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Institutions-growth spatial dependence: an empirical test

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Abstract

Do institutions spatially affect growth? By employing a neoclassical growth model with institutional controls and augmenting the model with a formal spatial framework, this study finds evidence that institutions has spatial spillover effect on economic growth based on a panel observation from 58 developing countries for the period between1985-2008. This study also shows that the spatial lag model is the most appropriate to model the spillover effect.

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1. Introduction

In the institutional literature, studies to formally incorporate institutional quality in spatial econometric modelling to account for its spatial dependence are undoubtedly of a recent vintage, see for example Kelejian *et al.* (2008), Faber and Gerritse (2009), Bosker and Garretsen (2009), Claeys and Manca (2010) and Arbia *et al.* (2010). These studies examine spatial spillover effect of institutional quality and uncover the channels of the institutional spatial spillover effect. Earlier, there are a number of empirical studies whose findings support the existence of institutional spatial dependence between neighbouring countries, such as Ades and Chua (1997), Easterly and Levine (1998), Murdoch and Sandler (2002) and Simmons and Elkins (2004); these studies however do not employ a formal spatial econometric framework. In this

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study, we employ a formal spatial econometric namely spatial lag model to investigate the spatial dependence between growth and institutions. A standard neoclassical growth model augmented with institutional controls is estimated and spatial lag model is found to be the most appropriate model to account for the spatial dependence. This indicates that the spatial externalities are not a nuisance factor, but a substantive one. Institutions are proxied by two indices reflecting property rights and political institutions and they are shown to significantly determine economic growth in developing countries and the institutional spillover is found to exist between the countries via an indirect route, i.e. institutions in a country lead to economic improvement in that country and subsequently give impact to the neighbouring countries' income growth. This study is organized as follows: section 2 explains the model and data sources, while in section 3 estimations results are discussed. Section 4 concludes.

2. Model and data sources

Consider a simple growth model as the following:

$$g_t = \alpha + \beta \log y_0 + X\theta + \varepsilon \qquad (1)$$

where $g_t = \Delta \log y_t$ which is a vector of real GDP percapita growth rates, α is a vector of constant terms, $\log y_0$ is a vector of logs of real GDP per-capita at the beginning of the period, X is a matrix of explanatory variables, β is the convergence coefficient, θ is a vector of parameters, and $\varepsilon \sim N(0, \sigma^2 I)$ is a vector of i.i.d. error terms. A set of explanatory variables X is added as steady state determinants and following Mankiw *et al.* (1992) stock of physical (*sk*) and human (*sh*) capitals, as well as a term ($n+g+\delta$) that accounts for the sum of population growth, growth in exogenous technological process, and depreciation rate, respectively are included (henceforth called MRW variables). To capture the absolute location effect of institutions, the model is augmented with indices of institutional quality namely the security of property right index (*iiqicrg*) and the political institutions index (*iiqpol*). In full, the matrix of K explanatory variables is therefore given by $X=[sk, sh, n+g+\delta, iiqicrg, iiqpol]$ where each element is an $Nx1$ vector.

The spatial dependence in the growth model of Equation (1) is tested via two ways, firstly via spatial autoregressive error term, which means the error term of Equation (1) is now composed by:

$$\varepsilon = \lambda W \varepsilon + u \qquad (2)$$

where W is a spatial weight matrix incorporating the spatial connections of the system, λ is a spatial autoregressive parameter, ε is a vector of spatially correlated errors, and u is a vector of a spatial disturbance term with i.i.d. properties. Equation (2) assumes that the spatial externalities are a nuisance factor since they propagate to neighbouring countries via the "error term". Secondly, a spatially lagged dependent variable is included in Equation (1) to model a more direct or more substantive effect of the spatial relationship:

$$g = \alpha + \beta \log y_0 + X\theta + \rho W g + u \qquad (3)$$

and ρ is the spatial autoregressive parameter capturing the effect of spatially lagged dependent variable, u is a vector of a spatial disturbance term with i.i.d. properties. The spatial weight matrix, W, becomes the linkage among the countries in the sample, and in this study it is specified as inverse squared distance[†] whose elements are defined according to a gravity function that provides an exponential distance decay. In other words, all features influence all other features but the farther away something is the smaller the impact it has. The advantage of using geographical-based distance is that it is unambiguously exogenous to the model, and therefore it eliminates the problem of identification, causal reversion, and non-linearity.

