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Proceedings of the 6th International Conference on Economics and Social Sciences (2023), ISSN 2704-6524, pp. 292-301

The 6th International Conference on Economics and Social Sciences
Geopolitical Perspectives and Technological Challenges for Sustainable Growth in the 21st Century
June 15-16, 2023
Bucharest University of Economic Studies, Romania

Spatial Econometric Analysis of the Main Indicators of the Romanian Educational System

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DOI: 10.24789788367405546-027

Abstract

The Romanian education system is a system characterised by a series of main indicators that quantitatively follow a general situation at the level of each county. Among them is the number of graduates. Analysing the data at the level of each county in Romania, it is possible to create an overview of the educational system, both at the pre-university and university level. However, by analysing these data considering the links that may exist between counties and their correlation with economic indicators, such as average wage, it is possible to observe a direct or indirect influence that a neighbouring county has on another county neighbour. Romania is characterised by several central poles that have a special influence on the neighbouring counties. Thus, this study aims to analyse the number of graduates in relation to the average wage in each county of the country by highlighting the relationships that exist between neighbouring counties. Using spatial econometrics models, it was concluded that the number of graduates of each county affects in the opposite direction the level of the average net salary.

Keywords: education, econometrics, spatial econometrics, statistics, Romania.

JEL Classification: I20, I23, I29.

1. Introduction

A society's development depends on education. Studying education gives one a thorough understanding of human development and offers chances to enhance educational procedures. It could be an opportunity to examine the educational system's operation and the potential for improvement in greater detail. Finding effective teaching, learning strategies, and resolving educational issues can both be aided by this. Education also enables one to comprehend the influences of social, political, and economic factors on educational processes. As a result, it is easier to

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comprehend how various social groups are impacted by the educational system, which can help to develop solutions for building a more equitable system. Studying education can aid in the discovery of novel and creative methods of instruction and learning, as well as reveal information about how educational policies and curricula are created. Understanding the role of technology in education and how it can be applied to enhance educational outcomes is another benefit of studying education.

This study is focused on the Romanian educational system that is strongly characterised by a discrepancy between the rural and the urban environment. The significant differences between urban and rural areas, for instance, necessitate the development of a strong rural economy in Romania. In the first place, a nation's employment rate reveals both its economic development level and the composition of its economic activities. However, it is observed that the economic activities that are carried out in a nation, or, to be more precise, in a state, a province, or a county, have a significant impact on access to education. However, these cause social and economic inequalities and poor economic growth. Romania also faces difficulties due to the poor education of the rural population, which is a result of several factors, including a lack of funding (Burja, Burja, 2014).

2. Problem Statement

The specialised literature is very extensive regarding the educational system. This section of the work aims to provide the reader with a starting point for a better understanding of the analysis conducted by providing a brief review of some studies, some recent, and some less recent but of particular importance.

Faith E. Crampton, in his 2009 study "Spending on School Infrastructure: Does Money Matter", presented a new line of quantitative research that sought to ascertain whether investments in school infrastructure had an impact on student achievement. According to the theoretical framework, financial investments in social, human, and physical capital boosted student achievement. The same result was reached by a 2011 Latin American study as well. In educational institutions, maintaining the infrastructure of the schools can result in better academic performance (Murillo, Roman, 2011). The school needs a factory-model system that receives significant inputs such as infrastructure and students continuously to produce the desired output. Students' or pupils' academic performance cannot be effective in an educational setting where the facilities and furniture are in a dysfunctional state of use. Schools should be most concerned with the accessibility of instructional or didactic resources and the calibre of their physical facilities (Jamil et al., 2018). Few schools, however, are aware of the interdependence and improvements that maintaining the school infrastructure (buildings and furniture) can bring to the enhancement of academic activities there (Taiwo, 2000).

Moreover, it is widely believed that human development and economic growth are closely related, particularly when it comes to education at all levels (Ranis, 2000). This conclusion has been supported by numerous studies that examined a country's economic situation while taking a variety of factors, including education, into consideration.

