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ECONOMIC GROWTH AND SPATIAL INTERDENPENDCE, EMPIRICAL EVIDENCE FROM ADJACENT REGIONS OF EAST JAVA PROVINCE INDONESIA

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ABSTRACT
Recent studies highlight the importance of spatial externalities on the economic growth. The growth in one region creates some information or technological spillover, which affect the growth of the surrounding regions. The main theoretical foundation is the growth model with Arrow-Romer Externalities. Although numerous studies have provided empirical evidence for the role of the spatial externalities among neighbouring countries, within the theoretical framework, this study considers the possible existence of the externalities among adjacent regions in a developed country. It conducts an empirical investigation to test the significance of the spatial externalities of the growth rate among cities in East Java Indonesia, for the tourism sector. The panel Spatial Autoregressive model is used. The result supports the hypothesis of the growth interdependence between adjacent regions.
Keywords: spatial externalities, growth interdependence, spatial autoregressive model.

1. INTRODUCTION

What factors determine economic growth have been the main issue for economists. The developed theoretical model has identified the role of different factors in promoting growth. One of the factors is the external effect on the accumulation of production factor. The recent models of endogenous growth which accommodate the external effect mainly adopt two approaches: "Marshallian externalities" (Romer 1986) and "technological spillover" (Romer 1990). They both explain that the progress of technology is based on endogenous accumulation of knowledge, which in turn promotes the endogenous growth. However the models still have certain limitation since it has not taken into account the spatial dimension of the externalities and how the spatial externalities explain the interdependence of growth among adjacent countries. More recent models (Vayá, Lópes Bazo et al. 2000; Fingleton and López-Bazo 2006; Ertur and Koch 2007) point out that because of the technological interdependence, countries cannot be treated as spatially independent observations. Fingleton and López-Bazo (2006) assert that when the empirical analysis on growth ignores the influence of spatial location on the process of growth, it may yield to bias and misleading conclusions. Therefore the spatial interactions must be explicitly accommodated in the growth model, which is well developed in Vayá, Lópes Bazo et al.(2000), Fingleton and López-Bazo (2006) and Ertur and Koch (2007).

Vayá, Lópes Bazo et al.(2000) argue that the externalities are not only limited across firms within a region, but these externalities can cross the barriers of regions. They use their argument to analyse the role of spatial externalities in explaining growth and economic convergence based on a simple endogenous growth model which includes externalities across countries. The also provides empirical evidence on the presence

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of significant externalities both across Spanish and European regions. This endogenous growth model with spatial externalities is then defined more extensively in Fingleton and López-Bazo (2006) and Ertur and Koch (2007).

Ertur and Koch (2007) extends the endogenous growth model by including capital externalities and spatial externalities. It is assumed that the technological interdependence exists via the latter. Using a spatial autoregressive model, they also conduct an empirical study using data from countries all over the world, to estimate the effects of related factors, including the spatial externalities, on the economic growth among countries. The model is supported by the empirical evidence, especially the significance of the spatial autocorrelation.

The following empirical studies analyse the extent of spatial externalities on the regional economic growth, in Dutch (Soest, Gerking et al. 2002), Italy (Deidda, Paci et al. 2003), Great Britain (Bishop and Gripaios 2009). They all support the significance of spatial externalities on growth, with certain precautions for the chosen geographical unit. They indicate that the geographical unit (e.g. city, region, country) determines mainly the extent of the spatial externalities.

Although the above studies have agreed that the spatial externalities play an important role in explaining the economic growth, the provided empirical studies are still limited for the case of developed countries. There is lack of empirical evidence of whether the theory is applicable in developing countries' situation.

The economic agents, e.g. firms or households in developing countries may behave differently from their counterpart in the developed country due to the existing gap between the levels of growth of the two groups. This difference has been detected in Ertur and Koch's (2007) empirical study. They point out that Asian countries and European countries for example, exhibit different pattern of interdependence growth. Moreover, they also have different geographical situation. European countries are very closedly located to each other such that the technological exchange between countries occurs without too much geographical obstacles. In contrast, the Asian countries are geographically as well as politically distant apart. There have been some limitations for the technological or information exchange between them. Soest, Gerking et al. (2002) identify that the knowledge or technological externalities might be more applicable at a narrower geographical scale. Therefore, in order to give some insight about the role of spatial externalities on regional economic growth of the developed country, this study uses municipality or city as a unit of study instead of country. Following the existing literature of the growth model with spatial externalities it conducts an empirical study of interdependence growth among neighbouring regions in East Java Indonesia. Each regency or municipality has its own autonomy to manage its economy, in which Trade, Hotel and Restaurant (THR) sectors dominate mostly its productivity. It motivates this study to test the significance of the spatial externalities on the growth rate of the THR sectors in those regions.

