The Developing Economies

*The Developing Economies* 59, no. 3 (September 2021): 275–305



# GROWTH SPILLOVERS FOR THE MENA REGION: GEOGRAPHY, INSTITUTIONS, OR TRADE?

MERVE AKSOYLAR BAYSOY[1] AND SUMRU ALTUG[2,3]*

[1]*Department of Economics, Koç University, Istanbul, Turkey;* [2]*Department of Economics, American University of Beirut, Lebanon; and* [3]*Centre for Economic Policy Research, London, UK*

*First version received March 2020; final version accepted November 2020*

We examine the role of spatial spillovers in economic growth for the Middle East and North Africa (MENA) region. We explicitly model spatial interactions that may arise from geography, bilateral trade, or institutional similarities, and ask how much they are likely to matter for growth externalities and spillover effects. We find that the economic growth of a MENA country is positively affected by the economic growth of countries that are geographically close and that have similar institutional characteristics. The spillover effects of growth are due to economic activities in countries that trade primarily in oil, which accounts for the gap in spillover effects due to institutional similarity between resource-rich and resource-poor countries in the MENA region. However, trade linkages matter less. Where they do have an effect, it is through the local range effects of a spatially lagged explanatory variable capturing the effects of the trade balance on growth.

*Keywords:* Growth regressions; Spillover effects; Spatial econometrics; MENA countries
*JEL classification:* F43, O40, R11

## 1. INTRODUCTION

ECONOMIC theories of growth have highlighted domestic factors for understanding a country's growth performance and have typically ignored the interaction among different economies. An extensive literature has empirically studied the phenomenon of the convergence of individual countries to more advanced ones based on the paradigm of neoclassical growth theory (Mankiw, Romer, and Weil 1992; Barro and Sala-i-Martin 1995). In subsequent analyses, the endogenous growth theory pioneered by Lucas (1988) and Romer (1990) proposes a mechanism that can potentially lead to the systematic divergence

We are grateful to two anonymous referees for helpful comments.
* Corresponding author: Sumru Altug, American University of Beirut, P.O. Box 11-0236, Riad El-Solh, Beirut, Lebanon, 1107 2020. Email: sa287@aub.edu.lb

 doi: 10.1111/deve.12267

between per capita incomes across countries observed in the data. For this purpose, Lucas (1988) develops a model of human capital accumulation in which the initial comparative advantage of countries increases by learning-by-doing while Romer (1990) emphasizes the role of knowledge capital.

The notion that a country's growth may depend on the economic performance of its neighbors has been emphasized in the recent literature. One mechanism through which such spillover effects may occur is openness and trade. Grossman and Helpman (1991) argue that countries with larger and more advanced trading partners should experience greater spillover effects from them. Vamvakidis (1998) shows that the market size of neighboring countries measured as the log of their GDP matters for the growth of the home country, after controlling for other measures of openness and model specification in a standard growth regression framework. He also finds that neighboring countries' level of development—especially if they are open—has significantly positive spillover effects on the home country's growth.

Various studies have allowed for geographical variables directly incorporated into the analysis. Hall and Jones (1999), Sachs and Warner (1997), and Lee, Pesaran, and Smith (1997) find that the latitude is a negative determinant of growth after controlling for other related factors. Gallup, Sachs, and Mellinger (1999) find that agricultural productivity growth is substantially lower in the tropics while Rappaport and Sachs (2003) argue that proximity to coastal regions provides an important source of productivity and quality-of-life effect for US regions. In a more recent contribution, Henderson et al. (2018) show that the spatial distribution of global economic activity, as proxied by lights at night, depends on geographical characteristics deemed to be important for agriculture versus trade, and varies according to the level of development. For early developed countries, structural transformation from agricultural to urban activities begins before transport costs fall, leading to a more uniform distribution of spatial activity and education (human capital). By contrast, for late developing economies, the existence of lower transport costs that precedes the process of structural transformation has led to agglomeration of education and economic activity in locations conducive to trade such as coastal regions.

Easterly and Levine (1998) provide one of the best-known studies that accounts for the importance of location for a country's economic growth dependencies in their study of economic growth in sub-Saharan Africa. These authors argue that both policy choice and growth performance may be contagious in that countries tend to imitate the policies of each other—while good policies were amplified in the East Asian context, the reverse has tended to occur in sub-Saharan countries.[1] Also considering the case of sub-Saharan African countries, Roberts and Deichman (2009, p. 1) add

[1] See also Collier and O'Connell (2007).

to this study by examining “a mechanism for the transmission of benefits, namely, infrastructure investment which facilitates interaction between countries through trade or communication of ideas.” Moreno and Trehan (1997) examine growth spillovers using data on 93 countries over the period 1965–89. They find evidence of extremely strong spillover effects using different measures of proximity and argue that such spillover effects may occur through location or common shocks or even institutional factors. They note that an instance of spillover effects occurring through common shocks is the yen’s appreciation of the mid-1980s and early 1990s, which led to the permanent transfer of Japanese technology and production facilities to other East Asian countries. Another type of spillover effect occurring through the adoption of different institutions and practices is how the growth model embraced by Japan was emulated by many of its East Asian neighbors, including South Korea.

The growth performance of the Middle East and North Africa (MENA) region and the prevalence of such spillover effects has received less attention. Andreano, Laureti, and Postiglione (2013) examine the process of $\beta$-convergence for a sample of 26 MENA countries that covers the period 1950–2007 and confirm the hypothesis of conditional convergence. While they control for the impact of the space dimension through dummies for five different regions, they argue that a more thorough spatial analysis of the region is required. Hanson, Huidrom, and Islamaj (2018) study growth spillovers in the MENA region using a structural VAR and find that trade and financial flows between MENA countries are modest. They also find that increased trade ties between China and other large emerging economies have led to an increase in growth spillovers from the largest emerging market economies to the developing MENA region. Moriyama (2010) examines the spillover effects of the global financial crisis on MENA countries using a financial stress index approach and finds that increased financial stress and slowdown in economic activity in advanced economies can explain about half of the drop in real GDP growth in MENA emerging countries after the Lehman shock.

In this paper, we examine the role of spillovers in economic growth for the MENA region by explicitly accounting for spatial effects in a growth regression framework. In our analysis, we postulate that spatial effects on growth for the MENA countries may arise from geography, bilateral trade, or institutional similarities. Examining the role of geographical spillovers seem pertinent for the MENA region, which covers a large geographical area, extending from Morocco in the west to Iran in the east and including a wide and heterogeneous group of countries with different economic characteristics. There are notable differences among the countries in the MENA region in terms of economic size, population, standards of living, natural resource endowments, external indebtedness, and trade and financial links with the rest of the world (El-Erian et al. 1996).

However, the countries in the region also share similarities in that they are natural resource–abundant economies and their top five export items are primary products. While the region was once an example of highly successful economic integration,[2] integration within the MENA region today remains low, particularly compared with other middle- and high-income regions of the world. Intraregional interaction is small, being heavily weighted toward labor flows between certain countries, with rather limited trade in goods, and inadequate integration of capital markets.

The focus on institutional quality as a source of spillovers is also relevant for the MENA region, which has been characterized by a high level of volatility due to factors such as oil price fluctuations, climatic conditions, remittances and capital movements, political instability, and regional conflicts. As Nugent and Pesaran (2006) note, however, the volatility observed in this region is a condition that is only partly attributable to the fluctuating price of oil. The impact of institutions on economic growth and its determinants is a topic of interest in the literature on the new growth empirics (e.g., Hall and Jones 1999; Acemoglu, Johnson, and Robinson 2001; Rodrik, Subramanian, and Trebbi 2004). As Abreu, de Groot, and Florax (2005) note, institutions are the result of initial conditions like climate, location, and natural resources abundance, among other factors. According to this study, countries sharing better institutions may be characterized by stronger linkages, making spillover effects more likely to occur among them. Such spillover effects may arise from the existence of foreign direct investment, which typically flows to countries that promote property rights and the rule of law (Aziz 2018). Nunn and Trefler (2014) postulate another mechanism whereby institutions that allow for better contractability may be a source of comparative advantage for countries in terms of producing and exporting more complex products. Indeed, they argue that contracting institutions may be as important as the traditional sources of comparative advantage (i.e., factor endowments). According to their analysis, three institutions—(1) institutions that support property rights and alleviate holdup problems and underinvestment; (2) institutions associated with financial development; and (3) labor market institutions that allow for the efficient functioning of labor markets—may promote economic growth through enhanced trade and comparative advantage.

Abreu, de Groot, and Florax (2005) classify the empirical literature on the space-growth relation according to absolute and relative locations, the first referring to the impact of being at a particular point in space, such as a certain climate zone or latitude, while the second refers to the impact of being located near to or

[2] Findlay and O'Rourke (2007) mention in their discussion of the Golden Age of Islam (from the eighth to the thirteenth centuries) that the exchange in goods, techniques, ideas as well as movement of people was flourishing in this region.

far from certain regions or entities. A variety of papers has incorporated spatial considerations into growth model frameworks.[3] In our analysis, we explicitly model the interactions due to geography, bilateral trade, and institutions using a spatial econometric approach and ask how much they are likely to matter for growth externalities and spillover effects. Using results from the spatial econometrics literature, we test for the existence and type of spatial dependence in terms of a spatial autoregressive model (SAR), spatial autocorrelation or the spatial error model (SEM), and spatial Durbin model (SDM). We provide estimates of the direct and indirect effects of the trade balance as a share of GDP on MENA countries' growth using the different estimated weighting matrices and different model specifications.

Our findings may be grouped under four headings. First, there is evidence for spatial dependence for the MENA countries in our estimates of the standard growth model in that the weighted growth rates of the other countries affect positively and significantly the growth rate of a given MENA country. Second, the economic growth of a MENA country is positively affected by the economic growth of countries that are geographically close and that have similar institutional characteristics rather than through bilateral trade. Third, the spillover effects of growth are due to economic activities in countries that trade primarily in oil. The growth effects that oil-rich countries create for oil-poor ones display somewhat similar patterns and magnitudes based on the geographical and institutional weighting matrices. Oil production is known to be among the least contractually or institutionally intensive industries in terms of investment in this sector being less prone to specific buyer–seller relationships and holdup problems (Nunn 2007) or its production not being subject to a large number of input suppliers that require institutions to facilitate the intermediation of transactions (Levchenko 2007). These factors account for the gap in spillover effects due to institutional similarity between resource-rich and resource-poor countries in the MENA region. Fourth, in the absence of more complex contracting institutions that lead to horizontal specialization (across industries) or vertical specialization (specialization in lower or higher quality goods within industries), the spillover effects on growth arising from bilateral trade linkages are also limited to just a few countries, which is not enough for the emergence of economic growth spillovers within the region. The weak effects due to bilateral trade linkages may also

[3] Fingleton (2001) develops a model for manufacturing productivity growth that assumes increasing returns and spatially varying technical progress. Ramirez and Loboguerrero (2002) use spatial econometrics to test whether a country's economic growth is influenced by the economic growth of its neighbors. When using levels of income rather than growth rates, the authors find empirical evidence of spatial dependence. Ho, Wang, and Yu (2013) extend the Solow growth model with spatial terms, and estimate it using a sample of 26 OECD countries over the period 1971–2005. They provide evidence for spatial spillover through trade linkages instead of geographical distance.

derive from the fact that the public sector continues to play a dominant role in the development process in the region, thereby impeding the growth of private enterprises. Where trade linkages do have an effect, it is through the local range effects of a spatially lagged explanatory variable capturing the effects of the trade balance rather than through the spatial multiplier effects of growth among a country's trade partners.