Using education data from 2005-2018, a study conducted in Croatia validated that a framework that is not sensitive to regional inequalities can only deepen them (Dobrotic, Matkovic, 2022). Moreover, these inequalities already exist and can be intensified without a proper policy (Velkey, 2022). The need for a quality education and professional training is understood beyond the borders of Romania to achieve a competitive economic growth. From the fundamental macroeconomic literature to empirical studies (Topel, 1999; Temple, 2001; Krueger and Lindhal, 2001; and Sianeis and Van Reenen, 2003), schooling was one of the most important factors influencing the growth of GDP per capita. Another study (Hanushek, 2016) that came to the same conclusion as this one supports the notion that primary education lays the groundwork for the skills that students go on to use in higher education and the job market.

A study that brings attention to this point is Stanef (2013), which used regression models to compare education variables in urban and rural areas and concluded that the level of educational inclusion in Romania's counties contributes to the country's economic disparities. Children who have financially challenged parents or parents with low levels of education are more likely to travel the same road. According to a study by Albig et al. (2017), this is an example of a vicious circle. Due to a lack of resources, these families often neglect to invest in their children's education, which results in low incomes.

Due in large part to the process of globalisation, education now plays a crucial role in every economic system. As a result, the relationship between unemployment and education is inverse (Serban, 2012). A person with more education is more likely to land a good job that will help the economy grow. Additionally, to adapt to lifelong changes, education must continue. Education-related expenditures are not independent goals in themselves but rather tools for achieving economic growth. The quantity and quality of domestic and international investments should be considered as well as education alone (Ranis, 2000). Another study carried out in Italy validated the same results. The existing inequalities between the north and the south of the country at the level of the educational system lead to economic inequalities (Guarini et al., 2018). The same results were obtained for Spain using a synthetic index of exclusion in the educational sphere and regional public spending on education (Garcia Luque et al., 2023).

3. Research Questions (Hypotheses)

The research hypotheses of this study concern the link between the factors related to the educational system (the number of high school graduates), and indicators related to the economic situation (average net salary).

H: The number of high school graduates influences the average net salary.

Using the data provided by the National Institute of Statistics in Romania at the level of each county from 2010 to 2020 and using spatial econometrics models, the present study seeks to test the above hypothesis. This time interval was chosen because, at the time of writing the study, it was the only one that contained available data for all the counties of the country.

4. Research Methods

Spatial econometrics models are factual strategies planned to analyse spatial information and measure the effect of geographic area on the results. These models are capable of capturing the connections between economic action and topography, counting diverse sorts of location-based impacts such as spillovers and externalities. They give effective bits of knowledge on the elements of territorial economies and help policymakers get it to the significance of considering components like area when defining economic approaches. At the heart of these models may be a concept known as spatial autocorrelation: the idea that variables that are spatially near (in physical separate) tend to be related. Spatial autocorrelation can be measured utilising diverse measurements, such as Moran's I or Geary's C, and these measurements can give significant data approximately on the quality of spatial connections. Spatial econometrics models integrate the impacts of spatial autocorrelation into their forecasts and allow analysts to account for the effect of spatial proximity on economic results such as poverty, migration, or income imbalance. Spatial econometrics models are a capable tool for economists and policymakers to much better get the complex elements that play inside territorial economies and make better choices. Although there are still numerous challenges related with these models (e.g., information accessibility), their use is developing in significance as increasingly organisations recognise the effect of spatial connections on economic results.

Kapoor et al. (2007), Baltagi et al. (2007), and Lee and Yu (2010) have proposed tests to choose the foremost fitting model for potential expectations (e.g., Hausmann test). A model created by Baltagi and Li (2004) is broadly utilised in experimental considers. This demonstration was made in a consider on cigarette request in 46 American states from 1963 to 1992.

