Artículos

Development perspectives of rural areas in Romania based on Autoregressive Moving Average (ARMA)*

How to cite this article: Dumitru, E., Sterie, C., & Marin, A. (2023). Development perspectives of rural areas in Romania based on Autoregressive Moving Average (ARMA). *Cuadernos de Desarrollo Rural*, *20*. https://doi.org/10.11144/Javeriana.cdr20.dpra

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DOI: https://doi.org/10.11144/Javeriana.cdr20.dpra
Received: 13 march 2023 ❙ Accepted: 10 june 2023 ❙ Published: 30 december 2023

Abstract:

The countryside is seen as the preserver of local traditions and customs and has a special cultural importance that cannot be quantified and appreciated at its true value. In addition to this aspect, it contributes to food security and mitigates the effects of climate change. Perhaps the most important component of the countryside is the rural population, which tends to decline as a result of the increasing urbanisation process and could create significant imbalances in terms of both food security and environment. Romania continues to have a high proportion of rural population (45.6%) and faces major difficulties in retaining this population due to the lack of jobs, poor infrastructure and the high degree of population ageing. The article aims to identify the prospects for rural development in the period 2021-2027, which is the third programming

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period in which Romania participates. It also aims to develop an econometric model to explain to what extent the rural population is influenced by different variables, taking into account the balance that should exist between urban and rural areas. To this end, the linear regression method and the ARMA (Auto-regressive Moving Average) forecasting model were used. The estimation of the model determined in this study cannot represent exact values of what will happen by the year 2027, but it rather understands the prospects and directions in which the variables analysed are going, in order to establish appropriate measures to mitigate or limit the damage. Based on the trend of the resulting analysis, demographic decline will continue over the forecast period, unless some measures to revitalise rural areas are taken.

Keywords: Rural Areas, Countryside, Rural Population, ARMA, Romania.

Perspectivas de desarrollo de las zonas rurales de Rumanía basadas en la media móvil autorregresiva (ARMA)

Resumen:

El campo se considera como el preservador de las tradiciones y costumbres locales y tiene una especial importancia cultural que no puede cuantificarse ni apreciarse en su justo valor. Además de este aspecto, contribuye a la seguridad alimentaria y mitiga los efectos del cambio climático. Quizá el componente más importante del campo sea la población rural, que tiende a disminuir como consecuencia del creciente proceso de urbanización, lo que podría crear importantes desequilibrios tanto en términos de seguridad alimentaria como de medio ambiente. Rumanía sigue teniendo una elevada proporción de población rural (45,6 %) y se enfrenta a grandes dificultades para retenerla, debido a la falta de empleo, las deficientes infraestructuras y el alto grado de envejecimiento de la población. El artículo pretende identificar las perspectivas de desarrollo rural en el periodo 2021-2027, que es el tercer periodo de programación en el que participa Rumanía. También pretende desarrollar un modelo econométrico para explicar en qué medida la población rural se ve influida por distintas variables, teniendo en cuenta el equilibrio que debe existir entre las zonas urbanas y rurales. Para esto, se utilizó el método de regresión lineal y el modelo de previsión ARMA (Auto-regressive Moving Average). La estimación del modelo determinado en este estudio no puede representar valores exactos de lo que ocurrirá en el año 2027, sino que permite comprender las perspectivas y direcciones en las que se proyectan las variables analizadas, con el fin de establecer medidas adecuadas para mitigar o limitar los daños. Según la tendencia del análisis resultante, el declive demográfico continuará durante el periodo previsto, a menos de que se tomen algunas medidas para revitalizar las zonas rurales.

Palabras clave: zonas rurales, campo, población rural, ARMA, Rumania.

Introduction

Since the Middle Ages, the countryside has been closely linked to urban areas, mainly because of the need to supply cities with food, and, over the years, investments have been made to develop infrastructure, thus facilitating the passage of goods (Mack et al. 2018; Pavel et al., 2020). In addition, since this period, cities have continuously invested in rural areas to make them more productive and welcoming (Guarin et al., 2020) (Table 1).

TABLE 1.

Description of the variables analysed

No. Crt.	Definition	Approach	Author
1	Hall et al. consider that rural can be defined by exclusion, in the sense that it is characterised by an absence of urban or reliance on agriculture and other rural industries, but also by a lack of health care.	Localisation Economic activities	(Hall et al., 2006)
2	The European Council Regulation identifies as rural areas those regions where the population density is below 150 inhabitants/km^2.	Density	(Šimková, 2007)
3	Rural areas are often most simply defined as those areas that are not urban.	Localisation	(Bogdanov et al., 2008)
4	Human settlements where infrastructure occupies small parts of the landscape, where fields and pastures, forest, water, mountain or desert predominate, where most people spend their time working on farms.	Localisation Economic activities	(Holland et al., 2003)
5	In some countries, rural areas are regulated as "all those areas outside the urban agglomerations of cities covered by Local Development Plans".	Localisation	(Giannakis, 2014)

Source: In house processing.

"Rural" is defined in countless ways and there is no uniformly recognised definition, although most definitions refer to geographical (physical) space. A number of definitions of rural are listed below, which may differ from region to region and country to country.

Although most definitions of rural areas refer to geographical location, most of them also include aspects of density and economic activity. However, the OECD (Organization for Economic Co-operation and Development) methodology takes a step-by-step approach to defining rural areas, starting with the identification of population density (below 150 inhabitants/km^2) and ending with the classification of regions according to the percentage of population living in these rural communities (Giannakis, 2014).

Kâyser B. classifies rural areas, taking into account economic and social aspects, into peri-urban (pre-urban), intermediate and marginal (peripheral) areas. Basically, peri-urban areas are those close to large cities (10-50 km), with a strong urban footprint, and are considered a hybrid between rural and urban (Giannakis, 2014). The economy is also mixed, relying on both agricultural and industrial activities or services, and in some areas even tourism (Figure 1).

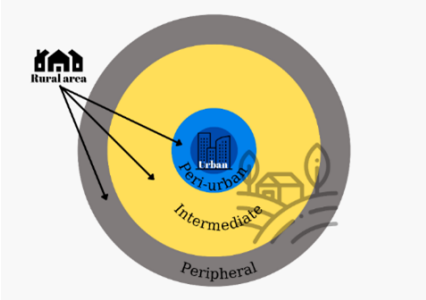

FIGURE 1.
The classification of rural areas
Source: Processing after Sterie and Dumitru (2021).

Intermediate areas occupy the largest area of the countryside, where agriculture is the predominant economic activity, and are considered the agricultural area of the countryside. The development of this type of area lies in the productivity and profitability of agricultural land (Figure 1).

Rural peripheries should be understood from an economic and social rather than a territorial point of view, and should be defined as the economic 'periphery' of the countryside, defined in social, agricultural and forestry terms. The potential of agricultural land, and its distance and accessibility to supply centres, define this type of area (Figure 1).

However, the rural environment is considered to be the keeper of local traditions and customs and has a particular cultural importance that cannot be quantified and appreciated as its true value (Zang et al., 2022; Nazzaro et al., 2021). In recent times, economic development in countries around the world has been concentrated in urban centres, or in their immediate surroundings, on economic activities that can increasingly generate profits for companies and ensure the creation of well paid jobs with qualified urban staff, and this leads to higher living standards for local residents (Batur et al., 2021; Csizmady et al., 2021; Jasi#ski et al., 2021).

Although the driving forces of today's economy, such as finance and knowledge, are increasingly intangible, the interdependence between cities and the countryside is more important than ever, especially in the context of a global population explosion, ensuring food security will be one of humanity's greatest challenges (Prusaczyk et al., 2022; Liu et al., 2022; Fayet et al., 2022).

Depopulation of rural areas is an eloquent indicator that reflects the degree of socioeconomic development of a region. Even the UN (United Nations) has addressed this issue in one of the Sustainable Development Goals (SDG11), which calls for a balance between urban and rural areas, as this is the only way to achieve greater sustainability in all these environments. Depopulation of rural areas is occurring in all parts of the world, with a predominance in localities that are far from economically strong urban centres (Iancu et al., 2022).

With the depopulation of rural areas, quality of life declines and people are exposed to the loss of basic services due to the loss of budgets managed by local authorities. Forcing young people to seek work in urban areas also leads to a loss of economic dynamism and contributes to the increase of poverty for the remaining population, which is mostly made up of an ageing population (Popescu et al., 2018).

In some countries, depopulation of rural areas is leading to the disappearance of crops, changing the local fauna. At the same time, the decline in agricultural production encourages the import of much needed products that would normally have been produced in these areas. In wooded areas, which are no longer tended, animals are no longer able to graze, which increases the risk of fires and hampers control capacity, increasing the risk of desertification (Iancu et al., 2022; Mihai, 2019).

The risks associated with rural depopulation have serious implications for urban areas. Perhaps the most serious phenomenon is overpopulation, which leads to an increase in the number of inhabitants/km^2, making it difficult to maintain the wellbeing of the population, as local authorities are unable to keep up with the development of essential services to meet the needs of the population. Population growth in these areas leads to an increase in the demand for certain products and services and hence their prices. By over populating urban areas, the quality of life decreases, as people living in these areas are more exposed to pollution, although at first glance this may represent an opportunity for people migrating to urban centres. It also contributes to the expansion of urban areas, taking up land found in rural areas, with implications for environmental conservation (Iancu et al., 2022; Mihai, 2019).

Thus, maintaining a balance between rural and urban areas is absolutely necessary, and action is needed to develop rural areas, with the rural population as a key component. Various studies advocate to diversify economic activities, stepping away from agriculture as the main source of livelihood, so that this diversification helps to attract businesses and workers. Farming should also not be neglected, instead it should be improved through the use of new technologies to increase yields. Although most policy approaches are geared towards supporting economically declining places, Dumitru et al. (2023) recommend supporting those rural localities that are enjoying population growth or have good prospects for sustainability. All these measures are difficult to implement without coherent and concrete measures at the government level, tailored to the specificities of each country, region or microregion (Iancu et al., 2022; Mihai, 2019).

