promotion in society. Finally, future research could address the uniqueness of each complementary aspect of energy economics by interpolating more variables into an extended analysis and comparing the results with previous research studies.

Author Contributions

Conceptualization: JVA MM MP.

Data curation: JVA MP.

Formal analysis: JVA MM MP.

Funding acquisition: MP.

Investigation: MM JVA.

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Article

The Impact and Determinants of Environmental Taxation on Economic Growth Communities in Romania

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Abstract: Environmental taxation represents a key influence on sustainable development in post-transition countries. Romania has experienced important transformations of environmental policy, including taxation, due to sustained reliance on traditional energy sources to satisfy its energy needs. The aim of this paper is to show a possible causal relationship between the Romanian GDP and several explanatory variables related to taxation of environmental damage and energy generation and consumption in the country. In order to do this, the authors make use of several statistical tests to verify the existence of a meaningful relationship between economic variables expressed in time series. The study has also attempted to identify the influence of environmental taxation on ensuring green economic development, starting from the premise that for emergent economies these taxes provide both a GDP increase and prevent environmental degradation by decreasing the pollution and environmentally harmful supplies and practices.

Keywords: energy; renewables; environment; taxation; development; emergent economy; economic growth

1. Introduction

In modern economies, the energy represents a key factor in ensuring of the sustainable development for the whole society. As there has been proven over time, modern economies are largely dependent on energy, which significantly contributes to the development of the current life standard, revolutionizing the transportation, communications, and industry, creating premises for raised productivity levels. For the countries in the European Union, the energy taxation and fiscal policy for energy represent key components in reducing pollution and in applying of the Kyoto Protocol requirements [1–3].

On the other hand, the tax burden on energy production and consumption involves additional costs, both for business and households, which are already struggling with high levels of taxation. The competitiveness of the industrial sector and of the entire economy is directly and significantly affected by energy taxation. Taking into account that the energy represents a heterogenous commodity, the associated fiscal policy has to reflect this diversification, both through considered quotas and the specific application forms. Therefore, the European fiscal policy in the field has been designed with the aim of functionality, in order to contribute to the efficient use of available energy resources, helping to settle potential issues in supply, preventing wastage and unsustainable consumption of resources.

Generally, an inadequate tax policy in the field of energy may lead to a distorted or even uncompetitive allocation of resources in the economy, which would result in an unnecessary increase of the production prices, implying decrease in national production, depressing competitiveness and the investments. In the literature, energy tax policies are severely criticized as being strongly distributive [4–6]. The tax burden on fuels production and consumption affect the consumers' standard of living in different manners; the major drawback of this policy approach is that the most affected are people and households with low levels of income.

On the other hand, in the lliterature [7–12], is a widely emphasized that the taxation represents an essential stimulus towards the optimal use of resources (including the energy ones), concomitant with reduction in greenhouse gas emissions. As a result, numerous studies [13–18] tried to evaluate the link between the energy taxation on the one hand, and economic growth, or occupation, on the other hand.

In this context, some researches revealed that use of some green tax has a direct impact on reduction in emissions and in increasing of the general economic output concomitant with reducing of the income gap between different social categories, and granting social welfare [19]. Further on, researches in the field proved that the relationship between capital investments and energy tax rates is not significant [19]. Other studies tried to develop new methodological approaches in order to evaluate the financial effects of environmental taxation [20,21].

The influence of fiscal policy towards the evolution of the national economy, production and consumption structures, investments and the promotion of environmental-friendly and energy-efficient technologies are common topics in current scientific debate. Thus, since 1920, the literature has expressed a wide range of opinions: some authors have argued for taxation of pollution and internalization of the associated costs, resulting of a Pegouvian tax [22]; in other views, the energy consumption has to be treated as a contributive factor in increasing pollution. Other studies proved that fuel taxation is highly progressive in contemporary economies, as in the cases of the United States or Austria [23]. In this field exists a plethora of approaches: some consider only the gasoline consumption and the associated fees [24]; other argue that in the US's case the economy faces an opposite phenomenon, at least in households with high incomes [6]; not least, some researches try to evaluate the variation in taxation across countries and the subsequent consequences, based on data provided by the Statistical Office of the European Union (Eurostat) [24,25].

If the altering of industrial competitiveness represents a certain short-run effect of environmental taxation, in the long run, the diversity of the promoted environment policies have proved different but significant effects on the structure of the national economy, helping to reduce carbon emissions, carbon intensity and energy consumption [26–28]. In the literature [10], it is also claimed that the taxation of energy consumption and associated fees can be aimed both towards internalizing of the costs associated to the greenhouse emissions, and reducing of these emissions [10].

In this context, the main objective of this paper is the analysis of the impact and determinants of environmental taxation on economic growth communities in Romania by analyzing the effects of this policy on the national economic paradigms.

2. Materials and Methods

The main research feature of this article is the use of Granger causality tests [29], trying to evaluate the causal relationship between environmental taxes and various measures of energy production and consumption in Romania, on the one hand, and economic growth, on the other hand. to the author's best knowledge, this represents the first attempt in using of the Granger causality tests in studying of the causal relationship between environmental taxes and various measures of energy production and consumption in Romania.

In studying the direction of causal relations between a set of variables, Granger causality tests have been extensively employed with positive outcomes. As has been proven in the literature [28–30], if there is co-integration in a pair of series that are integrated of order one, $I(1)$, there must be causation in at least one direction. Starting from this assumption, this appears to be a result of the presence of cointegration, implying that an error correction model can be formed, of which the error correction term has a significant effect on the dependent variable. Moreover, in the literature it has been proven that the inter-linkages between the energy sector and the economic performance are dependent to a great extent on the development level and economic structure of the considered countries [30–35].

As a reflection of its importance for the European Union objectives, the environmental taxation represents a well-defined and independent policy domain. According to the Maastricht Treaty (1992) the regulations in this field are adopted by the European Commission and not by the member states. To carry out the present research objectives, the environmental taxation approach has been employed consistent with the Eurostat definition, applied at the EU-28 level, including Romania. According to the official statistics definition [36] and to the specific literature approaches [37–39] an environmental tax is considered to be any type of tax which covers an impaired perception of the environment, whose application is intended to limit or reduce a harmful effect.

Following the Eurostat framework, the considered datasets are represented by environmental tax revenues calculated as a proportion of GDP (Table 1). The environmental tax revenues consist of various taxes, such as taxes on transportation and energy products, vehicle excise duty, the value-added tax applied to petroleum, and the air passenger duty. The taxes refer to both one-off and recurrent taxes, such as sales of equipment and road tax, respectively. In the first stage, the European countries designed the fuel taxes on energy and transportation as energy measurements (to decrease dependence on petroleum imports); at present, they serve environmental purposes [40]. According to the latest available dataset, in Romania, the energy tax accounts for 1.8% of GDP and 5.8% of total taxation [41]. Table 1 presents the descriptions of the variables used for carrying out the research in the current paper.

The results cover Romania, and the data are imported from the Eurostat database, consisting of the environmental taxes as a percentage of total GDP and as total tax revenue. The real GDP is expressed per capita. The explanatory variables of the research include, as in [30], the primary production of renewable energy (*Ppre*), domestic material consumption (*DMC*), final energy consumption of petroleum (*Fecp*), and total gross electricity generation (*Tgeg*) (all expressed per capita). Primary production of renewable energy is employed as a proxy for environmental subsidies, in tons of oil equivalent, as there are not sufficient and representative data on environmental subsidies for analysis. Table 1 includes the description of the variables used in the study. The series of data used has a length of 12 years, and it runs from 2000 to 2011, starting in 2000 as these are the earliest data available in the Eurostat database for all the complete variable datasets, and the summary statistics are presented in Table 2.

Table 1. Description of variables. Source: authors' own selection based on EUROSTAT database [41].

Variable	Description
Y	Real GDP per capita
Taxy	Total environment taxes to GDP (%)
Taxye	Environmental taxes as % of GDP—Energy
Taxt	Environmental taxes as % of Total Taxation—Energy
I_taxe	Implicit tax rates—Energy
Taxypr	Environmental taxes as % of GDP—Pollution resources
Ppre	Primary production of renewable energy per capita
DMC	Domestic material consumption per capita
Fecp	Final energy consumption of petroleum per capita
Tgeg	Total gross electricity generation per capita

Table 2. Data summary statistics based on the raw data.

Statistics	*Y*	*Taxy*	*I_taxe*	*Taxye*	*Taxt*	*Taxypr*	*Ppre*	*Tgeg*	*DMC*	*Fecp*
Mean	3859.189	2.186136	52.69121	1.900517	6.746930	0.128970	0.214043	2.652599	16.91417	0.163907
Median	3900.000	2.034668	52.40125	1.766802	6.389863	0.103556	0.218385	2.691645	16.37000	0.164637
Maximum	4800.000	3.430490	68.75033	3.224650	10.67382	0.361268	0.262924	2.895884	26.83000	0.200175
Minimum	2760.667	1.779444	35.22194	1.408918	5.025840	0.006326	0.150526	2.367942	7.700000	0.125214
Std. Dev.	716.1577	0.439889	10.90903	0.458582	1.439085	0.132298	0.034606	0.183337	5.354503	0.023938
Skewness	−0.212915	2.001134	−0.166889	2.132977	1.750853	0.692123	−0.515793	−0.311396	0.132096	−0.021466
Kurtosis	1.571094	6.489732	1.988086	7.061617	5.782362	2.032511	2.189466	1.696055	2.337197	1.764997
Jarque-Bera	1.111551	14.09819	0.567689	17.34755	10.00174	1.426087	0.860567	1.044071	0.254552	0.763538
Probability	0.573627	0.000868	0.752884	0.000171	0.006732	0.490150	0.650325	0.593312	0.880491	0.682653
Sum	46310.27	26.23363	632.2945	22.80621	80.96316	1.547637	2.568521	31.83118	202.9700	1.966886
Sum Sq. Dev.	5641700.	2.128526	1309.076	2.313276	22.78064	0.192531	0.013173	0.369739	315.3777	0.006303
Observations	12	12	12	12	12	12	12	12	12	12

3. Research Methodology

In this paper, the research methodology is designed based on Granger non-causality, starting from previous research studies [30,42–45]. Despite some technical differences, as remarked in some studies, the general approach of the Granger non-causality tests, either using time series or panel data, involves the application of cointegration techniques with the subsequent error correction model used to test short- and long-run causality [16,29,30,38,44,45].

Also, the concept of Granger non-causality usually incorporates a number of related aspects such as cointegration, stability and controllability [2,10,11,14,20]. In applying the designed methodology, the first step routinely involves testing for a panel unit root using the Im Pesaran and Shin (IPS) test, as has been used in some previous researches [1,30,33,46]. If the variables are found to be $I\,(1)$, it is then necessary to test for cointegration, in this case the Granger test is employed. Applying the following research model:

$$y_t = \alpha_0 + \alpha_1 x_t + \varepsilon_t \tag{1}$$

where y_t is GDP (expressed in logarithms), α_0, α_1 are parameters to be estimated in the study and x_t is the exogenous variable considered (also if the causality testing runs in the opposite direction, x_t would be considered the dependent variable).

