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### Corruption and governance around the world

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## *Chapter 6*

# Geography and Governance: Does Space Matter?

“Everything is related to everything else,  
but near things are more related than distant things.”

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Tobler (1970)

## 6.1 Introduction

There is increasing evidence that government governance has an impact on economic development. For instance, Rajkumar and Swaroop (2007) show empirically that the differences in the efficacy of public spending can be largely explained by the quality of governance. Major donors and international financial institutions make their aid and loans increasingly conditional upon reforms that ensure ‘good governance’. Although definitions of governance differ, there seems to be broad consensus that good governance means that the government concerned is accountable, transparent, responsive, effective and efficient, and follows the rule of law, thereby assuring that corruption is minimized.

Various studies have examined cross-country differences in governance. Geography is often taken into account in these studies. Variables like lati-

tude, climate, temperature, country size, climate-related diseases, or dummies indicating that countries are landlocked, islands, or belong to a particular region are commonly used as proxies for geography (Acemoglu et al., 2001, 2002; Easterly and Levine, 2003; Rodrik et al., 2004; Olsson and Hibbs Jr., 2005). However, these studies ignore that cross-country data are generally characterized by spatial dependence. According to Anselin (2006: 901), “Spatial dependence is a special case of cross-sectional dependence, in the sense that the structure of the correlation or covariance between observations at different locations is derived from a specific ordering, determined by the relative position (distance, spatial arrangement) of the observations in geographic space.”

There are several reasons why the geography-governance nexus may be characterized by spatial dependence. The first reason is that survey based indicators of governance may contain measurement errors. A bias may occur when a respondent rates a country as poorly-governed because its neighbors are badly-governed. Another systematic error may arise from the halo effect of other variables that are associated with governance through space. Finally, an error may occur when missing values are imputed on the basis of available information.

The second reason is more substantive. Like other political and economic phenomena—democracy, war and peace, or economic liberty (O’Loughin et al., 1998; Ward and Gleditsch, 2002; Simmons and Elkins, 2004)—governance may have a spatial dimension due to spillovers and diffusion-adoption processes. Other possible factors that may cause spatial dependence include policy convergence (Mukand and Rodrik, 2005), interdependence of policy decisions (Brueckner, 2003), or transmission of government forms (Starr, 1991).

Another problem that may arise when data have a locational component is that the parameters in such a model are not homogenous over space but vary across different geographical locations. This is known as spatial heterogeneity (Anselin, 1988). For example, the effect of the determinants of governance may differ across countries due to differences in institutions,

norms, or other country-specific characteristics.

Using the governance indicators of Kaufmann et al. (2006), we examine the existence of both spatial dependence and spatial heterogeneity. Our findings show that governance in one country exhibits a positive relationship with governance in neighboring countries, i.e., poorly (well) governed countries are geographically clustered with other poorly (well) governed countries. In a series of models explaining cross-country differences in governance, we find that this interaction effect is robust to different spatial weights matrices measuring the spatial arrangement of the countries in the sample. In addition, we find that the impact of the determinants of governance is different for different countries.

The remainder of the paper is organized as follows. Section 2 provides some preliminary empirical evidence of geographical clustering and introduces two spatial econometric models to operationalize spatial dependence. Section 3 examines the phenomenon of spatial heterogeneity, while section 4 concludes.

## 6.2 Spatial Dependence

### 6.2.1 Preliminary Evidence

To test for spatial dependence of governance among different countries, we use the dataset of Kaufmann et al. (2006). We employ a governance index that is constructed as the unweighted average of the various components of governance, i.e., voice and accountability, political stability, government effectiveness, regulatory quality, rule of law, and control of corruption in 2005 (see Appendix 4a for further details). Our index ranges from  $-2.5$  to  $+2.5$ , where a higher score reflects better governance.

Figure 6.1 displays every country's governance index against the distance to the country with the highest (Iceland) and the lowest governance index (Somalia). The distance to these countries is measured as the kilometer-converted row-normalized great circle distance (explained below). The figure shows that the closer a country is located to the world's best (worst)

practice, the higher (lower) is its governance index.

As a more formal test, we calculate Moran's  $I$  and Geary's  $c$  statistics as two common measures of spatial autocorrelation. The null hypothesis is no spatial dependence. If  $I$  is greater (smaller) than its expected value,  $E(I)$ , the overall distribution of governance is characterized by positive (negative) spatial dependence. If  $c$  is greater (smaller) than its expected value,  $E(c)$ , the overall distribution of governance is characterized by negative (positive) spatial dependence. The statistical inference is computed on the basis of  $z$ -statistics.

These two statistics are computed using two different spatial weights matrices.<sup>1</sup> The first spatial weights matrix that we use ( $\mathbf{W}^1$ ) is based on the kilometer-converted great circle distance ( $d_{ij}$ ) between two countries ( $i$  and  $j$ ) on the sphere:

$$d_{ij} = \arccos [(\sin \phi_i \sin \phi_j) + (\cos \phi_i \cos \phi_j \cos |\delta\gamma|)], \quad (6.1)$$

where  $\phi_i$  and  $\phi_j$  are the latitude of country  $i$  and country  $j$ , respectively, and  $|\delta\gamma|$  denotes the absolute value of the difference in longitude between  $i$  and  $j$ .<sup>2</sup> To follow Tobler's First Law of Geography, this distance is substituted into a distance-decay function of the form:

$$w_{ij}^1 = (d_{ij})^{-1}. \quad (6.2)$$

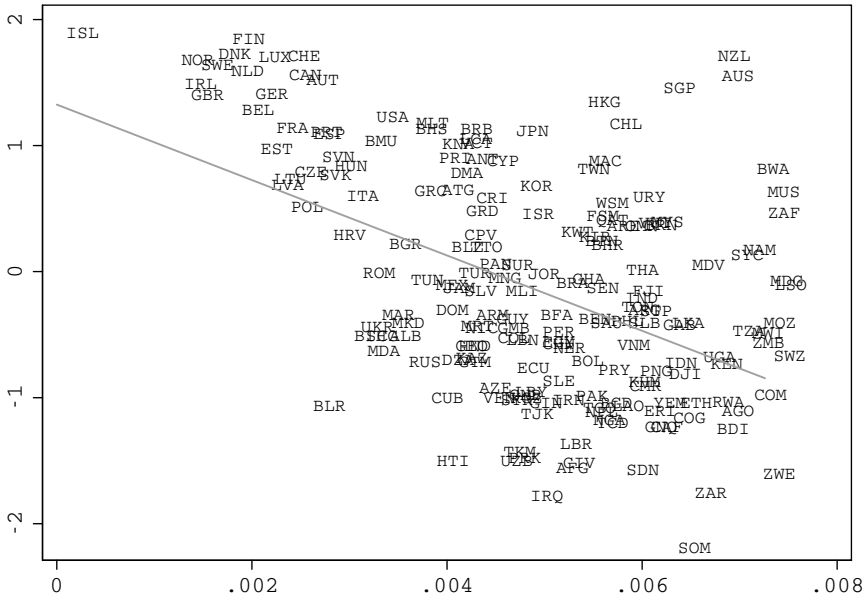
In the second matrix ( $\mathbf{W}^2$ ), we also take the type of political regime

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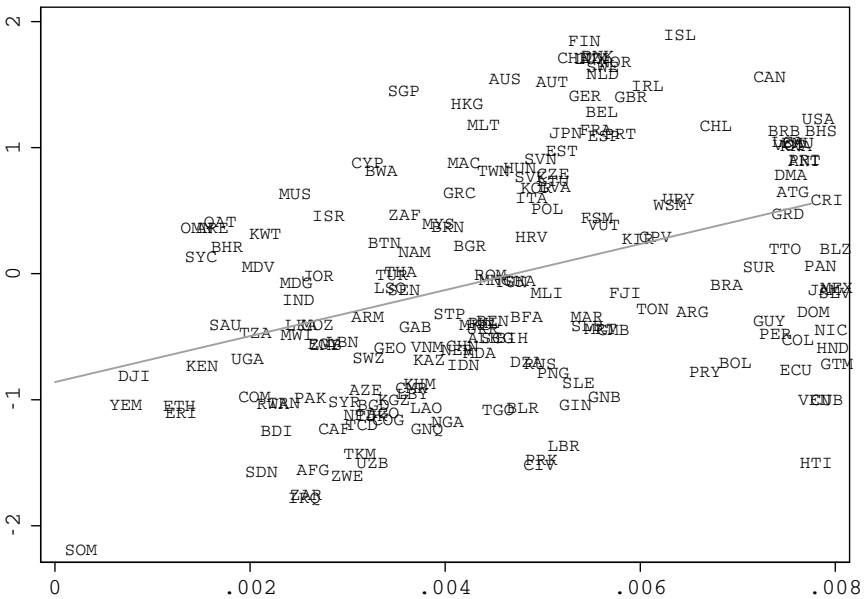
<sup>1</sup> A spatial weights matrix  $\mathbf{W}$  is a  $N$  by  $N$  nonnegative matrix, which expresses for each country (row) those countries (columns) that belong to its neighbourhood set as nonzero elements. By convention, the diagonal elements of the weights matrix are set to zero, since no country can be viewed as its own neighbour. For ease of interpretation, it is common practice to normalize  $\mathbf{W}$  such that the elements of each row sum to one. Since  $\mathbf{W}$  is nonnegative, this ensures that all weights can be interpreted as an averaging of neighbouring values.

<sup>2</sup> If simplified into a Cartesian space, latitude-longitude coordinates may correspond to the vertical-horizontal axes. Using the coordinates of a country, we may construct a contiguity structure by defining a 'neighboring country' as one lying within a particular distance.

Figure 6.1: Governance and Distance to Worst and Best Practices, 2005



(a) Distance to Best Practice



(b) Distance to Worst Practice

into account:

$$w_{ij}^2 = e^{-|r_i - r_j|} (d_{ij})^{-1}. \quad (6.3)$$

For this purpose, we use the regime indicator of Cheibub and Gandhi (2005). This indicator  $r$  ranges from 0 to 5, where 0 represents a parliamentary democracy, 1 a mixed democracy, 2 a presidential democracy, 3 a civilian dictatorship, 4 a military dictatorship, and 5 a royal dictatorship. It is likely that countries having a similar political regime are more sensitive to spill-over effects and diffusion-adoption processes than countries having different regimes.

Table 6.1 shows that Moran's  $I$  statistic is greater than -0.005 with highly positive  $z$ -values, while Geary's  $c$  statistic is smaller than one with highly negative  $z$ -values. These results indicate positive spatial dependence of the governance index among countries. The correlation between the governance index  $g$  and the governance index weighted by the (political) distance to other countries ( $\mathbf{W}^1 g$  or  $\mathbf{W}^2 g$ ) confirms this conclusion.