The remainder of the paper is structured as follows. Section 2 describes the spatial econometric models and the different types of weighting matrices used in our analysis. Section 3 presents the results while Section 4 discusses the average direct and indirect effects implied by them. The final section provides some concluding remarks.

## 2. MODEL SPECIFICATION

Countries are connected to each other in several ways. The economic growth of a given MENA country may depend on the growth of its geographical neighbors, its institutional neighbors, or its trade neighbors. Since the concept of "space" should not be restricted only to geography, we will also use several suitably defined nongeographical notions of distance.

According to LeSage and Pace (2009), the cost of ignoring spatial dependence among the variables in a regression model is relatively high since omitting one or more relevant explanatory variables will result in biased and inconsistent estimates. Disregarding the role of spatial relationships can underestimate spillover effects and externalities across countries. In spatial panel data econometric analyses, the spatial autocorrelation coefficient which captures the degree of neighboring relationships is defined through the spatial weighting matrices. Given these matrices, one can create and estimate spatial econometric models.

### *2.1. Spatial Growth Models*

In this section, we formulate the empirical counterpart of the standard growth equation as well as the version that includes spatial interdependence. Following Durlauf, Johnson, and Temple (2005), a cross-country regression model for the growth rate of real GDP per capita may be defined as

$$\begin{aligned} g_{it} &= \gamma \ln(Y_{i,\tau}) + X^{*}_{i,t}\theta + \epsilon_{it} \\ &= X_{i,t}\beta + \varepsilon_{it},\ i = 1,\ldots,N;\ t = 1,\ldots,T. \end{aligned} \tag{1}$$

The dependent variable $g_{it} = (\ln Y_{i,t} - \ln Y_{i,\tau})/(t - \tau)$ is the average growth rate of GDP per capita of country $i$ between time $t$ and $\tau$, where $Y_{i,t}$ is GDP per capita for time $t$ and $Y_{i,\tau}$ is the initial level of GDP per capita for a given time span between $t$ and $\tau$. In this expression, $X^*_{i,t}$ is a vector of explanatory variables that includes a constant. This representation follows the simple growth regression model analyzed by Barro (1991); Mankiw, Romer, and Weil (1992); and Barro and Sala-i-Martin (1995).[4] We include the logarithm of initial GDP per capita $Y_{i,\tau}$ among the explanatory variables, $X_{i,t}$, and rewrite the growth regression model in an alternative way to provide consistency with the remainder of our analysis below, where $\beta = [\gamma, \theta']$ is a $K \times 1$ vector of parameters; $g_t$ is an $N \times 1$ vector of growth rates for countries $i = 1, \ldots, N$; $X_t$ is an $N \times K$ matrix of explanatory variables; and $\epsilon_t$ is an $N \times 1$ vector of error terms. Using this notation, the growth equation may be expressed as $g_t = X_t\beta + \epsilon_t$, for $t = 1, \ldots, T$.

Various authors have noted that spatial interactions across countries or regions are not explicitly modeled in the neoclassical growth model (Le Gallo and Fingleton 2014). Instead, the usual assumption of a common growth rate of technological progress may be interpreted as implying perfect diffusion of technological change across the regions. To account for spatial interactions, Ertur and Koch (2007) develop a growth model with technological interdependencies between countries that operate through spatial externalities and show that this framework leads to the general form of the spatial regression denoted by the SDM. In this model, not only does the capital stock of any country increase its own level of technology but so does the stock of technology of other countries, though at a decreasing rate due to socioeconomic or institutional dissimilarities captured by geographic distance or border effects. As a result of this technological externality, countries cannot be analyzed by themselves but must be considered as an interdependent system. This framework yields a spatial autoregressive conditional convergence equation with parameter heterogeneity, which implies a convergence speed for each country. Ertur and Koch (2011) extend this methodological framework to explain growth processes from a Schumpeterian perspective. This model differs from the Solow growth model with technological interdependence in that knowledge increases with investment in R&D.

Using similar notation as above, the SDM that incorporates such technological externalities can be expressed as[5]

---

[4] It is well known that this equation follows from the growth equation derived from a linear approximation of transitional dynamics around the deterministic steady state (Barro and Sala-i-Martin 1995):$[\ln(Y_t) - \ln(Y_0)]/T = \beta_0 + \beta_1 \ln(Y_0) + \beta_2 \ln\left(\frac{s}{n+g+\delta}\right)$, where $s$ denotes the exogenous saving rate; $n$, $g$, and $\delta$ are the growth rates of population, technology, and the depreciation rate; $T$ is the sample period. In this expression, $\beta_0 = [(1 - \exp(-\lambda T))\ln(A_0)/(1 - \alpha) + gT]/T$, $\beta_1 = -(1 - \exp(-\lambda T))/T$, $\beta_2 = [\alpha/(1 - \alpha)](1 - \exp(-\lambda T))/T$, where $A_0$ is the initial level of technology and $\alpha$ is the elasticity of output with respect to capital. As Islam (1995) shows, the panel data framework is made possible by dividing the total period into several shorter time spans.

[5] For a derivation of the growth equation, see Ertur and Koch (2007).

$$g_t = \rho W g_t + X_t \beta + W X_t \Gamma + \mu + \varepsilon_t,\ t = 1, \ldots, T. \tag{2}$$

Here $\beta$ and $\Gamma$ are $K \times 1$ vectors of fixed but unknown parameters. In the SDM, the exogenous spatial lags can measure whether the GDP growth rate of country $i$ depends on the growth determinants of other countries as well. Here $W$ is an $N \times N$ non-stochastic weighting matrix, whose elements $w_{ij}$ measure the intensity of the spatial interaction between units $i$ and $j$, while $\mu$ denotes an $N \times 1$ vector of spatial-specific effects, which are used to control for all space-specific time-invariant variables whose omission could bias the estimates in a typical cross-sectional study (Elhorst 2014).[6]

There are two fundamental justifications for the SDM: one justification may derive from spatial dependence in the disturbances of an OLS regression model and the second is the existence of an omitted explanatory variable that exhibits nonzero covariance with a variable included in the model. As LeSage and Fischer (2008) argue, in spatial growth regressions the long-run income of a given country modeled through the SDM depends on the effects of own-country as well as neighboring country characteristics, the spatial connectivity structure of the countries, and the strength of spatial dependence.

The SAR has a spatial lag structure in the dependent variable. This model is more appropriate when the growth rate of a particular country is related to that of its neighbor's growth.

$$g_t = \rho W g_t + X_t \beta + \mu + \varepsilon_t,\ t = 1, \ldots, T, \tag{3}$$

$$\varepsilon_t \sim \mathrm{N}\left(0, \sigma_\varepsilon^2 I_N\right) \text{ and } \mathrm{E}\left(\varepsilon_{it}, \varepsilon_{js}\right) = 0,\ i \neq j \text{ and/or } t \neq s,$$

where $\rho$ is called spatial autoregressive coefficient.

The SEM has a spatial lag structure in the error term, which implies that only an exogenous shock in a spatial unit of the model has some impact on the dependent term in all spatial units. It is more suitable to implement the SEM if all countries share similar unobserved features.

$$g_t = X_t \beta + \mu + \phi_t \text{ and } \phi_t = \lambda W \phi_t + \varepsilon_t, \tag{4}$$

6 Models with controls for spatial fixed effects utilize the time-series component of the data, whereas models without controls for spatial fixed effects utilize the cross-sectional component of the data. As a result, some studies argue that models with controls for spatial fixed effects tend to give short-term estimates and models without controls for spatial fixed effects tend to give long-term estimates (Baltagi 2005, pp. 200–201).

$$\varepsilon_t \sim \mathrm{N}\left(0, \sigma_\varepsilon^2 I_N\right) \text{ and } \mathrm{E}\left(\varepsilon_{it}, \varepsilon_{js}\right) = 0,\ i \neq j \text{ and/or } t \neq s.$$

In these expressions, $\phi_t$ reflects the spatially autocorrelated error term and $\lambda$ is called the spatial autocorrelation coefficient. Provided $(I - \lambda W)^{-1}$ exists, we may write this equation as $g_t = X_t\beta + \mu + (I - \lambda W)^{-1}\varepsilon_t$, or

$$g_t = \lambda W g_t + (I - \lambda W)[\mu + X_t\beta] + \varepsilon_t, \tag{5}$$

which differs from both the SAR and SDM specifications of spatial dependence.

### 2.2. *Spatial Weighting Matrices*

The spatial weighting matrices are the formal expression of spatial dependence between observations. The main assumption is that the structure of spatial dependence is known, not estimated, and that it specifies the degree of interdependence among observations based either on Euclidean distance, or even nongeographical distances.[7]

#### 2.2.1. *The geographical weighting matrix*

Geographical weighting matrices are clearly exogenous to the growth process. Mayer and Zignago (2011) construct geodesic distances, $d_{ij}$, which are calculated following the great circle formula using latitudes and longitudes of the most important cities. We use the inverse of the distance $1/d_{ij}$ as elements of the matrix, because in the geographical distance matrix, a larger value implies a greater weight $w_{ij}$.

$$w_{ij}^{GEO} = 0 \text{ if } i = j; \tag{6}$$

$$0 < w_{ij}^{GEO} = \frac{1}{d_{ij}} \Big/ \left(\sum\nolimits_j \frac{1}{d_{ij}}\right) \leq 1 \text{ otherwise.} \tag{7}$$

To normalize the outside influence upon each country, the spatial weighting matrix is standardized such that the elements of a row sum up to one.[8]

[7] Elhorst (2014) mentions that spatial econometric models can also be used to explain the behavior of economic agents other than geographical units if they are related to each other through networks.