In this case it is required further more to pre-test each variable considered in the model in order to show and determine the order of integration for each variable and highlight the best influence. By definition, any cointegration imposes the mandatory requirement that both variables of the same order be integrated. The common method employed for these cases is done using the Augmented Dickey-Fuller (ADF) unit root test in order to infer the number of unit roots (if any) in each of the variables under investigation [30,45]. The testing procedure for the ADF unit root test is used and applied to one of the following models [47]:

$$\Delta y_t = \gamma^* y_{t-1} + \sum_{j=1}^{p} \varphi_j y_{t-j} + \varepsilon_t \tag{2}$$

$$\Delta y_t = \alpha + \gamma^* y_{t-1} + \sum_{j=1}^{p} \varphi_j y_{t-j} + \varepsilon_t \tag{3}$$

$$\Delta y_t = \alpha + \beta t + \gamma^* y_{t-1} + \sum_{j=1}^{p} \varphi_j y_{t-j} + \varepsilon_t \tag{4}$$

The two hypotheses of the test are according to literature definitions, as following [14]: H_0: $\gamma^* = 0 \Leftrightarrow$ series is non-stationary and has a unit root; H_1: $\gamma^* < 0 \Leftrightarrow$ series is stationary and has no unit root. α is a constant; β is the coefficient on a time trend series; γ^* the coefficient of y_{t-1}; p is the lag order of the autoregressive process; $\Delta y_t = y_t - y_{t-1}$ are first differences of y_t; y_{t-1} are lagged values of order one of y_t; Δy_t are changes in lagged values; and ε_{it} is the white noise.

For the last specification, the test is done under the joint hypothesis $\beta = \gamma^* = 0$.

Once the hypothesis of the unit root test is rejected, the long-run equilibrium relationship is estimated in the form of an Ordinary Least Squares (OLS) regression line. If the variables cointegrate, the OLS regression equation yields a "super-consistent" estimator [47]. This means that there is a strong linear relationship between the variables under study. The strong linear relationship can be tested in either of the following ways [30]:

(a) The coefficient of x_t yields a value that falls between 0.5 and 1.
(b) The plot of y_t against x_t shows coordinates appearing in an increasing or decreasing direction. The next step is to estimate the error correction model (ECM) of the dynamic structure, starting from equation:

$$y_t = \alpha_0 + \gamma_0 x_t + \gamma_1 x_{t-1} + \alpha_1 y_{t-1} + \varepsilon_t \tag{5}$$

taking some algebraic manipulation as [30,47] results:

$$\Delta y_t = \gamma_0 \Delta x_t - (1-\alpha_1)\left[y_{t-1} - \frac{\alpha_0}{(1-\alpha_1)} - \frac{(\gamma_0+\gamma_1)}{(1-\alpha_1)} x_{t-1}\right] + \varepsilon_t \tag{6}$$

$$\text{Taking } \beta_0 = \frac{\alpha_0}{(1-\alpha_1)} \text{ and } \beta_1 = \frac{(\gamma_0+\gamma_1)}{(1-\alpha_1)} \tag{7}$$

the equation becomes

$$\Delta y_t = \gamma_0 \Delta x_t - (1-\alpha_1)\left(y_{t-1} - \beta_0 - \beta_1 x_{t-1}\right) + \varepsilon_t \tag{8}$$

which is the ECM with $-(1-\alpha_1)$ as the speed of adjustment, and $\varepsilon_{t-1} = y_{t-1} - \beta_0 - \beta_1 x_{t-1}$ as the error-correction mechanism which measures the distance of the system from equilibrium. The coefficient of ε_{t-1} should be negative in sign in order for the system to converge to equilibrium. The size of the coefficient $-(1-\alpha_1)$ is an indication of the speed of adjustment towards equilibrium in that [48]:

- small values of $-(1-\alpha_1)$, tending to -1, indicate that economic agents remove a large percentage of disequilibrium in each period;
- larger values, tending toward 0, indicate that adjustment is slow;
- extremely small values, less than -2, indicate an overshooting of economic equilibrium;
- positive values would imply that the system diverges from the long-run equilibrium path.

Testing for cointegration is achieved using the Kao test [30,48] based on a version of the ADF test on the residual (ε_t) of Equation (1):

$$\varepsilon_t = \rho \varepsilon_{t-1} + \sum_{j=1}^{p} \lambda_j \Delta \varepsilon_{t-j} + \nu_t \tag{9}$$

This is further used to develop the following form of the ADF statistic as it is shown by the line described by Equation (3), which is a one tailed test and where $\hat{\sigma}_v^2$ is the estimated variance and $\hat{\sigma}_{0v}^2$ is the estimated long-run variance of the error term and follows the parameters of the standard normal distribution [14,30]. Also, the τ_{ADF} is the ADF statistic designed in Equation (8) [30]:

$$ADF = \frac{\tau_{ADF} + \sqrt{6N}\hat{\sigma}_v / \left(2\hat{\sigma}_{0v}\right)}{\sqrt{\hat{\sigma}_{0v}^2 / \left(\hat{\sigma}_v^2\right) + 3\hat{\sigma}_v^2 / \left(10\hat{\sigma}_{0v}^2\right)}} \tag{10}$$

The final research is conducted using the OLS method and employing the following empirical model:

$$
\begin{aligned}
y_t = \quad & \beta_0 + \beta_1 Taxy + \beta_2 Taxye + \beta_3 Taxt + \beta_4 \Delta I\_taxe + \beta_5 Taxypr \\
& + \beta_6 Ppre + \beta_7 DMC + \beta_8 Fecp + \beta_9 Tgeg + \varepsilon_t
\end{aligned} \quad (11)
$$

where y_t is the logarithm of the real per capita GDP; as series $Taxy$, $Taxye$, $Taxt$ and $Taxypr$ are stationary (see IPS unit root test—Table 4), they are used as such; the other series have been stationarized as follows: ΔI_taxe is the first-order difference of the I_taxe; and for the series $Ppre$, DMC, $Fecp$, and $Tgeg$ the annual percentage changes were considered.

4. Results and Discussion

In order to evidence the causal relationship between the Romanian GDP and several explanatory variables related to taxation of environmental damage and energy generation and consumption in Romania, some statistical tests were carried out for the data employed in the study. The results for the IPS panel unit root tests are presented in Table 3 and show that, except for environmental taxes on GDP, environmental taxes as % of GDP (energy) and environmental taxes as % of total taxation (energy and pollution resources), the variables contain a unit root, suggesting the need to differentiate these variables before testing for non-causality.

Table 3. IPS unit root tests.

Variable	Level	Differenced
Y	−1.2833	−2.6897
Taxy	−5.8591 ***	−5.3437 ***
Taxi	−1.1290	−5.0960 ***
Taxye	−6.4893 ***	−4.0979 **
Taxt	−5.0750 ***	−3.9825 **
Taxypr	−2.7870 *	−5.7531 ***
Ppre	−1.8994	−3.8708 **
Tgeg	−1.7476	−4.2807 **
DMC	−1.6525	−3.4231 **
Fecp	−1.0655	−3.2733 **

Notes: Lag length is determined by the modified Akaike Information Criteria. *, **, *** indicates the significance at 1%, 5%, 10% levels (one tailed test).

The cointegration tests for the considered dataset are contained in Table 4. It was tested for cointegration in both directions, with both variables acting as the dependent variable.

The Kao test for cointegration results shows evidence of a stable long-run cointegrating relationship when the taxes are the dependent variable and they are considered as a proportion of GDP. However, there is evidence of a stable long-run relationship between GDP, as the dependent variable, and total gross electricity generation, consistent with other researches [30,38].

Based on the results obtained during the research, it can be remarked that, despite some evidence of a stable long-run relationship when the taxes are the dependent variable of the model, there is no evidence showing when GDP becomes the dependent variable. So, using the Granger method, where there is evidence of cointegration, the error correction term will be included in the non-causality tests, but excluded where there is no evidence [49–51].

Table 4. Tests for cointegration.

Test Statistic	X→Y	Y→X
Y/Taxy	0.24691	5.33313 **
Y/Taxi	0.53319	5.26506 **
Y/Taxye	0.19499	5.36005 **
Y/Taxt	0.05136	4.50340 **
Y/Taxypr	1.65858	0.20420
Y/Ppre	0.07900	6.24810 **
Y/Tgeg	9.83934 **	0.08716
Y/DMC	4.27421	6.23856 **
Y/Fecp	2.67204	4.82740 **

Notes: In the first and second columns, the dependent variable in the cointegrating relation is first followed by the explanatory variable. ** Indicates rejection of the null hypothesis of no cointegration at the 5% level of significance.

Table 5 contains the results from the ECM estimation. These results are, in the long-run, despite the significance of estimated coefficients, outstanding and statistically relevant—in fact, overshooting influences tending to equilibrium from economic growth to primary production of renewable energy and final energy consumption of petroleum. Conversely, regarding the long-term causal effect from these variables on economic growth despite significance, the negative values of the coefficients, far less than above [52–56], indicate their reduced influence towards the economic growth. In case of the remaining variables, the long-term causal results show their divergence in both directions with economic growth. This is consistent with other previous studies in the field where either little or ambiguous evidence was discovered of the energy taxes' influence on economic growth [10,11,33,34].

Table 5. Granger causality tests.

Causality Direction	ECT (*t*-Statistic)	Speed of Adjustment (*t*-Statistic)	Lag Coefficient (*t*-Statistic)	*F*-Statistic
Y→Itaxe	0.0153 (13.622) **	−0.012 (−0.326)	0.001 (0.315)	0.392
Itaxe→Y	6.539 (7.036) **	−0.970 (−9.928) **	−89.444 (−6.216) **	38.622 **
Y→Ppre	−45.57 (−16.665) **	0.342 (0.798)	−0.0787 (−0.047)	0.813
Ppre→Y	−0.0219 (−17.038) **	−0.889 (−7.887) **	0.226 (4.837) **	55.229 **
Y→Tgeg	0.686 (0.736)	−0.107 (−0.965)	0.339 (1.690)	1.542
Tgeg→Y	1.457 (3.280) **	−0.109 (−0.494)	7.184 (3.626) **	11.260 **
Y→DMC	0.100 (3.52) **	−2.207 (−3.623) **	0.006 (1.087)	5.830 **
DMC→Y	9.966 (4.271) **	−0120 (−0.317)	−105.237 (−2.63) **	5.017 **
Y→Fecp	−35.356 (−15.913) **	0.560 (0.647)	1.157 (0.465)	2.712
Fecp→Y	−0.028 (−18.769) **	1.356 (7.197) **	0.673 (10.264) **	39.697 **

** Indicates that *t* it is significantly different to 0 at the 5% level of significance.

Nevertheless, the short-run causality results indicate convergence and significant results from implicit tax rates regarding energy and primary production of renewable energy and effects economic growth, the speed of adjustment being from 88% to 97% of adjustment back to the long-run in a year. Also, the results offer evidence of overshooting short-term equilibrium from economic growth to domestic material consumption.

As in other studies [11,30] evidence supports Granger causality from renewable energy, proxying environmental subsidies to economic growth, although it is negatively signed, suggesting that expenditure on environmental protection as yet has not produced the technological spillovers and subsequent increase in growth. Finally, taking into account the IPS test results, the results yielded from OLS regression for the considered model are presented in Table 6.

Table 6. OLS regression results (ordinary least square).

Variable	Coefficient
Constant	8.256 (1557.8) ***
Taxy	0.345 (65.7) ***
Taxye	−0.479 (−49.7) ***
Taxt	0.052 (19.8) **
Taxypr	−1.301 (−394.1) ***
Ppre	0.001 (18.4) **
DMC	−0.001 (−57.2) ***
Fecp	0.001 (33.5) ***
Tgeg	−0.001 (−130.2) ***
F-statistic	97777.14 ***

Note: the values in round brackets are the *t*-statistics. **, *** indicate the coefficients which are statistically significant at 5%, and 10%, respectively. F-statistics are reported to test for the joint significance of the coefficients.

Despite the difficulties induced by the model specification in direct interpretation of the results (Table 6), they indicate that all the considered variables exert significant influence on economic growth, direct correlated with total environment taxes to GDP, environmental taxes as % of total taxation—energy, primary production of renewable energy, and final energy consumption of petroleum. Nevertheless the results indicate a negative relation between the economic growth and environmental taxes as % of GDP—energy, environmental taxes as % of GDP—pollution resources, domestic material consumption and total gross electricity generation [30].