Table 6.1: Moran's  $I$  and Geary's  $c$  for Governance

Matrix	Moran's $I$	E(I)	SD(I)	$z$ -stat.	
$\mathbf{W}^1$	0.170	-0.005	0.011	16.004	***
$\mathbf{W}^2$	0.430	-0.005	0.019	22.532	***
	Geary's $c$	E(c)	SD(c)	$z$ -stat.	
$\mathbf{W}^1$	0.831	1.000	0.014	-12.058	***
$\mathbf{W}^2$	0.588	1.000	0.022	-18.593	***
Correlation:					
$\mathbf{W}^1 g$ vs $g$	0.661	***			
$\mathbf{W}^2 g$ vs $g$	0.731	***			

\*\*\*: significant at 1%

## 6.2.2 Spatial Regression Models

In the previous section a series of evidence has indicated that governance is spatially dependent. However, we are not certain about the type of spatial dependence. In this section we further specify the type of spatial dependence. As pointed out by Anselin (1988, 2006), when specifying spatial de-

pendence among the observations, the model may contain a spatially lagged dependent variable, or the model may incorporate a spatially autoregressive process in the error term. The first model is known as the spatial lag model and the second as the spatial error model.

Formally, the spatial lag model is formulated as

$$g = \rho \mathbf{W}g + \mathbf{X}\beta + \epsilon, \quad (6.4)$$

where  $g$  is an  $[n \times 1]$  vector of the dependent variable (i.e., governance),  $\mathbf{X}$  is an  $[n \times k]$  matrix consisting of the explanatory variables,  $\rho$  is the spatially autoregressive parameter,  $\beta$  is the  $[k \times 1]$  vector of parameters, and  $\epsilon$  is an  $[n \times 1]$  vector of i.i.d. error terms.

There are two issues to be dealt with in estimating equation 6.4. First, the presence of the spatially lagged dependent variable generates feedback effects, because each country is also a neighbour of its neighbors. If  $g_j$  enters on the right-hand side of  $g_i$ ,  $g_i$  also enters on the right-hand side of  $g_j$ . Second, the right-hand variable  $\mathbf{W}g$  is correlated with the error term,  $\epsilon$ , as can be seen from a slight reformulation of model (4):

$$g = (\mathbf{I} - \rho \mathbf{W})^{-1} \mathbf{X}\beta + (\mathbf{I} - \rho \mathbf{W})^{-1} \epsilon. \quad (6.5)$$

Due to the spatial multiplier matrix  $(\mathbf{I} - \rho \mathbf{W})^{-1}$ ,  $g$  in a particular country  $i$  not only depends on its own error term, but also on the error terms of other countries. Hence,  $\mathbf{W}g$  also depends on the error term of other countries, as a result of which  $E[(\mathbf{W}g)_i \epsilon_i] \neq 0$ . Estimating the spatial lag model by OLS, called Spatial OLS (SOLS), will therefore not be consistent. Franzese Jr. and Hays (2008) show that in case of positive (negative) spatial dependence, SOLS will overestimate (underestimate)  $\rho$  and underestimate (overestimate)  $\beta$ . By contrast, Maximum Likelihood (ML) estimation, taking into account the Jacobian term of the transformation from the error term to the dependent variable  $|\partial g / \partial \epsilon| = |\mathbf{I} - \rho \mathbf{W}|$ , yields consistent and efficient parameter estimates (Anselin, 1988, 2006).



In the spatial error model, the error term of country  $i$  is taken to depend on the error term of neighbouring countries according to the spatial weights matrix  $\mathbf{W}$  and an idiosyncratic component  $\xi$ , or formally:

$$g = \mathbf{X}\beta + \epsilon \text{ and } \epsilon = \lambda\mathbf{W}\epsilon + \xi, \quad (6.6)$$

where  $\lambda$  is the spatial autocorrelation parameter and  $\xi$  is an  $[n \times 1]$  vector of i.i.d. error terms. This model is consistent with a situation where the determinants of governance omitted from the model are spatially autocorrelated, and with a situation where unobserved shocks follow a spatial pattern. Andrew (2003, 2005) calls these unobserved effects ‘common shocks’, covering a wide range of macroeconomic, political, and environmental shocks. Although the OLS estimator of the response parameters of this model is unbiased, it is not efficient. ML estimation, taking into account the Jacobian term of the transformation from the error term to the dependent variable  $|\partial g/\partial \epsilon| = |\mathbf{I} - \lambda\mathbf{W}|$ , again solves this problem.<sup>3</sup>

### 6.2.3 Data

The explanatory variables of governance in our model have been selected on the basis of the results of previous studies. Income per capita is included, as higher incomes may increase demand for good governance (La Porta et al., 1999; Kaufmann and Kraay, 2002). The data are drawn from the Penn World Table (PWT) 6.2.<sup>4</sup>

The second variable is trade openness, defined as the log ratio of trade and GDP, and is also drawn from the PWT. Several studies report that openness influences governance (*inter alia* Bonaglia et al., 2001; Knack and Azfar, 2003; Dollar and Kraay, 2003; Wei, 2000b). According to Rodrik (2002: 4), “... a free trade regime is likely to reduce the corruption and

<sup>3</sup>The spatial lag model and the spatial error model can also be estimated by generalized method-of-moments (GMM) (see Kelejian and Prucha, 1998; Anselin, 2006). Software packages to estimate spatial econometric models are Stata, Spacestat, Geoda (freely downloadable) and Matlab (see [www.spatial-econometrics.com](http://www.spatial-econometrics.com)).