The remainder of this article is structured as follow: First, it starts with the definition of the theoretical model followed by the econometric model specification. Next it provides data and specifies the empirical results. The findings of the empirical study are then discussed. Finally concluding remarks are presented.

2. THE THEORETIAL MODEL

This study is based on the theoretical model which has been developed extensively in Vayá, Lópes Bazo et al.(2000), Fingleton and López-Bazo (2006), and Ertur and Koch (2007): A Growth Model with Arrow Romer Externalities (MAR) and Spatial Externalities.. The model implies that *N* neighbouring regions, will have technological interdependence. Using this model, it will be shown theoretically that the technological interdependence or technological spillover in turn creates interdependence growth among neighbouring regions. An aggregate Cobb –

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Douglas production function for location *i*, with constant return to scale in labor and capital:

$$Y_i = A_i K_i^{\alpha} L_i^{1-\alpha} \qquad \textbf{(2.1)}$$

with standard notation: Y_i the output, K_i the level of invested capital, L_i the level of labour, and A_i the aggregate level of technology for region *i*. The last term is defined as:

$$A_i = \Omega k_i^{\phi} \prod_{j \neq i}^{N} A_j^{\gamma w_{ij}} \qquad \textbf{(2.2)}$$

It describes that the aggregate level of technology of region *i* depends on an exogenous and identical technological progress (Ω) in all regions, the capital investment per worker in that region ($k_i = \frac{K_i}{L_i}$) , and the aggregate level of technology of the neighbouring regions ($A_j, j \neq i$). The parameter ϕ with $0 \leq \phi < 1$, describes the strength of local externalities produced by the capital investment per worker, γ with $0 \leq \gamma < 1$ measures the degree of technological interdependence generated by the level of spatial externalities, and w_{ij} measures the degree of connectivity between regions. The friction terms w_{ij} are assumed as non-negative, non-stochastic, finite for *i* = 1, ..., *N*, and $i \neq j$. Further it is assumed that $0 \leq w_{ij} \leq 1$ and $w_{ij} = 0$ if $i = j$.

The definition in (2.2) assumes that the capital investment in one region not only increases the level of technology locally but also increases the technology level of the surrounding regions through the knowledge spill over. The function in (2.2) can be written in matrix form:

$$A = \Omega + \phi k + \gamma W A \qquad \textbf{(2.3)}$$

with *A* the $(N \times 1)$ vector of the logarithm of the level of technology, *k* the $(N \times 1)$ vector of the logarithm of the level of capital per worker, and *W* the $(N \times N)$ matrix with the friction terms w_{ij} as its elements.

The form in (2.3) can be rewritten as:

$$A = (I - \gamma W)^{-1} \Omega + \phi (I - \gamma W)^{-1} k \qquad \textbf{(2.4)}$$

The Cobb – Douglass production function in (2.1) can be defined as the output per worker as follows:

$$\frac{Y_i}{L_i} = A_i \left(\frac{K_i}{L_i} \right)^{\alpha} \leftrightarrow y_i = A_i k_i^{\alpha} \qquad \textbf{(2.5)}$$

in which $y_i = \frac{Y_i}{L_i}$ and $k_i = \frac{K_i}{L_i}$ as the output per worker and capital investment per worker respectively, such that by taking the logarithm of each side of (2.5), the following matrix form holds:

$$y = A + \alpha k \qquad \textbf{(2.6)}$$

By substituting (2.4) into (2.6) and pre multiplying both sides by $(I - \gamma W)$ to obtain the following relation:

$$y = \Omega + (\phi + \alpha) k - \alpha \gamma W k + \gamma W y \qquad \textbf{(2.7)}$$

with *y* the $(N \times 1)$ vector of the logarithm of the output per worker, *k* the the $(N \times 1)$ vector of the logarithm of the level of capital per worker, and *W* the $(N \times N)$ matrix with the friction terms w_{ij}.

3. THE ECONOMETRIC MODEL SPECIFICATION

The relation in (2.7) implies that the growth in region *i* will be a function of the capital investment in region *i*, the capital investment in the surrounding regions, and the growth of the surrounding regions. The model which includes the spatial lags of exogenous variables (capital per output of neighbouring regions) together with the spatial lags of endogenous variable (output per worker of neighbouring regions) in (2.7) can be defined generally as the Spatial Durbin Model (SDM):

$$y = X\beta + WX\theta + \rho W y + \varepsilon \qquad \textbf{(3.1)}$$

where *y* is the $N \times 1$ vector of the logarithm of the output per worker, *X* is the $N \times 2$ matrix of explanatory variables, which includes the constant terms and the vector of logarithm of the level of capital per worker. *W* is the row standardized $N \times N$ spatial weight matrix, *WX* is the (*N* × 2)

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matrix of spatially lagged exogenous variables and *Wy* is the spatial lag variable. $\beta' = [\Omega \quad \phi + \alpha]$ $\theta = -\alpha\gamma$ and $\rho = \gamma$.

