SPATIAL ANALISIS OF EFFECT OF GOVERNMENT EXPENDITURES ON ECONOMIC GROWTH

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Abstract

Among the many factors which affect the economic growth of a country, governments are considered to be the most influential stimulants. Due to the importance of studying government expenditure on economic growth, many techniques have been suggested in this regard..

In this article we apply a new technique, namely the Spatial Econometrics Method. This method examines "neighborhood" and "location" factors, which are influential in debilitation and reinforcement. Using Ram's growth model (1986) and applying the geographic aspect to global regression models, we attempt to discover the effect of U.S state government expenditures on the economic growth of its states. It was revealed that the growth of each state is influenced by that of its neighboring states and that state government expenditures have no effect on economic growth. In addition, the growth of the labor force is introduced as an influential element affecting state economic growth.

Keywords: Government expenditures, spatial econometrics, geographic weighted regression

JEL classification: C31, E62, H72, R12

1. Introduction

Economic growth and its underlying foundations are important factors discussed widely in recent years. Government expenditure is a major factor that influences economic growth through its allocation to education, infrastructure, public goods and services and law enforcement. Various methods have been used to investigate the effect of government expenditure on economic growth with different results. Based on a cross-country study for 96 countries, Landau 1983 [1], found a negative relationship between government expenditure and economic growth. Atrayee. 2009 [2] reached the same results for the United States over the years between 1950-1998 by developing a multi-equation model. However, Kormendi and Meguire 1985 [3] found a non-significant relationship while Summer and Heston 1984, Ram 1986 [4] found positive and significant effect. Moreover; Haggins et al (2006 [5], based on data from 1970 to 1998, examine this relationship on three i.e. the federal, state and local levels. Using the 3SLS-IV approach they clarified that the federal, state and local governments are either negatively correlated, or, uncorrelated with economic growth.

Most of the studies mentioned above considered the economic growth of one or several places as dependent variable and place-specific factors as independent variables. But one of the influential factors which was most often ignored was "location" and, as a result, the contiguousness of physical place. Therefore, because of the spatial dependency that exists between various regions the classical assumptions for estimation using the OLS approach would not be satisfied [6]. By adding geographic aspects to econometric analysis, a new method was introduced called spatial econometrics. Consequently the methods of estimation changed.

Today many economic studies use this method as a useful technique to complete previous models and increase the power of prospective prediction [7],[8],[9].

In this study, we present a brief introduction to spatial econometrics. We then compare the global regression and geographic weighted regression models and prove that the latter is the more appropriate choice. Finally we apply spatial analysis to examine the effect of government expenditure on economic growth and to detect models of spatial dependency.

2. Methodology

2.1. Geographic weighted regression

This method was introduced for the first time by L.Anselin [10]. Many specialists in economy, geography and other regional sciences use the technique as a major part of planning for urban development. In this kind of regression, the global form of regression such as

$$Y_i = a_0 + \sum_k a_k x_{ik} + \varepsilon_i \tag{1}$$

changes to:

$$y_i = a_0(u_i, v_i) + \sum_k a_k(u_i, v_i) x_{ik} + \varepsilon_i \tag{2}$$

where (u_i, v_i) is the co-ordinate of the ith point in space and $a_k(u_i, v_i)$ is a realization of the continuous function $a_k(u, v)$ at point i. Consequently the estimator of the variables is shown as:

$$\hat{a}(u_i, v_i) = \left(X^T w(u_i, v_i) X\right)^{-1} X^T w(u_i, v_i) Y \tag{3}$$

W denotes an n×n weighted matrix similar to the weighted regression matrix, the elements of which are 1 if the two regions are contiguous and 0 if otherwise. For easier computation the matrix has to be normalized so that its elements are divided by the number of neighbors [11]. One of the ways to form this matrix is by using the latitude and longitude of the regions as used in certain software such as GWR.

2.2. Spatial heterogeneity

Spatial heterogeneity is variation in relationship over space such that every point in space may have different relationships. Thus the linear relationship is shown as:

$$y_i = x_i \beta_i + \varepsilon_i \tag{4}$$

Where i represents points in space and x_i is a vector of independent variables associated with its parameter β_i . ε_i denotes a stochastic disturbance.