[8] Row normalization is used to create proportional weights in cases where individual units have an unequal number of neighbors and it implies that the impact on each unit by all other units is equalized.

*2.2.2. The trade weighting matrix*

Incorporating trade into the analysis requires recognizing the potential endogeneity of trade to growth, as countries that have higher income or better policies may trade more. Using trade policies instead of trade shares also does not solve the endogeneity problem, as countries that adopt free-trade policies may also implement free-market monetary and fiscal policies. Frankel and Romer (1999) use the predictions of the gravity model, which posits that bilateral trade flows depend on economic size and the distance between two units, to argue that geographic variables may be used to create a valid instrument for international trade and find that trade raises growth.

Extending the relationship between trade and growth to account for explicit cross-correlations in economic growth across countries, we construct the trade weighting matrix from bilateral trade flows between countries $i$ and $j$ as

$$w_{ij}^{TR} = 0 \quad \text{if} \quad i = j, \tag{8}$$

$$0 < w_{ij}^{TR} = \frac{m_{ij} + x_{ij}}{\sum_{i \neq j} m_{ij} + x_{ij}} \leq 1 \quad \text{otherwise}, \tag{9}$$

where $m_{ij}$ is imports between countries $i$ and $j$ while $x_{ij}$ shows exports. In the spatial econometrics literature, the weighting matrix is assumed to be exogenous with respect to the dependent variable. Here, because GDP growth may affect the trade flow in time $t$, we use the average of trade flows between 1990 and 2014 to avoid endogeneity problems (as in Ertur and Koch 2011).

*2.2.3. The institutional weighting matrices*

The literature on spatial spillover effects of growth has also examined the role played by institutions. Bosker and Garretsen (2009) show that the spatial linkages between countries are not only in terms of absolute geography, but also relative geography. More specifically, they analyze the importance of the geography of institutions in a sample of 147 countries and show that the institutional quality in neighboring countries is also important for a country's economic development. Arbia, Battisti, and Di Vaio (2010) investigate the productivity convergence across European regions for the period 1991–2004 by allowing for spatial externalities and find that the country-specific institutions are strongly and positively related to the region's productivity growth rate. They incorporate spatial externalities by means of a nonconventional spatial weighting matrix built from geo-institutional distances, in which the weights reflect the confluence of geographical and institutional distance. Ahmad and Hall (2012) also examine the effect of institutional quality on the income growth rate for a sample of 58 developing countries over the period 1985–2008. They find a positive significant absolute effect of institutions on economic growth in developing countries. They show that the institutional spillover effects on growth arise in an indirect way: Institutions in one country lead to improvements in economic growth in that country, which subsequently generate spillover effects on economic growth in neighboring countries.

Following these approaches, we incorporate institutional distance into the spatial analysis directly by creating an index of institutional proximity. We follow the approach in Ahmad and Hall (2012) and use a weighting matrix proposed by Kogut and Singh (1988) for cultural distance to define the institutional distance (*ID*) index as

$$ID_{ij} = \frac{\sum_{k=1}^{n} \left[ \left( I_{ik} - I_{jk} \right)^2 / V_k \right]}{n}, \tag{10}$$

where $I_{ik}$ is the index value for institutional dimension $k$ for country $i$, $I_{jk}$ is the index value for institutional dimension $k$ for country $j$, $V_k$ is the variance of the index of the institutional dimension $k$, and $n$ is the number of institutional dimensions. The institutional indicators that we used to construct this index are from the Worldwide Governance Indicators (WGI) from the World Bank database.[9] As in the construction of geographical distance, we use the inverse of institutional distance to obtain a value for institutional proximity between entities $i$ and $j$. Thus, $1/ID_{ij}$ is used as elements of the institutional weighting matrix, which implies a larger value the greater the weight. Additionally, the weighting matrices are row normalized for the spatial estimation.

$$w_{ij}^{INST1} = 0 \quad \text{if} \quad i = j; \tag{11}$$

$$0 < w_{ij}^{INST1} = \frac{1}{ID_{ij}} / \left( \sum\nolimits_j \frac{1}{ID_{ij}} \right) \leq 1 \quad \text{otherwise.} \tag{12}$$

In their analysis, Arbia, Battisti, and Di Vaio (2010) also propose a weighting matrix based on linguistic distance to avoid endogeneity problems in the

[9] WGI reports aggregate and individual governance indicators for over 200 countries and territories over the period 1996–2015 for six dimensions of governance: voice and accountability; political stability and absence of violence; government effectiveness; regulatory quality; rule of law; and control of corruption. We compute the institutional distance index ($ID_{ij}$) using these six dimensions of governance indicators as an average over the years 1996–2006 to avoid potential endogeneity issues arising from growth in a given year affecting institutions and hence, institutional proximity in other years.

Table 1. Correlation Between Spatial Matrices

| | $W^{GEO}u$ | $W^{INST1}u$ | $W^{INST2}u$ | $W^{TR}u$ |
|---|---|---|---|---|
| $W^{GEO}u$ | 1 | | | |
| $W^{INST1}u$ | 0.0160 | 1 | | |
| $W^{INST2}u$ | 0.1861 | 0.2097 | 1 | |
| $W^{TR}u$ | 0.0247 | 0.0321 | 0.1615 | 1 |

construction of the weighting matrix for geo-institutional similarity. Linguistic distance is defined as ethnological differences by families of languages. Since they are stable in the short run, they can be unambiguously considered exogenous to the model. One problem with this measure of institutional proximity is that for the case of the MENA region, the countries do not display sufficient variation in linguistic distance, which may make it difficult to rationalize its use as an instrument for heterogeneity in institutions across countries. Despite this qualification, we use linguistic distance as a second measure of the institutional proximity of the countries in question.[10] The weights in the new weighting matrix are thus defined using the summary index *CL* (common language index), which ranges between 0 and 1. It takes a value equal to zero if the degree of linguistic proximity between two countries is null, whereas *CL* tends to 1 when the linguistic proximity between these two countries is high.

$$w_{ij}^{INST2} = 0 \quad \text{if} \quad i = j; \tag{13}$$

$$0 < w_{ij}^{INST2} = \frac{CL_{ij}}{\sum_{i \neq j} CL_{ij}} \leq 1 \quad \text{otherwise}, \tag{14}$$

where $CL_{ij}$ represents the *CL* between countries *i* and *j*.

Table 1 shows the correlation measure between all weighting matrices constructed from the product of each interaction matrix with the standard normal random variable, *u*, following LeSage and Pace (2009). Table 1 shows that the correlation between the two institutional weighting matrices is the highest, suggesting that such measures are relatively similar across the regions. However, we find that the institutional weighting matrix proxied by linguistic distance is

[10] Melitz and Toubal (2014) construct measures of linguistic proximity that show the cultural similarities between countries. They summarize the evidence of the linguistic influences in a common language index (*CL*), which rests strictly on exogenous linguistic factors. This summary index *CL* is constructed from different proxies: common official language (*COL*), common native language (*CNL*), and language proximity (*LP*). Data on common language is available at http://www.cepii.fr/CEPII/en/bdd_modele/presentation.asp?id=19.

more correlated with the geographical and trade weighting matrices than the institutional weighting matrix constructed from the WGI, suggesting that there are effects of a common language or linguistic similarity that go beyond its role in serving as a proxy for common institutions. Nevertheless, the correlations between the different weighting matrices are, in general, relatively low, which allows us to make inferences about the different spatial interactions.

## 3. ESTIMATION RESULTS

### *3.1. Variable Description and Data*

There is no agreed-upon definition of MENA countries. Several international organizations such as the IMF and the World Bank define the MENA region to include different countries. Here, with the available data, we select the following 18 MENA countries: United Arab Emirates (ARE), Bahrain (BHR), Djibouti (DJI), Algeria (DZA), Egypt (EGY), Islamic Republic of Iran (IRN), Iraq (IRQ), Israel (ISR), Jordan (JOR), Kuwait (KWT), Lebanon (LBN), Morocco (MAR), Malta (MLT), Oman (OMN), Qatar (QAT), Saudi Arabia (SAU), Tunisia (TUN), and Turkey (TUR). We use a panel of nine periods based on five-year averages of real GDP growth rates.

In our analysis, we include the standard variables used in growth regressions to control for model misspecification and to obtain the net effects of the economic performance of neighboring countries. GDP per capita is measured in PPP terms and computed in 2005 international prices. Let $Y_{it}$ denote real GDP per capita for country $i$ at date $t$, and $g_{it}$ its five-year average growth rate as $g_{it} = [\ln(Y_{it}) - \ln(Y_{i,t-5})]/5$.[11] The set of macroeconomic variables are selected according to factors that might affect the economic growth in the empirical literature (Barro and Sala-i-Martin 1995). They include ln $Y_{i,t-5}$ (log of the initial value of the per capita GDP for a particular period); $n$ (the mean logarithmic growth rate of population as an annual percentage); *inv/gdp* (the share of investment in real GDP to proxy for the saving rate); *gov/gdp* (government consumption spending as a percentage of GDP as a proxy for government expenditure); and *tb/gdp* (trade balance as export minus imports as a share of GDP to control for openness).[12] All data are annual and are collected from Penn World Table for the sample period between 1970 and 2014.

[11] We follow Islam (1995) in choosing a five-year interval to study the implications of the standard growth model augmented with spatial effects.

[12] In the literature, it is more standard to measure openness as the sum of imports and exports of a country as a ratio of GDP. However, in results that are available upon request, we found that the SAR and the SDM estimates which are based on the openness variable imply that its effect is either insignificant (when used as an explanatory variable in the SAR specification) or negative (when used as a spatially lagged explanatory variable in the SDM specification). Hence, in what follows, we use the trade balance as a share of GDP as the explanatory variable in the growth regressions. We discuss further the results of using the openness variable in the next section.

In addition to accounting for the relative location effect of institutions through the institutional weighting matrix, we seek to control for the absolute location effect of institutions by including an index of political rights from the Freedom House database denoted *pol. rights*.[13] Appendix Table 1 gives an overview of the characteristics of the variables used in this study.

### *3.2. Testing for Spatial Dependence*

In the spatial panel data estimation, country-specific effects must be controlled for, which may be treated as fixed or random effects. According to the spatial Hausman test, we strongly reject the null hypothesis that the random effects model is the correct model, and a fixed effects model is thus chosen for the rest of this empirical analysis.

Next, we test for the presence of spatial dependence using Moran's *I* test. The approach is to start with a nonspatial linear regression model using OLS (which includes fixed effects) and then test whether the model needs to be extended with spatial interaction effects. Table 2 shows that the Moran's *I* test adapted to OLS regression residuals strongly rejects the null hypothesis of no spatial dependence, regardless of the spatial weighting matrix that is used.