<sup>4</sup>[http://pwt.econ.upenn.edu/php\\_site/pwt\\_index.php](http://pwt.econ.upenn.edu/php_site/pwt_index.php)

rent-seeking associated with trade interventions. Similarly, tariff bindings ... may generate greater predictability in incentives and solidify property rights—two important attributes of a high-quality institutional framework.”

The third determinant of governance taken into account is legal origin. Following La Porta et al. (1999), we consider three legal traditions: socialist, civil, and common law traditions that reflect the degree of state involvement. Socialist Law is “a clear manifestation of the State’s intent to create institutions to maintain its power and extract resources, without much regard for protecting the economic interests or the liberties of the population.” Civil Law tradition can be taken as “a proxy for an intent to build institutions to further the power of the State, although not to the same extent as in the socialist tradition.” Finally, Common Law tradition can be taken as “a proxy for the intent to limit rather than strengthen the State.” (La Porta et al., 1999: 231-232). We use an index ranging from 1 to 3, where 1 indicates the strongest state intervention (Communist Law), 3 the least state intervention (British Common Law), and Civil Law is in between.

Fourth, we include the mostly-used geographic variable, namely absolute latitude. This variable may explain cross-country variation in governance for various reasons. Hall and Jones (1999: 101) argue that distance from the equator is correlated with Western European influence which, in turn, creates good institutions: “Western Europeans were more likely to settle in areas that were broadly similar in climate to Western Europe, which again points to regions far from the equator.”<sup>5</sup> Other authors use this variable to instrument for rule of law to disentangle the relationship between income, institutions, integration, and geography (Dollar and Kraay, 2003; Rodrik et al., 2004). The data are taken from the CIA World Factbook.<sup>6</sup>

Finally, we consider the fraction of the population with a Protestant religion drawn from Barro and McCleary (2005). A common view of Protestantism is that it is more egalitarian than other religious traditions. La

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<sup>5</sup> See also Acemoglu et al. (2001; 2002).

<sup>6</sup> <https://www.cia.gov/library/publications/the-world-factbook/>

Porta et al. (1997) find that more hierarchical religions are related to poor governance. Similar results are reported by Treisman (2000) and Persson and Tabellini (2003).

To enhance data availability and to avoid reverse causation problems, data on these explanatory variables have been collected for the year 2000.

## 6.2.4 Results

This section reports our findings for cross-country differences in governance in 2005.<sup>7</sup> The first column of Table 6.2 shows the results of the OLS estimator applied to the model  $g = \mathbf{X}\beta + \epsilon$  without a spatially lagged dependent variable or a spatially autocorrelated error term. This OLS model is used as a benchmark. The classic indicators for a spatial lag model or for a spatial error model are the Lagrange Multiplier (LM) tests, which may be calculated from the residuals of the OLS model and which follow a chi-squared distribution with one degree of freedom (Anselin, 1988). Using these tests, both the hypothesis of no spatially lagged dependent variable and the hypothesis of no spatially autocorrelated error term must be rejected at a one per cent significance level.

The other columns of Table 6.2 show the results of different estimations that all use the weights matrix  $\mathbf{W}^1$ . The second column of Table 2 shows the results of the model extended to include a spatially lagged dependent variable estimated by SOLS and the third column shows the results for the model estimated by ML. The fourth column shows the results of the model extended with a spatially autocorrelated error term estimated by ML. Both the spatial autoregressive parameter  $\rho$  and the spatial autocorrelation coefficient  $\lambda$  appear to be significant. According to the spatial lag model estimated by ML, the quality of governance of a particular country increases by 6 per cent if the quality of governance in surrounding countries increases by 10 per cent. In the SOLS model the corresponding figure is about 7.5 per cent. Hence, as predicted, SOLS overestimates  $\rho$  by about 23 per cent

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<sup>7</sup> We also examined sub indexes of governance, but this did not change our overall conclusions. Results are available on request.

compared to ML.

Table 6.2: Spatial Governance using  $W^1$

Determinants	OLS		SOLS		MLSL		MLSE	
Ln GDP	0.449	***	0.384	***	0.397	***	0.435	***
per Capita	(0.040)		(0.043)		(0.041)		(0.042)	
Ln Openness	0.241	***	0.216	***	0.221	***	0.235	***
	(0.063)		(0.062)		(0.061)		(0.062)	
Legal	0.226	***	0.251	***	0.246	***	0.243	***
Origin	(0.068)		(0.067)		(0.06)		(0.068)	
Distance	0.011	***	0.009	***	0.009	***	0.012	***
to Equator	(0.003)		(0.003)		(0.003)		(0.003)	
Fraction of	0.908	***	0.707	***	0.745	***	0.797	***
Protestant	(0.199)		(0.202)		(0.196)		(0.209)	
Constant	-5.831	***	-4.903	***	-5.231	***	-5.714	***
	(0.343)		(0.430)		(0.372)		(0.390)	
$\rho$			0.747	***	0.606	***		
			(0.219)		(0.179)			
$\lambda$							0.791	***
							(0.183)	
(Pseudo) $R^2$	0.719		0.736		0.730		0.719	
Log Likelihood					-125.626		-126.478	
Spatial Lag:								
$LM_\rho$	12.358	***						
$LM_\rho^r$	4.081	**						
Spatial Error:								
$LM_\lambda$	10.475	***						
$LM_\lambda^r$	2.198							

Standard errors in brackets; \*\*\*, \*\*, and \*: significant at 1%, 5%, and 10%

To find out whether the spatial lag model or the spatial error model is more appropriate to describe the data, we use the robust LM-tests,  $LM_\rho^r$  and  $LM_\lambda^r$ , proposed by Anselin et al. (1996). These tests are robust in the sense that the existence of one type of spatial dependence does not bias the test for the other type of spatial dependence. The results show that the hypothesis of no spatially lagged dependent variable must still be rejected at 5 per cent significance. However, the hypothesis of no spatially autocorrelated error term can no longer be rejected. This indicates that the spatial lag model is more appropriate. This finding is also consistent

with the fact that the value of the log-likelihood of the spatial lag model is greater than that of the spatial error model,  $-125.63$  versus  $-126.48$ .

