Growth Spillover Effects for Developing Economies Using Spatial Analysis

by

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ABSTRACT

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Economic theories of growth have highlighted domestic factors for understanding a country's growth performance and have typically ignored the interaction among different economies. This thesis examines the role of spatial spillovers in economic growth for different groups of developing economies. The study argues that the economic growth is an important issue for developing countries and their growth rates are not independent from each other. In order to investigate the interdependencies of countries' growth rate, I use spatial econometric approach. At first, I test the existence and the type of spatial dependence. In addition to specification tests which belong to spatial models, choosing the best weighting matrix that represents data is explained. I explicitly model these spatial interactions that may arise on the basis of geographical, cultural or institutional similarities or bilateral trade and ask how much they are likely to matter for growth externalities and spillover effects.

For a different kind of grouping of developing economies; firstly my spatial exploratory analysis for the growth rate of GDP per capita of Emerging Market Economies (EME) shows that there is no spatial pattern and it is not possible to identify any spillover effects among their economic growth even using different kind of proximity definitions. The results suggest that their growth rates are not interacted well, even though the growth process is very important for all defined countries. Then I turn the focus to some other region, while my results indicate that the Middle East and North Africa (MENA) countries' growths have positive spatial interaction. They are positively affected by economic growth of countries that are geographically close and that have similar cultural and institutional characteristics. However, trade linkages among the different partners matter less for MENA countries' growth spillovers. I find that spillover effects of growth are mainly due to economic activ-

ities in countries that trade primarily oil. The importance of trade diversification within the region gain significance because it cannot be seen substantial spillover effects due to bilateral trade weights.

ÖZETÇE

Mekansal Analiz Kullanarak Gelişmekte Olan Ekonomilerin Büyümelerinin Yayılma Etkileri
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Ekonomik büyüme teorileri, bir ülkenin büyüme performansını yerel faktörler ile açıklamaktadır ve genellikle farklı ekonomiler arasındaki etkileşimi göz ardı etmiştir. Bu tez, gelişmekte olan ekonomilerin farklı grupları için mekansal yayılmanın ekonomik büyümedeki rolünü incelemektedir. Çalışma, ekonomik büyümenin gelişmekte olan ülkeler için önemli bir konu olduğunu ve bunların büyüme oranlarının birbirinden bağımsız olmadığını savunuyor. Ülkelerin büyüme hızının karşılıklı bağımlılıklarını araştırmak için mekansal ekonometrik yaklaşım kullanıyorum. Öncelikle, mekansal bağımlılık varlığını ve türünü test ediyorum. Ayrıca mekânsal modellere ait belirleme testlerinin yanı sıra verileri en iyi temsil eden uygun ağırlık matrislerinin nasıl belirlendiği izah edilmektedir. Coğrafi, kültürel veya kurumsal benzelikler veya ikili ticaret temelinde ortaya çıkabilecek bu mekansal etkileşimleri açıkça modellendiriyorum ve büyüme dışsallıkları ve yayılma etkileri için ne kadar önemli olabileceklerini soruyorum.

Gelişmekte olan ekonomilerin farklı bir gruplaması için; ilk olarak Yükselen Piyasa Ekonomilerinin kişi başına GSYIH büyüme oranına ilişkin mekansal açıklayıcı analizim, mekansal bir örüntü olmadığını ve farklı tür yakınlık tanımları kullanarak bile ekonomik büyümeleri arasında herhangi bir yayılma etkisini tanımlanmasının mümkün olmadığını göstermektedir. Sonuçlar, büyüme sürecinin tüm tanımlanmış ülkeler için çok önemli olmasına rağmen, büyüme oranlarının iyi etkileşmediğini göstermektedir. Daha sonra odağı başka bir bölgeye çeviriyorum, sonuçlarım Orta Doğu ve Kuzey Afrika ülkelerinin büyümelerinin aralarında olumlu mekansal etkileşim olduğunu gösteriyor. Coğrafi olarak yakın olan ve benzer kültürel ve kurumsal özelliklere sahip ülkelerin ekonomik büyümesinden olumlu yönde etkileniyorlar. Fakat, farklı ortaklar arasındaki ticaret bağlantıları MENA ülkelerinin büyüme

yayılmaları için daha az önemlidir. Esasen büyümenin yayılma etkilerinin petrol ticareti yapan ülkelerdeki ekonomik faaliyetlerden kaynaklandığını düşünüyorum. Büyüme yayılmasında ikili ticaret ilişkilerinden kaynaklı mühim etkiler görülemediğinden bölgedeki ticaret çeşitliliğinin önemi anlam kazanmaktadır.

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Chapter 1

INTRODUCTION

1.1 Motivation and Aim

Economic growth is a wide multidimensional topic. The literature seeks to understand the sources, patterns and dynamics of economic growth and development process. Rather than attempting to identify the most relevant deeper sources of economic growth, it might be as fulfilling to understand the interdependence of economic growth of countries. The aim of this dissertation is to broaden the understanding of economic growth spillover within some group of countries. Furthermore, the influence of different kind of connectivity relations among the countries is analyzed more deeply. The focus will be on developing countries, instead of developed ones. While developing countries are achieving rapid growth rates and become more integrated to whole world, and I expect to see some spillover effects among their economic growth. Additionally, another objective of this thesis is to examine the impact of growth spillover experience of different clustering of countries as well.

1.2 Key Questions

Firstly, I will mention some questions that are related to the main objective of this thesis.

- Is economic growth integrated or isolated?

- What kind of connectivity relations are more effective on the integration of economic growth of countries?

- If the counties' economic growth is not independent from the other countries' growth, then how can I define this independency?
- The spillover effect of economic growth can define/identify/represent this independency.
- The objective is to respond, which kind of proximity of the countries can give better economic growth spillover among the selected group of countries?
- Is there any lack of integration within some group of countries, why, and it depends on more what?