2.3. Spatial dependency

Spatial dependency may occur in many models which mean that the amount of Y in location i might be associated with Y in neighboring location j. In other words [12]:

$$y_i = f(y_j) \quad i = 1, 2, \dots, n (i \neq j) \tag{5}$$

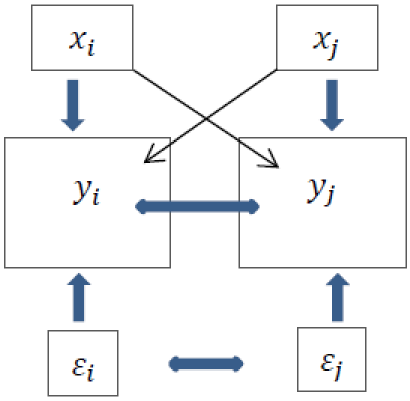
There are two major models that contain spatial dependency:
The first is the spatial autoregressive model (SAR) shown as:

$$y = \rho w y + x\beta + \varepsilon \tag{6}$$

$$\varepsilon \sim N(0, \sigma^2 I_n)$$

where y is an n×1 vector of dependent variables, x contains the n×k vector of independent variables and w is a spatial weighted matrix always of first-order contiguity. If ρ , the coefficient on the spatial lagged dependent variable, is significant the model will be proved to be SAR. In other words the level of Y (the dependent variable) depends on the level of Y in neighboring regions. Figure.1 illustrates this concept.

Figure 1. Spatial autoregressive model (SAR)



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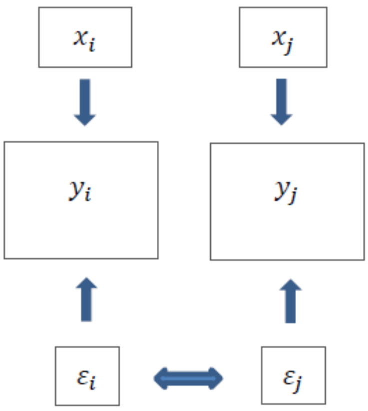
The second model is the Spatial Error Model (SEM). This model includes the unmeasured errors and independent variables of contiguous points which, being unmeasurable, are considered within the error domain. This model is shown as:

$$\begin{aligned} y &= x\beta + u \\ u &= \lambda w u + \varepsilon \\ \varepsilon &\sim N\left(0, \sigma^2 I_n\right) \end{aligned} \quad (7)$$

Y is an n×1 vector of dependent variables, x is an n×k matrix of independent variables and w is a spatial weighted matrix. Statistically significant, a coefficient on the spatially correlated errors, is the sign of the existence of an SEM model shown in Figure 2.

Figure 2. Spatial error model (SEM)



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2.4. Economic model and data sources

To analyze the spatial aspect, and investigate the effect of government expenditures on economic growth the Rati Ram 1984 growth model was used. Based on this model, which is adapted from reasoning developed by Greshon Feder[13], economy consists of two sectors: government and non-government. The output of these sectors is the result of their labor and capital. In addition, non-government outputs are derived from government outputs. The final model is shown with Y representing the total output of the two sectors, *I* the total investment, $\dot{L}$ the growth of the labor force, and finally $\dot{G}$ representing government expenditures:

$$\dot{Y} = \alpha\left(\frac{I}{Y}\right) + \beta\dot{L} + \left(\frac{\delta}{1+\delta} - \theta\right)\dot{G}\left(\frac{G}{Y}\right) + \theta\left(\dot{G}\right) \tag{8}$$

Moreover α is the marginal product of capital in the non-government sectors, β and θ are respectively the elasticity of non-government output with respect to L and the elasticity of nongovernment output with respect to G. indicates differences in input factors in the two sectors. For example positive shows higher input productivity in the government sector.

3. Data

Data was collected from the US Census Bureau, Federal Reserve and State Government Finances. Spatial analysis is carried out for 2006 and 2009 (before and after the 2008 United States financial crisis) with the data of all fifty states. GWR, Geoda and GIS were used as the necessary software.

4. Result

4.1. Global regression versus geographic weighted regression

The first step in proving the difference between global regression and Geographic Weighted Regression (GWR), is estimating the parameters of the global model using the OLS approach over a period of two years. According to the t-statistic, the growth of the labor force is the only significant variable whereas the growth of government expenditures, beside other variables, is insignificant.

Table 1. Parameter estimation of global model by OLS approach

YEAR	Intercept	I/GDP	$\dot{L}$	$\dot{G}$ (G/Y)	$\dot{G}$
2006	4.81***	-43.2	0.81	1.53	-0.09
	(3.1)**	(-0.54)*	(2.55)	(0.75)	(-0.33)
2009	-1.07	-18.23	-0.17	-1.29	0.2
	(-1.27)	(-0.36)	(-0.62)	(-1.1)	(1.06)

*** Estimated values
** t-statistic values
* Rejection of H_0 at 5% level of significance

To compare these two models, an ANOVA test has been used to test the null hypothesis that the GWR model represents no improvement over a global model. As the F-statistics results show, GWR is the appropriate model for prediction.