There are three types of spatial interactions to consider. The first model, SAR, looks at how the dependent variable in unit i affects the dependent variable in unit j (j being different from i). This dependence is calculated with the help of a spatial weight matrix WYt that displays the spatial associations between the observations of endogenous variables. The model follows the equation:

$$Y_t = \rho WY_t + Xt\beta + U_t \quad (1)$$

where ρ stands for the spatial autoregressive parameter and Ut represents a vector of errors. The second model, SEM, measures the effect of interactions between the error terms. This is calculated using a spatial weight matrix Wμt which shows that the units could act similarly due to an unobserved trait. This model follows the equation:

$$Yt = Xt\beta + U_t \quad (2)$$

where λ is the spatial autoregressive parameter and Vt is a vector of errors.

A model that encompasses both effects, called SAC, would look like (Elhorst, J.P., 2017):

$$Y_t = \rho WY_t + Xt\beta + u_t,\ u_t = \lambda u_t + \varepsilon_t. \quad (3)$$

The parameters ρ and λ measure the strength of these spatial dependencies. For panel data, the model includes fixed or random effects and takes the following form (Elhorst, J.P., 2017):

$Y_t=\rho WY_t+Xt\beta+\mu+u_t$, $ut = \lambda u_t + \varepsilon_t$. (4)

μ: vector for fixed or random effects. In order to test which of these dependencies should be included in the regression model, the following tests are necessary:

a. LM test for spatial lag

H0: No spatial lag dependency of the dependent variable (The classic regression model is the right one)

H1: There is a spatial lag dependency of the dependent variable (The spatial regression model is the right one)

b. LM test for spatial errors

H0: No spatial error dependency

H1: There is a spatial error dependency

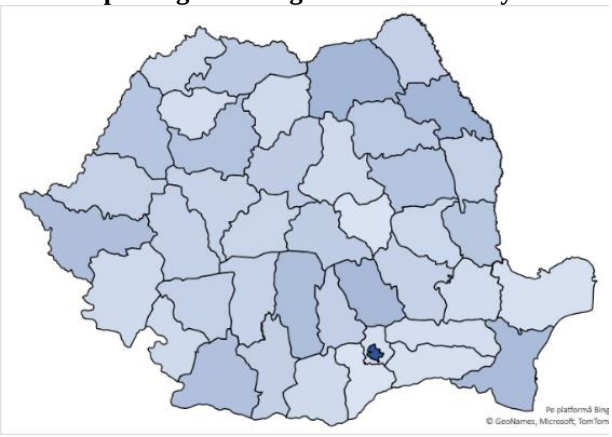
After the results of the tests have been obtained, the most suitable model to explain the relationship between the endogenous and the exogenous variables is chosen, with the interpretation of the coefficients that resulted.

The accessibility to these models has increased as various software have been developed through which the necessary tests can be performed. Thus, in this study, Geoda (software dedicated to spatial econometrics) and the specific packages from STATA are used. This is an ideal environment for analysis due to the already existing tools and infrastructure in panel data analysis. These available packages offer comprehensive and important tools in estimating econometric models by integrating both the spatial components between observations and those arising from errors. In addition, both models with fixed or random effects are implemented. With the help of the Geoda software, the spatial weight matrix is created and then introduced into STATA to create the spatial models.

5. Findings

The situation of high school graduates in 2020 can be seen in the figures below. There are no big differences between the counties, but Bucharest stands out as the first.