1.3 How to estimate economic growth spillovers?

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 studied empirically the phenomenon of the convergence of individual countries to more advanced ones based on the paradigm of neoclassical growth theory; see (47) or (10). In this literature, β-convergence captures the notion that poor countries or regions tend to grow faster than rich ones based on measures of per capita income, attributing a finding of a negative relationship between initial per capita income and growth rates to the presence of convergence across countries. By contrast, σ-convergence occurs when the dispersion of real per capita income across a group of economies falls over time. In subsequent analysis, endogenous growth theory pioneered by (45) and (62) proposes mechanism that can potentially lead to the systematic divergence between per capita income across countries observed in the data. For this purpose, (45) develops a model of human capital accumulation in which the initial comparative advantage of countries increases by learning-by-doing while (61; 62) emphasizes the role of knowledge capital.

The notion that a country's growth may depend on the economic performance of its neighbors has also been emphasized in the recent literature. One mechanism through which such spillover effects may occur is through openness and trade. (30) argue that countries with larger and more advanced trading partners should experience greater spillover effects from them. (68) shows that the market size of neighboring countries measured as the log of neighboring countries' GDP grow faster, 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 significant positive spillover effects on the home country's growth.

Some studies have explicitly allowed for geographical variables directly into the analysis. (32), (64) and (40) find that latitude is a negative determinant of growth after controlling other related factors. Gallup and Sachs (2000) find that agricultural productivity growth is substantially lower in the tropics.[1] Generally, however, the cross-sectional observations have been taken independently from one another and the importance of the dependencies between different locations in determining economic growth has been rarely analyzed.

As economies are not islands, there are many ways in which countries are connected, and also there are many types of questions that can be addressed that deal with space. The notion of how space is defined and conceived can help shed light on how countries connected and integrate into particular growth path. In this context, for practical and convenient mechanism to analyze diverging growth experiences across nations, I will utilize the spatial econometrics, which has evolved and become integrated into the economic growth literature. The importance of "space" in an economic growth is an empirical issue that has been taken into consideration recently. The reason for adopting spatial econometrics view is that this allows us to analyze the influence of space connections between countries' growth rates. The framework of spatial interaction in growth theory gives rise to a wide variety of questions that can be studied.

In this thesis, the different kind of proximity specifications are used to define

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[1](1) classify the empirical literature according to the channels through which space affects economic growth in terms of relative and absolute location.

the growth spillover between countries given a spatial context. Rather than modelling the impediments of space and distance directly, spatial process models start from exogenously provided information about the spatial structure. In my analysis, I postulate that spatial effects in growth may arise on the basis of geographical, cultural or institutional similarities and bilateral trade. In order to investigate the interdependencies of countries' growth rates, I explicitly model such interactions using a spatial econometric approach and ask how much they are likely to matter for growth externalities and spillover effects.

To detect spatial dependence in growth rates, I make use of the model with spatially lagged dependent variables as well as the model with spatially autocorrelated error terms. Using results from the spatial econometrics literature, I test for the existence and type of spatial dependence. I also 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.

In a prominent paper that focuses on the growth experience of Sub-Saharan Africa, (19) argue that much of the poor growth performance Sub-Saharan African countries may be due to the contagious effects of their neighbors' growth. Also considering the case of Sub-Saharan African countries, (58) add to this literature by examining "a mechanism for the transmission of benefits from one country or region to another, namely, infrastructure investment which facilitates interaction between countries through trade or communication of ideas." (52) note that growth spillovers may occur through location or common shocks or even institutional factors.[2]

1.4 Thesis Contribution

This thesis contributes to the empirical literature on the predictive factors of the spatial spillover of economic growth among different grouping of countries. First, this

[2]Commenting on factors that led to such spillovers in the East Asia experience, they note that the yen appreciation of the mid-1980's and early 1990's led to the permanent transfer of Japanese technology and production facilities to other East Asian countries. Likewise, the growth model embraced by Japan was emulated by many of its East Asian neighbors, including S. Korea.

thesis constructed a spatial panel data set, which contain information on the growth experience of large cross-section of countries of over time and focus on groupings where spatial effects are likely to be localized. Most of the data that economists use is cross-sectional and they do not take into account the dependencies between different locations.

Understanding the role of spatial spillovers provides new empirical evidence to the existing research on the evolution of developing economies' growth experience and can inform policymakers on how developing countries extend and sustain future growth as there are concerns of slowing growth. I begin my analysis with Emerging Market Economies, as they become important global players and I expect to see more integration within them and their growth spillovers with each other as well. However, my spatial exploratory analysis' results cannot show any spillover effects between them. Although they are interested to develop and modernize their economies and societies, the reality is that each of them faces their own different conditions and domestic challenges. Their interests diverge greatly on different subjects, therefore they do not necessarily share a common agenda or even similar economic, political, social and cultural features. It is not convenient to use Emerging Market Economies to identify the growth spillovers among them. Then, the focus of the countries should be changed to some region, where the countries have same kind of characteristics and their proximities make more sense for the growth spillovers.

Additionally, my results indicate that the economic growth of a Middle East and North Africa (MENA) countries is positively affected by the economic growth of countries that are geographically close and that have similar cultural and institutional characteristics rather than through the growth of its trade partners. I also find differing patterns of the direct and indirect effects of the trade balance as a share of GDP for growth spillovers based on the different weighting matrices. I find that spillover effects of growth are mainly due to economic activities in countries that trade primarily oil. The importance of trade diversification within the region gain significance because it cannot be seen substantial spillover effects due to bilateral trade weights. These results, in turn, entail policy recommendations that have been voiced by many commentators regarding the MENA region involving the regional trade integration, economic diversification and institutional reform for generating intra-regional growth spillovers.

I will address several issues throughout this thesis. The starting point is study on economic growth, while the focus is on the analysis of interdependencies between countries. The very first step, presented in Chapter two, is to define economic growth theories, its determinants, and spatial dependencies of growth. Chapter three deals with how modeling the growth spillovers, while using spatial econometrics. It is important to highlight that this thesis aims to also address the question of how economic growth of countries interact with each other at different spatial scales, while Chapter four rely on the different definitions of space, which are based on the proximities within the selected group of countries. The results from the empirical applications are employed in Chapter five. I will introduce alternative way of clustering of developing countries. First, I will focus on Emerging Market Economies and then I return to the Middle East and North Africa region. In the last chapter I will give my all conclusion from my empirical research.