Table 2 also shows the results of Lagrange multiplier tests and their robust versions for testing the null hypothesis of no spatial lags against the alternatives of spatial lagged dependence and spatial error autocorrelation due to Florax, Folmer, and Rey (2003). Note the test statistic for spatial lagged dependence by $L_\rho$ and the test statistic for spatial error correlation by $L_\lambda$, and their robust versions by $L_\rho^*$ and $L_\lambda^*$, respectively.[14] The second and third rows of Table 2 show that we can reject the null hypothesis of no spatial lags and no spatial error term for the classical version of the LM test using $L_\rho$ and $L_\lambda$ at the 1% level. Since both tests are significant, we choose the specification showing higher significance of the robust tests. The LM test statistics given by $L_\rho^*$ and $L_\lambda^*$ show that the SAR model dominates the SEM for capturing spatial dependence since $L_\rho^* > L_\lambda^*$ for the geographical and trade weighting matrices and $L_\lambda^*$ is not significant for the institutional weighting matrices.

A more general model that nests both the SAR and SEM models of spatial dependence is given by the SDM. According to the general-to-specific approach, if the nonspatial model is rejected, then the most general model, the SDM, is estimated to test whether it can be simplified to the spatial lag or the spatial error model. Based on estimates of the SDM, the null hypothesis $H_0$: $\Gamma = 0$ can be used to investigate

[13] This variable ranges between 1 and 7, with 1 denoting countries "enjoying a wide range of political rights" and 7 denoting countries having "few or no political rights because of severe government oppression, sometimes in combination with civil war." We scale this variable by 100 to make its values comparable to the other variables used in our analysis.

[14] The degrees of freedom is 1 in this case because the only excluded variable is the spatial lag or spatial error.

Table 2. Tests for Spatial Dependence

| | $W^{GEO}$ | $W^{INST1}$ | $W^{INST2}$ | $W^{TR}$ |
|---|---|---|---|---|
| Moran's $I$ test | 0.1134*** | 0.1559*** | 0.1312*** | 0.1322*** |
| $L_\rho$: no spatial lag | 15.0290*** | 10.9683*** | 25.5415*** | 6.8920*** |
| $L_\lambda$: no spatial error | 9.2308*** | 2.9652* | 17.5903*** | 2.9652* |
| $L_{\rho^*}^*$: no spatial lag | 9.6459*** | 6.7906*** | 8.7273*** | 7.1462*** |
| $L_\lambda^*$: no spatial error | 3.8477** | 2.1377 | 0.7761 | 3.2194* |
| Wald: spatial lag | 12.2672* | 5.3048 | 7.3200 | 13.5262** |
| Wald: spatial error | 12.1552* | 4.8162 | 6.1896 | 11.5966* |
| LR: spatial lag | 9.5620 | 5.1520 | 7.0678 | 12.2369* |
| LR: spatial error | 10.4205 | 4.9199 | 7.5507 | 11.4217* |

Note: Let $p = \Pr(\Xi \geq \xi)$ where $\Xi$ denotes the relevant test statistic under the null hypothesis and $\xi$ is its observed value.
***$p < 0.01$; **$p < 0.05$; *$p < 0.10$.

whether the model can be simplified to the SAR and the hypothesis $H_0$: $\Gamma = -\rho\beta$ (or equivalently, $H_0$: $\Gamma + \rho\beta = 0$) can be used to determine whether the model can be simplified to the SEM (Burridge 1981).[15] Both tests follow a chi-square distribution with $K$ degrees of freedom, where $K = 6$ denotes the number of restrictions under the null hypothesis. If both models are estimated, then these tests take the form of a likelihood ratio (LR) test. Otherwise, they take the form of a Wald test.

The third part of Table 2 presents the results for specification tests based on the Wald and LR tests, which follow the general-to-specific approach. In the Appendix, we present the results of estimating the SDM. Based on the results of the Wald and LR tests reported in Table 2, we cannot reject the null hypotheses that the SDM is simplified to the SAR and SEM models for the two types of the institutional weighting matrices at conventional significance levels. However, there is some evidence against the SAR and SEM specifications based on the Wald test for the case with the geographical weighting matrix. This evidence becomes stronger when we consider the trade weighting matrix. Here the SAR specification can be rejected at the 5% level against the SDM. Likewise, the Wald test for the SEM specification as well as the LR tests for both the SAR and SEM specifications indicate evidence against these models at the 10% level.

Appendix Table 2 reports the coefficient estimates for the SDM, which shows that the spatial dependence parameter $\rho$ becomes negative for the cases with the institutional and trade weighting matrices and positive but insignificant for the case with the geographical weighting matrix. The main finding from Appendix

[15] To see this last point, substitute for $\Gamma = -\rho\beta$ in the regression equation as $g_t = \rho W g_t + X_t\beta + WX_t(-\rho\beta) + \mu + \epsilon_t$. Simplifying yields $(I - \rho W)g_t = (I - \rho W)X_t\beta + \mu + \epsilon_t$, or $g_t = X_t\beta + (I - \rho W)^{-1}(\mu + \epsilon_t)$ which is the SEM specification.

Table 2 is that the spatial interaction term with the trade balance is positive and significant for all weighting matrices. These results imply that trade linkages work through local spatial range effects deriving from the behavior of the spatially lagged explanatory variable for the trade balance signified by the term $W\Gamma_r$ as opposed to the global range spatial effects or spatial multiplier effects deriving from the impact of the spatially lagged dependent variables, $(I - \rho W)^{-1}\beta_r$, where $\Gamma_r$ and $\beta_r$ denote the coefficients relating to the trade balance. As Anselin (2003) notes, the spatial correlations deriving from spatially lagged dependent variables are global in nature as they relate all units to one another whereas the spatial correlations due to local effects depend on the "nearest neighbors."[16] In the next subsection, we provide additional estimates of the SAR model as a parsimonious specification that allows for spatial dependence and compare the implications of the SDM and SAR specifications based on their direct and indirect effects.

### *3.3. Estimates of the Spatial Autoregressive Model*

The first column of Table 3 provides OLS estimates of the standard growth equation in the absence of spatial dependence. The coefficient on initial GDP is negative and highly significant. This supports the conditional convergence hypothesis postulated in the growth literature. The convergence speed is 4%, which is comparable to the values obtained by Islam (1995) and others in models with fixed effects.[17]

[16] Anselin (2003) distinguishes between global and local forms of autocorrelation in spatial models. For the SAR model, we may view the error term as being given by $\epsilon = \rho W\epsilon + u$, which can be rewritten as $\epsilon = (I - \rho W)^{-1}u$, so that $\mathrm{E}(\epsilon\epsilon') = \sigma^2(I - \rho W)^{-1}(I - \rho W)^{-1'}$. Since $\rho < 1$ and the elements of $W$ are typically less one due to the row normalization, $\mathrm{E}(\epsilon\epsilon') = (I_N + \rho W + \rho^2 W^2 + \rho^3 W^3 + \ldots)(I_N + \rho W + \rho^2 W^2 + \rho^3 W^3 + \ldots)'$, which implies that the spatial correlation based on this expansion yields higher orders of contiguity, given that $W$ displays first-order contiguity. Thus, the structure of the variance–covariance matrix which characterizes the simple SAR model is *global* in that every location is correlated with every other location in the system, but closer locations more so. By contrast, an error structure that has the form of a spatial moving average $\epsilon = \gamma Wu + u$ is *local* in nature because the variance–covariance matrix of the error terms given by $\mathrm{E}(\epsilon\epsilon') = \sigma_u^2(I + W\gamma)(I + W\gamma)' = \sigma_u^2(I + \gamma(W + W') + \gamma^2 WW')$ depends only on first- and second-order neighbors, assuming the weighting matrix $W$ is defined as first-order contiguity. Extending this notion to the spatially lagged explanatory variables, a model comprised solely of spatially lagged explanatory given by $g = X\beta + WX\Gamma + \epsilon$ would provide an example with local spillovers only. The SDM generalizes both specifications to obtain $g = (I - \rho W)^{-1}X\beta + (I - \rho W)^{-1}WX\Gamma + (I - \rho W)^{-1}\epsilon$ so that it may be viewed as containing both global range and local range spillovers.

[17] The convergence speed is defined as $\lambda = -\ln(1 + 5\gamma)/5$, where $\gamma$ is the coefficient on initial lagged GDP. Elhorst, Piras, and Arbia (2010) argue, however, that the convergence rates in models with and without fixed effects may not be directly comparable because the former model is measuring the time to return to equilibrium in the presence of shocks to country-specific factors such as population growth, investment/saving rates, etc., conditional on the fixed effects, while the latter model measures the time before such persistent differences disappear.

Table 3. Spatially Autoregressive Model (SAR)

| | OLS | $W^{GEO}$ | $W^{INST1}$ | $W^{INST2}$ | $W^{TR}$ |
|---|---|---|---|---|---|
| ln $Y_{i,t-5}$ | $-0.036^{***}$ | $-0.037^{***}$ | $-0.037^{***}$ | $-0.037^{***}$ | $-0.036^{***}$ |
| | (0.011) | (0.010) | (0.010) | (0.010) | (0.010) |
| *n* | $-0.642^{**}$ | $-0.553^{***}$ | $-0.593^{***}$ | $-0.583^{***}$ | $-0.595^{***}$ |
| | (0.252) | (0.220) | (0.224) | (0.223) | (0.228) |
| *inv/gdp* | $0.155^{*}$ | $0.170^{**}$ | $0.165^{**}$ | $0.163^{**}$ | $0.169^{**}$ |
| | (0.079) | (0.069) | (0.070) | (0.070) | (0.071) |
| *gov/gdp* | −0.108 | −0.079 | −0.078 | −0.074 | −0.085 |
| | (0.069) | (0.060) | (0.061) | (0.061) | (0.062) |
| *tb/gdp* | $0.192^{***}$ | $0.149^{***}$ | $0.170^{***}$ | $0.161^{***}$ | $0.168^{***}$ |
| | (0.049) | (0.043) | (0.044) | (0.043) | (0.044) |
| *pol. rights* | 0.768 | 0.474 | 0.593 | 0.545 | 0.613 |
| | (0.749) | (0.655) | (0.665) | (0.663) | (0.680) |
| $\rho$ | - | $0.430^{***}$ | $0.400^{***}$ | $0.417^{***}$ | $0.246^{**}$ |
| | | (0.105) | (0.108) | (0.105) | (0.109) |
| Observations | 162 | 162 | 162 | 162 | 162 |
| $R^2$ | 0.201 | 0.355 | 0.334 | 0.337 | 0.308 |
| AIC | - | −326.98 | −322.59 | −324.29 | −318.48 |
| BIC | - | −350.70 | −346.31 | −348.02 | −342.20 |

Notes: 1. Dependent variable: $g_{it} = [\ln(Y_{it}) - \ln(Y_{i,\,t-5})]/5$.
2. Let $p = \Pr(\Xi \geq \xi)$ where $\Xi$ denotes the relevant test statistic under the null hypothesis and $\xi$ is its observed value.
3. Standard errors are in parentheses.
$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.10$.