In line with previous studies, the coefficients of the explanatory variables in the OLS model, the spatial lag model and the spatial error model are significantly different from zero and have the expected signs. Higher income and trade openness promote good governance. A legal system supporting state intervention leads to poor governance. Countries situated far from the equator tend to have better governance. Finally, a larger fraction of Protestant population is related to good governance. Nevertheless, since the spatial lag model is found to be more appropriate than the spatial error model, the coefficients of the explanatory variables in the OLS model are biased. The most affected variable is distance to the equator. In the spatial lag model estimated by ML its coefficient is 0.009 and in the OLS model it is 0.011. This means that the latter coefficient is overestimated by 25 per cent. Similarly, the coefficient of GDP per capita is overestimated by 13 per cent, of openness by 9 per cent, of Protestantism by 22 per cent, while the coefficient of legal origin is underestimated by 8 per cent.

We now examine whether our conclusions are sensitive to the choice of the spatial weights matrix. Table 6.3 reports the estimation results for the spatial weights matrix  $\mathbf{W}^2$  that also captures similarity in the political regime between countries. In general, the results are in line with those of Table 6.2, the difference being that the spatial autoregressive parameter  $\rho$  in the spatial lag model falls from 0.61 to 0.49.<sup>8</sup> It shows that the degree of interaction decreases if political regime similarity is made part of the spatial weights matrix.

Up to this point, the spatial weights matrices have been row-normalized. However, row normalization may be criticized. If, for example, an inverse distance matrix is row normalized, it will lose its economic interpretation of distance decay (Anselin, 1988). There are two reasons for this. First, due

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<sup>8</sup> We also ran regressions for an adjusted governance index excluding voice and accountability, since to some extent it is related to the political regime. Again, we found that the spatial error model must be rejected in favour of the spatial lag model.

to row normalization the spatial weights matrix may become asymmetric, as a result of which the impact of country  $i$  on country  $j$  is not the same as that of country  $j$  on country  $i$ . Second, due to row normalization remote countries will have the same impact on all other countries in the sample as core countries.

Table 6.3: Spatial Governance using  $\mathbf{W}^2$

Determinants	SOLS		MLSL		MLSE	
Ln GDP	0.369	***	0.374	***	0.402	***
per Capita	(0.039)		(0.038)		(0.041)	
Ln Openess	0.198	***	0.201	***	0.220	***
	(0.058)		(0.057)		(0.058)	
Legal	0.176	***	0.179	***	0.221	***
Origin	(0.063)		(0.062)		(0.067)	
Distance	0.006	***	0.006	***	0.008	***
to Equator	(0.003)		(0.003)		(0.004)	
Fraction of	0.568	***	0.590	***	0.640	***
Protestant	(0.191)		(0.187)		(0.206)	
Constant	-4.630	***	-4.710	***	-5.225	***
	(0.371)		(0.360)		(0.417)	
$\rho$	0.523	***	0.488	***		
	(0.087)		(0.081)			
$\lambda$					0.826	***
					(0.104)	
(Pseudo) $R^2$	0.719		0.760		0.716	
Log Likelihood			-114.410		-116.216	
Spatial Error:						
$LM_\lambda$	44.439	***				
$LM_\lambda^r$	15.770	***				
Spatial Lag:						
$LM_\rho$	48.313	***				
$LM_\rho^r$	19.645	***				

Standard errors in brackets; \*\*\*, \*\*, and \* are significant at 1%, 5%, and 10%  
 $LM$  statistics are based on OLS residuals.

Following Elhorst (2001), we therefore also consider a normalization procedure where each element of  $\mathbf{W}$  is divided by its largest eigenvalue  $\omega_{max}$ :  $w_{ij}^* = w_{ij}/\omega_{max}$ . This has the effect that the eigenvalues of  $\mathbf{W}$  are also divided by  $\omega_{max}$ , as a result of which the largest eigenvalue of the

matrix  $\mathbf{W}^*$  equals one, just like the largest eigenvalue of a row normalized matrix, but without changing the mutual proportions between the elements of  $\mathbf{W}$ .

Table 6.4 reports the estimation results of the spatial lag model using the largest-eigenvalue-corrected spatial weights matrices ( $\mathbf{W}^{1*}$  and  $\mathbf{W}^{2*}$ ). The robust *LM* statistics based on the OLS residuals again indicate that the spatial lag model is the preferred specification.<sup>9</sup> The coefficient estimates of the explanatory variables using the largest-eigenvalue-corrected spatial weights matrices are also very close to those found for row-normalized spatial weights matrices. However, the spatial autoregressive parameter  $\rho$  increases from 0.61 to 0.68 when using  $\mathbf{W}^{1*}$  and from 0.49 to 0.63 when using  $\mathbf{W}^{2*}$ .