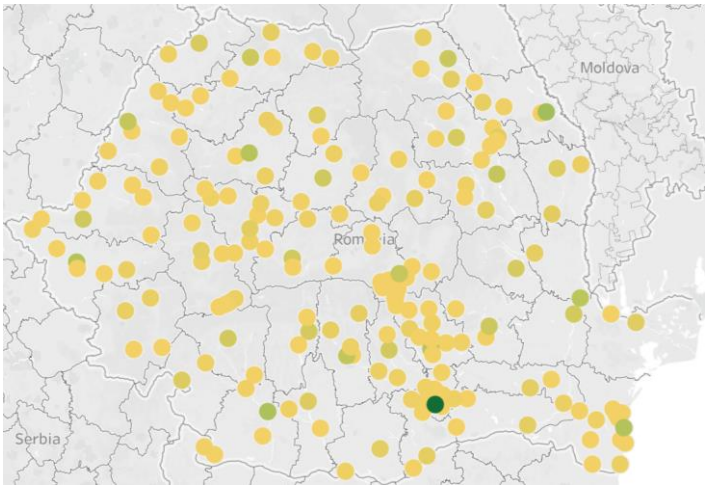
Figure 1. Map of high school graduates at county level – 2020



Source: Created by author based on collected data.

Regarding the data at the locality level for the number of graduates in 2020, Figure 2 suggests in the best possible way the current situation. Again, Bucharest remains the city with the highest number of high school graduates, followed by Iasi, Timisoara, Cluj-Napoca, Constanța, and Ploieşti. Also, in the figure from point 2, it can be observed that there is a cumulation of high schools in the Muntenia area, as well as a deficit in the north of the country.

Figure 2. Map of high school graduates at locality level – 2020



Source: Created by author based on collected data.

In order to see how the number of graduates influences the average net wage, an econometric analysis was conducted. Spatial model specifications with panel data were estimated to account for the presence of spatial dependencies.

In the first stage of the analysis, the stationarity of the data was checked. With a p-value less than 0.05, the null hypothesis was accepted, showing that the panel is stationary, both for the dependent variable and the independent variable. The variables were logarithmised before the testing.

Following spatial dependence tests (Pesaran test), the null hypothesis was rejected. The spatial errors are not independent, which means that a spatial model is required. Regarding the normal distribution of errors, the null hypothesis cannot be rejected for a 90% probability of guaranteeing the results.

In terms of spatial dependence, an attempt was made to estimate the fitted model using Stata's xsmle package. Beginning with the SDM model, it was determined whether it could be reduced to SAR or SEM. Additionally, an inverse squared distance matrix was employed. The tests revealed that the model can transform into either SAR. The following step was to develop a model with autoregressive errors (SAC). Thus, the SAC model is better (based on loglikelihood, AIC and BIC) than SDM or SAR and the results can be seen in Table 1 below:

Table 1. Spatial econometrics model: SAC

Parameters	SAC
Number of high school graduates	-1.643052***
Spatial Parameters	
Lambda	1.90e+07***
Rho	2.78e+07***
Variance	
Sigma2_e	0.0276216***

*** Statistically significant at the 5% level.

Source: Authors' own contribution using STATA.

The results show that there is an inverse relationship between the number of high school graduates and the average net salary. Therefore, an increase in the number of high school graduates leads to a decrease in the average net salary in a county. This may be surprising, but it can be explained by the fact that a greater supply of labour, graduates now available on the labour market, leads to a decrease in wages. Moreover, the model has, as an independent variable, the number of high school graduates. This can mean that a lower qualification leads to a lower net income. Such, education represents an important factor, but secondary education is not enough.

The advantage of this model is given by the spatial coefficients. The spatial coefficient rho, which is associated with the variable's spatial lag, is positive and significant for the model. This positive value is the residual spatial dependence after accounting for the positive spatial dependence reflected in the lambda parameter. As a result, we can say that what happens in one county has a significant impact on activity in neighbouring counties. As a result, an increase in the average net salary in one county can lead to an increase in another. Thus, we can speak of a contagion effect through which the development of a neighbouring county will lead to the development of the adjacent counties. This is also visible at the level of Romania if we consider the fact that the cities located around the country's major economic poles are developed.

Moreover, changes in the values of the independent variables in a county have a direct effect on the average net salary from that county, and an indirect effect on the average net salary from another county. The indirect influence increases the direct influence, increasing the overall effect. The results of the tests confirm the existence of all these effects, with both of them being negative. The overall effect is increased. Results are presented in Table 2.