At the European Council level, Resolution 422/2017 discussed issues relating to rural areas which are characterised by social, economic and environmental diversity, but it emphasised the differences between areas which enjoy a prosperous population and areas which face depopulation, demographic ageing, high levels of poverty and heavy dependence on small scale agricultural production. It also expressed concerns about the phenomenon of depopulation of rural areas and the exodus of young people, stressing the need for these rural areas and communities to be monitored (Tudor et al., 2022; Iancu et al., 2022).

This is reinforced by some additional data from a report of the World Bank, in which the EU's rural population is expected to fall by around 25% in 2021 compared to 1960. From a rural population of around 147 million in about 60 years, the number has fallen to around 111 million, as Europe's population has been declining since the year 2000 (Tudor et al., 2022).

The European Union's concern for the development of rural areas dates back almost to its inception and continues today, allocating for the period 2021-2027 just under 378.53 billion euros through the two pillars, of which around 87.9 billion euros are allocated exclusively to the second pillar of the CAP, which covers rural development measures. Like the objectives of the two previous programming periods, Pillar II aims at the increase of the competitiveness of agriculture, the sustainable management of natural resources and combating climate change, as well as ensuring a balanced territorial development of rural economies and communities (creating jobs and maintaining existing ones) (Sterie and Dumitru, 2021).

The EU countries with the highest number of people living in rural areas are Germany, Italy, Poland, France and Spain, but only Poland has managed to increase its rural population in recent years. Among EU Member States, this performance was achieved by Austria, the Czech Republic, Slovakia, Ireland and Cyprus. However, only Austria and Cyprus have managed to show a continuous trend of rural population growth, surpassing the reference year 1960 (Fayet et al., 2022). These countries can serve as an example of how to focus on the development of rural areas and keep the rural population in these areas, taking into account the particularities of each country

and the factors that have contributed to population growth in rural areas. Based on this concept, the "theoretical background" section discussed below has been developed, taking as a basis the countries that have performed well in this respect.

Brief context of rural Romania

Before the 1989 revolution, Romania's rural population had clear tasks set by the communist regime, with particular importance being given to agriculture. Agricultural land was cultivated exclusively by state owned systems, to which all rural people contributed. Children were also engaged in light agricultural work. Urban areas included people who worked in industry, and the financial gaps between these two groups were considerable (Dumitru et al., 2021; Iacu et al., 2022; Dinu et al., 2020).

After the fall of the communist regime, the rural population showed a slight upward trend, mainly due to economic instability following the closure of certain industrial centres (Argatu and Razvanta, 2022). After the 2000s, the temptation to migrate to Western European countries has increased in search of better paid jobs and a higher standard of living, while even more than 30 years after the fall of the communist regime and 15 years after its integration into the European Union, Romania's rural areas are still facing serious infrastructure problems, such as drinking water and sewage, gas for heating homes, local roads, doctors' surgeries and educational facilities (Ciutacu et al., 2015; Comanescu et al., 2019; Mitrică et al., 2020).

After Romania's accession to the European Union, rural regions have benefited from considerable European funds aimed at financing agriculture and new agricultural activities, with the main role of improving economic performance and creating new jobs. At the same time, the European funds accessed in the two completed programming periods that Romania has benefited from so far, have offered the possibility of making investments in rural localities. The regions in the west of Romania are geographically and behaviourally closer to the developed European countries, with a better performance in terms of absorption of European funds, which has deepened the disparities between Romanian regions, something that existed even before accession to the European Union (Tudor et al., 2022).

This poor infrastructure, coupled with a lack of jobs or low paid employment (most of it focused on agriculture), has led to a sharp migration of young people from rural areas to urban centres or other countries, leaving behind an ageing population with bleak prospects for revitalizing these areas (Figure 2). Rural areas also do not have favourable credit conditions to encourage business development in these regions or to attract young people who want to start their own businesses, although European funds can be an opportunity for them, but the lack of investment co-financing is a real constraint (Popovici et al., 2018; Bran et al., 2020; Pavel et al., 2020).

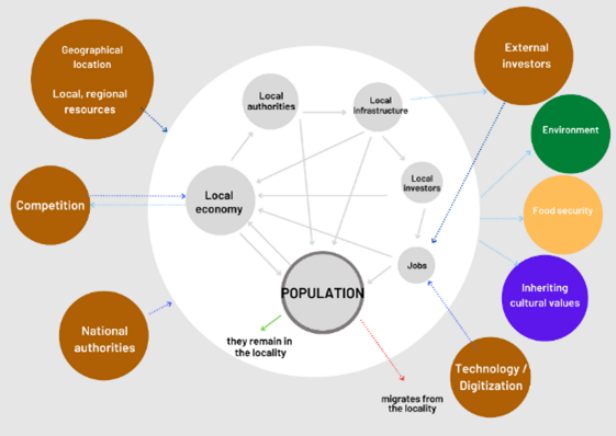

FIGURE 2.
Interdependence of internal and external factors influencing settlements
Source: Processing after Iancu et al. (2022).

The theoretical basis of this paper is the importance of rural areas, where the population of these areas is the main component, in a context of increased urbanisation, which could create significant imbalances, both in terms of food security and from an ecological point of view, in addition to totally unforeseen events, such as the covid-19

pandemic or the war in Ukraine, which could jeopardise the wellbeing of the population (Popescu et al., 2018; Mihai et al., 2018).

According to World Bank data, Romania ranks second among the EU Member States in terms of rural population as a percentage of the total population, with a figure of 45.6%, second only to Slovakia, which had a rural population share of 46.2%, while taking into account the sharp downward trend in this population at European level, thus categorising them, according to OECD methodology, as intermediate rural regions (Tudor et al., 2022).

The aim of the paper is to identify the prospects for rural development in the period 2021-2027, which is the third programming period in which Romania participates, in the context of the need to maintain a balance between urban and rural, but also taking into account the challenges faced by Romanian rural areas. The aim is also to develop an econometric model to explain the extent to which the rural population is influenced by different variables, in order to highlight the impact they have on the dependent variable with a view to identifying the solutions needed to redress the rural demographic situation.

Theoretical background

The literature review was based on the identification of countries in the European Union with a positive outlook for rural population development and a high share of rural population in the total population, in order to identify the aspects that contributed to these positive values. China was also considered because it has the highest economic growth in the world, but also because of the highest exodus of the rural population to urban centres, which has led to a rural-urban imbalance, an aspect pointed out by Chinese researchers and highlighted by the bibliometric analysis.

In China, there has been a recent emphasis on urban development at the expense of agriculture or the rural economy, leading to a widening gap between urban and rural areas. This rapid urbanisation has endangered the environment, with particularly serious implications for rural livelihoods and the welfare of the rural population (Yuan et al., 2018). Also, through the process of urbanisation, pressure on farmers has led to the economic inefficiency of growing the main, traditionally cultivated, agricultural crops. More and more people are migrating from rural to urban areas, and occupational hazards in work environments and poor living conditions make rural people more vulnerable to health risks than other groups (Zhao & Liu, 2022; Zhang et al., 2022).

China's socio-economic transformation, driven by the recombination of regional development factors and industrial restructuring, has led to substantial change in rural areas. The authors of the study "Differentiation of rural development driven by industrialization and urbanization in eastern coastal China" argue that it is very important to understand rural development in the context of a coordinated and balanced rural-urban development in developing countries driven by strong industrialization and accelerated urbanization (Long et al., 2009).

In the case of Austria, that faces local demographic problems, the potential for tourism and the practice of certain types of agriculture, complementary to touristic activity, allowed to positively exploit these resources, which can explain the demographic growth of these areas (Nordbeck et al., 2020). However, one of the main challenges in these regions of Austria is the ageing population, but the authorities are taking action by giving older people the opportunity to continue working. At the same time, there are measures to encourage the exchange of farmers between generations (Dax & Fischer 2018). However, more and more rural regions are facing depopulation as a result of industrial robotisation, which has had a negative impact on employment in manufacturing and has led to increased external migration to local markets (Glatz & Bodi-Fernandez, 2020).

In the Czech Republic, the process of suburbanisation reflects a population growth driven by the migration of young couples with high reproductive index values. In addition, the most important predictors of birth promotion are time, education and residential environment (Vobecká & Piguet 2012). Currently, the population is attracted

to rural areas with good natural and socio-cultural conditions, even if they are at a considerable distance from urban centres. Almost all small communes have a positive migration balance. This is helped by retirees buying property in rural areas, but also by the changing residential preferences of people and entrepreneurs. At the same time, positive trends of migration to areas with a well-preserved environmental heritage are highlighted and can be identified as a process of counter urbanisation (Notova et al., 2013).

The decrease of the rural population in Slovakia was mainly observed in the period 1970-1985 due to extensive urbanisation. After the political and socioeconomic changes that occurred after 1989, there was a significant slowdown in the migration process. However, in the first part of the twentieth century, the rural population of Slovakia represented more than 75% of the total population (Podolak 2005). At the same time, the rural population has a significant share of population growth, to which cultural and religious factors contribute. As in the Czech Republic, Slovakia's rural landscape has undergone extensive transformation in recent decades, to which suburbanisation processes have also contributed (Dicka, 2019).

One aspect that is not so well understood is that, in countries with a high standard of living, jobs that are not usually attractive to the native inhabitants of those areas are filled by nationals from Eastern European countries. This phenomenon became more pronounced with the accession of the former Soviet Union countries to the European Union in 2004, especially Poland, and continued with the accession of Romania and Bulgaria in 2007. This has led to increases in the rural population in some regions of European countries, but has not practically solved the problems of rural population decline in these countries (Dicka, 2019; Novotna et al., 2013).

Materials and Methods

Bibliometric analysis

The first step in the study was to identify the importance of the scientific environment on the rural population for which the connectivity of the keywords used, including year classification, and the relationships between co-authors from different countries were identified.

To this end, data were collected from the Web of Science platform on the number of publications on the topic "rural population", and a total of 69,798 publications were generated.