Chapter 2

ECONOMIC GROWTH

2.1 Economic Growth Theories

The Classical Growth Theory states that the economy has a subsistence level that refers to minimum amount of income required to survive. If the real GDP has increased above this level, then it would cause the population explosion and later on bring back the real GDP to the subsistence level. This theory assumes that the country's economic growth decrease with an increasing population and limited resources. The population increase has an adverse effect on the GDP as resources become limited due to higher demand. (57) modified the theory by including diminishing returns to land but assuming no technological change. However the Classical Growth Theory ignores the economies of scale, while holding technology as constant.

The Neoclassical Growth Theory is a modern approach to growth theory that draw out how a steady economic growth rate when three economic factors are considered: labor, capital and technology. (65) and (66) developed the main model with the assumption of diminishing returns to capital and labor. The capital accumulates through savings and investment, while its stock constantly decreases due to depreciation. In the short term, the rate of growth slows down as diminishing returns take effect, and the economy converts into a steady-state economy. Whatever share of GDP invested, capital or worker eventually converges on the steady state, leaving the growth rate of output or worker determined only by the rate of technological progress.Therefore, the theory argues that technological change has a major influence on the overall functioning of an economy. With a constant rate of technological change, all countries have the same steady state rate of growth. The important prediction of the model is the convergence theory, which captures the notion that poor countries tend to grow faster than rich ones based on measures of per capita income, attributing a finding of a negative relationship between initial per capita income and growth rates. The main assumptions are as follows, firstly the level of technology taken as given and thus exogenously determined, and secondly the form of production function assumes constant returns to scale and lastly diminishing returns to each input.

The prediction of exogenous technological progress was an unsatisfied assumption, therefore in 1980s technology started to endogenize. The Endogenous Growth Theory, which is launched by Romer (61, 62) and Lucas (45), incorporated a new concept of human capital, the skills of knowledge that make workers more productive. The theory suggests that the more motivation there is for pursue to innovative ideas, the more creativity will be fostered. This is directly related to the rate of technological advancement. This theory relaxed the usual assumption of diminishing returns on factors, therefore the investment is more important for long-run growth. With constant or increasing returns to capital, long-term rate of growth becomes endogenous. While exogenous technological change is ruled out, the model can be driven primarily by the accumulation of knowledge. In Romer (61) technology is endogenized but treated as externality, assuming perfect competition. In Romer (62) it also internalized through some explicit R& D sector and the growth is explained by technological change that stems from investment decisions made by profit-maximizing agents. Lucas (45) develops a model of human capital accumulation in which the initial comparative advantage of countries increases by learning-by-doing.

As I mentioned earlier in the chapter, the assumptions of the Neoclassical Growth model are the diminishing returns to reproducible factors and exogenous saving rates, population growth and technological progress, then policies have no role in shaping long-term economic growth. Under these circumstances, richer countries grow at a slower rate than poorer countries. However, evidence of this process of unconditional convergence has weakened, therefore the concept of convergence can only be reconciled with the data if one moves to conditional convergence, which shows the relation between growth rate and initial conditions after controlling for other variables. The Endogenous Growth models imply conditional convergence while others do not. Therefore, for a conditional convergence I will more deeply investigate the determinants of economic growth.

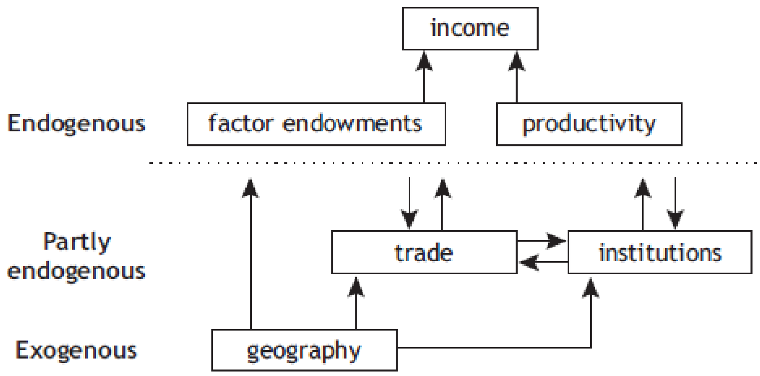
2.2 The Economic Growth Determinants

Determinants of economic growth are interrelated variables that directly affect the rate of economic growth. The growth theory assumptions suggest some basic determinants. First, the accumulation of physical capital has been considered with the significance differences in the investment rates. Secondly, the formal skills and experience embodied in the labor force represents a form of human capital. While it can be measured in many ways. Some of the authors use population growth, fertility rate, mortality rate, population in millions, enrollment rates, adult literacy rate and so on. Thirdly, technological advancements have permanent impact on the growth process. Research and development can be considered as an investment in knowledge that translate into new technologies. As higher R&D expenditure would be associated with constantly higher growth rates.

Additional to these basic determinants, some macroeconomic policy settings like inflation, government investment and expenditure and environmental variables, the financial development, international trade, and regional variables can also included in the growth process ((9)). (44) discuss the previously studied wide range of covariates to assess growth determinants, however they are still likely to fail to be identified, while they can suffer from uncertainties of theories, or specification or measurement issues. Also (18) identify 145 potential growth determinants from different well-known economic growth literature. They set forth that the vast majority of which have been found to be statistically significant using conventional standards. They show that the absence of any consensus on which growth determinants would be included in a growth model.