Table 2. Spatial effects

Efect	Coeficient	P-value
LR_Direct		
Number of high school graduates	-1.663172	0.000
LR_Indirect		
Number of high school graduates	-0.0835917	0.009
LR_Total		
Number of high school graduates	-1.746764	0.000

Source: Authors' own contribution using STATA.

6. Conclusions

According to the findings, a spatial model is the best fit to capture the neighbourhood effect of the selected variable on average net salary. This effect is significant and could not have been observed with a straightforward panel data model. First, by examining the main model's coefficients, the model confirms the findings already reported in the literature by validating the influence of education on economic indicators.

As the results demonstrated, secondary education is important, but not enough. This stage of education is crucial because it could help students develop the skills they will later need, for example, in the tertiary education level. This result is significant both for confirming the research hypothesis and for opening up the possibility of developing local and national policies in this direction. The policies that can be developed considering the results of the present study can address the problem of the quality of education. Considering the fact that a larger number of high school graduates leads to a decrease in the average net salary, the emphasis should be placed on the quality of education with the aim of providing a qualification, but also to offer the opportunity to attend university courses. In any case, education still represents an important factor that contributes to reducing income inequalities (Sylwester, 2002). However, secondary education is not as strong as tertiary education in reducing inequalities (Abdullah et al., 2013).

Additionally, the findings of this study can be used to support earlier research findings. Numerous others show that disparities between counties or regions of a country, whether they be based on gender, number of years of education, or public spending on education and research, frequently have a negative effect on the area's economic development. However, some bonds are stronger than others. According to Loening (2005), the impact of different educational levels on economic growth may be less than that of health sector policies. Because of this, the nation cannot perform as well as other states where these differences have been reduced by various public or private measures implemented. A number of national and international reports from the European Union outline urgent measures, including expanding access to high-quality education for all children through public investment in schools, inspiring students throughout their academic careers, and providing extra support through remedial classes for students who are having trouble, decentralising public administered schools, and enhancing the freedom of decision-making, such as hiring teachers or using funds, creating. All of these actions could result in an improvement in the educational services provided, particularly in rural areas, with the ultimate result being the economic convergence of the counties.

Of course, there are a number of restrictions on this research that should be kept in mind. First and foremost, the perspective on education was only made from a quantitative point of view, excluding qualitative factors like: the level of qualification of teaching staff, the quality of the educational act, the digital proficiency of students and teachers, or the percentage of funding attracted by the school from outside sources. Data scarcity is one of the causes. The analysis contained in the proposed study cannot fully represent the Romanian educational

system without these data. Second, the only dependent variable in this analysis that is being examined is the average net salary. According to the current data, a future analysis might consider conducting separate analyses for pre-university and university education, considering not only the total number of graduates, but also factors like graduation average, professional status following graduation, and national baccalaureate exam pass rate.

However, the current study offers an econometrics and spatial perspective, which adds an important perspective to the specialised literature. As a result, this spatial model, unlike a traditional panel data model, also accounts for the interaction between counties. Thus, the work aids in the growth of this field's research.

References

[1] Abdullah, A., Doucouliagos, H., Manning, E. (2013). Does Education Reduce Income Inequality? A Meta-Regression Analysis, *Journal of Economic Surveys*, 29 (2), 301-316.

[2] Albig, H., Clemens, M., Fichtner, F., Gebauer, S., Junker, S., Kholodilin, K. (2017). *How rising income inequality influenced economic growth in Germany*, Berlin, DIW Economic Bulletin.

[3] Baltagi, B.H., Bresson, G., Pirotte, A. (2007). Panel Unit Root Tests and Spatial Dependence, *Journal of Applied Econometrics*, 22, 339-360.

[4] Baltagi, B.H., Li, D. (2004). Prediction in the Panel Data Model with Spatial Correlation. *Advances in Spatial Econometrics*, 283-295.