Scientometrics is seen as an important discipline of science, based on an informational process, quantitatively approaching science. Using in an epistemological sense and involving a general development of the subject under analysis, was based on interrelationships and disciplinary structures. However, structural scientometrics is approached through bibliometric linkages, cocitation and mapping of cognitive structures, aiming to provide an objective picture of how science is developing in that field over a given period of time. At the same time, this process also illustrates how the main topics of interest in academic activity are evolving and how they are organized (Barreto, 2022).

Alan Prichaed first used the term "bibliometrics" back in 1969, and it is considered a statistical and mathematical method for representing books and publications and a branch of scientometrics (Barreto, 2022).

Using VosViewer software (Centre for Science and Technology Studies, Leiden University, Leiden, The Netherlands), maps with the topic "rural population" for which a database was generated and unique results of publications studying the topic were obtained (Iancu et al., 2022).

Figure 3 illustrates the steps required to perform the bibliometric analysis, from how to collect the data, to the bibliometric analysis and visualization of the information, followed by step number three representing the author's contributions, by highlighting the trends and conclusions drawn from the analysed data (Figure 3).

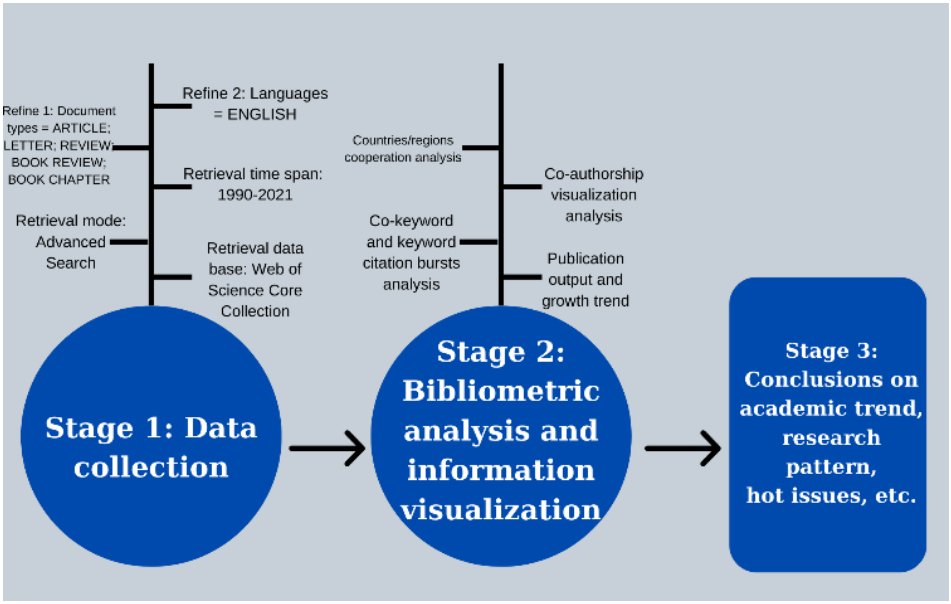

FIGURE 3.
Representation of the steps underlying bibliometric analysis
Source: Processing after Barreto (2022).

The bibliometric analysis also provided support for establishing the variables used in the econometric model, but with some limitations related to the consideration of English language publications and which are found in the Web of Science database. At the same time, the importance given by researchers to rural population differs from one country to another, depending on its particularities.

The reasoning of variables

The next step was to substantiate the variables analysed, with the aim of developing an econometric model to explain the proportion to which the rural population is explained by the following variables underlying the model (Table 2).

This paper starts from the hypothesis used by Iancu et al. that the decline of the rural population is mostly determined by birth rate, mortality, migration, high degree of ageing as well as the agricultural labour force which is the main occupation in rural areas.

TABLE 2.

DESCRIPTION OF THE VARIABLES ANALYSED

Variable	Variable type	Definition according to NSI [61]	Rationale
Rural population	dependent	Represents all persons with Romanian citizenship, foreigners and non-citizens, who have their usual residence in Romania and who live in rural areas.	It is the main component of the countryside in the context of maintaining an urban-rural balance, which can substantially affect the country's food and environmental security (Iancu et al. 2022).
Number of newborns in rural areas	independent	The newborn child - is the product of conception, ex-purified or extracted completely from the mother's body, independent of the duration of pregnancy and which, after this separation, shows a sign of life (breathing, cardiac activity, umbilical cord pulsation or will-dependent muscle contractions).	In the growing absence of young people in rural areas, increasing the birth rate in rural areas is increasingly important as it represents the future of these areas or localities. It is also one of the factors contributing to the decline in population numbers (Iancu et al. 2022; Popescu et al. 2018).
Agricultural labour force	independent	Represents the average number of employees comprising persons employed under a fixed term or indefinite contract of employment/employment relationship (including seasonal workers, manager, or administrator), whose contract of employment/employment relationship has not been suspended during the reference period and who work in agriculture, forestry, and fishing.	In countries such as Romania, which have a strong agricultural character, particularly in rural areas, the majority of jobs are in agriculture and are the basic occupation of the rural population (Vladu et al. 2018).
Rural departures	independent	Persons who have changed their place of residence within a certain period of time by moving to another locality.	Migration is one of the main factors contributing to the depopulation of rural areas, which has been favoured in Romania by the fall of the Communist regime in 1989 and the accession to the European Union in 2007 (Sterie 2020; Iancu et al. 2022)
Number of deaths (rural)	independent	A person whose vital functions have permanently ceased sometime after birth.	Poor living conditions (lack of medical facilities or adequate equipment) and the high degree of ageing of the rural population contribute to a higher mortality rate in rural than in urban areas (Sterie 2020; Iancu et al. 2022)
Rural population aged 65 and over	independent	Represents all people with Romanian citizenship, foreigners and noncitizens in rural areas over 65 years of age.	The Romanian countryside is characterised by a high degree of population ageing, which directly contributes to the depopulation of rural areas (Iancu et al. 2022). Liu and Liang found that population ageing puts pressure on social security, labour shortages, and other short-term problems. However, labour shortages and rising costs caused by population decline can form a reverse force mechanism for the transformation of agricultural production patterns (Liu and Liang 2021).

Source: Own calculations based on sources cited.

Once the variables were selected, the databases were downloaded from the Romanian National Institute of Statistics (ins.ro) platform. To have a more detailed overview, two other auxiliary variables were downloaded: the total population of Romania and the average net wage in agriculture. The period selected for the data analysis includes the two programming periods Romania has gone through, since its accession in 2007 and the end of the second programming period, that is, 2020, while the period 2021-2027, for which the estimation of the variables was also carried out, will be the third programming period Romania is part of. Programming is the process of organisation, decision making, and allocation of financial resources, aimed at implementing, on a multiannual basis, the joint action of the Union and the Member States to achieve the objectives of the Union's strategy for smart, sustainable, and inclusive growth, which usually covers a period of seven years.

The reasoning of variables

Data from the National Institute of Statistics were statistically processed using Eviews 12 Student Version Lite, IHS Global Inc., Irvine, CA, USA. For this purpose, the mean (1), median (2), maximum, minimum, standard deviation (3), Skewness index (4), Kurtosis (5) of the variables were determined based on the following formulas (Ho & Yu, 2015):

- $\bar{x} = \frac{x_1+x_2+\cdots+x_n}{n}$ (1)
- $\bar{x} = \frac{\sum f_x}{N}$, (2) where, x - the mean value of the set of given data, f - frequency of the individual data, N - sum of frequencies;
- $s = \sqrt{\frac{\sum(x-\bar{x})^2}{n-1}}$, (3) where, S - Sample standard deviation, $\bar{x}$ - Arithmetic mean of the observations
- Skewness = , $\frac{\sum_i^N (x_i-\bar{x})^3}{(N-1)\times\sigma^3}$ (4) Xi - ith Random Variable, X - Mean of the Distribution, N - Number of Variables in the Distribution, σ - Standard Distribution;
- Kurtosis = ,* $\frac{\sum_i^n (Y_i-\bar{Y})^4}{\sum_i^n (Y_i-\bar{Y}^2)^2}$ (5), Yi - ith Variable of the Distribution, $\bar{y}$ - Mean of the Distribution, n - Number of Variables in the Distribution.
- $r = \frac{n(\sum xy)-(\sum x)(\Sigma_y)}{[n\Sigma x^2-(\sum x)^2]\left[n\sum_y 2-(\Sigma_y)^2\right]}$, where, r = Pearson Coefficient, n - number of the pairs of the stock, ∑xy = sum of products of the paired stocks, ∑x = sum of the x scores, ∑y= sum of the y scores, ∑x2 = sum of the squared x scores, ∑y2 = sum of the squared y scores;
- Y=a+bX, where where Y is the dependent variable (that's the variable that goes on the Y axis), X is the independent variable (i.e. it is plotted on the X axis), b is the slope of the line and a is the y intercept.

Next, the correlation matrix between the variables was performed in order to identify the strength of the links between them, using the Pearson correlation coefficient:

The reasoning of variables

A quantitative analysis based on linear regression was also carried out using Eviews. This econometric technique analyses the dynamics of variables in different domains and can determine the interconnections between variables. This gives the possibility of confirm or deny the existence of correlations between dependent and independent variables. In this study, the independent variable was the rural population and the independent variables were the agricultural labor force, the number of newborns, the rural outmigration, the number of rural deaths, and rural population over 65, calculated according to the following formula (Constantin et al., 2022).

The reasoning of variables

The ARMA (Autoregressive Moving Average) model, specific to time series analysis, was used to estimate the evolution of the defined variables. This process was first described in 1951 by Peter Whittle. The ARMA model is a tool for understanding and predicting future values in the series. Thus the AR component involves regressing the variable on its own past values, and the MA part consists of modelling the error term, being a linear combination of error terms occurring simultaneously at different times in the past (Kim & Lee 2008).