When it is assumed that only the endogenous spatial lag variable and the explanatory variables are involved (α=0), the model is referred as the Spatial Autoregressive model (SAR):

$$y = X\beta + \rho Wy + \varepsilon \qquad \textbf{(3.2)}$$

with $\beta' = [\Omega \quad \phi]$ and $\rho = \gamma$. Maximum likelihood estimation method is used to estimate those parameters. Under the normality assumption of the error term, the log likelihood of the SAR model in (3.2) is defined as:

$$\ln L(\beta', \rho, \sigma^2) = -\frac{N}{2}\ln(2\pi) - \frac{N}{2}\ln(\sigma^2) + \ln|I - \rho W| - \frac{1}{2\sigma^2}[(I - \rho W)y - X\beta]'[(I - \rho W)y - X\beta] \qquad \textbf{(3.3)}$$

4. DATA AND EMPIRICAL RESULTS

The area under study is part of East Java Province, Indonesia, consisting of 11 adjacent regencies and municipalities. The empirical study is based on 2003 – 2009 data on growth and related factors of those regions, which are provided by East Java Central Statistical Biro (*BPS: Biro Pusat Statistik*). Since the productivity of those regions mostly relies on the Trade, Hotel and Restaurant (THR) sectors, this study uses GDP per capita of those sectors (*Y*) as a proxy for the growth and government investment (*GovInv*) and capital expenditure (*Cexp*) per capita of those sectors as proxies for invested capital.

The empirical model is based on the theoretical model in (2.1) with technological spillover. The Spatial Autoregressive model (SAR) in (3.2) is used to accommodate the spatial externalities or growth interdependence. The model is estimated based on the logarithm of the variables and the standarized rook contiguity matrix *W* to measure the degree of connectivity between the observed regions. Panel spatial analysis with fixed effect is used to accommodate the time dimension. The fixed effect is assumed since each of the observed regions has its own characteristics, and they are chosen without random sampling. The empirical model is defined as follows:

$$\ln y = \Omega + \phi_1 \ln GovInv + \phi_2 \ln CExp + \gamma W \ln y + \varepsilon \qquad \textbf{(4.1)}$$

Due to multicollinearity between the two explanatory variables (r = 0.732, with p-value = 0,000), Principal Component Analysis is applied to the data, and the parameters of the Spatial Autoregressive Panel model with Fixed Effect is estimated based on the principal components (see Table 1). The estimated parameters with their significance level are presented in In order to estimate the parameters of the original empirical model in (4.1) based on the estimated parameters from the principal component transformation using the following relation:

$$\hat{\beta}' = \hat{\beta}'_{PCA} \begin{bmatrix} PC1' \\ PC2' \end{bmatrix} \qquad \textbf{(4.2)}$$

where $\hat{\beta}' = [\hat{\phi}_1 \quad \hat{\phi}_2]$ and $\hat{\beta}'_{PCA} = [\hat{\beta}_{PC1} \quad \hat{\beta}_{PC2}]$. The results are presented in Table 3, leading to the following estimated empirical relation:

$$\ln \hat{y} = 12.52 + 0.156 \ln GovInv + 0.026 \ln CExp + 0.386 W \ln y \qquad \textbf{(4.3)}$$

Table 2. All the estimated parameters are significant at any level of significance. The principal component transformation yields a model which is not violated any required assumptions.

Table 1 The Principal Component Analysis: ln*GovInv* and ln*Cexp*

Eigenanalysis of the Covariance Matrix		
Eigenvalue	2,2103	0,2847
Proportion	0,886	0,114
Cumulative	0,886	1,000

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Variable	PC1	PC2
lnGovInv	0,855	-0,518
lnCExp	0,518	0,855

In order to estimate the parameters of the original empirical model in (4.1) based on the estimated parameters from the principal component transformation using the following relation:

$$\hat{\beta}' = \hat{\beta}'_{PCA} \begin{bmatrix} PC1' \\ PC2' \end{bmatrix} \quad \textbf{(4.2)}$$

where $\hat{\beta}' = \begin{bmatrix} \hat{\phi}_1 & \hat{\phi}_2 \end{bmatrix}$ and $\hat{\beta}'_{PCA} = \begin{bmatrix} \hat{\beta}_{PC1} & \hat{\beta}_{PC2} \end{bmatrix}$. The results are presented in Table 3, leading to the following estimated empirical relation:

$$\ln \hat{y} = 12.52 + 0.156 \ln GovInv + 0.026 \ln CExp + 0.386 W \ln y \quad \textbf{(4.3)}$$