The remaining results are standard: Population growth is found to have negative impacts on countries' per capita growth rates while investment and trade as a share of GDP have positive significant effects. Government consumption expenditures as a fraction of GDP reduces per capita GDP growth but it is not significantly estimated. Andreano, Laureti, and Postiglione (2013, p. 21) estimate the investment to GDP ratio to be insignificant, which they attribute to the "endemic lack of capital efficiency, due partly to the presence of public projects, devoted to low productivity investments." They also find the public expenditure to GDP ratio to be negative and significant and argue that "protectionism and lack of integration into international markets contribute to restrain competitiveness and efficiency" in MENA countries. The variable *pol. rights*, which captures the absolute effect of political rights, also does not have a significant effect on the per capita GDP growth rates for the MENA countries. According to the Freedom House index, such factors as political corruption, limits on the functioning of political parties and opposition groups, and foreign or military influence on politics tend to weaken political rights at a rating of 3, 4, or 5, but to a greater extent at each successive rating. Given that the average level of the political rights variable in the Freedom House rankings is 5 for the MENA countries, an insignificant coefficient on *pol. rights* is not surprising.

Next, Table 3 reports the estimates for the SAR model using the four different weighting matrices. The coefficient of initial GDP and the remaining explanatory variables hardly change compared to the OLS results with fixed effects. The key result in this table that differentiates our analysis from the standard growth regression has to do with the spatial effects captured through the weighted GDP growth of neighboring countries. The positive and significant value of the spatial autocorrelation coefficient $\rho$ implies that part of the economic growth of each investigated country is through the spatial effect of neighboring countries' growth. The parameter $\rho$ indicates that a 1% increase in the weighted average of neighboring countries' growth rates increases a MENA country's domestic growth by 0.43%, 0.40%, 0.42%, and 0.25% with geographical, institutional, linguistic, and trade weighting matrices, respectively.[18]

As an additional diagnostic, we also examine the weighting matrix $W$ that best measures the strength of the interaction between different spatial units for the different weighting matrices. For this purpose, we use information criteria that are among the most common model selection procedures such as the AIC and the BIC criteria. Considering the last two rows of Table 3, the geographical weighting matrix is the best based on the AIC and BIC, followed by the institutional weighting matrices. By contrast, the trade weighting matrix performs the worst, suggesting that bilateral trade linkages are not the primary source of growth spillovers among the MENA countries. In the Appendix, we further show that the estimates of the SDM yield a negative estimate for the spatial dependence parameter $\rho$ but highly significant positive coefficients on the trade balance variable *tb/gdp* either by itself or used as a spatially lagged explanatory variable, $W \times$ *tb/gdp*. Combining the results on the SDM with the results in Table 3 regarding the choice of the best weighting matrix, we can conclude that the effects of trade on economic growth of a given country occur through local range spatial effects based on the spatially lagged explanatory variable for the trade balance as opposed to occurring through the global spatial spillover effects of growth among a country's trade partners.[19]

[18] Unlike some other analyses (e.g., Ho, Wang, and Yu 2013), however, the inclusion of spatial dependence effects does not affect the convergence speed, which only changes with the inclusion of fixed effects.

[19] In results that are available upon request, we also estimated SAR and SDM specifications using the openness variable as an explanatory variable to capture the effects of trade on growth. Here the coefficient on *openness* is estimated to be insignificant in the SAR specification and the coefficient on the spatially lagged explanatory variable, $W \times$ *openness*, is estimated to be negative in the SDM specification. As we discuss below, the SDM then implies *negative* indirect effects of openness, which appears to be counterfactual. Hence, we do not report any specifications that contain this variable.

## 4. DIRECT AND INDIRECT EFFECTS

In this section, we discuss the direct, indirect, and total effects of a change in a given explanatory variable.[20] In the spatial growth model, the partial derivative associated with a given explanatory variable $X_r$ ($r = 1, \ldots, K$) is the derivative of the $N \times 1$ vector of growth rates $g$ with respect to the $r$th explanatory variable. In matrix form, equation (3) for a single cross-section becomes $g = (I_N - \rho W)^{-1} X\beta + (I_N - \rho W)^{-1}\epsilon$. Hence,

$$\frac{\partial g}{\partial X_r} = (I_N - \rho W)^{-1} I_N \beta_r = G I_N \beta_r,$$

where the $N \times N$ matrix $G$ denoted as the *impact matrix* has the form $G = (I_N - \rho W)^{-1} = I_N + \rho W + \rho^2 W^2 + \rho^3 W^3 + \ldots$ The impact of a change in the $r$th explanatory variable on growth will depend on: (1) the degree of friction between countries which is governed by the $W$ matrix used in the model, (2) the parameter $\rho$ measuring the strength of spatial dependence between countries, and (3) the estimated parameter, $\beta_r$. This is because the change in $X_r$ in country $i$ not only has a primary effect on the growth rate of country $i$, $g_i$, but also potential effects on $g$ in all other countries in the sample. These secondary effects on $g$ can be counted as spillover effects.[21]

The diagonal elements of the matrix $G = (I_N - \rho W)^{-1}$ contain the direct impacts, and the off-diagonal elements represent indirect impacts. The direct effect can be used to test the hypothesis as to whether a particular variable has a significant effect on the dependent variable. As Debarsy and Ertur (2019) note, the impact matrices $G$ are generally full and not symmetric, regardless of the sparsity and structure of the interaction matrix, $W$. They call the country in column $j$ of this matrix as the emitting country and country in row $i$ as the receiving country. The sum of the $i$th row of the $G$ matrix represents the total impact on the dependent variable in country $i$ due to a unit change in $X$ in all the countries in the sample. The sum of column $j$ gives the total impact on the dependent variable of all the countries of a unit change in $X$ in country $j$. In the SAR, the indirect effect can be used to test whether spatial spillovers exist.[22]

20 Without loss of generality, the direct and indirect effects may be derived for a single cross section, as the weighting matrices $W$ do not depend on the time dimension $t$ of the panel.

21 LeSage and Pace (2009) show how to compute the statistical measures of dispersion for these effects, which allow inferences regarding the statistical significance of the direct, indirect, and total effects. They propose an approximation to the infinite expansion of the $G$ matrix based on trace of the powers of the weighting matrix, $W$, where the highest power considered in the approximation is large enough to ensure approximate convergence.

22 By contrast, only the direct effect exists in the SEM.

Table 4. Impact Measures with All Weighting Matrices

| | $W^{GEO}$ | $W^{INST1}$ | $W^{INST2}$ | $W^{TR}$ |
|---|---|---|---|---|
| | Average Direct Effects | | | |
| $\ln Y_{i,t-5}$ | −0.036*** | −0.037*** | −0.037*** | −0.037*** |
| *n* | −0.568*** | −0.607** | −0.593*** | −0.600*** |
| *inv/gdp* | 0.175** | 0.168*** | 0.166*** | 0.170** |
| *gov/gdp* | −0.080 | −0.079 | −0.075 | −0.086 |
| *tb/gdp* | 0.153*** | 0.174*** | 0.164*** | 0.170*** |
| *pol. Rights* | 0.487 | 0.607 | 0.555 | 0.618 |
| | Average Indirect Effects | | | |
| $\ln Y_{i,t-5}$ | −0.026* | −0.023** | −0.026* | −0.011 |
| *n* | −0.402 | −0.382 | −0.407* | −0.190 |
| *inv/gdp* | 0.124 | 0.106* | 0.114 | 0.054 |
| *gov/gdp* | −0.057 | −0.079 | −0.052 | −0.027 |
| *tb/gdp* | 0.108* | 0.109* | 0.112 | 0.054 |
| *pol. rights* | 0.345 | 0.382 | 0.381 | 0.196 |

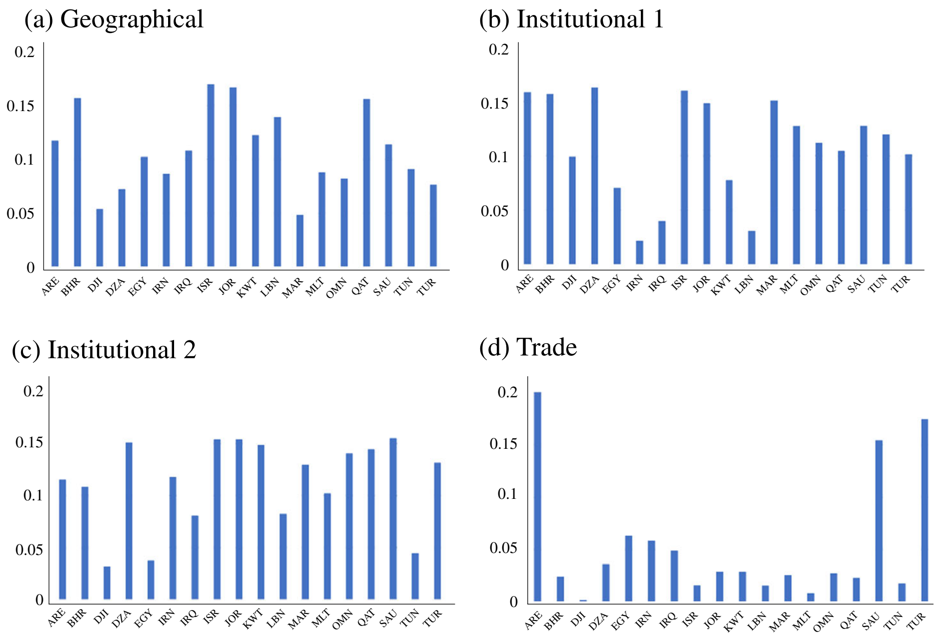
Note: Let $p = \Pr(\Xi \geq \xi)$ where $\Xi$ denotes the relevant test statistic under the null hypothesis and $\xi$ is its observed value.
$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.10$.

Table 4 gives the average impact measures of all explanatory variable in our analysis.[23] The first part of Table 4 gives a measure of the average direct effects, which summarizes the impact of changes in the explanatory variables using an average across the entire cross section of countries. The direct effects of an increase in the explanatory variables except for government expenditures as a share of GDP or political rights are quite significant. Any differences between the coefficients in Table 3 and the direct effects shown in Table 4 arise from feedback effects. Explanatory variables affect the growth rate of spatially similar countries, which feeds back to influence the own country's growth rate.