The AR (p) notation refers to the autoregressive model of order p, and the MA (q) notation refers to the moving average model of order q, with the following formulas:

- $x_t = \sum_{i=1}^{p} \varphi_i x_{t-1} + \varepsilon_t$ where φ are the parameters, c is the constant and random variable, ε_t is the white noise;
- $x_t = \mu + \varepsilon_t + \sum_{i=1}^{0} \theta_i \varepsilon_{t-i}$ where θ are the model parameters, μ is the expectation of Xt and ε_{t-i} are white noise error terms;

Thus the ARMA (p, q) model contains the following formula:

- $x_t = \varepsilon_t + \sum_{i=1}^{p} \varphi_i x_{t-1} + \sum_{i=1}^{0} \theta_i \varepsilon_{t-i}$

Box and Jenkins introduced three methodological steps for proper model selection for estimation and prediction of univariate models. These steps consist of: identification, estimation, diagnosis and forecasting. Most variables are non-stationary and need to be differenced to eliminate bias. The determination of 'p' and 'q' is done by checking the correlogram and following the autocorrelation function (ACF) and Partial Autocorrelation Function (PACF) to identify possible patterns (Dicka et al., 2019).

Materials and Methods

With the help of the Web of Science database, a map was generated that includes keywords found in the scientific paper at least 5 times. These words have therefore been grouped into sections (Figure 4).

FIGURE 4.
Connectivity of the topic "rural population" with the keywords used. Proprietary processing based on WoS results using VOSviewer
Source: In house processing.

The first cluster (red) named, "population" contains the following keywords: migration, area, growth, impact, trend immigration, employment, demography, development, cities, rural development, perspective, land use, population decline, rural, rural-urban migration, rurality, rural tourism, population change, regional development, management, quality of life (Figure 4).

Cluster number 2 (green) entitled "rural" includes the following terms health, rural health, rural health, rural population, care, stage, knowledge, covid-19, inequalities, access, survival, education, hospitals, rates, depression, behaviour, results, woman, treatment, prevention, physical-activities, diagnosis (Figure 4).

Cluster number 3 (dark blue) is associated with rural population, inequality, environment, income, ageing population, politics, rural settlements, rural revitalisation, mobility, labour migration, village, driving forces, mobility, transformation, transition, age.

The fourth group (yellow) includes terms such as children, prevalence, risk, intake, exposure, risk factor, adults, awareness, epidemiology, stroke, diet, blood pressure, diabetes, overweight, incidence, communities, and urban population (Figure 4).

Cluster 5 (purple) includes the following keywords: urbanisation, patterns, agriculture, populations, evolution, agriculture, city, population density, adaptation, birds, colony, colonisation, dispersion, climate change, scale, patterns, barriers, region. The numbered cluster (turquoise) includes: community, cancer, service, service, place, geography, health care, primary case, disparity, place, geography (Figure 4).

In terms of keywords addressed by the researchers, they were grouped according to years. So, in the period 2010-2012, the researchers addressed topics such as communities, service, primary care, children epidemiology, risk factors, stroke, prevalence, adults, blood pressure, diabetes, overweight, programme, adolescents, rates, rural care, urban population, fertility. In 2013-2014 the main topics were rural population, population, hypertension, disease, prevention, system. In 2015-2017 the focus was on health, rural, prevention, workforce, integration, area, growth, population decline, policy, patterns, agriculture, countryside, regional development, quality of life. In 2018 researchers were concerned with land use, migration, rural tourism, depopulation, land, diving forces, rural revitalisation, village, covid-19, awareness, health disparities, public health, barriers, rural-urban, employment, knowledge, urbanisation, depopulation (Figure 5).

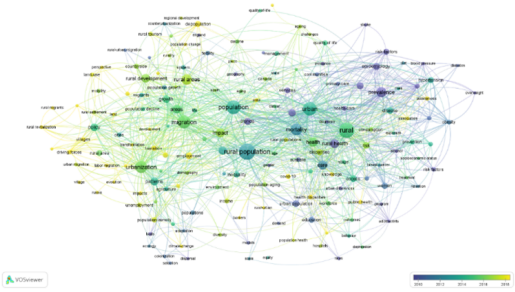

FIGURE 5.

Connectivity of the topic "rural population" with the keywords used by year. Proprietary processing based on WoS results using VOSviewer

Source: In house processing.

In order to be able to identify the degree of interrelationship between the countries that most address the topic under study, a map was made showing the frequency of co-authorship and partnerships between countries presented by nodes. We can also use the colours to identify the different research directions and the distance between nodes to show the level of cooperation between countries. As a result, the United States of America together with China, India, and Australia are the main countries concerned by the topic "rural population". According to the map, we have identified seven colours on the map, so there are seven research directions. It can be seen that Romania shows a high level of cooperation with the Czech Republic and Belgium, and together with France, Finland, Spain and the Netherlands, it is addressing the same research direction (Figure 6).

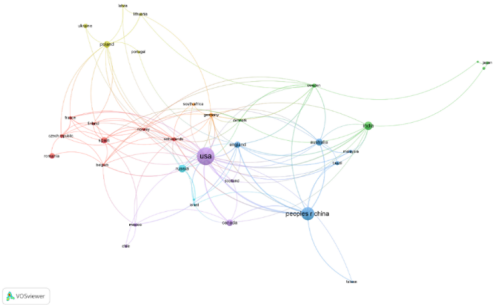

FIGURE 6.

Graphical representation of the topic "rural population" by co-author countries. Proprietary processing based on WoS results using VOSviewer

Source: In house processing.

According to the Web of Scenice database, the country with the most research on the topic "rural population" is the USA with 26,413 papers, followed by China with 10,648 papers, United Kingdom with 9,823 papers, Australia with 7,489 papers. Although in Romania about 45% of the population is located in rural areas, there are 715 articles on this topic (Figure 7).

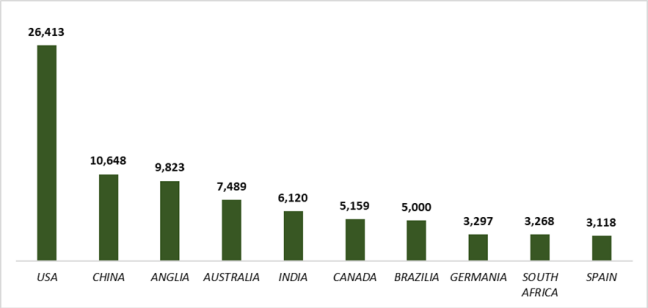

FIGURE 7.
Top author countries for the topic "rural population"
Source: In house processing.

While the majority of studies conducted by researchers around the world on the topic of rural people in 2010 focused on keywords such as rural health, prelevance or epidemiology, the trend of keywords based on the same topic has changed to rural development, rural areas or rural revitalization. This indicates an initial orientation of researchers in countries with a developed rural area such as the USA (which also has the highest number of publications on this topic) towards research based on rural health issues, so that over time this has shifted towards issues with direct implications for the rural population.

The topic of 'rural population' is still relevant for researchers, so the degree of study differs from country to country, depending on the share of the rural population in the total, the challenges they face and the directions they want to take. In the case of Romania, whose rural population is classed as intermediate (45.6% of the total), there is a particular interest, allocating through the two national rural development programmes, funds worth around EUR 15 billion, which aimed to increase the standard of living for those living in rural areas, by developing not only the rural economy, but also the whole rural area.

In terms of Romania's total population, the rural population and the number of newborns, there is a downward trend during the period under review. In the case of the rural population, it recorded a percentage value of 5.4% in 2021 compared to 2007, due to the decrease in the number of newborns and the increase in the number of deaths (Figure 8).

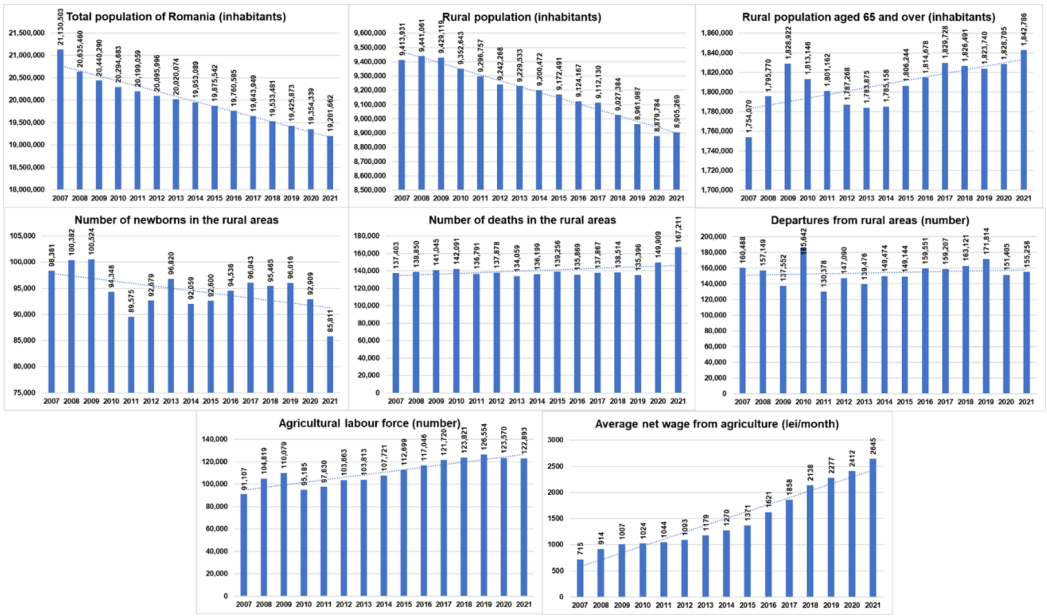

FIGURE 8.

Graphical representation of the demographic situation of rural areas in Romania

Source: In house processing.

It is worth noting that in 2021, compared to the previous year, the rural population recorded a slight increase, although the level of births decreased by 7.6% and the level of deaths increased by 11.5% compared to the previous year, which was caused by the migration of the population from urban to rural (more precisely, peri-urban) areas as a result of the measures adopted by the government against the spread of covid-19, whereby the movement of the population was restricted. In practice, these restrictions were felt by the working population in urban centres, who sought solutions to this inconvenience, so their response was to move to areas close to the cities, also favoured by the possibility of working from home (Figure 8).