Table 2. An ANOVA test for comparison of two models

Year	F- statistics
2006	3.28
2009	3.72

By switching the model from global to GWR, the values of R^2 and R^2_{Adj} change; according to Table 3 these values increase. This can be described as increase in the power of the model as a result of considering location factors collectively as a new independent variable.

Table 3. Coefficient of determination and adjusted coefficient of determination in two models

Global Regression		Geographic Weighted Regression	
R^2_{Adj}	R^2	R^2_{Adj}	R^2

2006	0.05	0.15	0.23	0.38
2009	-0.07	0.03	0.12	0.28

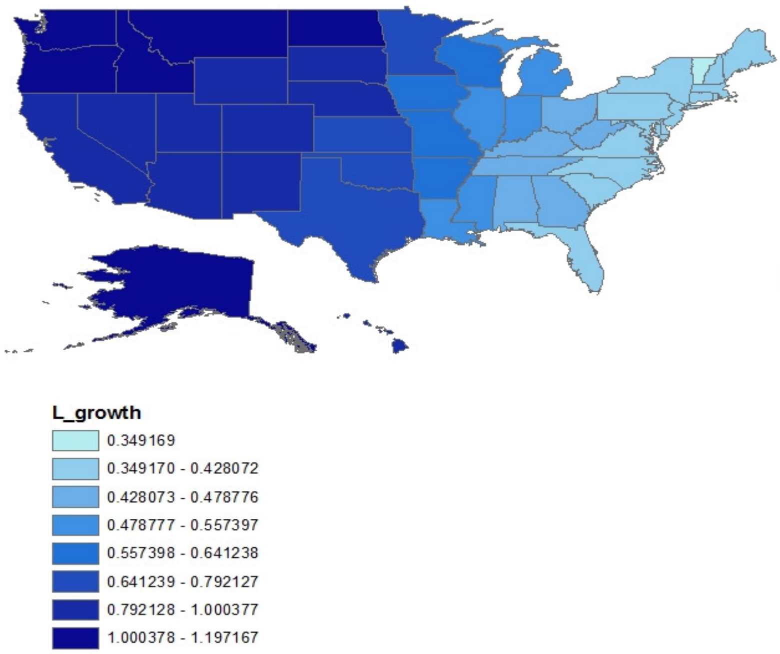
A five-number summary of the local parameters estimates is shown in Table 5. The minimum effectiveness of the only significant variable i.e. the growth of the labor force on economic growth is 0.36 and belongs to the state of Vermont and its maximum, 1.19, to the state of Alaska.

Table 4. A five-number summary of the local parameters estimation

	Year	Min	Lower Quartile	Median	Upper Quartile	Max
Intercept	**2006**	3.23	3.64	4.14	4.32	7.86
	2009	-2.37	-1.31	-0.8	-0.51	-0.36
(I /Y)	**2006**	-140.42	5.93	14.46	31.6	77.14
	2009	-66.89	-63.09	-54.56	-27.57	-52.67
$\dot{L}$	**2006**	0.34	0.42	0.54	0.9	1.19
	2009	-0.6	-0.19	-0.01	0.09	0.13
$\dot{G}\left(\frac{G}{Y}\right)$	**2006**	-1.06	-0.14	-0.0003	0.46	3.23
	2009	-3.33	-0.49	0.24	0.87	1.2
$\dot{G}$	**2006**	-0.56	-0.03	0.063	0.09	0.2
	2009	-0.1	-0.05	0.03	0.1	0.47

To illustrate the intensity of this effect, a GIS map was designed (Figure3). The dark and bright colors respectively represent the strong and weak influence of labor force growth on economic growth. As is shown, the highest effect of labor growth on the economic growth of the states is seen in the northern and north western states (Alaska being one) and its least effect belongs to the eastern and north eastern states (such as Vermont).

Figure 3. Intensity of labor growth effects on economic growth



4.2. <u>Detecting spatial dependency</u>

The Moran-I statistics and scatterplot are two indices used to examine the presence and extent of spatial dependency in economic growth. The results below show a spatial dependency in the economic growth of the states in the 2009 model (Figure 4). The Moran-I scatterplot also demonstrates this. This plot presents economic growth on the horizontal and spatial lag on the vertical axis. Based on this scatterplot, the states' dispersion in the first and third quadrants in Figure.4 declares that the states with positive economic growth are located near other states which likewise have positive growth and states with negative growth are neighbors to their likewise peers.