5. Research Limits and Future Directions for Research

From the methodological point of view, the most important limitation is represented by the relative shortness of the time series used, as these data for Romania are collected beginning in 2000. Through this paper, the authors tried to evaluate the evolutions in the field under research in an emergent economy-specific context. On the other hand, we did not take into account the assessment of possible effects of energy tax policy on greenhouse emissions and to what extent these measures can contribute to the internalization of these issues, which will be researched in future studies.

6. Conclusions

The results obtained during this research provide solid ground for the long-run causal effect on GDP due to the variables considered and used to demonstrate the influence on achieving the sustainable development criteria in an emergent economy, as in the case of Romania. The pertinent design of the environmental taxation system represents one of the determinant objectives for inland policymakers, taking into consideration that during the analyzed period the importance of environmental revenues has increased both as gross values and share of GDP [57]. Also, for an emergent economy, it is important for policy makers to discover the relationship between GDP and environmental taxation's influence in assuring welfare, because these final results in research can certainly help in proper design and imposition of energy policy. This paper has clearly communicated from the very beginning that this objective may represent an important output for policymakers.

The policy implications of this study are transversely connected. Environmental taxation is just a lever for assuring environmental protection and sustainable development. Environmental taxation has a quite decisive influence on the economy by influencing the consumption patterns, despite the fact that there is no direct connection between living standard, environmental protection, and degree of green freedom. For emergent economies, environmental taxation may represent a path to achieving sustainable development and a high degree of green revenues by taxing pollutants and promoting environmental friendly practices and technologies.

In order to ensure the effectiveness of the energy tax policy, a dual application both in the short and long term may represent a suitable solution. As in the short term, a paradigm shift in the use of energy resources is impossible, the classic fiscal measures imposed must envisage the taxation of energy overconsumption and of heavily polluting energy products [58]. This design of energy taxation is aimed specifically at reduction and partial replacement of the latter products with renewable energy products [56,59]; in the long-run, the fiscal measures should favor investments in the promotion of new energy efficient technologies.

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RESEARCH ARTICLE

Modelling Discrete Choice Variables in Assessment of Teaching Staff Work Satisfaction

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Abstract

Levels of self-reported job satisfaction and motivation were measured by survey in a sample of 286 teachers. Using the discrete choice framework, the paper tries to assess the relevance of the considered indicators (demographic, social, motivational) in overall teaching work satisfaction. The findings provide evidence that job satisfaction is correlated significantly with level of university degree held by the teacher, type of secondary school where the teacher is enrolled, revenues, and salary-tasks adequacy. This is important for the Romanian economy, since the education system is expected to provide future human resources with enhanced skills and abilities.

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Introduction

The educational system is a crucial link in transmitting the acquired knowledge between the past and future generations. It is largely considered that the current state of education influences dramatically the long-run (about 20 years) status of national community. Teaching staff motivation is one of the determinants of the educational system, affecting to some extent the behaviour of the actors involved in the educational process.

First, the teaching staff motivation is about motivating potential teachers. Due to the shortage of teaching staff, there are three aspects that concern the specialists: i) too few people entering the specialty studies for a teaching career; ii) too many beginner teachers who leave the educational system; and, iii) too many specialized graduates who does not want to practice. In the literature, there were identified three driving forces that influence behaviour of potential teachers: internal forces (or intrinsic personality related to teaching), external forces (environmental or extrinsic), and altruistic forces (internalized extrinsic) [1]. Based on these forces, the intrinsic motivation of potential teachers is influenced by: the reasons for which they prefer a teaching career; the probability of finding a job after graduation; the individual expectations and goals; and by the appetence of continuing their education through a master's program [2]. Regarding the motivational aspects, other researchers consider that intrinsic motivation is prevalent in choosing a teaching career. Therefore, the prospective teachers having a stronger intrinsic motivation are expected to have a longer practice in the field and with better results [3]. Other authors try to list the factors that influence the motivation of prospective teachers. Among the most mentioned factors in this respect, are: the positive opinion regarding own teaching skills and abilities, pleasure of working with students and intellectual stimulation implied by the profession [4]; the subject expected to be taught, which would give the opportunity to capitalize the expertise [5]; or cultural background of aspirant teachers [6]. Studying the situation of specialized graduates who does not want to practice, some authors argue that certain experiences during their studies lead the young people to ignore the option for a career in education. In contradistinction to this approach, other papers study the motivation of people to leave their current job to become teachers [7].

From the point of view of the current situation in education, the most urgent problem is motivating teaching staff in service. There are extensively researches that appraise the applicability of motivational theories in the educational system [8–14]. Newer researchers argue that teachers are a category of employees of whose work motivation and performance are influenced by a multitude of motivating and demotivating factors. According to these studies, the factors involved in teaching staff motivation are established upon the principle of *thesis-and-antithesis*, and their importance varies among different persons [13, 15–21]. Other researchers turned their attention to the relationship between motivation, job satisfaction, and teachers' performance. The results of these studies show that job satisfaction and motivation of teachers are significantly correlated with the level of responsibility, gender, subject taught, age, seniority, and the type of activity [22–24]. The analysis of the similarities and discrepancies between the teachers who work at different stages of education (primary, secondary and academia)—in terms of job satisfaction and motivation to remain in the education system—emphasize the increased importance granted by teachers to professional and interpersonal factors to the detriment of practical ones [25]. There are some researches that examine the correlation between developments in salaries of university graduates and teachers. A model developed in this respect outlines that, as salaries of graduates increase (phenomenon known as "rising talent premium"), the competent authorities shall adjust the salaries of teachers and quality standards [26]. However, often this does not occur, which determines many graduates and teachers in service to opt for the business sector, which offers better financial rewards. At the same time, the analysis of performance-based payment system in education shows that this type of payment has led to improvements in the results of schools, students, and teachers [27]. Nevertheless, in trying to solve these problems, teachers' motivation should not be affected, realizing that the way the teachers are treated today determines the future of the educational system.

Important lessons can be learned form researches focused on motivation factors that lead teachers to leave the educational system [19]. Thus, the most mentioned reason of resignations is the unrealistic expectations of future teachers—as their expectations do not match the actual teaching activity. As other papers point out, the human resources policies in education have to be accompanied by the full transparency and advice of future teachers on the educational system realities, in order to develop personal goals consistent with the specific of profession and outline realistic expectations [28].

Materials and Methods

Ethic statement

The research was approved by the scientific board of the Faculty of Economics—Valahia University.

Study methodology

The underlying idea of the model is that motivation is one of the main factors of influence upon job satisfaction. Consider a teacher *i* and, taking into account the literature above presented, assume the following motivation factors that determines work satisfaction (*WS*) reported by the interviewee: *AGE* = teacher age (in years); *DEG* = the professional degree the teacher holds; *EDU* = education (university) degree of the teacher; *LYC* = type of secondary school where respondent teacher works; *SRTY* = total work history (in years); *TEACH* = amount of experience in education (in years); *SAL* = satisfaction reported by the interviewee from the salary point of view; *FAIR* = satisfaction reported by the teacher about the salary adequacy with regard to efforts for tasks' accomplishment; *PREM* = satisfaction reported by the interviewee regarding the revenues received as premium.

The importance of demographic factors in work satisfaction is widely emphasized in literature [22–24, 29–30]. As a consequence, in the present paper, two measures for age (age and total work history) and two measures for amount of experience in education (teaching length of service and professional degree) will be used. The two measures for age are correlated, since seniority is expected to increase with the age; in our study, this statement is confirmed by the computations results. Analogue, for teachers enrolled in Romanian education system, is very usual to hold a teaching degree consistent with teaching length of service; also, in case of present study, the field situation is consistent with this assertion. Thus, these measures have to be used alternatively, giving the following forms of the model:

$$WS = f(DEG, EDU, LYC, SRTY, SAL, FAIR, PREM) \tag{1}$$

$$WS_2 = f(AGE, EDU, LYC, TEACH, SAL, FAIR, PREM) \tag{2}$$

In the Eq 1 and Eq 2, the endogenous variable, besides some exogenous variables, are limited dependent variables. The reasons for which the econometric modelling of this type of variables through the OLS regression model is not suitable are largely detailed in the literature [31–34]. The estimation of the model is set on the residual variable distribution function. Therefore, if is considered that the endogenous variable follows the normal distribution, *probit* methods may be employed; considering that the variable is logistic distributed, the *logit* model is the choice; in the same time, the *Weibull* distribution may be useful as well. The *probit* model is based on the normal cumulative distribution function, $\Phi(z) = \int_{-\infty}^{z} \varphi(x)dx$, where $\varphi(z) = e^{-z^2/2}/\sqrt{2\pi}$, whereas the *logit* model is based on the logistic cumulative distribution function $\Lambda(z) = 1/(1 + e^{-z}) = e^{z}/(1 + e^{z})$.

Specifically, in the case of multinomial ordered choices, the values of endogenous variable are subject of modelling through considering a latent (unobserved) variable, $y_i^* = \beta' x_i + \varepsilon_i$, $i = \overline{1,n}$, $\varepsilon_i \sim N(0, 1)$, β is a vector of parameters, not containing an intercept. The introduction of the latent variable within the model relies on the impossibility of its direct observation. In such cases, an individual chooses a certain level of satisfaction if the difference of utility exceeds a certain threshold level, depending on the overall exogenous variables, X_p, $p = \overline{1,k}$ [35].

$$y_i = \begin{cases} 0, & \text{if} \quad y_i^* \leq \delta_0 \\ 1, & \text{if} \quad \delta_0 < y_i^* \leq \delta_1 \\ 2, & \text{if} \quad \delta_1 < y_i^* \leq \delta_2 \\ J, & \text{if} \quad \delta_{J-1} \leq y_i^* \end{cases} \tag{3}$$

The δ-s represent the unknown "threshold"-parameters that are estimated along with β

coefficients, by maximizing the log-likelihood function, which requires that ε-s are assumed to be distributed either as a standard normal (in case of ordered *probit*), either the cumulative density of ε is the logistic function (and the modelling is done through the ordered *logit*).

Results the probability for the unit *i* of the population to belong to one of the considered classes:

$$\Pr(y_i = j|x_i) = \Pr(\varepsilon_i \le \delta_j - \beta' x_i) - \Pr(\varepsilon_i < \delta_{j-1} - \beta' x_i) = \Phi(\delta_j - \beta' x_i) - \Phi(\delta_{j-1} - \beta' x_i), j = \overline{1,J} \quad (4)$$

where $\Phi(z)$ represents the cumulative standard normal density function, $\Pr(A)$ is the probability of the event A, $\sum_{i=1}^{J} \Pr_i = 1$, and (for all the probabilities to be positive) $0 < \delta_1 < \delta_2 < \ldots < \delta_{J-1}$.

In this study, the estimation of the model parameters and of the variance matrix is based on second analytic derivative of the above function, using the optimizing algorithm Goldfeld-Quandt [36]. Specific to this method is that the convergence of a maximum is achieved in the absence of *a priori* knowledge regarding the strictly concavity of the function.

Usually, the marginal effects of the regressors x on the probabilities are not equal to the coefficients. For the probabilities above presented, the marginal effects of changes in the regressors may be described as

$$\frac{\partial \Pr(y = j|x_i)}{\partial x_i} = [\phi(\delta_{j-1} - \beta' x_i) - \phi(\delta_j - \beta' x_i)]\beta, \quad \text{with} \quad \sum \frac{\partial \Pr(y = i|x)}{\partial x} = 0 \quad (5)$$

The validity of the *probit* estimator can be tested after estimation. However, some issues arise when using conventional R^2-type measures. Specific to the discrete choice models is the existence of a variety of measures for goodness-of-fit, extensively described in the literature [31–32, 37]. In this study, in appraisal of the estimations accuracy, were employed two measures: $pseudo{-}R^2$ and the likelihood ratio test.

$$pseudo{-}R^2 = 1 - \frac{N}{N + 2(\ln L_U - \ln L_R)} \quad (6)$$

where N represents the number of observations. As $L_R < L_U$, the larger difference between the two likelihood values, the more extended ads to the very restrictive model.