A panel observation for 58 developing countries in Africa, East Asia, and Latin America for a period beginning 1984 to 2007 is used in this study. Data on real GDP per capita and population growth are obtained from World Development Indicators (WDI) from the World Bank (2009)[‡]. Investment share of real per capita GDP is used as a proxy for capital and the investment data is obtained from Penn World Table 6.3 (Heston *et al.* 2009). Secondary school attainment for population age 15 and above from Barro and Lee (2010) educational data[§] is used to proxy for human capital. Four institutional indicators based on International Country Risk Guide (ICRG) obtained from the PRS Group (2009) i.e. *Investment Profile, Law and Order, Bureaucracy Quality, and Government Stability* are used to measure institutional quality index that reflect security of property rights, whereas four indicators i.e. *Polity2* from Polity IV data (Marshall and Jaggers, 2008), *Political rights* from Freedom in the World index which is also known as Gastil index (Gastil, 1978), *Polcon3* from The Political Constraint Index (POLCON) Dataset (Henisz, 2010) and *Checks* from Database of Political Institutions by the World Bank (Beck *et al.*, 2001) are used to proxy the political institutions index. The index computed as simple average of the four indicators from ICRG is called *iiqicrg* and it reflects security of property right, while the average of four political indicators from four different sources become the second index called *iiqpol* reflecting the political institutions.

3. Estimation results and discussion

Based on the Equation (1) and (3), four different specifications are employed, all with real GDP percapita growth (g) as the dependent variable, and log of initial income (log y_{1984}) as variable to test for the convergence effect. Model (1) is a baseline model with only MRW variables i.e. physical (sk) and human capitals (sh) and a sum of population growth, exogenous technological process and depreciation rate ($n+g+\delta$). Model (2) and (3) introduce institutional controls using *iiqicrg* and *iiqpol* indices, respectively, and finally in Model (4) which is the general model both institutional indices enter the equation simultaneously.

Presented in Table 1 below, the results of OLS regression of Equation (1) fit the stylized facts of growth analysis since the conditional convergence hypothesis is fully supported in the developing countries under study with consistently negative significant coefficients for initial income across all estimations. Coefficients of the other growth determinants are also statistically significant with the expected sign except population growth which is positive. It is however not surprising to have positive population growth effect on economic growth especially in developing countries as shown by Headey and Hodge (2009) who found no strong support for the opposite hypothesis.

Meanwhile, the institutions growth-effect seems to originate from the property rights index, *iiqicrg*. Its coefficient in model specification (2), where only the index is used in the estimation, is significantly different from zero at 1% level. In model (3), when political institutions index, *iiqpol*, replaces *iiqicrg*, it

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[†] See Seldadyo *et al.* (2010) for more discussion on the calculation of the inversed squared distance function.

[‡] Exogenous technological change plus depreciation rate ($g+\delta$) is assumed 0.05 based on Mankiw *et al.* (1992), Islam (1995) and Hoeffler (2002), etc.

[§] The 5-year average educational data obtained from Barro and Lee (2010) are transformed into annual data by using Eviews copy command from low frequency data to high frequency data.

is also significant at 1% level. When both variables enter model (4) regression, however, only *iiqicrg* remains highly significant at 1% but *iiqpol* is now only marginally significant at 10% level. This result indicates the importance of property rights institutions towards economic growth, and its greater significance (in term of larger magnitude and higher significant level) in model (4) regression when both property rights and political institutions appear in the estimation have somehow attenuated the impact of political institutions previously found to be highly significant in model (3) regression.

Table 1: OLS regression of growth model with institutional controls

Model specification	(1)	(2)	(3)	(4)
$log\ y_{1984}$	-0.008*** (0.0015)	-0.009*** (0.0015)	-0.009*** (0.0015)	-0.009*** (0.0016)
sk	0.029***(0.0026)	0.025***(0.0026)	0.028*** (0.0026)	0.024*** (0.0027)
$n+g+\delta$	0.012***(0.0016)	0.011***(0.0016)	0.012*** (0.0016)	0.011*** (0.0016)
sh	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.001)	0.001*** (0.000)
iiqicrg	-	0.008*** (0.001)	-	0.009*** (0.001)
iiqpol	-	-	0.002*** (0.001)	0.001* (0.001)
constant	-0.115*** (0.017)	-0.126*** (0.017)	-0.118*** (0.017)	-0.136***
Adjusted R^2	0.136	0.176	0.140	0.170

Note: Dependent variable is real GDP percapita growth. Model specification (1) is baseline model with only MRW variables i.e. *sh, sk,* and $n+g+\delta$, model (2) with MRW variables and *iiqicrg*, (3) with MRW variables and *iiqpol*, and (4) with MRW variables, and both *iiqicrg* and *iiqpol* indices. Standard errors are in parentheses. ***, ** and * denotes significance at 1%, 5% and 10% respectively.