The second part of Table 4 shows the average indirect effects of a change in the explanatory variable, $X_r$. This table shows that aside from the initial level of income $Y_{i,t-5}$, there are almost no significant indirect effects of a change in the explanatory variables on neighboring countries' growth rates. There is some evidence of the positive indirect effects of the trade balance for the geographical matrix and one of the two institutional weighting matrices but these are significant only at the 10% level. Interestingly, the indirect effect of the trade balance when using the trade weighting matrix is nearly half of the indirect effects of this variable for the other weighting matrices.

[23] Two hundred simulations are used to compute the distributions for the impact measures.

Figure 1. Indirect Effects of the Trade Balance on GDP Growth




[Colour figure can be viewed at wileyonlinelibrary.com]

Figure 1 presents the indirect effects of the trade balance on the GDP growth rate of each country in our sample. These are generated as the multiplication of the estimated coefficient of the trade balance as a share of GDP (*tb/gdp*) from Table 4 and the sum of the corresponding columns of the simulated *G* matrices excluding the diagonal elements.[24] The indirect effects of the trade balance on growth for countries in the region mostly comes from the oil-exporting countries like Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates as well as Israel.

Based on a notion of geographical proximity displayed in Figure 1(a), countries like Bahrain and Qatar, on the one hand, or Israel, Jordan, and Lebanon, on the other, have higher spillover effects, which can arise due to contiguous border or neighboring relations between them. The indirect effects based on the second measure of institutional proximity deriving from linguistic distance in Figure 1 (c) show that the oil-exporting countries have largest spillover effects while the oil-importing countries like Djibouti, Egypt, and Tunisia have the smallest

[24] The shape of the indirect effects for all the explanatory variables are the same. However, the magnitudes change with respect to their estimated coefficients.

spillover effects. Thus, the spillover effects of growth are mainly due to economic activities in countries that trade in oil.

Surprisingly, the pattern of indirect effects based on the bilateral trade weighting matrix reported in Figure 1(d) is completely different from the pattern reported in Figure 1(a–c) for the geographical and institutional weighting matrices. In particular, Figure 1(d) shows that the countries with the largest indirect effects are the United Arab Emirates, Saudi Arabia, and Turkey, which are also the largest economies in the region with respect to their real GDP. The inclusion of Turkey, a non-oil-exporting country, is revealing in that the trade effects of growth arise mainly *outside* of the MENA region, as many commentators have claimed. While Turkey may be nominally grouped among the MENA countries, its policies of trade integration and financial liberalization instituted since the early 2000s imply that it has followed a different growth trajectory than the other non-oil-exporting countries of the MENA region.

To check the robustness of these results, we also calculate the direct and indirect effects of the different explanatory variables using the estimates of the SDM based on the trade weighting matrix in Appendix Table 2. These are reported in Appendix Table 3 and show that the indirect effects of the trade balance increase in value and become highly significant.[25] However, Appendix Figure 1 shows that the pattern of indirect effects across the different countries is virtually identical to those in Figure 1(d). These results suggest that the trade effects of growth for a country $i$ appear to operate through the local range spatial effects of trade captured by the term $W\Gamma_r$ as opposed to global range spillover or spatial multiplier effects occurring through term $(I - \rho W)^{-1}\beta_r$ of the remaining countries (Anselin 2003). This may have to do with the lack of bilateral trade between MENA countries due to the similarities in the goods produced by these economies, which are essentially resource-based and conduct their trade with the rest of the world.

As we discussed in the Introduction, there is an institutional gap between the oil-rich and oil-poor countries that explains this pattern of indirect effects. Essentially, the contracting institutions in the MENA region have been built around the production and sale of a relatively homogeneous good that is sold on organized exchanges and that does not require complex forms of contracting institutions. Hence, the comparative advantage associated with trade in goods that require more complex forms of contracting institutions is not captured by MENA countries, which rely on the growth effects that oil-rich countries create for oil-poor ones in the region based on such factors as remittances, aid, and investment

[25] That the indirect effects increase in magnitude for the SDM can be understood by noting that the indirect effects of the explanatory variable $X_r$ are obtained from the elements of the matrix $S_r(W) = (I_N - \rho W)^{-1}(I_N\beta_r + W\Gamma_r)$, which differs from the expression for the indirect effects implied by the SAR by the addition of the term $W\Gamma_r$.

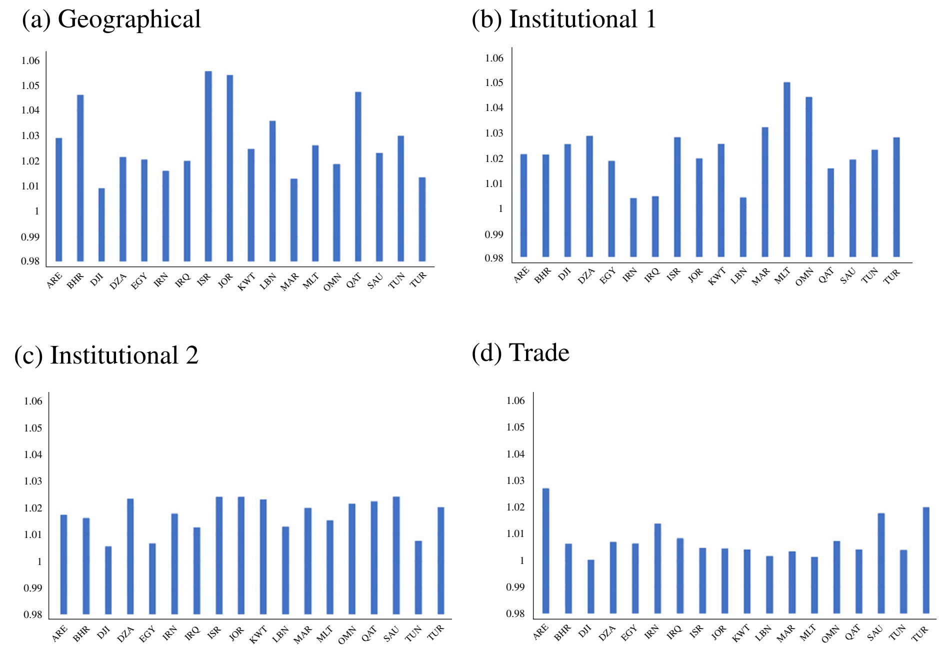
flows (Luciani 2017). Helpman, Melitz, and Rubinstein (2008) also argue that the extensive margin of trade represented by the number of exporters may matter as much as the intensive margin of trade, which refers to trade volume, in promoting bilateral trade flows across countries. This suggests that the absence of trade spillovers within the MENA region may be due as much to the lack of mutual trade partners within the MENA region. The impact of such arguments based on comparative advantage or the absence of bilateral trade partners is compounded by the existence of economies with large public sectors that have lagged in trade liberalization and diversification compared to other high- or middle-income regions. As Karam and Zaki (2015) have argued, the lack of trade liberalization and the restrictive trade practices in the MENA region, especially trade in services, limit the scope for trade among the MENA countries.[26] Considering the role of real and financial spillovers of Saudi Arabia for other Gulf Cooperation Council (GCC) countries where GDP spillovers are modeled using measures of non-oil GDP, Adedeji, Shahid, and Zhu (2018) also conclude that increased GCC trade and financial linkages in the context of diversification initiatives could enhance the role of growth spillovers in the region.

Our final set of results refers to the differences in the direct effects across individual countries, which arise from the feedback effects. Figure 2 shows the direct impact by country according to the different weighting matrices.[27] Here oil-rich countries have the highest feedback effects while the oil-poor countries have smaller than average direct effects based on the geographical weighting matrix and the institutional impact matrix measured by linguistic distance. This is similar to the indirect effects that we reported in Figure 1(a, b). However, based on the trade impact matrix, in addition to Saudi Arabia, the United Arab Emirates, and Turkey which generate the highest direct effects, Iran also has feedback effects that are higher than the average direct effect reported in Figure 2. Interestingly, Iran, Iraq, and Lebanon have very small direct effects with respect to the institutional impact matrices based on political rights. This finding may be attributable to the lack of political stability, weak institutional quality, and the pervasiveness of corruption and poor governance in these countries.

[26] These authors analyze the impact of trade in goods and services for the MENA countries using a growth regression framework that allows for an interaction between the two at the aggregate and sectoral level. They find a positive effect of both trade in goods and trade in services on real GDP. However, they show that the interaction effect between trade in goods and trade in services is negative, suggesting that as goods trade increases, the marginal effect of services trade on GDP decreases. However, they do not consider the spillover effects of trade between countries.

[27] Here we did not multiply by the coefficient of the explanatory variables in the spatial lag model but presented the impact effects by themselves.

Figure 2. Direct Effects




[Colour figure can be viewed at wileyonlinelibrary.com]

## 5. CONCLUSION

This paper investigates the existence of growth spillovers among MENA countries with respect to geographical, institutional, and trade characteristics. We use spatial econometric techniques to explore and understand possible linkages between integration and economic growth within the region. Our results are novel in that they suggest that the economic growth of one MENA country is positively affected by the economic growth of another with geographical or institutional proximity. However, trade linkages among the different partners matter less. This is related with the resource-based nature of many MENA countries and the fact that MENA countries trade primarily with countries or entities outside of their region such as the EU or China. Hence, the spillover effects on growth arising from bilateral trade linkages within the MENA region are limited to just a few countries, which is not enough for the emergence of economic growth spillovers in that region.

The policy choices of MENA countries have been the topic of extensive analysis. Typically, the focus has been on understanding the role of national policies and the benefits emanating from them for the individual country and the region. In this paper, we have taken an alternative approach and examined the role of growth interdependence in the MENA region. Our findings suggest that trade linkages contribute little to generating spillover effects, which work primarily through geographical and institutional proximity. Furthermore, institutional similarity among the MENA countries reflects the impact of resource-based contracting institutions and has failed to generate significant growth effects through specialization in production and comparative advantage. Thus, our results suggest a two-pronged policy approach for the MENA: increase and diversify trade linkages and trade liberalization while simultaneously improving institutional structures and regional governance to sustain more complex forms of economic interaction. The benefits from following such a strategy may yield great dividends in view of the spillover effects involved.

## REFERENCES

Abreu, Maria; Henri L. F. de Groot; and Raymond J. G. M. Florax. 2005. "Space and Growth: A Survey of Empirical Evidence and Methods." *Région et Développement*, no. 21: 13–44.