In sum, we may conclude that governance in one country is significantly related to that in surrounding countries and that the degree of interaction is approximately 0.63 to 0.68, depending on whether or not political similarity is taken into account.

## 6.3 Spatial Heterogeneity

### 6.3.1 Local Statistics

In this section we test for spatial heterogeneity. We first provide local indicators of spatial association, local Moran's  $I_i$  and local Geary's  $c_i$  ( $i = 1, \dots, n$ ), in order to identify the contribution of specific locations to the overall pattern of spatial dependence using the spatial weights matrices  $\mathbf{W}^1$  and  $\mathbf{W}^2$  (Anselin, 1995). Figures 6.2 and 6.3 graph these statistics for the observations arranged in alphabetical order (the first observation is Afghanistan and the last one is Zimbabwe). Values for  $I_i$  greater (smaller) than -0.005 and for  $c_i$  smaller (greater) than 1 indicate positive (negative) local spatial dependence, i.e., a clustering of countries with a (dis)similar governance index around country  $i$ . Furthermore, values for  $I_i$  above (below) the solid line and for  $c_i$  below (above) the solid line indicate countries of

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<sup>9</sup>Also, the exclusion of voice and accountability from the overall governance index does not change the conclusion that the spatial lag model is the preferred specification.

which the degree of spatial dependence is greater (smaller) than its global counterpart (see Table 6.1).

From Figures 6.2 and 6.3 it can be seen that local Moran's  $I$  of a wide range of countries points to positive spatial dependence: 71% in case of  $\mathbf{W}^1$  and 77% in case of  $\mathbf{W}^2$ . Similar results are obtained for local Geary's  $c$ : 78% in case of  $\mathbf{W}^1$  and 88% in case of  $\mathbf{W}^2$ . Furthermore, it can be seen that most observations lie within the range of  $\bar{I} \pm 2\sigma^2(I_i)$  and  $\bar{c} \pm 2\sigma^2(c_i)$ . Statistical outliers may be considered as 'hotspots'. For example, 10 'hotspots' with a statistically significant contribution to global Moran's  $I$  of 0.17 based on  $\mathbf{W}^1$  are found in Western and Northern Europe, namely Luxembourg (observation 101) with a local Moran's  $I$  of 1.19, the Netherlands (120; 1.10), Belgium (16; 0.97), Switzerland (163; 0.96), Germany (63; 0.96), Denmark (46; 0.94), Norway (126; 0.92), Sweden (162; 0.89), the UK (178; 0.81), and Austria (9; 0.77). The list of countries is provided in Appendix 4b.



Table 6.4: Normalization by Largest Eigenvalue ( $\mathbf{W}^{1*}$  and  $\mathbf{W}^{2*}$ )

Determinants	Matrix $\mathbf{W}^{1*}$		Matrix $\mathbf{W}^{2*}$	
	SOLS	MLSL	SOLS	MLSL
Ln GDP	0.384 (0.042)	0.395 (0.040)	0.381 (0.039)	0.386 (0.038)
per Capita				
Ln Openness	0.205 (0.062)	0.211 (0.060)	0.180 (0.060)	0.184 (0.058)
Legal	0.252 (0.066)	0.247 (0.064)	0.202 (0.063)	0.203 (0.062)
Origin	0.008	0.009	0.007	0.007
Distance				
to Equator	0.003	0.003	0.003	0.003
Fraction of	0.704	0.740	0.620	0.639
Protestant	0.197	0.192	0.191	0.186
Constant	-5.049 (0.380)	-5.186 (0.357)	-4.799 (0.364)	-4.870 (0.352)
$\rho$	0.824 (0.200)	0.680 (0.161)	0.629 (0.110)	0.586 (0.102)
(Pseudo) $R^2$	0.743	0.742	0.762	0.762
Log Likelihood		-123.339		-115.922
Spatial Lag:				
$LM_\rho$	20.130	***	44.232	***
$LM_\rho^r$	8.145	***	19.670	***
Spatial Error:				
$LM_\lambda$	14.630	***	39.069	***
$LM_\lambda^r$	2.645		14.506	***

Standard errors in brackets; \*\*\*, \*\*, and \* are significant at 1%, 5%, and 10%  
 $LM$  statistics are based on OLS residuals.

Figure 6.2: Local Moran's  $I$  Statistics (Matrices  $W^1$  and  $W^2$ )