Figure 4. Spatial dependency among economic growth of states (2009)

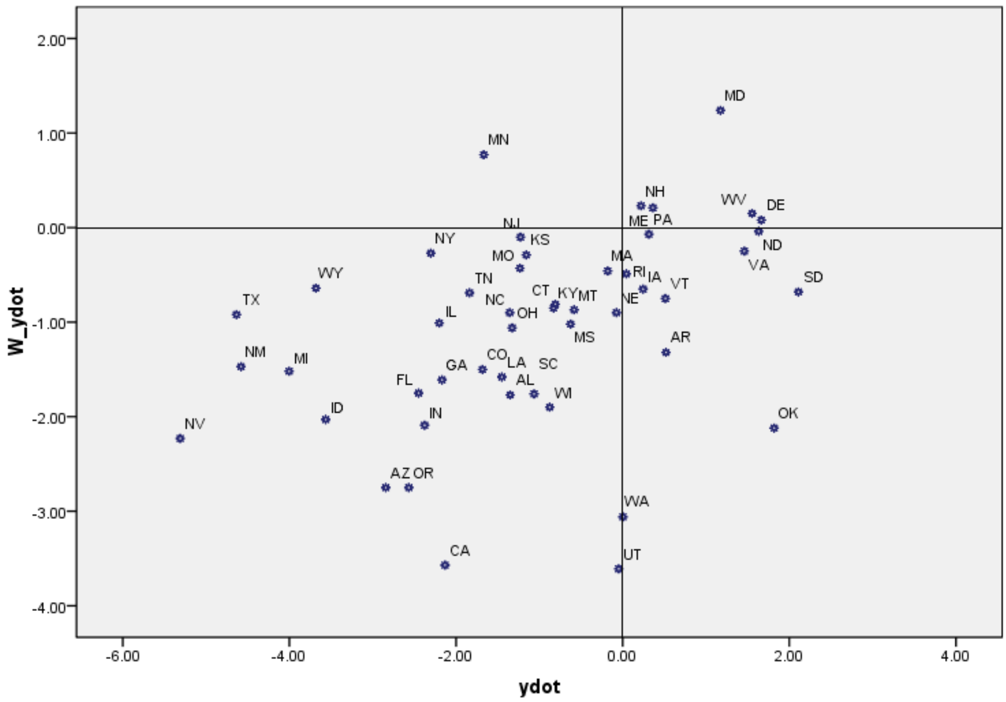


Table 5 shows the existence of spatial dependency as SAR and SEM models. The significant P-values admit the existence of these two models. These two kinds of spatial dependencies have been confirmed only in the 2009 model.

Table 5. Models of spatial dependency

	MI/DF		VALUE		PROB	
	2006	2009	2006	2009	2006	2009
Test						
Moran's I (error)	0.089	0.18	1.27	2.34	0.2	0.01
Lagrange Multiplier (lag)	1	1	0.12	3.08	0.72	0.07
Lagrange Multiplier (error)	1	1	0.84	3.65	0.35	0.05
Lagrange Multiplier (SARMA)	1	1	1.45	4.42	0.48	0.11

After detecting these dependencies, the estimation of variables is provided. The coefficient estimation of the SAR and SEM 2009 models are presented in Table 6 as:

Table 6. Estimation of, SAR and SEM model (2009)

Variables\models	SAR	SEM
Intercept	-0.87 (-1.11)*	-1.41 (-1.72)
I/GDP	-2.46	10.04

	(-0.054)	(0.19)
$\dot{L}$	-0.16 (-0.63)	-0.16 (-0.63)
$\dot{G}\left(\frac{G}{Y}\right)$	-1.49 (-1.4)	-1.28 (-1.24)
$\dot{G}$	0.22 (1.3)	0.19 (1.16)
ρ	0.32 (1.9)	- -
λ	- -	0.37 (2.25)
R^2	0.11	0.13

* *t*-statistic

t-statistic of Table 6 shows the parameters are not significant but λ (t =2.25) and ρ (t=1.9) are significant. So the presence of neighborhood effects is proved. Also the other important results which can be concluded from this table are:

1. Significant ρ shows that economic growth of states is affected by economic growth of contiguous states.
2. significant λ and consequently presence of SEM model confirm that there are some unknown factors of contiguous states that have influence on economic growth which is consider as an error term of the model.

5. Conclusion

Government expenditure and its effects on economic growth have been subjected to various economic studies in the past few decades. Among the possible methods, spatial analysis with its consideration of the contiguity factor is one of the new and competent ways to investigate this cause and effect.

By applying this method to the Rati Ram 1986 growth model for the 2006 and 2009 data, the results presented in this study indicated that geographic weighted regression was more appropriate than global models. Moreover, state government expenditure has no effect on economic growth but the growth of the labor force has a significant and positive effect on the economic growth of the states. As spatial analysis results showed, two models of spatial dependency, SAR and SEM, have been absorbed in the 2009 model.

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