The agricultural labour force fell sharply by 13.5% in 2010 compared to the previous year due to the migration of the rural population to western European countries with the emergence of firms recruiting skilled and unskilled labour. However, due to programs financed from the EU budget, whereby those who set up agricultural or non-agricultural activities in rural areas were made conditional on the creation of jobs, this led to an increase in the number of rural workers. At the same time, the development of farms has contributed to the creation of new jobs and farmers have been forced to increase their wages to make the sector attractive (Figure 8).

The values of the Skewness indicator show values different from 0, which indicates an asymmetric distribution of the analysed data, with the exception of mortality whose distribution is not symmetric, tending more towards the upper part. The Kurtosis index shows values greater than 3 for variable no. 5 (mortality), indicating a leptokurtic distribution. However, through the Jarque Barbera index, whose values are greater than 0, we can state that the distributions analysed are not normal, especially in the case of mortality which presents a value of 34.0 (Table 3).

TABLE 3.

Description of the variables analysed

	Agricultural labour force	Average net wage from agriculture	Birth registration (rural)	Departures from rural areas	Mortality (rural)	Rural population	Rural population aged 65 and over	Total population
Mean	110821.3	1504.5	94541.9	154449.9	140555.9	9185933.0	1808116.0	19970972.0
Median	110079.0	1270.0	94536.0	155258.0	137878.0	9200472.0	1813146.0	19953089.0
Maximum	126554.0	2645.0	100524.0	185642.0	167211.0	9441061.0	1842786.0	21130503.0
Minimum	91107.0	715.0	85811.0	130378.0	134059.0	8879784.0	1754070.0	19201662.0
Std. Dev.	11462.8	613.6	3891.0	13753.6	8270.6	184933.3	23680.3	521153.2
Skewness	-0.2	0.6	-0.4	0.4	2.5	-0.2	-0.6	0.5
Kurtosis	1.8	2.0	3.1	3.2	8.4	1.9	2.8	2.8
Jarque-Bera	1.0	1.6	0.4	0.4	34.0	0.8	1.1	0.7
Probability	0.6	0.5	0.8	0.8	0.0	0.7	0.6	0.7
Observations	15	15	15	15	15	15	15	15

Source: In house processing.

Taking into account the dependent variable, which we will consider below and which will be the basis for the linear regression model (rural population), a range between 8,879,784 and 9,441,061 inhabitants is shown, with a mean value of the range of 9,185,933 inhabitants. The Skewness indicator shows a negative value of 0.2, indicating an asymmetric distribution of the data, which tends more towards the lower part, and the Kurtosis value shows a value of 1.9 indicating a flat distribution of the data analysed. Also, with a value of 0.8 of the Jarque-Bera indicator we can state that the distribution analysed is not normal (Table 3).

It is important and vital that the statistical properties of a process that generates a series of data do not change over time. Stationarity, by taking consecutive samples of data of the same size, must have identical covariances.

Using the Dickey-Fuller augmented statistical test, the associated probability t-Statistic was identified for the variables analysed.

Using the Dickey-Fuller statistical test, in the initial version, only the variables "agricultural labour force" and "Departures from rural areas" show values lower than 0.05 of the associated t-statistic test*. Therefore, to validate the hypothesis, the data series were logarithmized, so the remaining variables also present values lower than 0.05 of the associated t-Statistic Prob*, the null hypothesis being rejected, and the alternative hypothesis being accepted (Table 4).

TABLE 4.

Results of the stationarity test of the variables analyzed (summarized)

Null Hypothesis:					
Exogenous: Constant					
Lag Length: 0 (Automatic - based on SIC, maxlag=1)					
Variable		**Initial data sets**		**Logarithm-matched data series**	
		t-Statistic	**Prob.***	**t-Statistic**	**Prob.***
Agricultural labour force	Augumented Dickey-Fuller test statistic	-3.140404	0.04981	-	-
Test critical values:	1% level	-4.200055	-	-	-
	5% level	-3.175351	-	-	-
	10% level	-2.728985	-	-	-
Birth registration rural	Augumented Dickey-Fuller test statistic	-2.43239	0.1523	-3.366433	0.0348
Test critical values:	1% level	-4.057909	-	-4.121989	-
	5% level	-3.119909	-	-3.144919	-
	10% level	-2.701103	-	-2.713750	-
Departures from rural areas	Augumented Dickey-Fuller test statistic	-4.741714	0.0027	-	-
Test critical values:	1% level	-4.803492	-	-	-
	5% level	-3.403313	-	-	-
	10% level	-2.841819	-	-	-
Mortality rural	Augumented Dickey-Fuller test statistic	-1.199383	0.9959	-3.698812	0.0483
Test critical values:	1% level	-4.004424	-	-5.604618	-
	5% level	-3.098896	-	-3.694851	-
	10% level	-2.690439	-	-2.982813	-
Rural population	Augumented Dickey-Fuller test statistic	-0.747358	0.9867	-3.241665	0.045
Test critical values:	1% level	-4.200055	-	-4.200055	-
	5% level	-3.175351	-	-3.175351	-
	10% level	-2.728985	-	-2.728985	-
Rural population aged 65 and over	Augumented Dickey-Fuller test statistic	-0.270094	0.9638	-3.143516	0.0475
Test critical values:	1% level	-4.200056	-	-4.200055	-
	5% level	-3.175352	-	-3.175351	-
	10% level	-2.728985	-	-2.728985	-

Source: In house processing.

A significant association is observed between the rural population and the agricultural labour force, with a negative correlation coefficient value of 0.8464 and a significance threshold of 0.0001, indicating an inverse proportionality and a strong link between the two variables (Table 5).

TABLE 5.

Correlation matrix between the variables analysed

Correlation/ Probability	Agricultural labour force	Average net wage from agriculture	Birth registration (rural)	Departures from rural areas	Mortality (rural)	Rural population	Rural population aged 65 and over
Agricultural labour force	1						

Average net wage from agriculture	0.9045	1					
	0.0000	-----					
Birth registration (rural)	-0.1914	-0.4601	1				
	0.0444	0.0544	-----				
Departures from rural areas	0.1407	0.2307	0.1230	1			
	0.0469	0.0480	0.0524	-----			
Mortality (rural)	0.3377	0.5739	-0.5741	0.0636	1		
	0.0383	0.0253	0.0252	0.0219	-----		
Rural population	-0.8464	-0.9608	0.5540	-0.1630	-0.4695	1	
	0.0001	0.0000	0.0321	0.0416	0.0374	-----	
Rural population aged 65 and over	0.7805	0.7513	-0.2637	0.1724	0.5328	-0.6089	1
	0.0006	0.0012	0.3423	0.5391	0.0408	0.0160	-----

Source: In house processing.

Also, between the rural population and newborns there is a medium association in terms of intensity (0.5540), but with a direct proportionality between the two variables. Also, between rural population and mortality, there is a medium association as intensity (0.4695), with an inverse proportionality, and the significance threshold presents a value of 0.0374 (Table 5).

After analysing the descriptive statistics on indicators, the next step is to design the cross-sectional linear regression model, which looks at the relationship between the rural population and the agricultural labour force, the number of newborns, the number of people who have migrated from the countryside, the number of deaths and the rural population aged over 65. The aim is thus to establish an equation for the rural population defined in relation to the other independent variables analysed (Table 6).

TABLE 6.

Linear regression model using the least squares method

Dependent Variable: LRURAL_POPULATION				
Method: Least Squares				
Sample: 2007-2021				
Included observations: 15				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	-7.005215	3.700378	1.893108	0.0909
AGRICULTURAL_LABOUR_FORCE	1.724306	2.758307	-6.259250	0.0010
LBIRTH_REGISTRATION_RURAL	0.210888	0.058899	3.580471	0.0059
DEPARTURES_FROM_RURAL_AREAS	-1.968070	1.477207	-1.34013	0.2131
LMORTALITY_RURAL	-0.018347	0.050276	-0.36492	0.7236
LRURAL_POPULATION AGED 65 AND_OVER	0.489337	0.268166	1.824753	0.1013
R-squared	0.916423	Mean dependent var		16.03299
Ajusted R-squared	0.869991	S.D. dependent var		0.020178
S.E. of regression	0.007276	Akaike info criterion		-6.719406
Sum squared resid	0.000476	Schwarz criterion		-6.436186
Log likelihood	2.526897	Hannan-Quinn criter.		-6.722423
F-statistic	19.73703	Durbin-Watson stat		2.156705
Prob(F-statistic)	0.004131			

Source: In house processing.

The coefficient of determination indicates that 91.2% of the rural population is explained by the agricultural labour force, the number of newborns, the number of people who migrated from the countryside, the number of deaths and the rural population aged over 65 (Table 6).

If the probability is below 0.05, the null hypothesis is rejected, which means that the parameters of the variables differ significantly from 0. In this case, in the econometric model, the probability has a value below 0.05, leading to the rejection of the null hypothesis and the acceptance of the alternative one (Table 6).

To balance the mechanical increase of the coefficient of determination, the adjusted R2 shows a decrease of only 5.06% compared to the value of the coefficient of determination; thus, the model is validated. Also, the Durbin-Watson test, which indicates autocorrelation between the model residuals, indicates that the successive error terms are within normal parameters, recording a value around 2 (Table 6).

Based on the stationarity test resulting from Table 2, the following were additionally determined: the value of the constant, the trend, the r-squared and the probability associated with the F-test, which help to identify the best model for estimating the variables under analysis (Table 7).

TABLE 7.