Acemoglu, Daron; Simon Johnson; and James A. Robinson. 2001. "The Colonial Origins of Comparative Development: An Empirical Investigation." *American Economic Review* 91, no. 5: 1369–401.

Adedeji, Olumuyiwa S.; Sohaib Shahid; and Ling Zhu. 2018. "Saudi's Growth and Financial Spillovers to Other GCC Countries: An Empirical Analysis." Working Paper no. 18/278. Washington, DC: International Monetary Fund. https://www.imf.org/en/Publications/WP/Issues/2018/12/11/Saudis-Growth-and-Financial-Spillovers-to-Other-GCC-Countries-An-Empirical-Analysis-46440

Ahmad, Mahyudin, and Stephen G. Hall. 2012. "Institutions and Growth: Testing the Spatial Effect Using Weight Matrix Based on the Institutional Distance Concept." MPRA Paper no. 42294. https://mpra.ub.uni-muenchen.de/42294/.

Andreano, M. Simona; Lucio Laureti; and Paolo Postiglione. 2013. "Economic Growth in MENA Countries: Is There Convergence of Per-capita GDPs?" *Journal of Policy Modelling* 35, no. 4: 669–83.

Anselin, Luc. 2003. "Spatial Externalities, Spatial Multipliers, and Spatial Econometrics." *International Regional Science Review* 26, no. 2: 153–66.

Arbia, Giuseppe; Michele Battisti; and Gianfranco Di Vaio. 2010. "Institutions and Geography: Empirical Test of Spatial Growth Models for European Regions." *Economic Modelling* 27, no. 1: 12–21.

Aziz, Omar Ghazy. 2018. "Institutional Quality and FDI Inflows in Arab Economies." *Finance Research Letters* 25: 111–23.

Baltagi, Badi H. 2005. *Econometric Analysis of Panel Data*. 3rd ed. New York: John Wiley & Sons. https://www.wiley.com/legacy/wileychi/baltagi3e/index.html.

Barro, Robert J. 1991. "Economic Growth in a Cross Section of Countries." *Quarterly Journal of Economics* 106, no. 2: 407–43.

Barro, Robert J., and Xavier Sala-i-Martin. 1995. *Economic Growth*. New York: McGraw-Hill.

Bosker, Maarten, and Harry Garretsen. 2009. "Economic Development and the Geography of Institutions." *Journal of Economic Geography* 9, no. 3: 295–328.

Burridge, Peter. 1981. "Testing for a Common Factor in a Spatial Autoregression Model." *Environment and Planning A: Economy and Space* 13, no. 7: 795–800.

Collier, Paul, and Stephen A. O'Connell. 2007. "Opportunities and Choices." In *The Political Economy of Economic Growth in Africa, 1960–2000*, vol. 1, edited by Benno J. Ndulu, Stephen A. O'Connell, Robert H. Bates, Paul Collier, and Chukwuma C. Soludo, 76–136. Cambridge: Cambridge University Press.

Debarsy, Nicolas, and Cem Ertur. 2019. "Interaction Matrix Selection in Spatial Autoregressive Models with an Application to Growth Theory." *Regional Science and Urban Economics* 75: 49–69.

Durlauf, Steven N.; Paul A. Johnson; and Jonathan R.W. Temple. 2005. "Growth Econometrics." In *Handbook of Economic Growth*, vol. 1A, edited by Philippe Aghion and Steven N. Durlauf, 555–677. Amsterdam: North-Holland.

Easterly, William, and Ross Levine. 1998. "Troubles with the Neighbours: Africa's Problem, Africa's Opportunity." *Journal of African Economies* 7, no. 1: 120–42.

El-Erian, Mohamed; Sena Eken; Susan Fennell; and Jean-Pierre Chauffour. 1996. *Growth and Stability in the Middle East and North Africa*. Washington, DC: International Monetary Fund. https://www.imf.org/external/pubs/ft/mena/00mena.htm.

Elhorst, J. Paul. 2014. *Spatial Econometrics: From Cross-Sectional Data to Spatial Panels*. Springer Briefs in Regional Science. Berlin Heidelberg: Springer-Verlag.

Elhorst, J. Paul; Gianfranco Piras; and Giuseppe Arbia. 2010. "Growth and Convergence in a Multiregional Model with Space-Time Dynamics." *Geographical Analysis* 42, no. 3: 338–55.

Ertur, Cem, and Wilfried Koch. 2007. "Growth, Technological Interdependence and Spatial Externalities: Theory and Evidence." *Journal of Applied Econometrics* 22, no. 6: 1033–62.

———. 2011. "A Contribution to the Theory and Empirics of Schumpeterian Growth with Worldwide Interactions." *Journal of Economic Growth* 16, no. 3: 215–55.

Findlay, Ronald, and Kevin H. O'Rourke. 2007. *Power and Plenty: Trade, War, and the World Economy in the Second Millennium*. Princeton Economic History of the Western World. Princeton, NJ: Princeton University Press.

Fingleton, Bernard. 2001. "Equilibrium and Economic Growth: Spatial Econometric Models and Simulations." *Journal of Regional Science* 41, no. 1: 117–47.

Florax, Raymond J. G. M.; Hendrik Folmer; and Sergio J. Rey. 2003. "Specification Searches in Spatial Econometrics: The Relevance of Hendry's Methodology." *Regional Science and Urban Economics* 33, no. 5: 557–79.

Frankel, Jeffrey A., and David H. Romer. 1999. "Does Trade Cause Growth?" *American Economic Review* 89, no. 3: 379–99.

Gallup, John Luke; Jeffrey D. Sachs; and Andrew D. Mellinger. 1999. "Geography and Economic Development." *International Regional Science Review* 22, no. 2: 179–232.

Grossman, Gene M., and Elhanan Helpman. 1991. *Innovation and Growth in the Global Economy*. MIT Press Books. Cambridge, MA: MIT Press.

Hall, Robert E., and Charles I. Jones. 1999. "Why Do Some Countries Produce So Much More Output per Worker than Others?" *Quarterly Journal of Economics* 114, no. 1: 83–116.

Hanson, Jesper; Raju Huidrom; and Ergys Islamaj. 2018. "Growth Spillovers to Developing MENA." Unpublished manuscript. https://editorialexpress.com/cgi-bin/conference/download.cgi?db_name=MEEA39&paper_id=113.

Helpman, Elhanan; Marc J. Melitz; and Yona Rubinstein. 2008. "Estimating Trade Flows: Trading Partners and Trading Volumes." *Quarterly Journal of Economics* 123, no. 2: 441–87.

Henderson, J. Vernon; Tim Squires; Adam Storeygard; and David Weil. 2018. "The Global Distribution of Economic Activity: Nature, History, and the Role of Trade." *Quarterly Journal of Economics* 133, no. 1: 357–406.

Ho, Chun-Yu; Wei Wang; and Jihai Yu. 2013. "Growth Spillover through Trade: A Spatial Dynamic Panel Data Approach." *Economics Letters* 120, no. 3: 450–53.

Islam, Nazrul. 1995. "Growth Empirics: A Panel Data Approach." *Quarterly Journal of Economics* 110, no. 4: 1127–70.

Karam, Fida, and Chahir Zaki. 2015. "Trade Volume and Economic Growth in the MENA Region: Goods or Services?" *Economic Modelling* 45: 22–37.

Kogut, Bruce, and Harbir Singh. 1988. "The Effect of National Culture on the Choice of Entry Mode." *Journal of International Business Studies* 19: 411–32.

Le Gallo, Julie, and Bernard Fingleton. 2014. "Regional Growth and Convergence Empirics." In *Handbook of Regional Science*, edited by Manfred M. Fischer and Peter Nijkamp, 291–315. Heidelberg: Springer.

Lee, Kevin; M. Hashem Pesaran; and Ron Smith. 1997. "Growth and Convergence in a Multi-Country Empirical Stochastic Solow Model." *Journal of Applied Econometrics* 12, no. 4: 357–92.

Lesage, James P., and Manfred M. Fischer. 2008. "Spatial Growth Regressions: Model Specification, Estimation and Interpretation." *Spatial Economic Analysis* 3, no. 3: 275–304.

LeSage, James P., and R. Kelly Pace. 2009. *Introduction to Spatial Econometrics*. Boca Raton, FL: CRC Press. https://www.taylorfrancis.com/books/introduction-spatial-econometrics-james-lesage-robert-kelley-pace/10.1201/9781420064254.

Levchenko, Andrei A. 2007. "Institutional Quality and International Trade." *Review of Economic Studies* 74, no. 3: 791–819.

Lucas, Robert E., Jr. 1988. "On the Mechanics of Economic Development." *Journal of Monetary Economics* 22, no. 1: 3–42.

Luciani, Giacomo. 2017. "Oil Rent and Regional Economic Development in MENA." In *Combining Economic and Political Development: The Experience of MENA*, edited by Giacomo Luciani, 211–30. International Development Policy Series 7. Geneva: Graduate Institute Publications.

Mankiw, N. Gregg; David Romer; and David N. Weil. 1992. "A Contribution to the Empirics of Economic Growth." *Quarterly Journal of Economics* 107, no. 2: 407–37.

Mayer, Thierry, and Soledad Zignago. 2011. "Notes on CEPII's Distances Measures: The GeoDist Database." CEPII Working Paper no. 2011-25. Paris: CEPII. http://www.cepii.fr/CEPII/en/publications/wp/abstract.asp?NoDoc=3877

Melitz, Jacques, and Farid Toubal. 2014. "Native Language, Spoken Language, Translation and Trade." *Journal of International Economics* 93, no. 2: 351–63.

Moreno, Ramon, and Bharat Trehan. 1997. "Location and the Growth of Nations." *Journal of Economic Growth* 2: 399–418.

