Modelling of spatial lag of X regression in the School Operational Aid

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Submission date: 15-Jul-2022 06:27AM (UTC+0700)
Submission ID: 1870628829
File name: f_Spatial_Lag_of_X_Regression_In_The_School_Operational_Aid.docx (592.17K)
Word count: 2060
Character count: 10925

Journal of Physics: Conference Series

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Modelling of spatial lag of X regression in the School Operational Aid

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Abstract. The issue of the allocation and distribution of the School Operational Aid (BOS) in Central Java Province is a complex problem since each region has different characteristics. The distribution formulation requires a spatial model as the neighbouring regions have dependencies. The variables in this research were BOS value, supervision/building cost, management cost, Human Development Index (HDI) analysed using the Spatial Lag of X (SLX) model with the weighting *of Rock Contiguity*. It is concluded that all variables have a spatial dependency with the BOS variable influenced by the variables of building and management costs significantly.

1. Introduction

One of the Indonesian government's policies in the context of national education is School Operational Aid (BOS) which is allocated to primary and secondary schools. The problem faced by the government is how to allocate the balance funds to the regions so that each region has BOS funds by the regional capabilities, characteristics and conditions. The problem of allocating or distributing BOS funds faced by the Central Java Provincial Government, in particular, is that the formulation of BOS distribution funds is a quite complex problem because each region has different characteristics . Each district and city area in Central Java has a different student population, in addition to different geographical conditions, causing differences in funding to build educational facilities.

Based on the problems above, it is necessary to do a mapping of BOS recipient areas which is useful in understanding the pattern of BOS distribution and finding out the territorial elements and the most influential factors. It is necessary to make spatial modelling for these relationships based on the factors that influence them. In spatial data, observations are frequently conducted in a location depending on the observations in other neighbouring locations. Then, the modelling used was spatial modelling with an area or point approach.

Several studies related to spatial modelling have been conducted, [1][2] examining the modelling of soybean production in Central Java Province used two spatial processes. They have modelled the incidence of malnutrition in East Java Province using *spatial regression*. Furthermore. Modelled the Gross Regional Domestic Product (GRDP) of the industrial sector in Central Java using the approach of Data Panel Spatial Autoregressive [3]. It is conducted a study of BOS spatial effects based on the *Spatial Error Model* (SEM) and *Spatial Autoregressive* (SAR) for the cities and regencies in Central Java [9].

The research on the BOS problem and the factors that influence it have been conducted by Kangjuan who examined about government investment in education using the spatial approach method. They concluded that in the spatial effects on government investment in education, there are links between one Province and other Provinces in China [4]. A study on BOS was also conducted, including [5] using a qualitative research approach suggesting that Regional Original Revenue (PAD) and the Human Development Index (HDI) are the variables that can be found in constructing school operational funding. [6] concluded that schools in the city of Semarang received BOS, but the government and the community were still rather weak in supervision.

With the presence of location aspects in this BOS data, the proximity factor between regions needs to be taken into account so that in this study Spatial Regression with *lags* in independent variables was used which is called spatial X (SLX) [7]. The SLX model is a local linear regression model that results in the estimated parameters of the local regression model. The variables used were the total cost of building, the Human Development Index (HDI) and the total cost of management of School Operational Aid (BOS) based on a spatial approach in the Regencies/ Cities in Central Java Province using the method of *Spatial Lag of X (*SLX*)* and considering the spatial effect using *Moran's I test* with the weighting matrix of the *Rock Contiguity* matrix. The model obtained later can be government policy for BOS funding.

2. Research Method

The data used in this study were the data obtained from the Ministry of Education and Culture for 2018 as many 15 cities. In this study, observation units were carried out in districts and cities in Central Java Province. The variable used is based on the Constitutional Court Minutes No. 13 / PUU-VI / 2008. A more complete explanation can be seen below:

Table 1. Operational definitions of variables

Variable	Indicator	Description
Y	BOS Value per city and regency	Million rupiah
X1	The total cost of supervision/guidance per city and regency	Million rupiah
X2	Total management costs per city and regency	Million rupiah
X3	Human Development Index	Per cent

2.1. Research Phase

The phases used in this study were described below:

- Mapping the value of BOS, the total cost of supervision, the number of management costs and HDI for each City and Regency in Central Java in 2018
- Formation of spatial weighting matrix (W) using the method of *Queen Contiguity*
- Spatial dependency test using *Moran's I Test* (globally)
- Spatial diagnostic test using *Lagrange Multiplier* (LM)
- Parameter test with the spatial effect on the SLX model
- Model interpretation and conclusions

3. Results and Discussion

The BOS spreading pattern in Central Java Province is explained in the figure below:

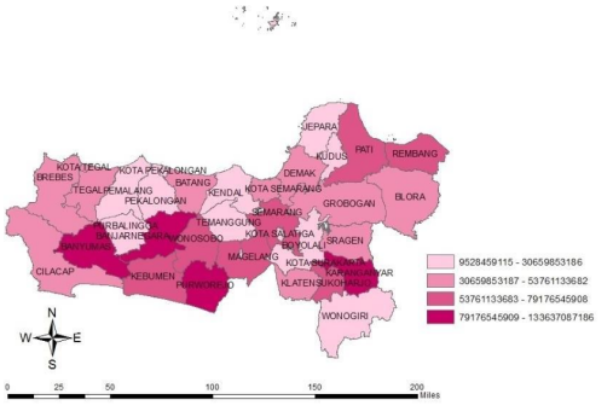

Figure 1. BOS funding in Central Java in 2018

Based on BOS data, we can see that cities and districts in BOS distribution are classified into four colors; the darker the color of the location, the higher the BOS. Cities and Regencies with the darkest colors of BOS are Banyumas, Banjarnegara, Purworejo, Karanganyar, and Surakarta City which get the largest BOS funds among other cities and regencies. The regions that received the smallest BOS funds were Pemalang, Pekalongan, Purbalingga, Kendal, Temanggung, Boyolali, Jepara, Kudus, Pekalongan City, and Salatiga City.

The spatial weighting matrix used was a row standardised spatial weighting matrix using the method of *Queen Contiguity*. Spatial dependency test was used to identify whether there is a relationship between the location of each variable or not using the Moran's I. the spatial dependency test results are presented in the following table:

Table 2. Moran's test by variables

Variable	Moran's I	P-Value	Conclusion
Y1	0.194	0.039 *	Rejecting Ho
X1	0.174	0.056 **	Rejecting Ho
X2	0.176	0.049 *	Rejecting Ho
X3	0.291	0.007 *	Rejecting Ho

Note:: * significant at α (5%)
** significant at α (10%)

The statistical objective of the *Moran's* test was to identify the relationship between locations in each variable, both response and explanatory variables. Based on the results of *Morans' I test*, it was found that the variables of BOS funds, Total Management Costs, and the Human Development Index have a significant spatial dependence at $\alpha = 5\%$, while the Total Building Cost variable has a significant spatial dependence at $\alpha = 10\%$. Then, it can be concluded that all of these variables have spatial dependencies.

3.1. Spatial Diagnostic Test

A spatial diagnostic test was used to identify which model to be used later. The spatial diagnostic tests used was Lagrange Multiplier test, and the spatial diagnostic test results are presented in the following table:

Table 3. Spatial diagnostic test

Testing	P-Value	Decision
LMerr	0.121	Accepting Ho
LMlag	0.179	Accepting Ho
RLMerr	0.195	Accepting Ho
RLMlag	0.299	Accepting Ho
SARMA	0.175	Accepting Ho
LMslx	0.005 *	Rejecting Ho

Note: * significant at α (5%)

Because Morans'I (error) is significant and has positive spatial dependencies, it is necessary to consider geographical attributes in its modelling. For the *Lagrange Multiplier* test on the *lag* that results in a probability value that is smaller than the significance level (α = 0.05), Ho is rejected meaning that there *is a lag dependency*, so it needs to proceed to the modelling. In the *Lagrange Multiplier* test, there is a *lag* that results in a probability value that is smaller than the significance level (α = 0.05), so Ho is rejected meaning that there is a lag dependency. Then, it is necessary to proceed with the modelling using the *Spatial Lag of X* (SLX) Model.

3.2. Parameter Estimation of SLX Model

This SLX model estimation resulted in the parameters that influenced the BOS funds in Central Java province with a significance level of 5%. The results of the estimated parameters are presented in the following table:

Table 4. SAR parameter estimation results

Parameters	SLX Coefficient	P-Value
Intercept	0.267	0.549
X1	1,842	0,000 *
X2	-1,204	0.017 *
X3	-0,093	0.579
WX1	0.112	0.694
WX2	-0.157	0.547
WX3	0.116	0.237
AIC	85.581	

Note: * significant at α (5%)

Based on table 4, it can be concluded that only the parameters X1 and X2 have a significant effect on SLX. In the SLX model, there are additional parameters weighed by the spatial matrix. After the weighting, nothing is significant. Thus, it can be concluded that the BOS funds in an area in Central Java were influenced by the total cost of building and the total cost of management from the closest area.

3.3. Model Interpretation

Informing the model in this study, the weighting matrix used was the matrix W with the method of *Rock Contiguity*. Then, the SLX models formed is:

$$Y = 0.26 - 1.842\,\mathrm{X1} - 1.204\,X2 - 0.093\,X3 + 0.112\,WX1 - 0.157\,WX2 + 0.116\,WX3 + \varepsilon \quad (1)$$

The estimated value of the spatial lag coefficient parameter of total development cost is negative at -1.842 indicating that the regencies/ cities with low total building costs and neighbouring with the regencies/ cities with low total building costs had high BOS funds. The estimated value of the spatial

lag coefficient parameter of total management costs is negative at -1.204, indicating that the regencies/ cities with low total management costs and neighbouring with the regencies/ cities with low total management costs had high BOS funds

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4. Conclusion

Based on *Moran's I*, all variables of School Operational Aid funds, Total Building Costs, Total Management Costs, and the Human Development Index have spatial dependencies. The wholeentire building and total management costs have a significant effect on the SLX model, and in this model, there is no weight variable with a significant effect. Thus, it can be concluded that the BOS Fund in an area in Central Java is influenced by the total building and total management costs from the closest area.

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