The likelihood ratio test is a common test, similar to the F test that all the slopes in a regression are zero:

$$LR = -2[\ln L_R - \ln L_U] \quad (7)$$

where L_U denotes the maximum (unrestricted) likelihood value of the model of interest, and L_R represents the maximum value of the likelihood function when all parameters, except the intercept are set (restricted) to zero.

Study setting and sampling

The data set used in this study was collected from a special organized research in secondary schools of Dambovita County. Specific to the Romanian educational system is the division of high schools in categories upon their main specific. According to this classification, at our study took part teachers from five national secondary schools, five theoretic high-schools, and five technologic secondary schools. Due to limited resources allocated to the research and because of unavailability of an accurate survey basis for building the sample, we used the multistage survey. In the first stage were extracted randomly, by the above mentioned types, the sample of secondary schools of all high schools in the area under investigation. In the next stage, the teachers of each school who responded to the questionnaire were chosen using the step counting method.

According to the Report regarding the state of school education in Dambovita County, for the first semester of the school year 2012–2013, were enrolled 1358 high school teachers. Based on this information, the initial research sample was set to 300 people, in order to ensure a significance level of 5%. However, in order to be protected against a too high rate of non-response, which could jeopardize the viability of the research, and to keep a uniform unit of observation, we determined the appropriate research sample of 375 teachers (25 teachers from each school under review).

Of the 375 teachers approached, 331 returned back completed questionnaires, i.e. an 11.7% ratio of non-responses. As 55 questionnaires indicate "do not know / no answer" for the dependant variable, that is, the work satisfaction, they could not be used in the model, as there was not possible to assign a specific value for this situation. Therefore, 276 questionnaires were used in the modelling process framework, as described above. Table 1 contains the main features of the considered sample in comparison with the statistic data for the teachers working in secondary education of Dambovita County.

Table 1. The main features of the considered sample vs. the actual data.

	Sample	Actual

[redacted]

Table 1 shows the comparison between the main statistical features of the research sample and of the data regarding the whole teachers population enrolled in the high schools in Dambovita County.

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As the deviation between the averages of the two series of data (actual and sample) does not exceed 10%, and taking into account that in the survey the age and the experience were not provided exactly, but upon certain ranges (Table 2), this may be considered an accurate representation of studied population. Table 2 presents the summary of collected data and values assigned in model.

The questionnaire used in the survey was structured as follows: (i) First section comprise 40 pre-coded items on professional, financial, and other sources of motivation. In assessing the answers to these items, there was used Likert's scale. This section covers the main part of the questionnaire. (ii) Second section consist of three (two open and one closed) questions, which aims to identify different motivational experiences and knowledge of the general level of job satisfaction of interviewed teachers. (iii) The last section questionnaire is dedicated to the items regarding social, demographic, professional, and contextual aspects of the teachers participating in the survey. These information are used in statistical processing of the questionnaire. Table 3 displays the descriptive statistics of the variables.

Results and Discussion

In order to determine the working satisfaction of the teachers participant at the survey, were considered the following demographic variables: teaching degree (*DEG*) and total length of service (*SRTY*) in Eq 1, respectively age (*AGE*) and amount of experience in education (*TEACH*) in Eq 2. This alternative use of two proxies for the same demographic variable is designed to ensure a double-check correlation between the work satisfaction and the two considered variables (age and seniority). The estimations use ordered *probit* and *logit* techniques and they are performed through using of Eviews software package. Tables 4 and 5 contain the reported results.

The output results using the *probit* and *logit* estimations are very similar, proofing the assertion that, generally these two forms give similar predictions [31]. Variables that reported statistically significant influence (at 5% level of significance) upon teachers work satisfaction are: *LYC* (secondary school type) – 1% according to *logit* model; *EDU* (university degree of the teacher); *SAL* (satisfaction reported by the interviewee from the salary point of view); and *FAIR* (satisfaction reported by the teacher about the salary adequacy with regard to efforts for tasks' accomplishment. Despite the importance granted to demographic variables and special design of the study in order to ensure a proper measure of their influence, the reported values are not statistically significant. This may be considered as inconsistent with some of above mentioned studies, eg. [22–24]. According to other points of view expressed in the literature, the job satisfaction starts at high level, decline, and then starts to improve with increasing of the age, following a *U*-shaped curve [8]. Therefore, as the age or seniority on the one hand, and the job satisfaction, on the other hand, are variables that do not evolve in a similar or inverse manner, there may not be established a relationship neither positive nor negative between them.

Specific to the discrete choice models is that neither the sign nor the value of the parameters is informative about the estimation results, thus, direct interpretation of the parameters is ambiguous. The coefficients of the variables reported as significant through the model are subject to future processing, in order to establish their true sense, that is, the marginal effects. Using the Eq 5 the coefficients are evaluated using standard normal densities at the „threshold"-points $\varphi(\delta_j)$. The resulting coefficients from Eq 1 using *probit* model (Table 4) are subject of this processing (as all the „threshold"-points δ_j reported statistically significant values). The

Table 2. Summary of general information and values assigned in the model[a].

	Value assigned in the model	Teachers (N = 276)
[redacted]		

Table 2 shows the summary of general information regarding the weight of provided answers by items, and values assigned in the model.

[a] The full dataset is available from the authors on request.

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Table 3. Descriptive statistics.

	WS	AGE	DEG	EDU	LYC	SRTY	TEACH	SAL	FAIR	PREM
[redacted]										

Table 3 presents descriptive statistics of the considered variables.

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estimates for the *probit* model imply

$$y* = -0.0197\ \ Deg + 0.1521\ \ Edu + 0.2684\ \ Lyc + 0.0008\ \ Srty + 0.1695\ \ Sal + 0.1475\ \ Fair + 0.0327 prem$$

$$y* = \begin{cases} 0, & if \quad y* = 0 \\ 1, & if \quad 0 < y* \leq 1.3313 \\ 2, & if \quad 1.3313 < y* \leq 3.571 \\ 3, & if \quad y* > 3.571 \end{cases}$$

The results are presented in the Table 6.

Table 4. Estimated Work Satisfaction: Eq 1 (DEG and SRTY).

Variables	***PROBIT*** **Coefficient**	***LOGIT*** **Coefficient**
[redacted]		

Table 4 displays the values of the estimated variables taking into account the professional degree held by the teacher (= *DEG*) and total work history (in years) (= *SRTY*) as proxies for the demographic factors.
Note: the values in brackets are the *z* statistics.
Significance at the 1, 5, and 10% levels is denoted by ***, **, and *, respectively.

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Table 5. Estimated Work Satisfaction: Eq 2 (AGE and TEACHING).

Variables	*PROBIT* Coefficient	*LOGIT* Coefficient
[redacted]		

Table 5 displays the values of the estimated variables considering the age of the teacher (= *AGE*) and the amount of experience in education (= *TEACH*) (both in years) as proxies for the demographic factors.
Note: the values in brackets are the *z* statistics.
Significance at the 1, 5, and 10% levels is denoted by ***, **, and *, respectively.

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The marginal effects express the influence upon the specific probabilities per unit change in the regressor; it depends on all the parameters considered in the model, the data, and which probability (cell) is of interest. It can be negative or positive. The figures in the Table 6 show the implied model for a teacher with the following characteristics: university degree of 2.018 (~ M.sc. degree), a professional degree of 3.196 (~ second grade), type of high school = 2.025 (~ theoretical), a total work history of 17.75 years, reporting average salary satisfaction (2.739), a tasks-salary adequacy (2.649) and financial incentives received (2.402). At the change in characteristics (x), the probability distribution changes accordingly. In terms of the figure, changes in the characteristics induce changes in the placement of the partitions in the distribution and, in turn, in the probabilities of the outcomes [37]. Fig 1 displays the work satisfaction implied model for a person with average characteristics, as described above.

As appears in the Table 6, the partial effects of expected change on the probabilities per additional degree of education are: -0.0468, -0.0036, 0.0494, and 0.0010, respectively. Roughly speaking, an improvement in university degree status to PhD. is more likely to lead to

Table 6. Estimation of conditional probabilities and marginal effects.

Φ	Marginal effects			
	EDU	LYC	SAL	FAIR
[redacted]				

In the Table 6 are presented the estimated values of conditional probabilities and marginal effects for the variables that reported significant influence.

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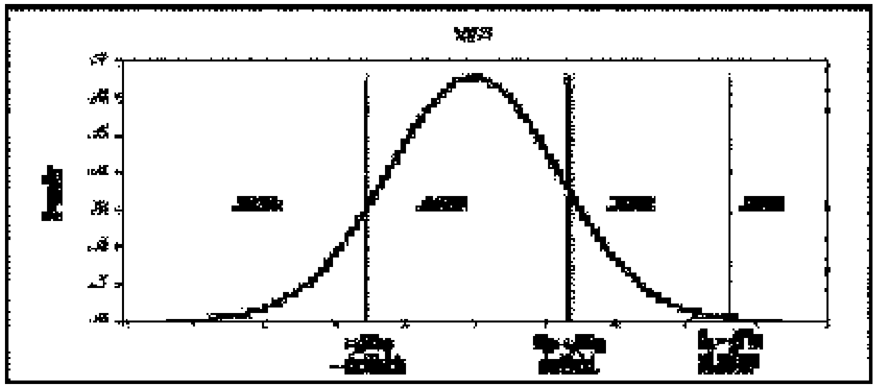

Fig 1. Estimated Ordered *Probit* Model. The plot depicts the work satisfaction implied model for teacher with average characteristics (by taking into account the considered variables).

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improvements in work satisfaction: since the effect are denominated as "marginal", the changes implied are typically of reduced magnitude, as it appears in the Fig 2.

According to the figures displayed in the Table 6, the situation shown in Fig 2 is common for the other significant variables, except the revenues. Regarding the salary satisfaction reported, it is interesting to remark that though the salary satisfaction reported is above mean, it has a negative effect over the work satisfaction: only for the teachers reported their job as very satisfactory, every new step in salary contempt is expected to lead to an increase in work satisfaction by 16.91%. If we consider the same individual shown in Fig 1, except now, with a salary satisfaction reported of five, the probability distribution for job satisfaction is presented in the Fig 3.

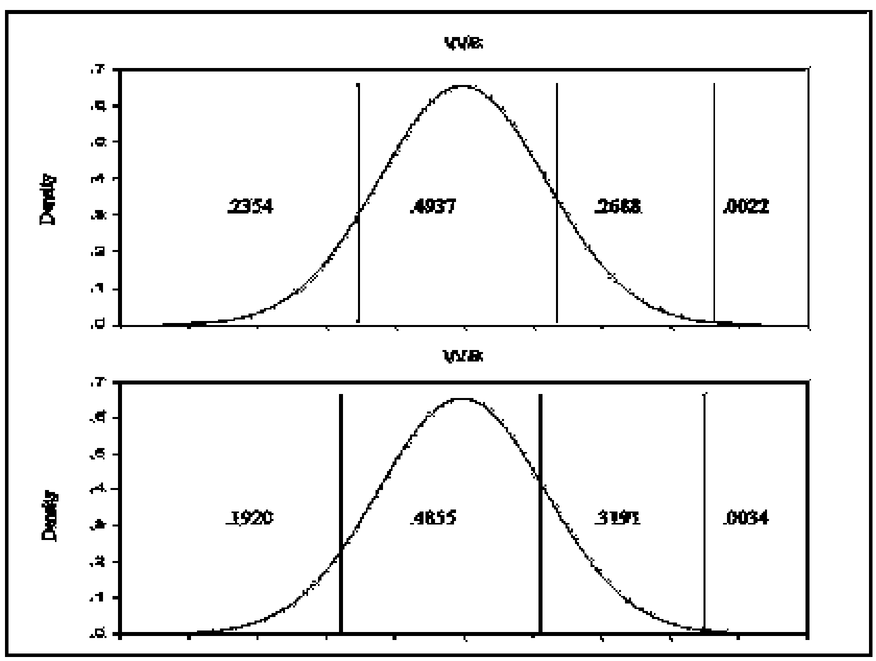

Fig 2. Partial effect of increase of educational degree (to PhD) in Ordered *Probit* Model estimated. The plot below depicts the work satisfaction implied model for a teacher who holds a PhD degree (all the other characteristics maintained unchanged, that is, at average level), in comparison with a teacher with average characteristics (in the plot above).