Moriyama, Kenji. 2010. "The Spillover Effects of the Global Crisis on Economic Activity in MENA Emerging Market Countries: An Analysis Using the Financial Stress Index." Working Paper no. 10/8. Washington, DC: International Monetary Fund.

https://www.imf.org/en/Publications/WP/Issues/2016/12/31/The-Spillover-Effects-of-the-Global-Crisison-Economic-Activity-in-Mena-Emerging-Market-23508.
Nugent, Jeffrey B., and M. Hashem Pesaran. 2006. “Introduction: Explaining Growth in the Middle East.” In *Explaining Growth in the Middle East*, edited by Jeffrey B. Nugent and M. Hashem Pesaran, 1–27. Bingley: Emerald.
Nunn, Nathan. 2007. “Relationship-Specificity, Incomplete Contracts, and the Pattern of Trade.” *Quarterly Journal of Economics* 122, no. 2: 569–600.
Nunn, Nathan, and Daniel Trefler. 2014. “Domestic Institutions as a Source of Comparative Advantage.” In *Handbook of International Economics*, vol. 4, edited by Gita Gopinath, Elhanan Helpman, and Kenneth Rogoff, 263–315. Amsterdam: North-Holland.
Ramirez, Maria Teresa, and Ana Maria Loboguerrero. 2002. “Spatial Dependence and Economic Growth: Evidence from a Panel of Countries.” Borradores de Economia Working Paper no. 206. Bogota: Banco de la República, Colombia. https://www.banrep.gov.co/es/node/457
Rappaport, Jordan, and Jeffrey D. Sachs. 2003. “The United States as a Coastal Nation.” *Journal of Economic Growth* 8: 5–46.
Roberts, Mark, and Uwe Deichman. 2009. “International Growth Spillovers, Geography and Infrastructure.” Policy Research Working Paper no. WPS5153. Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/4346
Rodrik, Dani; Arvind Subramanian; and Francesco Trebbi. 2004. “Institutions Rule: The Primacy of Institutions over Geography and Integration in Economic Development.” *Journal of Economic Growth* 9: 131–65.
Romer, Paul M. 1990. “Endogenous Technological Change.” *Journal of Political Economy* 98, no. 5, pt. 2: S71–S102.
Sachs, Jeffrey D., and Andrew M. Warner. 1997. “Fundamental Sources of Long-Run Growth.” *American Economic Review* 87, no. 2: 184–88.
Vamvakidis, Athanasios. 1998. “Regional Integration and Economic Growth.” *World Bank Economic Review* 12, no. 2: 251–70.

## APPENDIX 1. DESCRIPTIVE STATISTICS

The variables used in our analysis are described in Section 3.1 of the main text. The descriptive statistics associated with these data are provided in Appendix Table 1.

In the growth regression literature, the impact of trade is often measured as trade openness, which is defined as the sum of exports and imports as a fraction of GDP. In results that are available upon request, we tried using this variable in our spatial model in place of the trade balance. However, the coefficients on both the investment and trade variables became insignificant, though the spatial autoregressive parameter $\rho$ increased slightly. Furthermore, the estimates of the SDM with this measure of trade implied negative values for the spatial autocorrelation parameter and negative estimates of the coefficient on the spatially lagged value of openness, leading to negative estimates of the indirect effects of trade. We also tried to include a measure of human capital. However, due to the lack of data availability, this dramatically reduces $N$ and makes the estimation unreliable.

App. Table 1. Descriptive Statistics of Variables

| | $N$ | Mean | SD | Min | Pctl(25) | Pctl(75) | Max |
|---|---|---|---|---|---|---|---|
| $g_{it}$ | 162 | 0.030 | 0.067 | −0.154 | −0.003 | 0.060 | 0.268 |
| ln $Y_{t-5}$ | 162 | 9.345 | 1.155 | 6.955 | 8.423 | 10.101 | 12.408 |
| $n$ | 162 | 0.033 | 0.029 | −0.038 | 0.017 | 0.040 | 0.177 |
| *inv/gdp* | 162 | 0.255 | 0.105 | 0.033 | 0.180 | 0.321 | 0.599 |
| *gov/gdp* | 162 | 0.215 | 0.110 | 0.031 | 0.148 | 0.263 | 0.613 |
| *tb/gdp* | 162 | −0.015 | 0.236 | −0.810 | −0.115 | 0.124 | 0.830 |
| *pol. rights* | 162 | 0.050 | 0.017 | 0.010 | 0.044 | 0.060 | 0.070 |

# APPENDIX 2. THE SPATIAL DURBIN MODEL

Appendix Table 2 presents the results obtained in the estimation of the models with the general model, the SDM, using different weighting matrices. In columns 2 through 5, we report estimates with geographical, institutional, and trade weighting matrices, respectively.

Appendix Table 2 reports the coefficient estimates for the SDM, which shows that the spatial dependence parameter $\rho$ becomes negative for the cases with the institutional and trade weighting matrices and positive but insignificant for the case with the geographical weighting matrix. The main finding from Appendix Table 2 is that the spatial interaction term with the trade balance is positive and significant for all weighting matrices. These results imply that trade linkages work through local spatial range effects deriving from the behavior of the spatially lagged explanatory variable for the trade balance signified by the term $W\Gamma_r$ as opposed to the global range spatial effects or spatial multiplier effects deriving from the impact of the spatially lagged dependent variables, $(I - \rho W)^{-1}\beta_r$. We discuss these findings more extensively in the text.

We also provide estimates of the direct and indirect effects implied by the SDM. Recall that the SDM has the general representation in a matrix form as $g = \rho Wg + X\beta + WX\Gamma + \mu + \epsilon$, which can be written as $(I_N - \rho W)g = (\beta + W\Gamma)X + \mu + \epsilon$. Defining

$$V(W) = (I_N - \rho W)^{-1} = I_N + \rho W + \rho^2 W^2 + \rho^3 W^3 + \ldots,$$

$$S_r(W) = V(W)(I_N \beta_r + W\Gamma_r),$$

the SDM has the representation, $g = \Sigma_{r=1}^{k} S_r(W)X_r + V(W)\mu + V(W)\epsilon$. Thus, the impact on country $i$'s growth of a change in the explanatory variable $r$ of country $j$ may be computed as

App. Table 2. Spatial Durbin Model (SDM)

| | $W^{GEO}$ | $W^{INST1}$ | $W^{INST2}$ | $W^{TR}$ |
|---|---|---|---|---|
| $\ln Y_{i,t-5}$ | −0.052*** | −0.050*** | −0.053*** | −0.048*** |
| | (0.012) | (0.04) | (0.011) | (0.009) |
| *n* | −0.489*** | −0.355*** | −0.381*** | −0.355** |
| | (0.162) | (0.162) | (0.177) | (0.154) |
| *inv/gdp* | 0.149*** | 0.151** | 0.143 | 0.075 |
| | (0.083) | (0.090) | (0.092) | (0.081) |
| *gov/gdp* | −0.043 | −0.076 | −0.106 | −0.011 |
| | (0.074) | (0.062) | (0.070) | (0.076) |
| *tb/gdp* | 0.128*** | 0.157*** | 0.152** | 0.131** |
| | (0.063) | (0.070) | (0.072) | (0.073) |
| *pol. rights* | −0.0195 | 0.595 | −0.715 | 0.346 |
| | (0.407) | (0.149) | (0.483) | (0.609) |
| $W \times \ln Y_{i,t-5}$ | 0.0004 | 0.025 | −0.0314 | 0.009 |
| | (0.022) | (0.019) | (0.17) | (0.018) |
| $W \times n$ | −0.937 | −0.408 | −0.785 | 0.162 |
| | (0.841) | (0.421) | (1.37) | (0.584) |
| $W \times$ *inv/gdp* | −0.142 | −0.120 | 0.0015*** | −0.367 |
| | (0.366) | (0.172) | (0.381) | (0.233) |
| $W \times$ *gov/gdp* | −0.333 | −0.157 | −1.148*** | 0.143 |
| | (0.210) | (0.172) | (0.336) | (0.270) |
| $W \times$ *tb/gdp* | 0.350*** | 0.427*** | 0.484** | 0.517** |
| | (0.116) | (0.19) | (0.222) | (0.139) |
| $W \times$ *pol. rights* | −1.509 | 5.123* | 8.719 | 1.130 |
| | (1.961) | (2.94) | (7.969) | (2.344) |
| $\rho$ | 0.005 | −0.009 | −0.705* | −0.216 |
| | (0.138) | (0.095) | (0.359) | (0.113) |
| $R^2$ | 0.378 | 0.349 | 0.333 | 0.370 |

Notes: 1. Dependent variable: $g_{it} = [\ln(Y_{it}) - \ln(Y_{i,t-5})]/5$.
2. Let $p = \Pr(\Xi \geq \xi)$ where $\Xi$ denotes the relevant test statistic under the null hypothesis and $\xi$ is its observed value.
3. Standard errors are in parentheses.
$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.10$.

$$\frac{\partial g_i}{\partial X_{jr}} = S_r(W)_{ij},\ i, j = 1, \ldots, N.$$

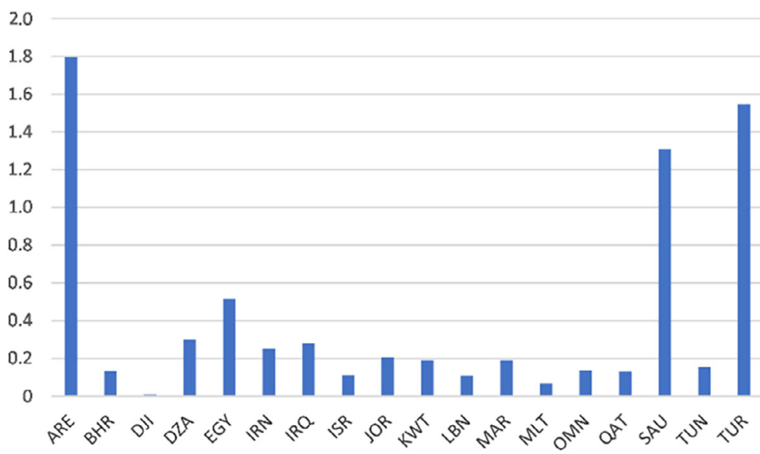
The terms that differentiate this from the standard nonspatial regression coefficient $\beta$ are the impacts of the spatial autocorrelation parameter, $\rho$, which also arises in SAR model, as well as the spatial lag parameter on the explanatory variables, $\Gamma_r$.

App. Table 3. SDM with $W^{TR}$

| | Direct Effects | Indirect Effects | Total Effects |
|---|---|---|---|
| $\ln Y_{i,t-5}$ | $-0.049^{***}$ | 0.015 | $-0.033^{**}$ |
| *n* | −0.369 | 0.206 | −0.163 |
| *inv/gdp* | 0.087 | $-0.323^{*}$ | −0.236 |
| *gov/gdp* | −0.016 | 0.118 | 0.101 |
| *tb/gdp* | $0.121^{***}$ | $0.412^{***}$ | $0.534^{***}$ |
| *pol. rights* | 0.322 | 0.861 | 1.184 |

Note: Let $p = \Pr(\Xi \geq \xi)$ where $\Xi$ denotes the relevant test statistic under the null hypothesis and $\xi$ is its observed value. The total effects are the sum of the direct and indirect effects.
$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.10$.

App. Figure 1. SDM Indirect Effects of the Trade Balance Variable




[Colour figure can be viewed at wileyonlinelibrary.com]