Completion of the stationarity test for ARMA model estimation

Variable		Coefficient	Std. Error	t-Statistic	Prob.
RURAL_POPULATION	C	76442.81	29106.91	2.626277	0.0221
	@TREND("2007")	-37009.20	12653.63	-2.924790	0.0127
	R-squared	0.473547			
	Prob(F-statistic)	0.021289			
BIRTH_REGISTRATION__RURAL_	C	-1246.51	1006.023	-1.239047	0.0467
	@TREND("2007")	-27009.20	10673.59	-2.723460	0.0092
	R-squared	0.571546			
	Prob(F-statistic)	0.022058			
MORTALITY__RURAL_	C	-59777.88	57829.12	-1.033699	0.0335
	@TREND("2007")	70850.55	39032.87	1.815151	0.0468
	R-squared	0.31286			
	Prob(F-statistic)	0.036984			
AGRICULTURAL_LABOUR_FORCE	C	21437.19	3641.38	5.887107	0.0042
	@TREND("2007")	-2215.24	406.07	-5.455343	0.0055
	R-squared	0.953824			
	Prob(F-s tatistic)	0.008901			
DEPARTURES_FROM_RURAL_AREAS	C	199638.80	42311.87	4.71827	0.0006
	@TREND("2007")	964.23	943.56	1.021902	0.3288
	R-squared	0.682183			
	Prob(F-statistic)	0.001828			

Source: In house processing.

It is observed that both the constant, the trend and the probability associated with the F test show values less than 0.05, which leads to the rejection of the null hypothesis and the acceptance of the alternative one (Table 7).

Based on the autocorrelation function (ACF) and partial autocorrelation function (PACF) correlogram for each variable, the values for "p" and "q" were determined, from which the best variance of the estimated forecast model was presented below, taking into account the significant ARMA components and by comparing the Akaike, Schwartz and Hannan-Quinn indicators.

With the exception of the variables "newborns" associated with MA(2), "labour force in agriculture" associated with AR(1) and "migration from rural areas" associated with MA(1), probability values greater than 0.05 were recorded. However, the values obtained are close to the reference value and are therefore considered acceptable for the achievement of the pre-vision (Table 8).

TABLE 8.

Estimated models selected for forecasting purposes

Variable		Coefficient	Std. Error	t-Statistic	Prob.
RURAL_POPULATION	C	-42479.33	10246.69	-4.145664	0.0016
	AR(1)	-0.902264	0.486943	-1.852915	0.0409
	MA(1)	0.614729	0.876530	0.701320	0.0477
	R-squared		0.180301		
	Akaike info criterion		4.597230		
	Schwarz criterion		4.786040		
	Hannan-Quinn criter.		4.595220		
	Prob(F-statistic)		0.016137		
BIRTH_REGISTRATION__RURAL_	C	-58111.05	46399.12	-1.252417	0.2389
	AR(1)	-0.058850	0.397861	-0.147917	0.0453
	MA(2)	-0.737676	0.385026	-1.915911	0.0513
	R-squared		0.364700		
	Akaike info criterion		9.380170		
	Schwarz criterion		9.562750		
	Hannan-Quinn criter.		9.363260		
	Prob(F-statistic)		0.019138		
MORTALITY__RURAL_	C	14199.55	14262.06	0.995616	0.0343
	AR(2)	0.333631	1.039711	0.320888	0.0449
	MA(2)	-0.999998	5631.498	-0.000178	0.0479
	R-squared		0.298757		
	Akaike info criterion		10.73335		
	Schwarz criterion		10.91593		
	Hannan-Quinn criter.		10.71644		
	Prob(F-statistic)		0.029402		
AGRICULTURAL_LABOUR_FORCE	C	22972.96	19795.81	1.160496	0.0273
	AR(1)	-0.529172	0.781331	-0.677270	0.0514
	MA(1)	0.911416	0.998704	0.912599	0.0383
	R-squared		0.187355		
	Akaike info criterion		10.66561		
	Schwarz criterion		10.84819		
	Hannan-Quinn criter.		10.64870		
	Prob(F-statistic)		0.051740		
DEPARTURES_FROM_RURAL_AREAS	C	23851.11	13347.57	0.178693	0.0462
	AR(2)	0.28736	0.25718	1.117350	0.0290
	MA(1)	0.49537	0.46153	1.155320	0.0519
	R-squared		0.641295		
	Akaike info criterion		12.55393		
	Schwarz criterion		12.73652		
	Hannan-Quinn criter.		12.53703		
	Prob(F-statistic)		0.013452		

Source: In house processing.

The next step is to verify the estimation of the ARMA process by identifying the inverse positioning of the AR/MA roots. This can be visualized in Figure 8, which validates the positioning of the points within the circle.

The final step is to make forecasts based on the steps taken so far. In the case of the rural population, the downward trend in the number of inhabitants continues until 2027, so that if in 2021 the rural population numbered about 8.9 million inhabitants, according to the calculated model it will fall to about 8.58 million inhabitants, representing a decrease of 3.6% (Figure 9).

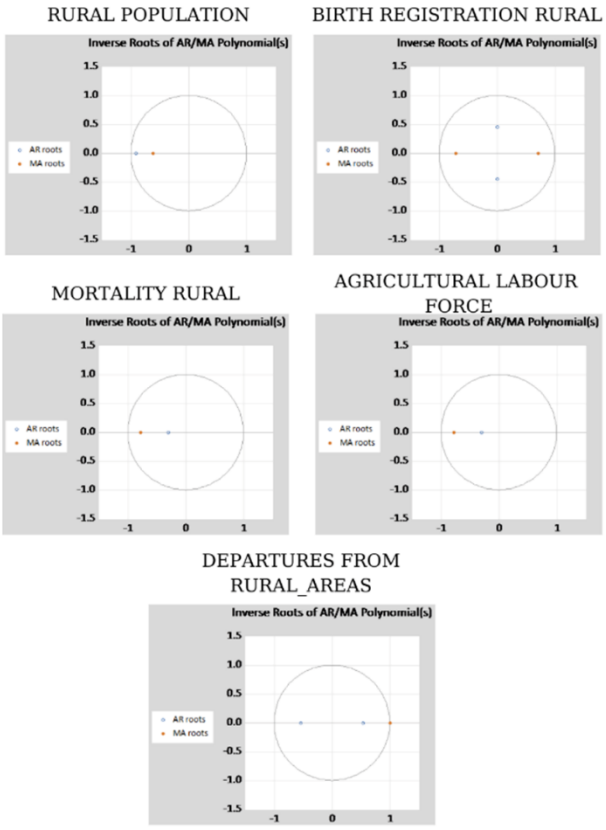

FIGURE 9.
Inverse Roots of AR/MA Polynomial. Source: In house processing
Source: In house processing.

In terms of the number of newborns, there is a slight increase of 0.78% in the year 2027 compared to the period 2021, reaching in the forecast year a number of approximately 86.5 thousand newborns. Regarding mortality, a steady increase in the number of deaths has been forecast, with an estimated 182.3 thousand deaths, an increase of 9% compared to 2021 (Figure 10).

The agricultural labour force has been estimated at 137.6 thousand jobs, up 11.9% compared to 2020. Also, according to the ARMA model, rural outmigration appears to moderate, with an estimated decrease of 14.3% in 2027 compared to 2021 (Figure 10).

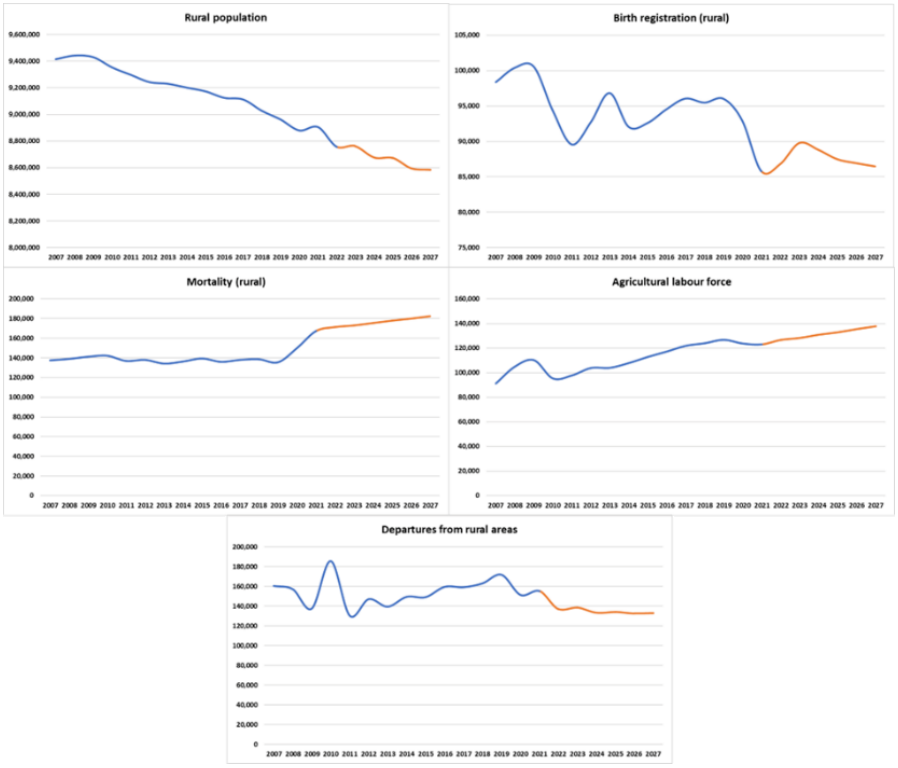

FIGURE 10.
Forecasting the main variables determined according to the ARMA model
Source: In house processing.

Discussion

The topic of "rural population" remains a topical one for researchers around the world, so it is predominantly concentrated in those countries with significant financial power to support with appropriate measures targeting rural populations (Ivanovic et al., 2009). Another important factor is the scale of the rural population at country level (Ardakani et al., 2020; Slámová & Belčáková, 2019). Even so, this topic has also begun to be addressed in countries that have experienced significant imbalances between urban and rural populations, which have sought to identify contributing factors in order to find solutions. Most of the authors who address the topic of rural population come from the US, but lately, due to the increasing urbanisation process in China, Chinese authors have focused on this topic, taking into account the imbalances that have arisen.