On the other hand, (59) differentiates the "proximate" and the "deep" determinants of growth. The proximate determinants are physical capital deepening, human capital accumulation and productivity growth, while these are basic determinants

Figure 2.1: All Growth Determinants



Source: (59)

that I mentioned earlier in the chapter as well. Additionally, the deeper determinants are shown in the Figure 2.1 as geography, integration (trade) and institutions. Rodrik explains them more detailed as geography relates to the advantages and disadvantages posed by country's physical location. It plays a direct and obvious role in determining income because natural – resource endowments are shaped in large part by it. The quality of natural resources depends on geography. Geography also influences the income by trade and institutions as well. Because of the transportation costs and depended on the trade policies geography has an impact on trade. Similarly, geography shapes institutions, while the historical experience with colonialism has been a key factor in the institutional development. He also argues that, trade and institutions are partly endogenous and co-evolve with economic performance. Trade relates to the market size and the benefits and costs of participation in international trade in goods, services, capital and labor. Additionally, institutions refer to the quality of formal and informal sociopolitical arrangements that play an important role in promoting or hindering economic performance.

2.3 Spatial Growth Literature

One of the best known studies that take into account the importance of location for a country's economic growth dependencies is provided by (19), who argue that both policy choice and growth performance may be contagious in that countries tend to imitate each other's policies: while good policies were amplified in the East Asian context, the reverse has tended to occur in Sub-Saharan countries.[1] They use a border dummy variable to analyze the growth experience of Sub-Saharan Africa and find evidence of positive spatial effects across countries. Even after controlling for the standard indicators in growth regressions as well as variables such as black-market premium, financial market depth, and fiscal stance, they find that the growth performance of neighboring countries matter. They infer that the impact of policy changes on growth will be more effective when coordinated with neighboring countries' policies.

(52) examine growth spillovers using data on 93 countries over the period 1965 to 1989. They find evidence of extremely strong spillover effects using different measures of proximity. Their findings suggest that the growth rates of countries located close by are more reliable predictors of a given country's growth rate than are the growth rates of its trading partners. (58) also investigate the strength of cross-country spillovers of long-term growth in various regions of the world, with a particular emphasis on growth in Sub-Saharan Africa. They find that effective integration through investments in transport and telecommunications arises as a prerequisite in generating spillover effects from any original growth stimuli that may affect a region.

(27) develops the model for manufacturing productivity growth that assumes increasing returns and spatially varying technical progress. He finds that productivity levels and growth rates are higher in 178 estimated E.U. regions when the financially assisted regions have faster output growth. His model is related to endogenous growth theory and, in particular, to the "new economic geography".

Various researchers have also extended the notion of (10) β-convergence to a spatial context. (56) examine the existence of spatial dependence within US regions under the unconditional β-convergence model for the 1929-1994 period. They find positive and statistically significant spatial effects in levels of state per capita

[1] See also (16).

incomes. Similarly, (11) analyze the effect of spatial dependence in a sample of 138 European regions over the 1980-1995 period. They estimate various spatial models and find strong evidence of spatial autocorrelation for the unconditional β-convergence model.

(24) develop a growth model with technological interdependencies between countries which operate through spatial externalities. 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 socio-economic or institutional dissimilarities captured by geographic distance or border effects. They show that this framework yields a spatial autoregressive conditional convergence equation with parameter heterogeneity which yields a convergence speed for each country. (25) 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.

(35) also extend the Solow growth model with spatial terms, and estimate it using a sample of 26 OECD countries over the period 1971 -2005. They show the positive spillover effects of growth from one country to its trade partners. They provide evidence for spatial spillover through trade linkage instead of geographical distance. On the other hand, (13) 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.

(6) construct spatial growth models based on geographical and institutional weighting matrices to investigate the productivity convergence across European regions for the period 1991-2004. They use an institutional weighting matrix in their study while instrumenting the endogenous institutional matrix using exogenous linguistic distance. They study the inverse of linguistic distance to create a measure of language similarity that reflects similar institutional structures. They find that

the country-specific institutions are strongly and positively related to the region's productivity growth rate.

(4) also examine the effect of institutional quality on income growth rate on a sample of 58 developing countries over the period 1985-2008. They show the existence of a positive significant absolute effect of institutions on economic growth in developing countries. They find 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.

Chapter 3

MODELLING GROWTH SPILLOVER

To account for the potential interdependencies between the different countries, I make use of spatial econometrics. As is well known, spatial econometrics is a sub-field of econometrics dealing with spatial interaction effects among geographical units. (67) stated the First Law of Geography as: "everything is related to everything else, but near things are more related than distant thing." This first law can be counted as a keystone of the fundamental precepts of spatial econometrics.

The first generation of spatial models was derived for cross-sectional data. The methodologies and specifications developed are mainly related to a two-dimensional approach that refers to observations on cross-sections of regions, cities or countries over several time periods. As (22) notes, spatial panel models can be used in applied economic research to control for relationships over time, space and between units. Panel data are generally more informative, and they contain more variation and less collinearity among the variables. The use of panel data results in a greater availability of degrees of freedom, and hence, increases efficiency in the estimation.

According to (42), the cost of ignoring spatial dependence variable is relatively high since omitting one or more relevant explanatory variable from a regression 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 analysis, 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. A spatial weighting matrix W is a representation of the spatial structure of the data. I should select a conceptualization that best reflects how individual units actually interact with each other.

3.1 The Growth Equation with Spatial Externalities

I begin by deriving the growth equation that has been used in cross-country regressions to test for convergence across countries and then extend it to allow for spatial interdependence across countries. The standard neo-classical growth model is based on a constant returns to scale production technology combined with a constant saving rate and constant growth rates of technological and population growth. Following (47)'s paper (hereinafter MRW) that interprets in terms of country-specific data, and assumes the existence of a Cobb-Douglas function;

$$Y_{it} = A_{it} K_{it}^{\alpha} L_{it}^{1-\alpha} \qquad 0 < \alpha < 1, \tag{3.1}$$

where Y_{it} is the level of country-specific output (Real GDP), K_{it} denotes the level of capital and L_{it} is labor employed in the country and A_{it} is the country-specific level of labor-augmenting technological progress (total factor productivity). Assume that technology and labor grow at the constant rates g_i and n_i respectively, so that

$A_{it} = A_{i0} \exp(g_i t)$

$L_{it} = L_{i0} \exp(n_i t)$

The evolution of the economy is determined by

$$d\tilde{k}_{it} = s_i \tilde{y}_{it} - (n_i + g_i + \delta), \tag{3.2}$$

where $\tilde{k}_{it} = K_{it}/(A_{it}L_{it})$ is capital per effective worker, $\tilde{y}_{it} = Y_{it}/(A_{it}L_{it})$ is output per effective worker, assuming a common depreciation rate, δ, of existing capital across countries while using the law of motion of capital per effective worker. At the deterministic steady state, the capital stock per effective worker is given by

$$\tilde{k}_i^{\,*} = [s_i/(\delta + n_i + g_i)]^{1/(1-\alpha)}, \tag{3.3}$$

where s_i is the constant country-specific saving rate as a fraction of output per effective worker.