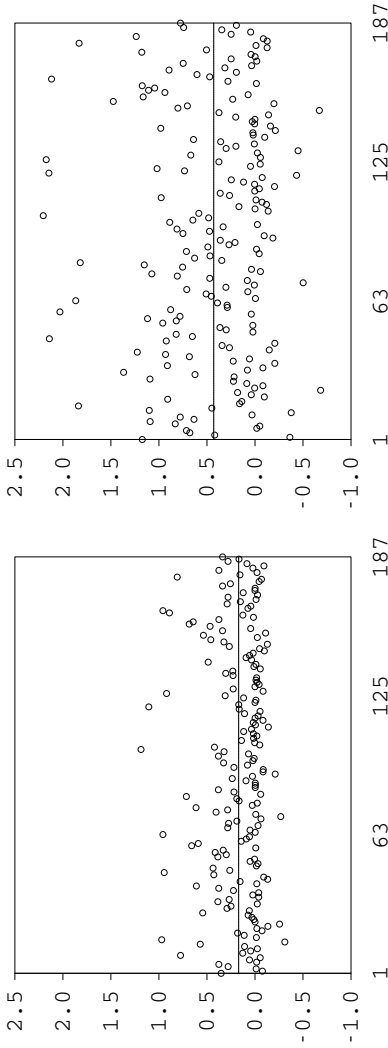
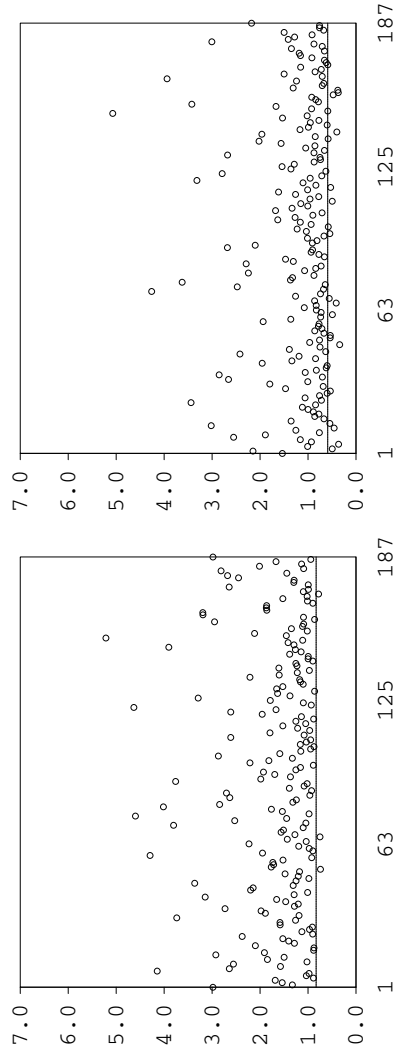


Figure 6.3: Local Geary's  $c$  Statistics (Matrices  $W^1$  and  $W^2$ )



### 6.3.2 Geographically Weighted Regression

In the models estimated in Section 6.2 it has been assumed that the coefficients of the determinants of governance are the same for all observations. In this section we examine whether the determinants of governance vary over space. In other words, we analyze the issue of spatial non-stationarity defined as “the variation in relationships and processes over space” (Brunsdon et al., 1999: 497). For this purpose, we apply a geographically weighted regression (GWR) technique of Brunsdon et al. (1996, 1999) that allows for variability in the parameters (see also LeSage, 2004).

The model resembles the standard OLS model, but with varying parameter coefficients; that is

$$g_i = \sum_j \mathbf{X}_{ij} \beta_{ij}(\phi_i, \ell_i) + \epsilon_i, \quad (i = 1, 2, \dots, N), \quad (6.7)$$

where  $\beta_{ij}(\phi_i, \ell_i)$  is the parameter of the  $j$ -th explanatory variable of observation  $i$ , located at  $(\phi_i, \ell_i)$  in a geographical space.<sup>10</sup> The inclusion of the index  $i$  implies that equation 6.7 is not a single equation, but a set of  $n$  equations where the dimensions of  $\beta$  are  $n \times J$ . This results in a set of localized regression estimates, where each observation is given a certain weight such that neighboring countries have more influence on the parameters than those located farther away. If  $\vartheta_{ik}$  is defined as the weight of the  $k$ -th observation in predicting the  $i$ -th observation, constructed on the basis of the Euclidean distance  $d_{ik}$  between  $i$  and  $k$ , and arranged as the  $k^{th}$  diagonal element of a diagonal matrix<sup>11</sup>, we have

$$\vartheta_{ik} = e(-d_{ik}/h^2) \quad (6.8)$$

where  $h$  is the kernel bandwidth calibrated by minimizing the cross-validated

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<sup>10</sup>In our case, the location is determined via the country’s longitude and latitude. We locate the observations in such a way that all countries lie in the positive-positive (East-North) Cartesian quadrant.

<sup>11</sup>Since local areas are relatively small, it is not necessary to use the great circle distance.

sum of squared errors.

Figure 6.4 shows the local parameter estimates of the determinants of governance where the vertical and horizontal axes are, respectively, the parameter estimates and the country code (see Appendix 4b). Although the means of these local parameter estimates are close to their counterparts reported in Tables 6.2, 6.3 and 6.4, there is substantial heterogeneity of the local parameters across observations. Whereas the local parameters of openness, legal origin and distance to the equator are still closely scattered around their global parameters (the solid horizontal lines passing through the plots), those of the constant term, income and Protestant religion are widely dispersed.

A closer look at Figure 6.4 reveals which countries are responsible for this result. The local coefficient of trade openness is found to deviate from its global value for Samoa (observation 141 with coefficient 0.58) and Tonga (170; 0.57), as well as for Fiji (57; -0.46), Kiribati (89; -0.16), New Zealand (122; -0.70) and Vanuatu (182; -0.23). Interestingly, these countries are all small islands situated in the ‘tip’ of the earth.

The same small island countries are also identified as spatial outliers for the income variable. A highly positive income effect is found for Samoa (141; 1.06) and Tonga (170; 1.05), while a highly negative income effect is found for Fiji (57; 0.02), Vanuatu (182; 0.12), Kiribati (89; 0.13) and New Zealand (122; -0.05). The same countries are also spatial outliers for the local parameters of the other explanatory variables.

Table 6.5 reports the results of test statistics whether the local parameters are significantly different from their global values, based on 1000 Monte Carlo simulations. In line with Figure 6.4, this table illustrates that the parameters of three variables vary significantly over space at one per cent significance, namely the constant term, income and Protestant religion. The Monte Carlo simulation based bandwidth test indicates that GWR outperforms the global linear regression model with coefficients that are homogeneous across space.