[5] Burja, C., Burja, V. (2014). Sustainable Development of Rural Areas: A Challenge for Romania, *Environmental Engineering and Management Journal*, 1861-1871.

[6] Crampton, F.E. (2009). Spending on school infrastructure: does money matter?, *Journal of Educational Administration*, 47(3), 305-322.

[7] Dobrotic, I., Matkovic, T. (2022). Understanding territorial inequalities in decentralised welfare systems: early childhood education and care system expansion in Croatia, *Public Sector Economics*, 47(1), 89-110, https://hrcak.srce.hr/294990.

[8] Garcia Luque, O., Martinez, U.F., Lafuente-Lechuga, M. (2023). Social and Territorial Inequality of Education in Spain, *Multidisciplinary Journal of Educational Research*, 13(1), 166-195.

[9] Guarini, G., Laureti, T., Garofalo, G. (2018). Territorial and individual educational inequality: A Capability Approach analysis for Italy, *Economic Modelling*, 71, 247-262.

[10] Hanushek, E. (2016). Will more higher education improve economic growth?, *Oxford Review of Economic Policy*, 538-552.

[11] Jamil, M., Mustafa, G., Ilyas, M. (2018). Impact of school infrastructure and pedagogical materials on its academic performance: evidence from Khyber Pakhtunkwa, *FWU Journal of Social Sciences*, 12(1), 42-55.

[12] Kapoor, M., Kelejian, H.H., Prucha, I.R. (2007). Panel Data Models with Spatially Correlated Error Components, *Journal of Econometrics*, 140, 97-130, doi:10.1016/ j.jeconom.2006.09.004.

[13] Krueger, A., Lindahl, M. (2001). Education for Growth: Why and for Whom?, *Journal of Economic Literature*, 1101-1136.

[14] Lee, L., Yu, J. (2010). Some recent developments in spatial panel data models, *Regional Science and Urban Economics*, Elsevier, vol. 40(5), 255-271.

[15] Loening, J. (2005). *Effects of Primary, Secondary and Tertiary Education on Economic Growth: Evidence from Guatemala*. World Bank Policy Research Working Paper.

[16] Murillo, F.J., Roman, M. (2011). School infrastructure and resources do matter: analysis of the incidence of school resources on the performance of Latin American students. *School Effectiveness and School Improvement, An International Journal of Research*, 22(1), 29-50.

[17] Ranis, G. (2000). *Economic Growth and Human Development. World Development*, Elsevier, 197-219.

[18] Serban, A.C. (2012). Implicații ale nivelului de educație asupra pieței muncii. *Economie teoretică și aplicată [Implications of the level of education on the labor market. Theoretical and applied economics]*, 125-135.

[19] Sianesi, B., van Reenen, J. (2003). The Returns to Education: Macroeconomics, *Journal of Economic Surveys*, 157-200.

[20] Sylwester, K. (2002). Can education expenditures reduce income inequality?, *Economics of Education Review*, 21(1), 43-52, https://doi.org/10.1016/S0272-7757(00)00038-8.

[21] Stanef, M. (2013). Urban and rural educational system disparities in Romania, *Theoretical and Applied Economics*, 121-130.

[22] Taiwo, B. (2000). Maintenance of School Infrastructure for Effective Academic Performance, *Ilorin: Kwara State College of Education*, Ilorin.

[23] Temple, J. (2001). Generalisations that aren't. Evidence on Education and Growth, *European Economic Review*, 905-918.

[24] Topel, R. (1999). The Labour Market and Economic Growth . In O. Ashenfelter, D. Cards, The Handbook of Labour Economics, p. 44, Amsterdam: North Holland.

[25] Velkey, G. (2022). "The Increasing Replication of Territorial and Social Inequalities in Public Education in Hungary – Causes, Components, Practices and Mechanisms" *Social Sciences* 11, no. 3: 95, https://doi.org/10.3390/socsci11030095.