Substituting this result in the production function (3.1) and taking the log provides us the following equation for the output per capita $y_{it} = Y_{it}/L_{it}$ at the steady state as

$$\ln(y_{it}) = \ln(A_{i0}) + g_i t + \frac{\alpha}{1-\alpha} \ln\left(\frac{s_i}{n_i + g_i + \delta}\right) \tag{3.4}$$

MRW used this equation to show how differing accumulation of capital by saving and population growth can explain the differences in the current per capita incomes across countries. Then by, they suggest to include the human capital into production function as another input. Because this augmentation of human capital leads more realistic estimates of α, which shows the elasticity of output with respect to capital.

Next, the endogenous growth equation developed by implementing a log-linear approximation to equation (3.2) around the steady state (see (47), pp. 422-423) as $d\tilde{k}_{it}/dt = \lambda_i[\ln(\tilde{k}_i{}^*) - \ln(\tilde{k}_{it})]$, in turn, yields $d\ln(\tilde{y}_{it})/dt = \lambda_i[\ln(\tilde{y}_i{}^*) - \ln(\tilde{y}_{it})]$, where $\ln(\tilde{y}_i{}^*)$ is the steady state level of income per effective worker and $\lambda_i = (1-\alpha)(n_i + g_i + \delta)$ is convergence rate. This equation implies that

$$\ln(\tilde{y}_{it}) = (1 - \exp(-\lambda_i t)) \ln(\tilde{y}_i^*) + \exp(-\lambda_i t) \ln(\tilde{y}_{i0}) \tag{3.5}$$

where $\lambda_i > 0$ shows the convergence of effective units output to its steady state and depends on other parameters of the model. Now replace the effective units of output and output per effective units at an initial date by

$\ln(\tilde{y}_{it}) = \ln(y_{it}) - \ln(A_{i0}) - g_i t$

$\ln(\tilde{y}_{i0}) = \ln(y_{i0}) - \ln(A_{i0})$

then re-write the previous equation as

$$\ln(y_{it}) = g_i t + (1 - \exp(-\lambda_i t)) \ln(\tilde{y}_i^*) + (1 - \exp(-\lambda_i t)) \ln(A_{i0}) + \exp(-\lambda_i t) \ln(y_{i0}) \tag{3.6}$$

Define $g_{it} = [\ln(y_{it}) - \ln(y_{i0})]/t$ as the growth rate of output per worker for country i. Then by substracting $\ln(y_{i0})$ the equation (3.6) can be written as (see (18));

$$g_{it} = g_i + \beta_{i1}(\ln(y_{i0}) - \ln(\tilde{y}_i^*) - \ln(A_{i0})), \tag{3.7}$$

where $\beta_{i1} = -(1 - \exp(-\lambda_i t))/t$. In this representation, the coefficient β_{i1} shows that in a cross-section of countries, there should be a negative relationship between average rates of growth and initial output over any time period - countries that start out below their balanced growth path must grow relatively quickly if they are to catch up with other countries that have the same levels of steady-state output per effective worker and initial efficiency. However, this negative coefficient of initial income does not imply conditional convergence, while countries might move toward their own different steady-state growth paths. It requires the development of $\ln(\tilde{y}_i^*)$, while the equation (3.4) for output per capita at steady state in efficiency levels; then the growth equation becomes like;

$$g_{it} = g_i - \beta_{i1}\ln(A_{i0}) + \beta_{i1}\ln(y_{i0}) - \beta_{i1}\frac{\alpha}{1-\alpha}\ln\left(\frac{s_i}{n_i + g_i + \delta}\right) \tag{3.8}$$

Under the usual assumption that $g_i = g$, the common growth rate of technological progress g may be interpreted as implying perfect diffusion of technological change across the regions. Also MRW assume A_{i0} is constant across countries, while it should be interpreted as reflecting not just technology but also country-specific influences on growth such as resource endowments, climate and institutions. They assume these differences vary randomly as, $\ln(A_{i0}) = \ln A + e_i$, where e_i is a country-specific shock distributed independently from explanatory variables.

To account for spatial interactions, (24) assume that spatial externalities are generated from technological interdependencies. The production function for country i is given by equation (3.1) and following (61)'s treatment of knowledge spillover from capital investment, each unit of capital investment not only increases the stock of physical capital but also increases the level of technology for all firms in the economy through knowledge spillovers. Thus, (24) assume that the aggregate level of technology evolves as

$$A_{it} = \Omega_t k_{it}^{\phi} \prod_{j \neq i}^{N} A_{jt}^{\gamma w_{ij}}, \tag{3.9}$$

Let $\Omega_t = \Omega_0 e^{\mu t}$ denote the component of technological progress that is exogenous and common across all countries and let $k_{it} = K_{it}/L_{it}$ represents the capital-labor ratio in country i for the knowledge spillovers generated by physical capital, while the parameter ϕ with $0 < \phi < 1$ measures the strength of home externalities generated by physical capital accumulation. By modelling the knowledge spillover in country i as a geometrically weighted average of the stock of knowledge of its neighbors denoted by j, this specification assumes the external effect of knowledge embodied in capital in place in one country extends across its borders but does so with diminished intensity because of friction generated by socio-economic and institutional dissimilarities, for instance. The degree of international technological interdependence generated by the level of spatial externalities is described by γ, with $0 < \gamma < 1$, which is assumed identical for each country.