The presence of spatial autocorrelation in the residuals of OLS regression is tested using Moran's I test. The results in Table 2 indicate that the Moran's I null hypothesis of no global spatial autocorrelation in the residuals of OLS regression is overwhelmingly rejected. This finding holds across difference model specifications hence it can be safely inferred that Equation (1) is misspecified and the OLS estimates are invalid. Once the spatial autocorrelation is detected, robust Lagrange Multiplier (LM) tests developed by Anselin *et al.* (1996) is used to decide between the spatial error model or spatial lag model. From the robust LM test statistics reported in Table 2, spatial error model is apparently inappropriate to explain the data as it fails in a number of cases (specifically in model (2) and (4)) compared to spatial lag model, hence the latter model is preferred.

Table 2: Moran's I and Robust LM tests statistics

Model specification	(1)	(2)	(3)	(4)
Moran's I test statistics	5.185***	4.884***	4.901***	4.744***
Spatial error: Robust LM test	40.286***	1.768	34.930***	2.53
Spatial lag: Robust LM test	67.543***	12.168***	59.907***	14.229***

Note: Dependent variable is real GDP percapita growth. Please refer Table 1 note for information about Model (1) until (4). Standard errors are in parentheses. ***, ** and * denotes significance at 1%, 5% and 10% respectively.

The results from maximum likelihood estimation of the spatial lag growth model are presented in Table 3 and they have somehow mirrored the previous findings in OLS estimation, particularly the effect of institutional quality on growth. The parameter of interest in this regression is the coefficients of the spatially lagged dependent variable, ρ, and they are positive significant across all model specifications at 1% level and Wald test for null hypothesis of $\rho = 0$ are overwhelmingly rejected in all occasions. This finding gives an empirical support to the proposition of positive spatial autocorrelation in per-capita income growth of the developing countries. As positive effect of institutional quality towards per-capita income growth is already reported earlier, this further confirms that institutional spatial dependence between the countries runs via indirect route, where institutions in a country lead to economic improvement in that country and generate spillover effect to neighbouring countries' income growth. This finding is apparently similar to Easterly and Levine (1998), Ades and Chua (1997), Murdoch and Sandler (2002), Bosker and Garretsen (2009) and Arbia *et al.* (2010) who find evidence of positive spillover effect of growth in neighbouring countries to home countries' growth.

Table 3: Spatial lag maximum likelihood regression of growth model using inverse squared distance weight matrix

Model specification	(1)	(2)	(3)	(4)
log y_{1984}	-0.007*** (0.001)	-0.001*** (0.001)	-0.008***(0.001)	-0.009***(0.001)
sk	0.026*** (0.003)	0.022*** (0.003)	0.025***(0.003)	0.022***(0.003)
n+g+δ	0.012** (0.005)	0.012** (0.005)	0.013**(0.005)	0.012**(0.005)
sh	0.001*** (0.00)	0.001*** (0.000)	0.001***(0.000)	0.001***(0.001)
iiqicrg	-	0.008*** (0.001)	-	0.008***(0.001)
iiqpol	-	-	0.002** (0.001)	0.001* (0.001)
constant	-0.119** (0.048)	-0.129*** (0.047)	-0.122** (0.048)	-0.131*** (0.047)
ρ	0.336*** (0.060)	0.277*** (0.060)	0.325*** (0.060)	0.269*** (0.061)
Squared Correlation	0.154	0.184	0.158	0.186
Variance Ratio	0.126	0.178	0.132	0.181
Log likelihood	2147.774	2174.965	2150.104	2176.432
Wald test	31.172***	21.004***	29.046***	19.693***
No of observations	1392	1392	1392	1392

Note: Dependent variable is real GDP percapita growth. Please refer Table 1 note for information about Model (1) until (4). Standard errors are in parentheses. Wald test is for null hypothesis that ρ=0 ~$\chi^2(1)$. ***, ** and * denotes significance at 1%, 5% and 10% respectively.

4. Concluding remarks

On overall, this study finds an empirical support for institutions-growth spatial dependence in the developing countries under study. Specifically, it shows that institutions exert positive significant spillover effect towards economic growth and the effect is found to run via indirect route i.e. institutions in a country lead to improvement in economic growth in that country and this situation consequently generates spillover effect on economic growth in neighbouring countries. This finding is similar to that of

Easterly and Levine (1998); Ades and Chua (1997); Murdoch and Sandler (2002); Bosker and Garretsen (2009); and Arbia *et al.* (2010).

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