Table 2 Estimated Parameter of the model using Principal Component Transformation

	Estimate	S.E	t value	p value
Intercept	12.518	0.286	43.618	< 2.2e-16 **
ρ	0.386	0.085	4.527	5.981e-06 **
β_{PC1}	0.147	0.021	6.953	3.585e-12 **
β_{PC2}	-0.058	0.018	-3.300	0.0009657 **

** for highly significant at any level of α
R^2 = 0.664.

Table 3 The Estimated Parameters of the Transformed and Original Models

	Estimated Parameter of the Scored Variable	PC1	PC2		Estimated Parameter of the Original Variable
Inter-cept	12.518	-		Ω	12.518
P	0.386	-		γ	0.386
β_{PC1}	0.147	0,855	-0,518	Φ_1	0.156
β_{PC2}	-0.058	0,518	0,855	Φ_1	0.026

5. DISCUSSION AND CONCLUDING REMARKS

The observed regions, 11 adjacent municipalities and regencies in East Java Province Indonesia are clustered around the capital city of the province (Surabaya). Its function as the province capital city, invites many visitors or urban migration into Surabaya and its adjacent regions. The well-built telecommunication and transportation infrastructure connecting those regions enable them to have high productivity in the THR sectors. The mentioned conditions motivate this study to test empirically the significance of the growth interdependence among those regions.

The results of the empirical analysis (see In order to estimate the parameters of the original empirical model in (4.1) based on the estimated parameters from the principal component transformation using the following relation:

$$\hat{\beta}' = \hat{\beta}'_{PCA} \begin{bmatrix} PC1' \\ PC2' \end{bmatrix} \quad \textbf{(4.2)}$$

where $\hat{\beta}' = \begin{bmatrix} \hat{\phi}_1 & \hat{\phi}_2 \end{bmatrix}$ and $\hat{\beta}'_{PCA} = \begin{bmatrix} \hat{\beta}_{PC1} & \hat{\beta}_{PC2} \end{bmatrix}$. The results are presented in Table 3, leading to the following estimated empirical relation:

$$\ln \hat{y} = 12.52 + 0.156 \ln GovInv + 0.026 \ln CExp + 0.386 W \ln y \quad \textbf{(4.3)}$$

Table 2 and Table 3) show that all of the estimated parameters are significant at any level of α. Given the results, the complete interpretations of the empirical model for the growth rate of THR sectors of the 11 adjacent municipalities/regencies in East Java Province Indonesia, are:

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- 1% increase of government investment increase the growth of THR sectors by on average 0.16%, by holding other variables constant.
- 1% increase of capital expenditure of those sectors increase the growth by on average 0.03%, by holding other variables constant.
- 1% increase of growth of THR sectors in one region, increase the growth of its neighbours by 0.4%, by holding other variables constant.

Without neglecting the significance of the local government investment and capital expenditure, this study focuses on the estimated γ. Theoretically, it measures the degree of technological interdependence generated by the level of spatial externalities among those regions. The results in In order to estimate the parameters of the original empirical model in (4.1) based on the estimated parameters from the principal component transformation using the following relation:

$$\hat{\beta}' = \hat{\beta}'_{PCA} \begin{bmatrix} PC1' \\ PC2' \end{bmatrix} \qquad \textbf{(4.2)}$$

where $\hat{\beta}' = \begin{bmatrix} \hat{\phi}_1 & \hat{\phi}_2 \end{bmatrix}$ and $\hat{\beta}'_{PCA} = \begin{bmatrix} \hat{\beta}_{PC1} & \hat{\beta}_{PC2} \end{bmatrix}$. The results are presented in Table 3, leading to the following estimated empirical relation:

$$\begin{aligned} \ln \hat{y} &= 12.52 + 0.156 \ln GovInv \\ &+ 0.026 \ln CExp + 0.386 W \ln y \end{aligned} \qquad \textbf{(4.3)}$$

Table 2 indicate that the estimated γ is significant. It confirms that the observed municipalities or regencies interact significantly on their economic activity, especially for the THR sectors. Interestingly, the marginal effect of the growth of the surrounding growth (γ) is the largest (on magnitude) among all of the accommodated factors in the model.

For a conclusion, in order to maintain the positive growth of the regions, the local government should not only concentrate on the capital investment. It must facilitate all of possible communication and technological exchange among those regions, since the economic growth of the adjacent regions creates much bigger effect on the local growth.

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