Figure 6.4: Local Coefficients

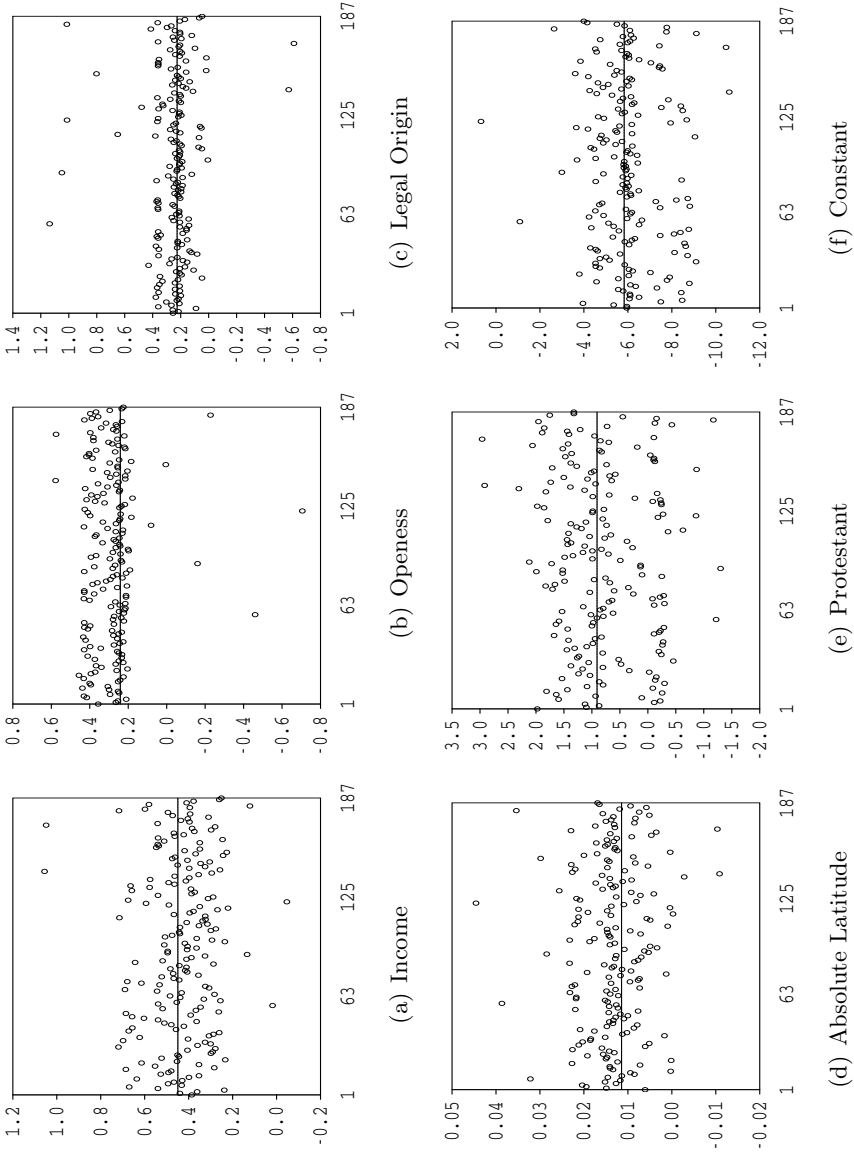


Table 6.5: Significance Tests

Independent Variables	$\bar{\beta}_j$	$\beta_j^{min}$	$\beta_j^{max}$	Non-Statry. Test		Per cent Outliers
				$\sigma_{\beta_j}^2$	Sign.	
Significance Test for Non-Stationarity						
Ln GDP per capita	0.432	-0.047	1.055	0.147	***	3.21
Ln Openness	0.287	-0.705	0.577	0.134		3.74
Legal Origin	0.246	-0.611	1.136	0.178		4.28
Absolute Latitude	0.013	-0.011	0.045	0.007		4.81
Fraction of Protestant	0.798	-1.301	2.962	0.785	***	3.74
Constant	-5.976	-10.617	0.681	1.520	***	4.28
Significance Test for Bandwidth						
Bandwidth	37.603				***	

Outliers are defined as those outside a range of  $\bar{\beta}_j \pm 2\sigma_{\beta_j}^2$

Summing up, the relationship between governance and its determinants is not homogeneous over space but instead varies over different countries.

## 6.4 Conclusion

We have found a strong relationship between governance similarity and locational similarity. Countries are clustered according to their distance to the world best (worst) practice in governance. Statistics used to test for global spatial dependence confirm these results: well (poorly) governed countries are found to be located near other well (poorly) governed countries.

Our econometric analysis of cross-country differences in governance, in which we controlled for GDP per capita, openness, legal origin, distance to the equator and Protestant religion, has also shown that the classic OLS model must be rejected in favor of a model extended to include governance observed in neighboring countries weighted by an inverse distance matrix. This conclusion also holds when we employ a spatial weights matrix that captures similarity in the political regime between countries or when the spatial weights matrix is normalized by dividing all elements by its largest eigenvalue rather than normalizing the elements such that the rows sum to one. Overall, the degree of interaction of the governance index among countries appeared to be approximately 0.63 to 0.68, depending on whether

or not political similarity is taken into account.

Finally, our findings have shown that the relationship between governance and its determinants is not homogeneous over space but instead varies over different countries. In other words, both global and local spatial dependencies systematically colour world governance.