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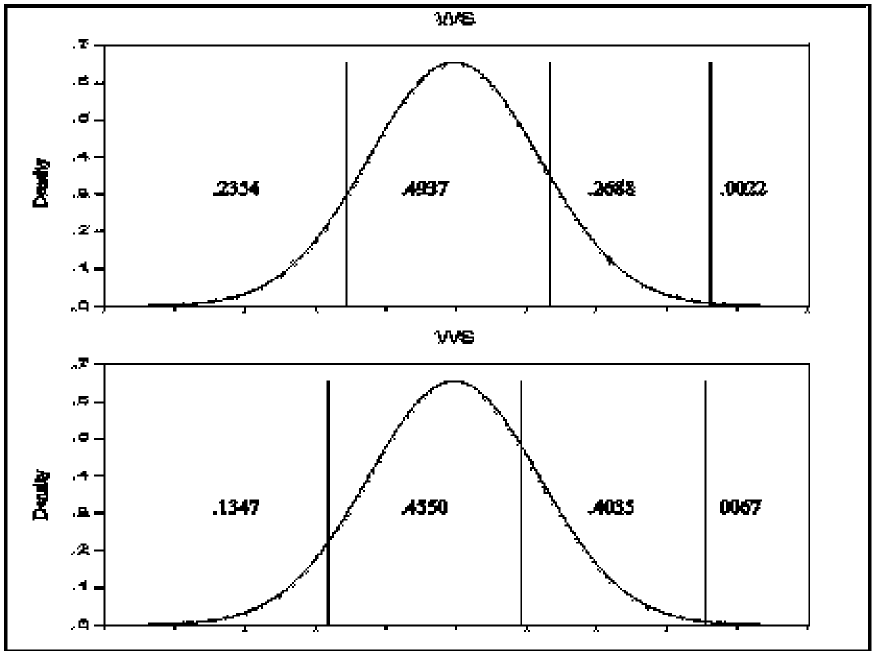

Fig 3. Partial effect of increase (to 5) of salary satisfaction reported in Ordered *Probit* Model estimated. The plot below depicts the work satisfaction implied model for a teacher reporting the salary as *rather satisfactory* (all the other characteristics maintained unchanged, that is, at average level), by comparison with a teacher with average characteristics (in the plot above).

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This situation may be also the result of a dissimulated reporting of job satisfaction concomitant with reduced levels of salary contempt: the statistical significance of revenues satisfaction within the model of work satisfaction expresses that type of reporting is sizeable.

Conclusions

The quality of education significantly influences the general situation of national community in long-run and may be also considered as an important economic issue. The future status of Romanian emergent economy, besides its' societal facet, is mostly dependent on the quality of graduates as the main channel providing human resources for companies. Improvements in

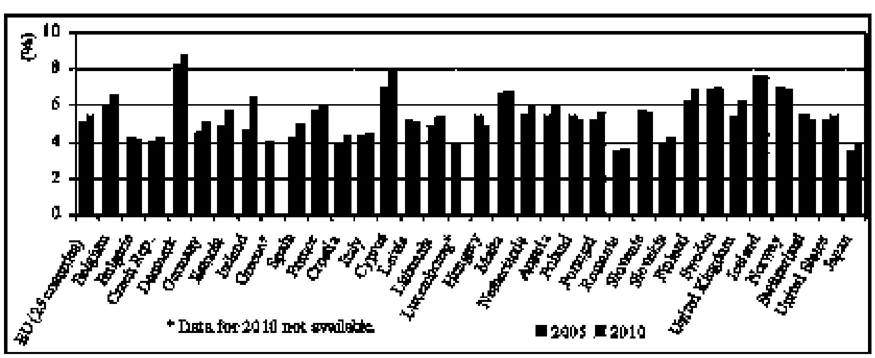

Fig 4. Total public expenditure on education in European Economic Area countries, United States and Japan as % of GDP, for all levels of education combined. Romania has the lowest allocation as % of GDP for education from all the considered countries. *Data source*: Eurostat.

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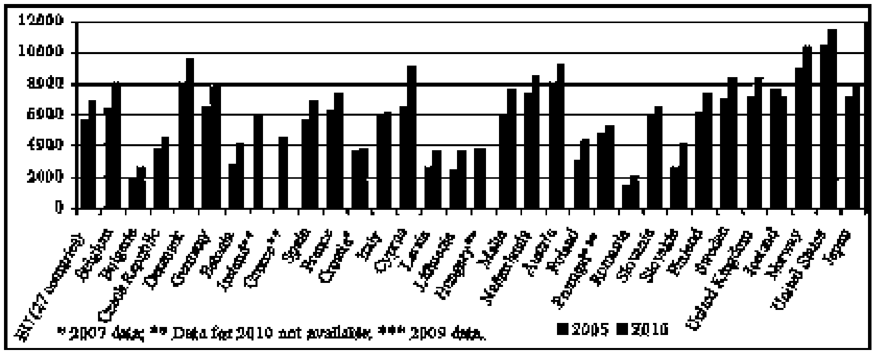

Fig 5. Annual expenditure on public and private educational institutions per pupil/student, 2005 and 2010 (by level of education—PPS based on full-time equivalents). Romania has the lowest allocation for education per pupil/student in all the considered countries. *Data source*: Eurostat.

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motivation of teaching staff may lead to enhanced skills and abilities of future human resources. In assessment of teacher work satisfaction, the present paper uses ordered choice approach and employs the estimation method exposed in [36]. To the authors' best knowledge, this is the first study that examines the work satisfaction of teaching staff in Romania using discrete choice approach. The findings in present study may contribute to relevant literature as evidence for work satisfaction in education and may serve as a model for sectoral researches.

The results indicate the salary as an issue point in Romanian teaching staff motivation. This situation is the joint-result of reduced subsidies and incentives for sponsorship, as is depicted in the Figs 4 and 5, as well as of the place and evolution of salaries in education in general hierarchy of revenues (Figs 6 and 7). On the average, teachers report job as rather satisfactory though the salary influences negatively this satisfaction. This situation is consistent with the theory according to that job satisfaction results when intrinsic aspects of work (motivators: e.g. recognition, promotions, etc.) promote feelings of happiness in the worker, and job dissatisfaction results when the extrinsic factors (hygienes: e.g. salary, working conditions, etc.) are considered [8]. Though, this approach is criticised by findings of further studies that indicate that the same factors can cause both satisfaction and dissatisfaction [23, 38].

Overall, the results of the present study indicate a significant effect of the secondary school type, university degree, salary and adequacy between tasks and salary in teaching staff work satisfaction. Following previous researches that reported age and seniority as significant factors influencing personal work satisfaction of teachers, two different proxies for age and two proxies

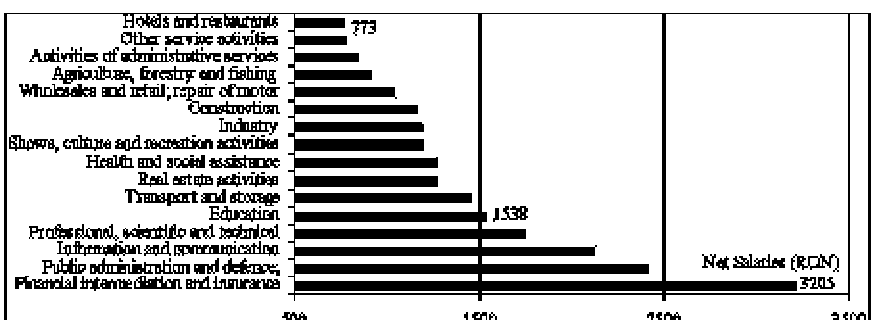

Fig 6. Hierarchy of average net nominal monthly earnings in Romania in 2008, by CANE section. The education occupies the fifth rank in this hierarchy. Average exchange rate in 2008: 1 Euro = 3.6826 RON (European Central Bank). *Data source*: National Institute of Statistics.

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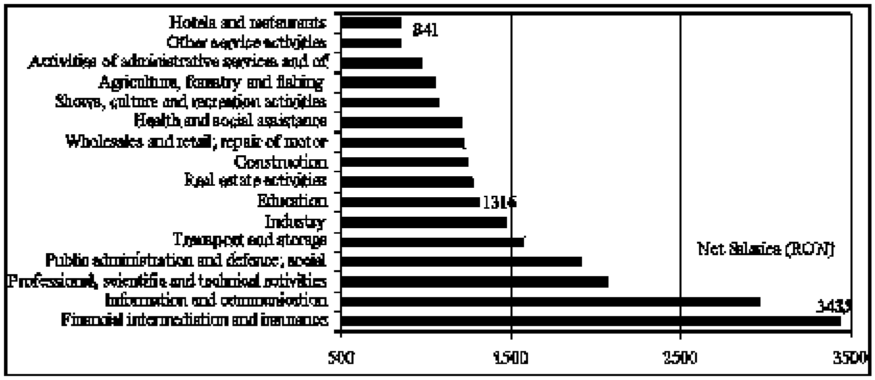

Fig 7. Hierarchy of average net nominal monthly earnings in Romania in 2011, by CANE section. The education occupies the seventh rank in this hierarchy, concomitant with a reduction in average net nominal monthly salaries of 14.34% (26.6% in Euros). Average exchange rate 2012: 1 Euro = 4.2391 RON (European Central Bank). *Data source*: National Institute of Statistics.

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for years of teaching experience are used. Despite the special design of the study for adequate control the social and demographic variables, these factors do not seem to have an important influence upon job satisfaction. Since we found this evidence, the role of motivation is expected to become more critical within efforts for improvement the quality of education. However, the overall teaching staff (for all levels of education) has the largest share in the total state staff of Romania. To overcome the adverse financial and state budget developments due to unexpectedly and significant growth in teaching staff costs, the incentive instruments and private sponsorships should be encouraged by the authorities. In this way, improvements in quality education and economic recovery may be achieved in a way less dependent on the state budget. The results of this study may hopefully present an idea on the teaching staff motivation in similar economies. A future study covering a cross-country analysis may provide a broader idea on the teaching staff motivation factors in developing countries.

Author Contributions

Conceived and designed the experiments: MM CP AMT VT. Performed the experiments: MM CP AMT VT. Analyzed the data: MM CP AMT VT. Contributed reagents/materials/analysis tools: MM CP AMT VT. Wrote the paper: MM CP AMT VT.