Like much of Europe's developing countries, Romania is facing demographic problems overall, caused by population migration to other countries and social changes in the population. The departure from traditions and customs can be seen as a key element, with young people focusing on careers, seeking a good income and a decent living, and limiting themselves to a small number of children (Popescu et al., 2018; Ibanescu, 2020). The implications for divorce rates are also a key issue, which confers instability at family level and limits the number of children per family.

Basically, the ageing population has remained in rural areas, while young people without social and professional development prospects have migrated to urban centres. Only the bordering areas close to cities enjoy population increases, but this cannot be considered an exclusively rural area, if compared to other truly rural regions in Romania, where basic infrastructure and connectivity between localities may even be lacking. Also, the variable on departures from rural localities, which shows low variations, can be explained by the perspective that those who wanted to leave have already left by now (Kudo et al., 2015; Constantino et al., 2022; Zhao & Liu, 2022).

Characterised by an ageing population (including health problems caused by old age) they have given up farming and opted to rent out their land to large farms in the area. Also, the heirs who moved to the city did not consider continuing the family's farming activities. In the process, family farms involving all family members are becoming fewer and fewer (Zhang et al., 2022; Gašić et al., 2022; Harbiankova & Gertsberg, 2022).

Demographic decline coupled with an ageing population cannot provide the labour force that agriculture needs, even if investments in agricultural machinery and equipment contribute to increasing labour productivity. The need for skilled labour to manage this equipment is a real impediment. Thus, the increase in net income from agriculture has been mainly due to labour shortages in the context of a strong migration of the rural population (Gašić et al., 2022; Mack et al., 2018; Raicov et al., 2021; Špulerová et al., 2018).

All this is also highlighted by the close links that have been established between these variables analysed. It is clear that the rural population tends to decrease as long as the number of newborns continues to fall and the number of deaths tends to increase. This cannot be tempered as long as the lack of jobs is a key issue in ensuring a decent living for inhabitants (Lile et al., 2018; Cebotari et al., 2017).

The linear regression model determined shows that the dependent variable (rural population) is influenced to a considerable extent (91.6%) by the other variants under analysis. Therefore, encouraging young people in these areas to contribute to the increase in birth rate may be a key component in the resuscitation of these areas. On the other hand, keeping young people in these areas cannot be done without providing them with well paid jobs and ensuring that the localities of residence have an adequate building infrastructure.

Although the estimated number of deaths may be considered relatively high, it is clear that in the years to come this estimate will be increasingly unlikely as the number of over 65s years increases exponentially in 2030. This is due to the communist regime, which, since 1968, has banned abortions, resulting in an explosion in the birth rate, and the results of which will really be felt in 2030 (representing the age of 65 they will reach on that date), putting pressure on the Romanian economic system.

Recently, in Romania, there have been harmoniously developed localities (which are not on the outskirts of urban centres), but which, with the help of European funds, have succeeded in harmoniously developing their localities and attracting young people from urban centres. Unfortunately, these cases are very few in number, but they can nevertheless be used as a model.

Both Romania and the other Member States of the European Union need to place greater emphasis on stabilising rural population decline and population growth. Encouraging the establishment of agricultural and, above all, non-agricultural activities must remain a priority among EU and national measures. Only by creating viable economic activities can jobs be created and by collecting taxes, local authorities will have funds to invest in infrastructure (Iancu et al., 2022).

Conclusions

The paper has provided an overview of the demographic outlook of the population in rural Romania, paying special attention to the factors that can influence this variable. The simulations in this paper have shown to what extent the predictions of rural population, the number of births and deaths, the agricultural labour force and the departures from rural areas depend on the authors' approach.

Therefore, the model estimates determined in this study cannot represent exact values of what will happen by the year 2027, but rather to understand the prospects and directions in which the variables analysed are heading, in order to establish appropriate measures, reverse or limit damage.

Birth rate, mortality rate, labour force employed in agriculture, migration of the rural population and the number of inhabitants aged over 65 years in rural areas influence in a very high proportion (91.6%) the decline of the rural population.

However, the estimated results present a preservation of the general trends calculated on the basis of the existing data series, which may give us a plausible degree, perhaps less so in the case of deaths, which may occur in unforeseen events, as was the case with the COVID-19 pandemic or other predictable events that will occur in 2030.

The initial development of pilot areas, in which loans can be granted on preferential terms to the rural inhabitants of these areas, could be a start in terms of revitalising these areas, given that in order to access European funds, beneficiaries need a significant share of financial resources, which most of the rural population do not have. Young people may be tempted to stay or migrate from urban areas to rural areas to access preferential credit and open their own businesses, which can generate jobs for the rural population and tax revenue for local authorities, with which they can develop local infrastructure. As this measure is implemented, the impact it could have can be assessed and consideration can be given to extending the programme nationwide.

References

Ardakani, Z., Bartolini, F., & Brunori, G. (2020). New Evaluation of Small Farms: Implication for an Analysis of Food Security. *Agriculture 2020, 10*(74). https://doi.org/10.3390/agriculture10030074

Argatu, R., & Razvanta, F. (2022). Sustainable societal development perspectives for rural Romania in light of Horizon 2020. *Proceedings of the International Conference on Business Excellence, 16*(1), 2495-508. https://doi.org/10.2478/picbe-2022-0048

Barreto Riaño, H., Escobar, J. W., Linfati, R., & Ortiz-Araya, V. (2022). Disciplinary Categorization of the Cattle Supply Chain-A Review and Bibliometric Analysis. *Sustainability 2022, 14*(21), 14275. https://doi.org/10.3390/su142114275

Batur, F., Bocci, R., & Bartha, B. (2021). Marketing Farmers' Varieties in Europe: Encouraging Pathways with Missing Links for the Recognition and Support of Farmer Seed Systems. *Agronomy 2021, 11*(11), 2159. https://doi.org/10.3390/agronomy11112159

Bogdanov, N., Meredith, D., & Efstratoglou, S. (2008). A typology of rural areas in Serbia. *Ekonomski anali 2008, 53*(177), 7-29.

Bran, F., Ciobanu, G., Popescu, M. L., & Vasilache, P. C. (2020). Sustainable Local Development in Romania in the Opportunity of Creating Jobs. *Eur. J. Sustain. Dev., 9*(3), 287. https://doi.org/10.14207/ejsd.2020.v9n3p287

Cebotari, S., Cristea, M., Moldovan, C., & Zubascu, F. (2017). Renewable energy's impact on rural development in northwestern Romania. *Energy Sustain. Dev., 37*, 110-123. https://doi.org/10.1016/j.esd.2017.02.002

Ciutacu, C., Chivu, L., & Andrei, J. V. (2015). Similarities and dissimilarities between the EU agricultural and rural development model and Romanian agriculture. Challenges and perspectives. *Land Use Policy, 44*, 169-176. https://doi.org/10.1016/j.landusepol.2014.08.009

Comanescu, I. S., Foris, D., & Floris, T. (2019). Dimensions of the Funding Programmes for Sustainable Rural Development in Romania. *Econ. Sci. Rural Dev.*, 50, 44-51.

Constantin, M., Sacală, M.-D., Dinu, M., Pișta lu, M., Pătărlăgeanu, S. R., & Munteanu, I.-D. (2022). Vegetable Trade Flows and Chain Competitiveness Linkage Analysis Based on Spatial Panel Econometric Modelling and Porter's Diamond Model. *Agronomy, 12*(2), 411. https://doi.org/10.3390/agronomy12020411

Costantino, C., Mantini, N., Benedetti, A. C., Bartolomei, C., & Predari, G. (2022). Digital and Territorial Trails System for De-veloping Sustainable Tourism and Enhancing Cultural Heritage in Rural Areas: The Case of San Giovanni Lipioni, Italy. *Sustainability 2022, 14*(21), 13982. https://doi.org/10.3390/su142113982

Csizmady, A., Csurgó, B., Kerényi, S., Balázs, A., Kocsis, V., & Palaczki, B. (2021). Young Farmers' Perceptions of Sustainability in a Wine Region in Hungary. *Land, 10*(8), 815. https://doi.org/10.3390/land10080815

Dax, T., & Fischer, M. (2018). An alternative policy approach to rural development in regions facing population decline. *European Planning Studies, 26*(2). https://doi.org/10.1080/09654313.2017.1361596

Dicka, J. N., Gessert, A., & Snincak, I. (2019). Rural and non-rural municipalities in the Slovak Republic. *Journal of Maps, 15*(1). https://doi.org/10.1080/17445647.2019.1615010

Dinu, M., Patarlageanu, S. R., Chiripuci, B., & Constantin, M. (2020). Accessing European funds for agriculture and rural devel-opment in Romania for the 2014-2020 period. In *Proceedings of the 14th International Conference on Business Excellence (ICBE)-Business Revolution in the Digital Era*, (pp. 717-727). Sciendo. http://doi.org/10.2478/picbe-2020-0068

Dumitru, E. A., Micu, M. M., & Sterie, C. M. (2023). The key to the development of agricultural cooperatives in Romania from the perspective of those who run them. *Outlook on Agriculture, 52*(1), 89-100. https://doi.org/10.1177/00307270221138118

Dumitru, E. A., Ursu, A., Tudor, V. C., & Micu, M. M. (2021). Sustainable Development of the Rural Areas from Romania: Devel-opment of a Digital Tool to Generate Adapted Solutions at Local Level. *Sustainability, 13*(21), 11921. https://doi.org/10.3390/su132111921

Fayet, M. J. C., Reilly, K. H., Ham, V. C., & Verburg, P. H. (2022). The potential of European abandoned agricultural lands to contribute to the Green Deal objectives: Policy perspectives. *Environmental Science & Policy, 133*, 44-53. https://doi.org/10.1016/j.envsci.2022.03.007

Gašić, M., Perić, G., & Dramića nin, S. (2022). Rural areas and rural development policy of the Republic of Serbia. *Management and Education, 18*(2).

Giannakis, E. (2014). The role of rural tourism on the development of rural areas: The case of Cyprus. *Romanian Journal of Regional Science, 8*(1), 38-53.