Under the existence of technological spillovers, countries cannot be analyzed in isolation of each other but must be considered as an interdependent system. In matrix form, (3.9) is written as $A = \Omega + \phi k + \gamma WA$, while $(I - \gamma W)^{-1}$ exists, A can be written as

$$A = (I - \gamma W)^{-1}\Omega + \phi(I - \gamma W)^{-1}k \tag{3.10}$$

where A is the $n \times 1$ vector of logarithms of the level of technology, k the $N \times 1$ vector of the logarithms of the aggregate level of physical capital per worker, and W is an $n \times N$ matrix of bilateral country weights.

This implies

$$A_{it} = \Omega_t^{\frac{1}{1-\gamma}} k_{it}^{\phi} \prod_{j=1}^{N} k_{jt}^{\phi \sum_{r=1}^{\infty} \gamma^r w_{ij}^{(r)}}, \tag{3.11}$$

where $w_{ij}^{(r)}$ are the elements of row i and column j of the matrix W raised to the power r. Now replacing that into production function (3.1) and get the output per worker for country i, $y_{it} = Y_{it}/L_{it}$, as

$$y_{it} = \Omega_t^{\frac{1}{1-\gamma}} k_{it}^{u_{ii}} \prod_{j \neq i}^{N} k_{jt}^{u_{ij}}, \tag{3.12}$$

where $u_{ii} = \alpha + \phi \left(1 + \sum_{r=1}^{\infty} \gamma^r w_{ij}^{(r)}\right)$ and $u_{ij} = \phi \sum_{r=1}^{\infty} \gamma^r w_{ij}^{(r)}$.

In the Appendix, I derive the growth equation with externalities. Specifically, I show that $d\ln(y)_{it}/dt = g - \lambda_i[\ln(y_{it}) - \ln(y_{it}^*)]$, where λ_i is defined in the Appendix. As before, this equation may be solved as

$$\ln(y_{it}) - \ln(y_{i0}) = gt - (1-\exp(-\lambda_i t))\frac{\mu}{1-\gamma}\frac{1}{\lambda_i} - (1-\exp(-\lambda_i t))\ln(y_{i0}) + (1-\exp(-\lambda_i t))\ln(y_i^*).$$

Let $g_{it} = (\ln(y_{it}) - \ln(y_{i0}))/t$. Taking account of the interdependence among the output of the different countries and substituting for the steady state values, I can re-write the growth equation with externalities as

$$g_{it} = \Delta_i - \beta_1 \ln(y_{i0}) + \beta_2 \ln\left(\frac{s_i}{n_i + g + \delta}\right) + \beta_3 \sum_{j \neq i} w_{ij} \ln(y_{j0}) \tag{3.13}$$
$$+\beta_4 \sum_{j \neq i} w_{ij} \ln\left(\frac{s_j}{n_j + g + \delta}\right) + \beta_5 \sum_{j \neq i} \frac{w_{ij}}{1 - \exp(-\lambda_j t)} [\ln(y_{jt}) - \ln(y_{j0})].^1$$

The last equation is my basic econometric specification. This kind of specification, including both a spatial lag of the dependent as well other independent variables is referred to as the Spatial Durbin Model (SDM).

3.2 Spatial Growth Models

In this section, I formulate the empirical counterpart of the standard growth equation as well as the version that includes spatial interdependence. Following (18), a cross-country regression model for the growth rate of real GDP per capita may defined as follows

$$\begin{aligned} g_{it} &= \alpha + \gamma \log Y_{i,t'} + X^*_{i,t}\theta + \epsilon_{it} \\ &= \alpha + X_{i,t}\beta + \epsilon_{it}, \end{aligned} \tag{3.14}$$

The dependent variable $g_{it} = (\log Y_{i,t} - \log Y_{i,t'})/T$ is a average growth rate of GDP per capita between time t and t' and, $Y_{i,t}$ is GDP per capita for time t and $Y_{i,t'}$ is

[1] In this equation, the coefficients are given by

$$\begin{aligned} \beta_1 &= -(1 - \exp(-\lambda_{it}))/t, \\ \beta_2 &= \frac{(\alpha + \phi)}{(1 - \alpha - \phi)}(1 - \exp(-\lambda_{it}))/t, \\ \beta_3 &= \frac{\gamma(1 - \alpha)}{(1 - \alpha - \phi)}(1 - \exp(-\lambda_{it}))/t \\ \beta_4 &= -\frac{\gamma\alpha}{(1 - \alpha - \phi)}(1 - \exp(-\lambda_{it}))/t, \\ \beta_5 &= \frac{\gamma(1 - \alpha)}{(1 - \alpha - \phi)}(1 - \exp(-\lambda_{it}))/t. \end{aligned}$$

initial level of GDP per capita for a given period, where T is the number of periods, α is vector of constant terms, and X^*_{it} is a vector of explanatory variables. This representation follows from the simple growth regression model analyzed by (9), (47) and (10). The panel data framework is made possible by dividing the total period into several shorter time spans.[2] I include initial GDP per capita $Y_{i,t'}$ among the vector of explanatory variables, X_{it} and re-write the growth regression model in an alternative way to provide consistency with the remainder of my analysis below, where β includes both γ and θ. If I sum it for N countries and re-write them as a matrix form then the growth equation becomes as $g_t = \alpha + X_t\beta + \epsilon_t$.

To extend this model with spatial effects, I consider (24)'s model with technological interdependencies, which leads the general form of the spatial regression denoted by the Spatial Durbin Model (SDM). Using matrix notation, this can be expressed as

$$g_t = \rho W g_t + X_t\beta + W X_t \Gamma + \mu + \epsilon_t \tag{3.15}$$

where β and Γ are $(K \times 1)$ vector 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. μ denotes a spatial specific effect, which is used to control for all space-specific time-invariant variables whose omission could bias the estimates in a typical cross-sectional study ((22)).

As I mentioned in the previous chapters, the spatial growth regression models produce estimates and inferences that are conditional on the set of explanatory variables employed. However, additional source of model uncertainty arises from competing spatial regression specification. Before giving full explanation of the claim that SDM model produces unbiased coefficients, I will first consider taxonomy of linear spatial dependence models for panel data. As, (22) mentions that there are three types of different interaction effects that may explain why an observation associated with specific location may be dependent on observations at other locations.