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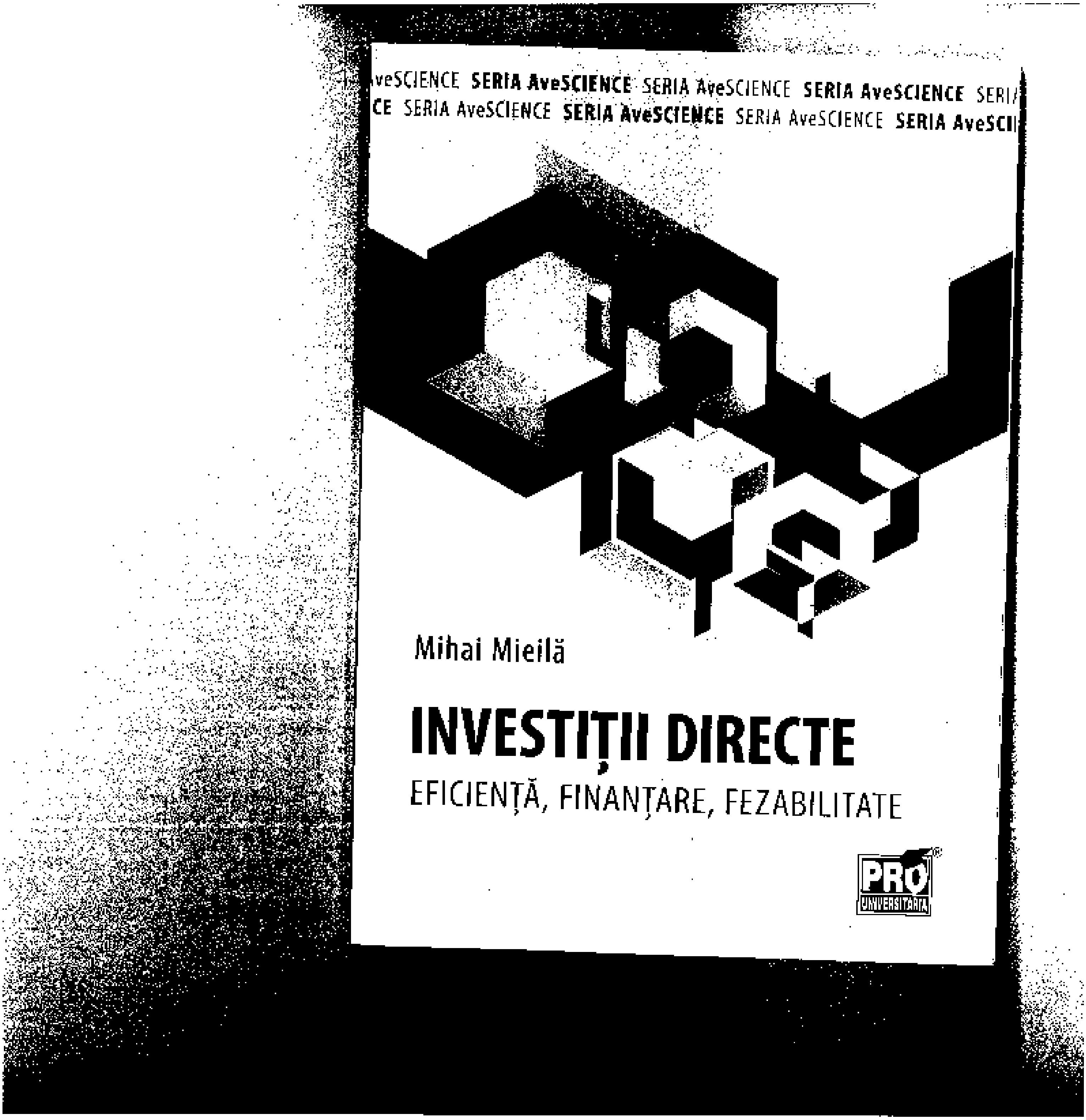
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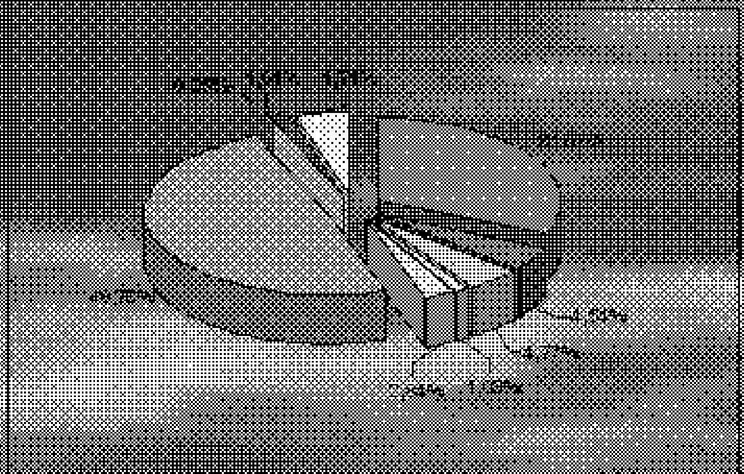

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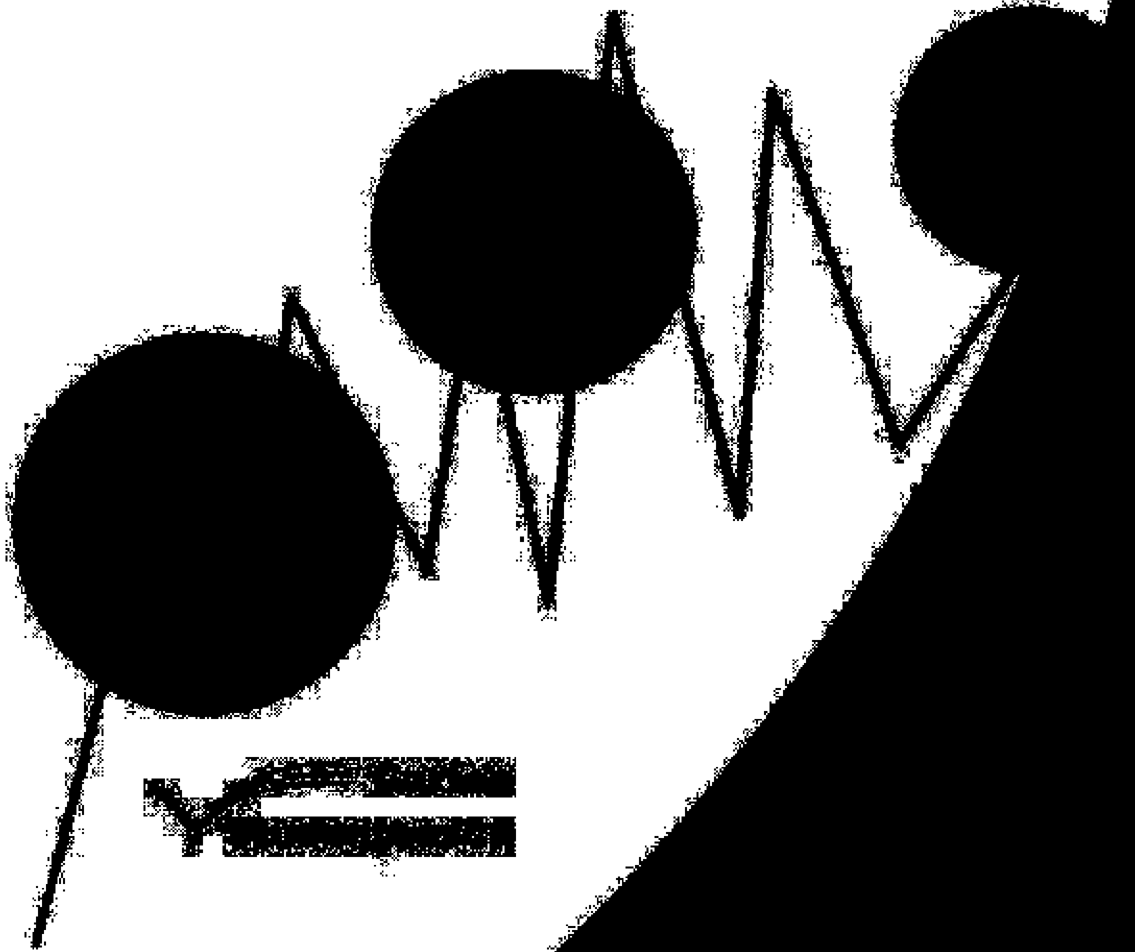

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Sustainable Technologies, Policies, and Constraints in the Green Economy

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Sustainable Development Indicators:
A Review of Paradigms

Mihai Mieilă
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ABSTRACT

Since the economic development ceased to represent by itself the main issue in achieving human well-being—at least for western societies—scientists have discovered that the sustainability may represent an even more significant threat for human civilisation in a fundamental sense, almost irrespective of material wealth. Sustainability assumes that the economic development is deployed in compliance with the other facets of human demands for well-being: preservation of biodiversity and climate, the human rights, the integrate approach of distributional justice, etc. Evaluation of development sustainability represents a real scientific challenge, proved by the wide variety of indicators in existing national and international sets. The Sustainable Development Indicators (SDIs) are the practical tool that address the balance between the development and sustainability, ensures evaluation and translation of knowledge into meaningful and manageable units of information to support analyses and research, and to inform planning and decision-making. There are pointed out the fundamentals of SDIs design and theoretic specific frameworks. As the majority of indicators are applicable straightforward, the main focus in presentation is upon the calculation algorithm of aggregate SDIs. In this respect, the chapter comprises the estimation algorithm of capital components of wealth; also, there are introduced the human life quality and environmental indicators, that can represent a suitable complement of wealth measurement, for a comprehensive development in agreement with the surrounding nature, society, and respect for future generations.

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The development of a green and sustainable economy continues to grow in awareness and popularity due to its promotion of a more comprehensive way of achieving economic development through social and environmental efficiency.

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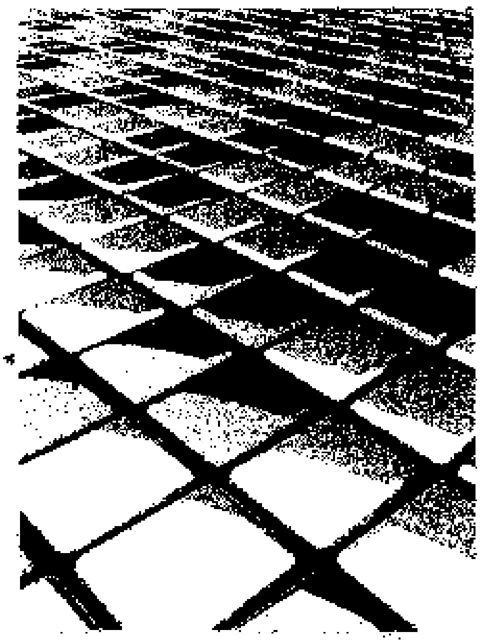

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THE EVOLUTION OF PRIVATE LOANS IN ROMANIA AND EXAMINATION OF SOME FACTORS OF INFLUENCE

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Abstract
The paper analyzes the evolution of Romanian private loans, in national currency (lei), granted to households and non-financial corporations in the period between July 2005 and April 2017. In this context, after reviewing the importance of credit within the context of national economy is presented the evolution of some factors considered as influential upon the evolution of credit. These factors are, namely: the average interest rate of outstanding private loans granted by credit institutions, the average interest rate of outstanding amount of deposits received by credit institutions, the ratio of minimum (or reserve) requirements, the interest rate on required reserves and the monetary policy rate. The database was built using the available data from the Statistical Section of the monthly bulletins released by the National Bank of Romania (herein after, referred to as NBR) and published on the institution's website. Every series of data is subject of testing for stationarity, using both the Augmented Dickey-Fuller and Pillips-Perron tests (herein after, referred to as ADF and PP, respectively), and the reported results are presented within the paper. In order to avoid spurious regression, following the stationarization of the data series, an analysis model is put in place and the significant results are subject to further interpretation.

Keywords: *credit, interest, monetary policy, economic growth, banking system,*

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1. Introduction and context of the study

The basic function of the banking system is represented by consolidating the monetary resources of the economy and their temporary orientation towards efficient economic activities. From the point of view of financial relations existing in the economy, the credit represents an economic category that expresses the relations of redistribution of a part of the Gross Domestic Product. Through these distribution relations, takes place the consolidation and distribution of a part of the existing resources in the economy, creating new means of payment in order to satisfy the needs of capital [1]. Thus, through the function of consolidation the temporarily available capitals and savings in the economy and their distribution, the credit represents an active tool in the process of stimulation of the economic growth and employment. The massive engagement in the economic process and the growth of labour productivity leaded to increase in revenues of population, which became a major player on the credit market, essentially in the role of moneylender [2].