Glatz, C., & Bodi-Fernandez, O. (2020). Individual social capital and subjective well-being in urban- and rural Austrian areas. *Österreich Z Soziol, 45*, 139-163. https://doi.org/10.1007/s11614-020-00399-9

Guarín, A., Rivera, M., Pinto-Correia, T., Guimar, N., Sumane, S., & Moreno-Pérez, O. M. (2020). A new typology of small farms in Europe. *Glob. Food Secur.*, 26, 100389. https://doi.org/10.1016/j.gfs.2020.100389

Hall, S. A., Kaufman, J. S., & Ricketts, T. C. (2006). Defining urban and rural areas in US epidemiologic studies. *Journal of Urban Health, 83*(2), 162-175.

Harbiankova, A., & Gertsberg, L. (2022). Information Model for Sustainable Rural Development. *Energies, 15*(11), 4009. https://doi.org/10.3390/en15114009

Ho, A. D., & Yo, C. C. (2015). Descriptive statistics for modern test score distributions: Skewness, kurtosis, discreteness, and ceiling effects. *Educational and psychological measurement, 75*(3), 365-388. https:doi.org/10.11 77/0013164414548576

Holland, J., Burian, M., & Dixey, L. (2003). Tourism in poor rural areas: Diversifying the product and expanding the benefits in rural Uganda and the Czech Republic. *Pro-Poor Tourism Partnership, PPT Working Paper*, (12). https://lib.icimod.org/record/11291

Iancu, T., Petre, I. L., Tudor, V. C., Micu, M. M., Ursu, A., Teodorescu, F.-R., & Dumitru, E. A. (2022). A Difficult Pattern to Change in Romania, the Perspective of Socio-Economic Development. *Sustainability, 14*(4), 2350. http://doi.org/10.3390/su14042350

IancuT., Tudor, V. C., Dumitru, E. A., Sterie, C. M., Micu, M. M., Smedescu, D., Marcuta, L., Tonea, E., Stoicea, P., Vintu, C., Jitareanu, A. F., & Costuleanu, L. C. (2022). A Scientometric Analysis of Climate Change Adaptation Studies. *Sustainability, 14*(19), 12945. https://doi.org/10.3390/su141912945

Ibanescu, B.-C., Eva, M., & Gheorghiu, A. (2022). Questioning the Role of Tourism as an Engine for Resilience: The Role of Acces-sibility and Economic Performance. *Sustainability, 12*(14), 5527. https://doi.org/10.3390/su12145527

Ivanovic, O. D. M., Golušin, M. T., Dodi'c, S. N., & Dodi'c, J. M. (2009). Perspectives of sustainable development in countries of Southeastern Europe. *Renew. Sustain. Energy Rev., 13*, 2079-2087.

Jasiński, J., Kozakiewicz, M., & Sołtysik, M. (2021). The Effectiveness of Energy Cooperatives Operating on the Capacity Market. *Energies, 14*(11), 3226. https://doi.org/10.3390/en14113226

Kim, S., & Lee, J. W. (2008). Demographic changes, saving, and current account: An analysis based on a panel VAR model. *Japan and the World Economy, 20*(20), 236-256. https://doi.org/10.1016/j.japwor.2006.11.005

Kudo, S., Mutisya, E., & Nagao, M. (2015). Population Aging: An Emerging Research Agenda for Sustainable Development. *Soc. Sci*., .(4), 940-966. https://doi.org/10.3390/socsci4040940

Lile, R., Boghicevici, C., & Stoian, C. D. (2018). Role of social professions in the process of sustainable development of rural area. Study case. *Jurid. Trib. Trib. Jurid., 8*(2), 415-424.

Liu, F. H., & Liang, M. (2021). New urbanization, human capital and industrial structure up-grading: Based on the moderating effect of population aging. *Journal of Social Science of Hunan Normal University, 50*, 46-55.

Liu, J., Jin, X., Xu, W., & Zhou, Y. (2022). Evolution of cultivated land fragmentation and its driving mechanism in rural devel-opment: A case study of Jiangsu Province. *Journal of Rural Studies, 91*, 58-72. https://doi.org/10.1016/j.jrurstud.2022.02.011

Mack, G., Fintineru, G., & Kohler, A. (2018). Do Rural Development Measures Improve Vitality of Rural Areas in Romania? *AgroLife Sci. J., 7*(2), 82-98. https://agrolifejournal.usamv.ro/index.php/agrolife/article/view/231

Mihai, C., Ulman, S. R., & David, M. (2019). New Assessment of Development Status among the People Living in Rural Areas: An Alternative Approach for Rural Vitality. *Sci. Ann. Econ. Bus.*, *66*(2), 167-192.

Mitrică, B., Serban, P., & Mocanu, I. (2020). Social Development and Regional Disparities in the Rural Areas of Romania: Focus on the Social Disadvantaged Areas. *Soc. Indic Res., 152*(1), 67-89.

National Institute of Statistics of Romania. (2022). https://insse.ro/cms/en

Nazzaro, C., Uliano, A., & Marotta, G. (2021). Drivers and Barriers towards Social Farming: A Systematic Review. *Sustainability, 13*(24), 14008. https://doi.org/10.3390/su132414008

Nordbeck, R., Clar, C., Fuchs, S., Löschner, L., Papathoma-Köhle, M., Thaler, T., & Fischer, T. (2020). The relevance of demographic change for Austrian flood risk management. *Österreichische Wasser- und Abfallwirtschaft, 72*(5-6), 245-251. https://doi.org/10.1007/s00506-020-00659-8

Novotna, M., Preis, J., Kopp, J., & Bartos, M. (2013). Changes in migration to rural regions in the Czech Republic: position and perspectives. *Moravian Geo-graphical reports* (21), 3. https://doi.org/10.2478/mgr-2013-0015

Pavel, A., Moldovan, B. A., Kourtit, K., & Nijkamp, P. (2020). Urban or Rural: Does It Make a Difference for Economic Resilience? A Modelling Study on Economic and Cultural Geography in Romania. *Sustainability, 12*(9), 3776. https://doi.org/10.3390/su12093776

Podolak, P. (2005). Demographic Changes OT Rural Population in Slovakia. *Rural Areas and Development, 3*, 1-14. https://ssrn.com/abstract=3717553

Popescu, A., Dinu, T. A., & Stoian, E. (2018). Demographic and Economic Changes Characterizing the Rural Population in Romania. *Sci. Pap. Ser. Manag. Econ. Eng. Agric. Rural Dev., 18*(2), 333-346.

Popovici, E. A., Mitrica, B., & Mocanu, I. (2018). Land concentration and land grabbing: Implications for the socio-economic de-velopment of rural communities in south-eastern Romania. *Outlook Agric., 47*(3), 204-213. https://doi.org/10.1177/0030727018781138

Prusaczyk, A., Karczmarz, S., Bogdan, M., Żuk, P., & Oberska, J. (2022). Family medicine in rural areas - perspectives and development opportunities. *Journal of Education, Health and Sport, 12*(11), 58-62. https://doi.org/10.12775/JEHS.2022.12.11.008

Raicov, M., Banes, A., Brad, I., & Feher, A. (2021). Absorption of Rural Development Funds. A Lesson Learned? *Sci. Pap. Ser. Manag. Econ. Eng. Agric. Rural Dev., 21*, 505-512.

Šimková, E. (2007). Strategic ap-proaches to rural tourism and sus-tainable development of rural areas. *Agricultural Economics, 53*(6), 263-270.

Slámová, M., & Belčáková, I. (2019). The Role of Small Farm Activities for the Sustainable Management of Agricultural Landscapes: Case Studies from Europe. *Sustainability, 11*(21), 5966. https://doi.org/10.3390/su11215966

Špulerová, J., Petrovič, F., Mederly, P., Mojses, M., & Izakovičová, Z. (2018). Contribution of Traditional Farming to Ecosystem Services Provision: Case Studies from Slovakia. *Land, 7*(2), 74. https://doi.org/10.3390/land7 020074

Sterie, M. S., & Dumitru E. A. (2021). Comparative analysis on accessing european funds through the two National Rural Devel-opment Programs in the South-Muntenia Region, Romania. *Sci. Pap. Ser. Manag. Econ. Eng. Agric. Rural Dev.*, *21*(1), 729-734.

Tudor, V. C., Dinu, T. A., Vladu, M., Smedescu, D., Vlad, I. M., Dumitru, E. A., Sterie, C. M., & Costuleanu, C. L. (2022). Labour Im-plications on Agricultural Production in Romania. *Sustainability, 14*(14), 8549. https://doi.org/10.3390/su14148549

Vladu, M., Panzaru, R. L., Savescu, P., & Matei, G. (2018). Studies on the Situation of Investments Made with Public Funds under 123 Measure "Increasing the Added Value of Agricultural and Forestry Products" of the National Rural Development Pro-gram, in the South-West Oltenia Development Region in Romania. *Rom. Agric. Res.*, *35*, 275281.

Vobecká, J., & Piguet, V. (2012). Fertility, Natural Growth, and Migration in the Czech Republic: An Urban–Suburban–Rural Gradient Analysis of Long-Term Trends and Recent Reversals. *Population, Space and Place, 18*(3). https://doi.org/10.1002/psp.698

Zang, L., Wang, Y., Ke, J., & Su, Y. (2022). What Drives Smallholders to Utilize Socialized Agricultural Services for Farmland Scale Management? Insights from the Perspective of Collective Action. *Land, 11*(6), 930. https://doi.org/10.3390/land11060930

Zhang, D., Yu, L., & Wang, W. (2022). Promoting Effect of Whole-Region Comprehensive Land Consolidation on Rural Revitali-zation from the Perspective of Farm Households: A China Study. *Land, 11*(10), 1854. https://doi.org/10.3390/land11101854

Zhao, X., & Liu, L. (2022). The Impact of Urbanization Level on Urban–Rural Income Gap in China Based on Spatial Econometric Model. *Sustainability, 14*(21), 13795. https://doi.org/10.3390/su142113795

Notes

* Research article.