[2]According to (37), the appropriate time span for studying growth convergence may be five-year periods.

A General Nesting Spatial (GNS) model with all types of interaction effects takes the form as;

$Y_t = \rho W Y_t + X_t \beta + W X_t \theta + \mu + \epsilon_t$

$\epsilon_t = \lambda W \epsilon_t + v$

where ρ is called the spatial autoregressive coefficient, λ the spatial autocorrelation coefficient, while θ, just as β, represents a $K * 1$ vector of fixed but unknown parameters to be estimated. W is a non-negative $N * N$ matrix describing the spatial composition of the units in the sample.

- **Endogenous interaction effects, WY,** indicate the decision of a spatial unit to behave in some way depends on the decision taken by other spatial units. The value of the dependent variable for one agent is jointly determined with that of neighboring agents.

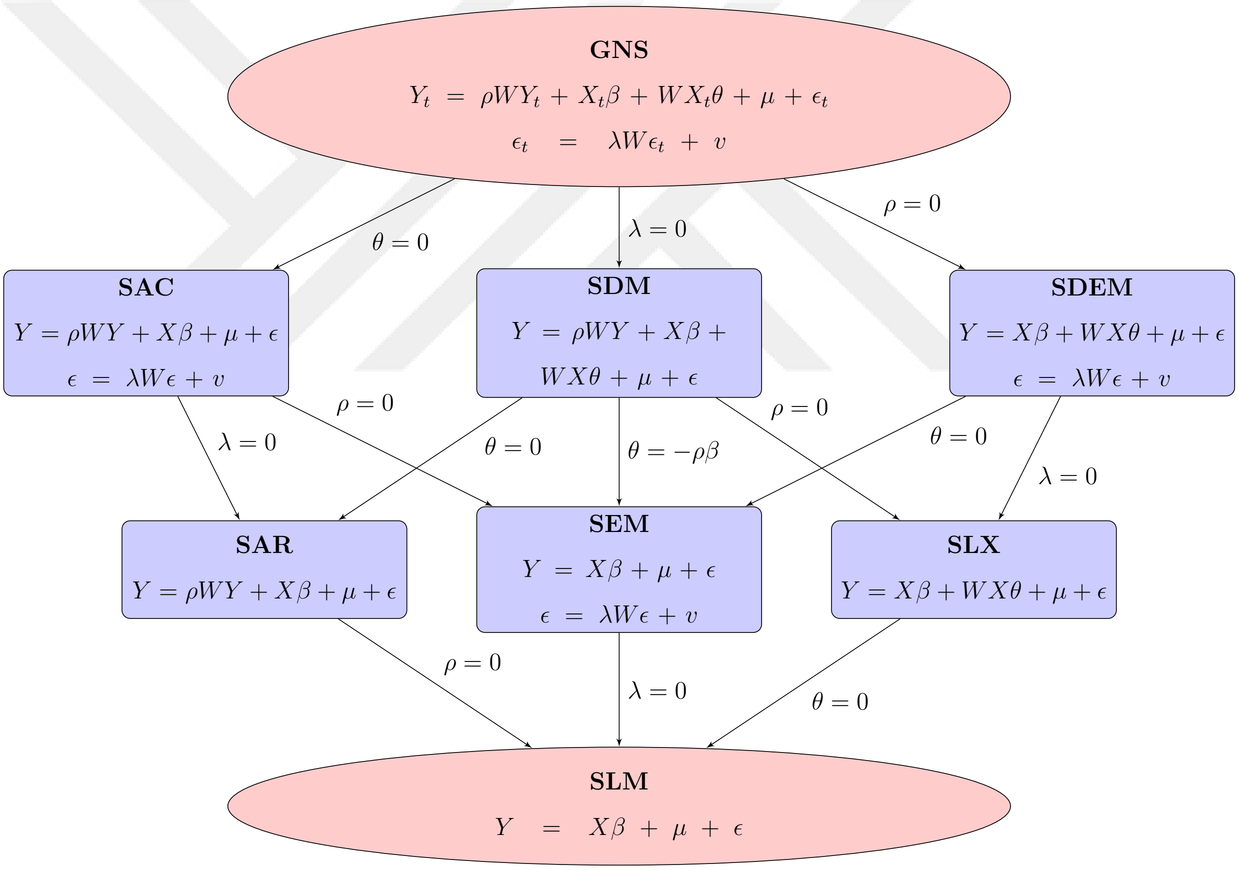
- **Exogenous interaction effects, WX,** are considered the dependent variable of a particular unit depends on independent explanatory variables of other spatial units. If the number of independent explanatory variables in a linear regression model is K, then the number of exogenous interaction effects is also K, provided that the intercept is considered as separate variable.

- **Interaction effects among error terms, Wϵ,** do not require a theoretical model for spatial or social interaction process, but instead, are consistent with a situation where determinants of the dependent variable omitted from the model are spatially autocorrelated, or with a situation where unobserved shocks follow a spatial pattern. These correlated effects show where similar unobserved environmental characteristics result in similar behavior.

The Figure 3.1 shows all the models with the restrictions, while these models contain the three interaction effect alone or with combinations with each other, while arrows show these possible combinations of interactions.

The frequently used spatial models in the growth literature show whether the spatial dependence is just in the dependent term (lag dependent variable) or in the

Figure 3.1: Spatial Econometric Models



disturbances. According to (43)', the theoretical justification for spatial regression models rests entirely on the plausibility of a conjunction of two circumstances that seem likely to arise in applied spatial growth regression modelling of regional data samples. One of these is spatial dependence in the disturbances of an ordinary least-squares regression model. The second circumstance is the existence of an omitted explanatory variable that exhibits non-zero covariance with a variable included in the model.[3]

The Spatial Autoregressive model (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.

$$g_t = \rho W g_t + X_t\beta + \mu + \epsilon_t \tag{3.16}$$

$$\epsilon_t \backsim N(0, \sigma_\epsilon^2 I_N) \quad and \quad E(\epsilon_t, \epsilon_s) = 0 \quad i \neq j \quad and/or \quad t \neq s$$

where ρ is called spatial autoregressive coefficient.(52), (58) and (35) use SAR to show the economic growth of a country is positively affected by the economic growth of its neighboring countries. The SAR growth equation in each country is not only affected bu its own initial per capita income and its conditioning variables, but also by the magnitudes of these variables in the whole system of countries.