The importance of the financing system is represented by its role for the development of the national economy. The credit relations represent the concrete tool in the process of transformation of savings into productive investments, which represents a real engine for economic development [3]. According to Keynesian theory, within the general framework of the macroeconomic objectives is pursued the equality between savings and investments, through transferring the capital from the treasury area to the productive action, with beneficial effects in terms of increasing the real wealth of the society. The role of the banking system in this respect is essential in the process of capital concentration, which is the prerequisite for efficient adaptation to market requirements, on this basis enhancing the marginal efficiency of capital. The credit relations of households and non-financial entities with banks are usually reciprocal, through the correlative mechanisms of money deposits and lending [2]. Typically, credit institutions are better placed than the general public in ensuring effective fructification of dormant deposits [4].

As the credit represents a cardinal category in the economy, results the importance of the way of its granting, and business banks act as a responsible financial analyst for directing the available resources to the most efficient placements.

The efficiency of the businesses' initiatives is subject of proof through the loan application prepared and analyzed, whereby is demonstrated the necessity and the efficiency of the pursued initiatives. Sometimes, the credit can represent a prerequisite for increasing of the market competition. By supporting various innovations or inventions of small firms, the credit contributes and favors the emergence of competition, with the possible limitation of the supply-side "shocks". Through the responsible monetary issuance function, the credit can also improve the business climate by supporting production and consumption and contributing to price stability; the most commonly used example in this context is the one of the market of agricultural products, with a strong seasonal supply feature and production costs typically incurred over a calendar year.

As the majority of the national economies actively take part in international trade as an important prerequisite for development, through capitalization of their competitive advantages, the credit manifests itself as a promoter of the international economic relations through the specific instruments of support of import and export operations.

Banking and interest credit have a direct effect on the dynamics of economic activity, being related to the level of financing resources and their cost [5]. Thus, the interest rates applied to both bank assets and liabilities are monetary instruments essential to achieving economic equilibrium, through the direct influence exerted both on the money supply in the economy and on the exchange rate of the national currency.

The new technologies in the field of payment instruments, transfers and bank compensations have determined the progressive reduction of cash usage. The predominant use of modern payment instruments, fundamentally based on credit relationships, is also the effect and cause of the increase in the volume and weight of the money bills. These tools are characterized by high efficiency and efficiency, while ensuring a considerable reduction in risks.

The objective of the present paper is an analysis of the evolution of total private loans granted by the Romanian banks, in national currency, between July 2005 and April 2017, with some factors influencing it.

2. Data series and preliminary results

In our study, besides the endogenous variable, that is, the evolution of total private loans granted by the Romanian banks, there were considered the following influence factors, as the independent variables:

- the average rate of outstanding private loans granted by credit institutions, denoted in our model by AIR;
- the average rate of outstanding amount of deposits received by credit institutions, denoted in our study by PIR;
- The ratio of minimum (or reserve) requirements. The reserve requirements represent a ratio of the bank's financial resources held in accounts opened with the NBR. In our model, this variable is denoted by MR. In fact, the reserve requirements represent a monetary policy instrument employed by the central banks in order to accomplish three functions [6]: to create a certain dependence of the banking system on the central bank; allow for the cash amount management, implying the management of intrest rates in short-run; and, represent means to ensure the stability of monetaty expansion. Through the value of the specific ratio is set the amount of money available to banks to lend to the real economy, according to the economic conjuncture and the pursued objectives. If the central bank finds an overpace in the dynamics of the credit process, it may increase the reserve ratio. At the same time, the MR mechanism is a stabilizer of

interbank interest rates. Banking specialists argue that through the mechanism of minimum reserves requirements induce augmentation in price of credit products.

- Interest rate on required reserves (% p.a.), denoted by RMR. The amounts deposited at the central bank as MR are interest bearing at a low rate, currently calibrated to 0.8% for amounts in lei. As the banks have to pay a higher costs for the amounts received as deposits, the yield difference represents a bank loss, which is covered by raising the interest on granted loans.
- The monetary policy rate (% p.a.), denoted by MPR, and represents the cap interest rate for the deposits from interbank market at central bank with maturity of one month.

The database was built using the available data on the NBR website. The figures refer to credit is granted to households credit and non-financial entities (non-financial corporations and non-monetary financial institutions). The datasets comprise the time range between July 2005 to April 2017, and is represented in the figure 1.

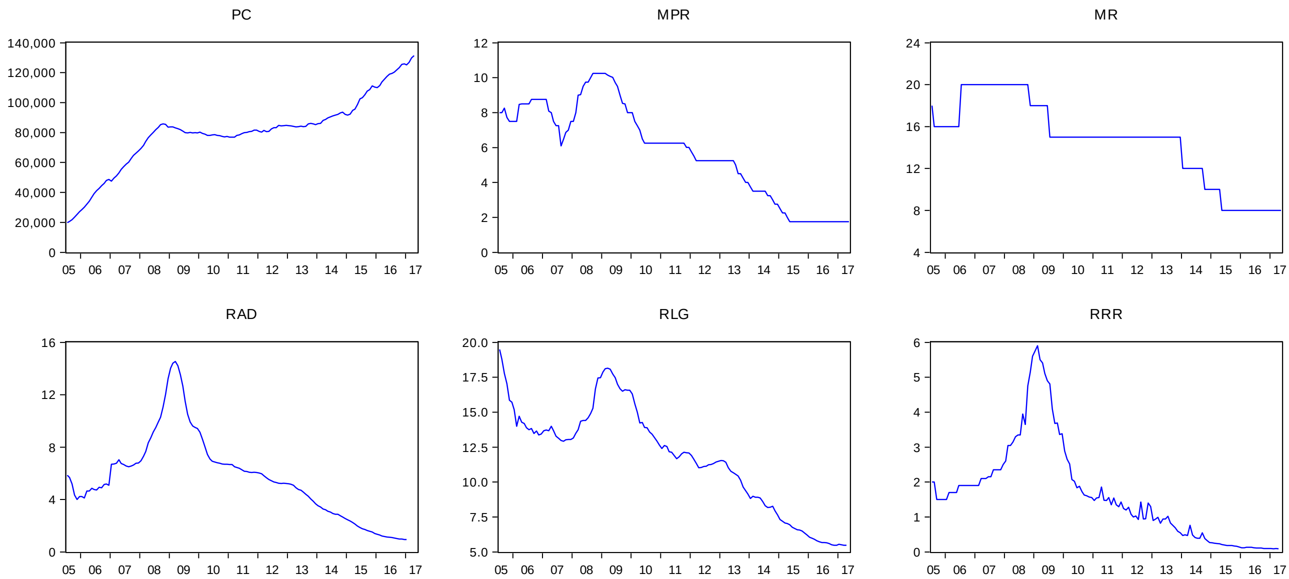

Figure 1. The graphical representation of the data series.

The summary staistics of the data series is presented in the table 1.

Table No. 1. Dataset summary statistics

	PC	AIR	PIR	MR	RMR	MPR
Mean	79055.19	11.840	5.625	14.754	1.676	5.918
Median	81408.3	12.145	5.275	15.000	1.500	6.250
Maximum	125945.8	18.790	14.530	20.000	5.900	10.250
Minimum	19832.7	5.470	0.940	8.000	0.100	1.750
Std. Dev.	23295.16	3.603	3.163	3.877	1.411	2.670
Skewness	-0.5419	-0.201	0.752	-0.386	1.183	-0.172
Kurtosis	3.4854	2.139	3.522	2.274	3.998	1.919
Jarque-Bera	8.1675	5.194	14.581	6.452	37.929	7.405
Probability	0.0168	0.075	0.001	0.040	0.000	0.025
Sum	10988671	1633.910	776.190	2036.000	231.310	816.720
Sum Sq. Dev.	7.49E+10	1778.727	1370.298	2059.623	272.718	976.297
Observations	138	138	138	138	138	138

From the collected data, results that the most significant positive change in the endogenous variable was recorded in November 2015 (+7.96%), whilst the most significant negative change was recorded in December 2008 (-2.18%). The last change may be linked to the first developments specific to the financial crisis. Also, as a measurement considered as an effect of the financial crisis as that moment, can be interpreted the highest interest rate on the minimum reserves of 5.9%, recorded in February 2009. Since then, the respective rate followed a downturn rate with a lowest level, of 0.09%, recorded in February 2017.

Both the interest rate for deposits from nonfinancial corporations and households and the rate for active banking operations followed a downward trend. The highest active interest rate was recorded in August 2005 (18.79%), while the lowest recorded in December 2016 (5.47%). The highest level of the interest rate for passive operations was recorded in March 2009 (14.53%), and the lowest level was in April 2017 (0.88%).

The maximum level of monetary policy rate was recorded in August 2008, at 10.25%, and the minimum was 1.75% in May 2015, a level that has been maintained so far.

From the above presentation, there may be observed the downward trend of all the intervention and market rates. Considering the stability of economic and financial environment in Romania, there may be stated the effectiveness of this policy, consistent with the European and international developments in the field. However, in the literature is argued that the cheap money policy may encounter certain limitations, and the numerous cases of stagflation of slumpflation proved that, in absence of some favorable conditions, the expansive usage of credit does not lead necessarily to economic recovery [7].

Analyzing the representations of the datasets in the figure 1, results that the stationarity of the time series is questionable. Due to the specific of time-series data, it is necessary to asses their stationary. In this aim, there were employed the ADF and Phillips-Peron (PP) tests. These tests allow determining the order of integration of the variables defined in Table 1. To apply the ADF test there were considered the methodology described in literature [8]-[9]. The test regressions that may be considered for the ADF test are the following:

$$\text{M}_1\text{: } \Delta y_t = \alpha y_{t-1} + \sum_{j=1}^{p} \gamma_j y_{t-j} + \varepsilon_t \qquad (1)$$

$$\text{M}_2\text{: } \Delta y_t = \mu + \alpha y_{t-1} + \sum_{j=1}^{p} \gamma_j y_{t-j} + \varepsilon_t \qquad (2)$$

$$\text{M}_3\text{: } \Delta y_t = \mu + \beta t + \alpha y_{t-1} + \sum_{j=1}^{p} \gamma_j y_{t-j} + \varepsilon_t \qquad (3)$$

under the null hypothesis $\alpha = 0$, series is non-stationary and has a unit root.

In case of model (3) the ADF test concern the joint-assumption $\alpha = \delta = 0$ (as the null hypothesis). The figures of the test are presented in the table 3.

The Phillips-Perron (PP) test is based on estimating of the non-augmented DF test equations:

$$\text{M}_3\text{: } \Delta y_t = \alpha y_{t-1} + u_t, \qquad (4)$$

$$\text{M}_5\text{: } \Delta y_t = \mu + \alpha y_{t-1} + u_t, \qquad (5)$$

$$\text{M}_6\text{: } \Delta y_t = \mu + \beta t + \alpha y_{t-1} + u_t, \qquad (6)$$

where u_t is assumed to be stationary in trend and may be heteroskedastic. Specific to the PP test is that the correction for serial correlation and heteroskedasticity in the residuals u_t is ensured by using nonparametric statistical methods.

Under the null hypothesis that $\alpha = 0$, the PP statistics have the same asymptotic distributions as the ADF t-statistic and normalized bias statistics, following the τ (tau) statistic. Using of the PP tests in the present paper takes into account that, over the ADF tests, the PP tests are robust to general forms of heteroskedasticity in the error term, u_t. The figures of the test are presented in the table 4.

The alternative hypothesis for both tests is $\alpha = 0$; that is, the time series is stationary. If the null hypothesis is rejected, it means that y_t is a stationary time series with zero mean in the cases of (1) and (4); y_t is stationary with a nonzero mean ($=\mu/\alpha$) in the cases of (2) and (5); in cases (3) and (6), y_t is stationary with a nonzero mean around a deterministic trend.

Table 3. The values of the ADF test for the variables considered within the model

Data series	By level	By first order difference	Integration order and the model
	-1.293	-5.753*** (p = 1)	I(1) with constant (*M*2)
PC	-1.896	-5.760*** (p = 1)	I(1) with constant and trend (*M*3)
	-	-2.441** (p = 2)	I(1) (*M*1)
	-0.934 (p = 1)	-7.411*** (p = 0)	I(1) with constant (*M*2)
AIR	-1.726 (p = 1)	-7.381*** (p = 0)	I(1) with constant and trend (*M*3)
	-2.247**(p = 1)	-	I(0) (*M*1)
	-0.862 (p = 4)	-4.858*** (p = 3)	I(1) with constant (*M*2)
PIR	-2.528 (p = 4)	-5.139*** (p = 3)	I(1) with constant and trend (*M*3)
	-0.683 (p = 4)	-4.869*** (p = 3)	I(1) (*M*1)
	-0.311 (p = 0)	-12.41*** (p = 0)	I(1) with constant (*M*2)
MR	-2.173 (p = 0)	-12.50*** (p = 0)	I(1) with constant and trend (*M*3)
	-1.452 (p = 0)	-12.34*** (p = 0)	I(1) (*M*1)
	-1.454 (p = 3)	-4.082*** (p = 2)	I(1) with constant (*M*2)
RMR	-2.803 (p = 3)	-4.153*** (p = 2)	I(1) with constant and trend (*M*3)
	-1.074 (p = 3)	-4.097*** (p = 2)	I(1)
	-0.510 (p = 4)	-4.179*** (p = 3)	I(1) with constant (*M*2)
MPR	-3.71** (p = 5)	-	I(0) with constant and trend (*M*3)
	-1.041	-4.086*** (p = 3)	I(1) (*M*1)

***, **, indicate the level of significance: at 1% and 5% significance level, respectively.

Table 4. Phillps-Perron test for the model variables

Data series	By level	By first order difference	Integration order and the model
	-1.359	-5.802***	I(1) with constant (*M*5)
PC	-1.925	-5.82***	I(1) with constant and trend (*M*6)
	-	-4.128***	I(1) (*M*4)
	-1.110	-12.05***	I(1) with constant (*M*5)
DRMO	-1.914	-12.03***	I(1) with constant and trend (*M*6)
	-1.08	-12.05***	I(1)
	-1.314	-7.484***	I(1) with constant (*M*5)
AIR	-2.135	-7.460***	I(1) with constant and trend (*M*6)
	-2.401**	-	I(0) (*M*4)
	-0.812	-4.872***	I(1) with constant (*M*5)
PIR	-1.694	-4.962***	I(1) with constant and trend (*M*6)
	-0.938	-4.862***	I(1) (*M*4)
	-0.305	-12.41***	I(1) with constant (*M*5)
MR	-2.171	-12.532***	I(1) with constant and trend (*M*6)
	-1.455	-12.336***	I(1) (*M*4)
	-0.370	-9.854***	I(1) with constant (*M*2)
MPR	-2.345	-9.877***	I(1) with constant and trend (*M*3)
	-1.374	-9.862***	I(1) (*M*4)

***, **, indicate the level of significance: at 1% and 5% significance level, respectively.

In the present paper, the acceptance of the null hypothesis is taken by comparison of computed absolute value of the tests statistics with MacKinnon critical *p*-values. According to this test, under the null, the computed absolute value of the test (based on the data series) is lower than the critical (absolute) *p*-value, in which case the time series is nonstationary. The rejection of the hypothesis that $\alpha = 0$ (or, if case, $\alpha = \delta = 0$) is rejected, results that the time series is stationary.

Analyzing the results of the two tests, there might be observed that all the considered series are first-order integrated, for a 1% level of signification; the only exception reported by the both tests is the stationarity with zero mean for the *RDA* series – models (1) and (4), at 5% level of significance.

3. Model and discussion

From the above paragraph conclusions, as the series resulted to be integrated of order one, within a regression model, they cannot be used as raw data. Following the procedures presented in the literature [8], as first differences of such time series are stationary, in the present paper, were considered the implied approach. The regression model considered for analysis of the evolution of total loans granted to the private sector, as result of specific influence factors is specified as following:

$$VPC = \beta_0 + \beta_1 \cdot D(AIR) + \beta_2 \cdot D(PIR) + \beta_3 \cdot D(MR) + \beta_4 \cdot D(RMR) + \beta_5 \cdot D(MPR) + \varepsilon \quad (7)$$

In order to ensure the stationarity of all the considered exogenous variables, as specified above they are considered in first order differences (i.e, $D(AIR) = AIR - AIR(-1)$).

As all the above presented variables are percentage ratio, in order to ensure the compatibility of the data, there were considered the following transformation for the endogenous variable:

$$VPC = \frac{PC_1 - PC_0}{PC_0} \cdot 100 \quad (8),$$

in which, *VPC* represents the monthly relative variation of the loans grated to private borrowers (*PC*).

The graphical representation of the transformed variables is presented in the figure 2 (in which, *VPC*=@*PC*(*PC*)).

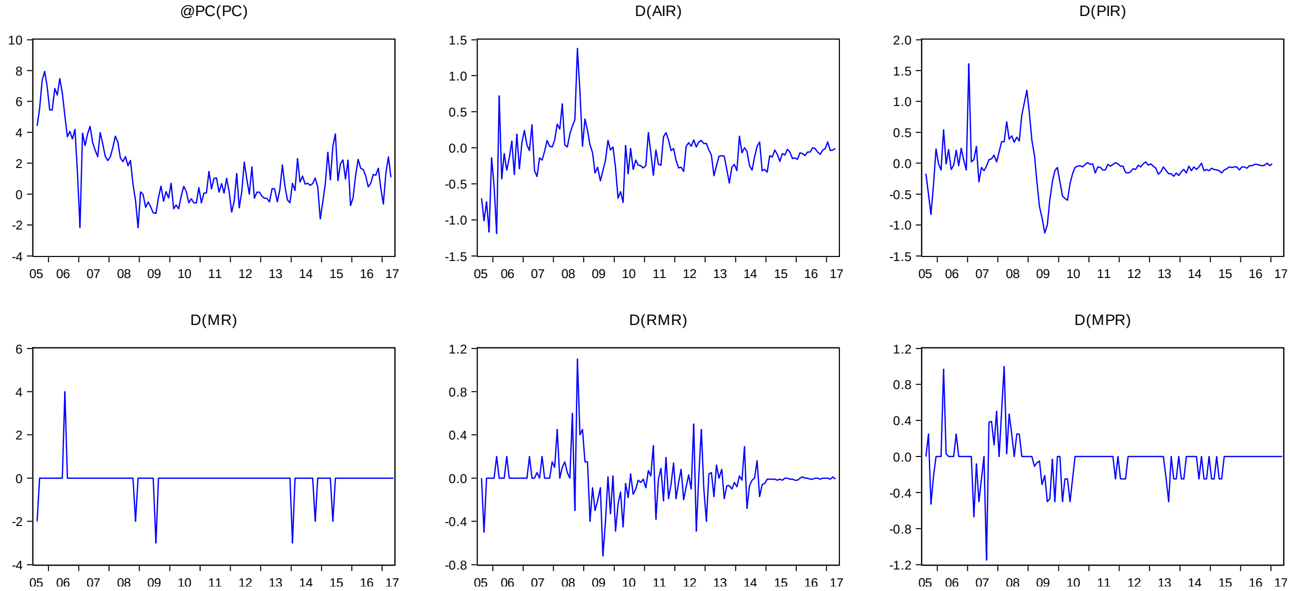

Figure 2. The graphical representation of the transformed data series

Analyzing the representations of the datasets (figure 2), one may observe that they are stationary. The results of the OLS regression are presented in the table 5.

The results in the table 5 show that the dependent variable is significantly influenced by the variation in the interest rate on granted loans and the monetary policy rate at 1% significance level and respectively, by the RMR at a 5% level of significance. In the present paper, one of the most important factors for there were considered the option for the additive model, estimated through OLS, is the possibility of direct interpretation of the results. Thus, the value of the constant shows that the autonomous rate of change of the private credit in lei is 1.28% each month, that is, the average rate of increase of the dependent variable, provided that all other factors remain unchanged.

The value of the β_1 coefficient, afferent to the AIR variable is -2.53. This result, although at first glance may describe an atypical evolution of credit reduction in situation of an increase in the interest rates of granted loans, in fact, reflects the positive evolution of the private credit outstanding amounts, provided the active interest rate followed a downward slope over the analyzed period. On average, a diminution in the *AIR* variable by 1 percentage point during the analyzed period resulted in an increase of 2.53 percentage points of the private credit. With regard to the possibility of extrapolating this trend in the future, there are of course certain limits, given both the penetration rate of banking services and the fact that there is a lower limit of the theoretical possibility of diminution in the interest rates, that is, equal to zero.

Table 5. The results of the OLS regression.

Variable	Coefficient
Constant	1.280*** (7.12)
D(AIR)	-2.530*** (-3.61)
D(PIR)	0.517 (1.717)
D(MR)	0.312 (1.10)
D(RMR)	1.870** (2.00)
D(MPR)	2.287*** (3.01)
R-squared	0.155
Adjusted R-squared	0.123
F-statistic	4.846
Prob(F-statistic)	0.000

Notes: t - stat values in paranthesis. ***, **, indicate the significant coefficients at 1% and 5% significance level, respectively.

The coefficient β_4 of the interest rate afferent to minimum reserves expresses that an increase by a percentage point of the respective variable is expected to increase on average by 1.78 percentage points of the credit granted to the population and to the non-financial corporations.

Another result that can be considered atypical is that the variance of the granted loans amount is positively influenced by the monetary policy interest rate. Considering the continuous downward trend of the latter two variables during the analyzed period, may be drawn the conclusion that this evolution contributed to a diminution in the evolution rhythm of the endogenous variable.

From the estimation results presented in the table, the model is verisimilar for a significance level of 1%, resulting from the probability associated with the Fisher test (0.000).

4. Conclusions

Lending operations are an essential part of the economic mechanisms, which has as primary aim to support the production and trade of economic goods. On this basis, credit relations represent a vital component in the process of value creation and economic growth. The Romanian economy is characterized by a low penetration rate of banking services compared to the existing situation at European level, but credit expansion is the most important way to improve this indicator.

The beneficial effects of credit expansion on the functioning of the economy are well known. However, the uncontrolled expansion of credit has given rise to imbalances that have evolved to phenomena such as banking and financial crises, inflation and deterioration of the national currency exchange rate. These developments have led to the emergence of a highly controversial current towards credit and the financial mechanism in place, whose efforts are directed towards a reinterpretation of the economic doctrine in the field. Trying to response to uncontrolled expansion of credit, some scholars argue for a required reserve of 100% [10].

In order to ensure that the money supply through credit represent a real economic support, it is necessary to assume of the financial analyst role by the business banks with maximum responsibility, guaranteeing the orientation of resources towards the most efficient placements. This action can be achieved if there are fulfilled the following conditions [7]: the existence of available workforce and capital goods; the credit should contribute to production of merchantable goods; the payback of granted amount in a short term.

In order to facilitate economic growth while developing a viable financial system and to prevent the negative phenomena, the prudential regulation and measures should aim at correlation between growth rates of credit and the possibilities of the real economy for sustainable absorption of the supplementary money created by credit mechanisms.

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