The SEM model 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 imply the SEM, if all countries share similar unobserved features. While the random shock in a country affect growth rates in that country and additionally impacts all other countries through spatial transformation. SEM equation recognizes the presence of global

[3]According to (43), spatial dependence is a widely observed phenomenon for variables such as: per capita income levels, employment, and population variables used in the growth regression literature. Furthermore, omitted variables are also likely to characterize empirical implementations of regional growth regressions, since sample data for measuring numerous factors that may play an important role in economic growth are often limited. It is also the case that these omitted (regional) variables would likely exhibit spatial dependence as well as correlation with at least one of the included variables.

externalities associated solely with random shock.

$$g_t = X_t\beta + \mu + \phi_t \quad and \quad \phi_t = \lambda W\phi_t + \varepsilon_t \tag{3.17}$$

$$\varepsilon_t \backsim N(0, \sigma_\varepsilon^2 I_N) \quad and \quad E(\varepsilon_t, \varepsilon_s) = 0 \quad i \neq j \quad and/or \quad t \neq s$$

$$g_t = X_t\beta + \mu + (I - \lambda W)^{-1}\varepsilon_t \tag{3.18}$$

where ϕ_t reflects the spatially autocorrelated error term and λ is called the spatial autocorrelation coefficient. (52) use both the SAR and SEM models. They show the effects of shocks that are common to geographic regions. However, they argue that models allowing for more general spillovers fit the data better. (11) also argue that SEM is the more appropriate spatial regime for their sample of 138 European regions over the period 1980-1995, as their estimation of Lagrange Multiplier tests indicate that the presence of spatial autocorrelation rather than a spatial lag variable.

Additionally, (24) prefer to work with SEM and extend it to the more general form SDM to estimate technological interdependence among economies and examine the impact of spillover effects. Finally, (6) also argue that the existence of spatial dependence among the disturbances of a standard growth regression leads to a model inclusive of substantive spatial dependence. However, they also extend it to SDM model, which implies a different and more complex spatial pattern than the one derived from the SEM structure.

3.3 Testing for spatial dependence

In analyses that seek to uncover dependencies, the first question to consider is whether the data exhibit spatial autocorrelation or not. The general approach is to start with a non-spatial linear regression model using OLS and then test whether or not the model needs to be extended with spatial interaction effects. Among many measures of spatial relationships, Moran's I statistic is the most widely used measure to test for spatial dependence. Moran's I statistic can be used to generate data that can theoretically or statistically justify the use of spatial models and it provides a method of checking for spatial correlation in the data, within an exploratory analysis framework.

$$I = \frac{N \sum_{i=1}^{N} \sum_{j=1}^{N} w_{ij} d_i d_j}{S \sum_{i=1}^{N} d_i^2} \tag{3.19}$$

where N denotes the number of areas, $d_i = x_i - \bar{x}$ measures the deviations of x_i from $\bar{x}$, the mean of all the observed values and w_{ij} is the entry of the i^{th} row and the j^{th} column in the spatial weight matrix W and S is the sum of all the entries is W. The Moran's I statistics can be calculated for the dependent variable.

The Global Moran's I test examines whether there are any regular patterns among geographically connected units ((51) and (15)). If there are no regular patterns of spatial association, then the static is not significant. Otherwise, if there are significant spatial associations, the static can be positive or negative. Moran's I usually ranges between -1 and 1, with large positive values indicating neighborhood similarity of the rates and values close to zero indicating absence of spatial autocorrelation. (31) argue that the formulation of equation (3.19) tells us that if most pairs of neighboring areas have the same sign regarding their deviations from the mean, then the values of I will be positive and away from 0, indicative of positive spatial autocorrelation. Otherwise, if a majority of the pairs of neighbors have deviations from the mean in the opposite directions, then I will be negative and away from 0. This suggest negative spatial autocorrelation is present. Statistically insignificant values of I indicates the absence of the spatial autocorrelation, it can be considered that the spatial allocation of the observations is random.

The Global Moran's I can be applied to regression residuals as well. Global spatial autocorrelation can arise in the residual from a regression model if some of the unobserved/unmeasured independent variables are themselves spatially autocorrelated. In spatial econometrics, testing for residual spatial autocorrelation is often a first step before fitting one or another spatial regression model. Now $d_i = \epsilon_i$, where ϵ_i I is the least square residual for the ith observation. There is no need to subtract the residual mean, as residuals have a mean of zero by construction. Second, because the sum of the residuals is zero, the residuals themselves are not independent: if you are given (N-1) residuals, knowing that the sum of the N residuals is zero, the

N^{th} residual can be calculated. For this reason, the mean and the variance of the sampling distribution for the global Moran's I statistic under the null hypothesis of no residual spatial autocorrelation is not the same as in the case under equation (3.19). However, the previously described permutation test remains an option to derive an empirical p-value.

If the panel data involves a spatial dependence, then OLS may result biased and inefficient coefficient estimates due to the omitted variable. In this case, Maximum Likelihood estimation will be more appropriate; (22). As (42) argue that by construction, the OLS model does not allow for spillovers since it makes the implicit assumption that outcomes for different units are independent of each other, which is restrictive especially when dealing with spatial data. One such model that allows an empirical assessment of the magnitude and significance of spillover effects is the SAR model. This is clearly an advantage compared to other widely used SEM model.

Also, in the panel data estimation, specific effects must be controlled for. These spatial specific effects may be treated as fixed effects (FE) or as random effects(RE). In the fixed effects model, a dummy variable is introduced for each spatial unit, while in the random effects model, μ_i is treated as a random variable that is independently and identically distributed with zero mean and variance σ. Furthermore, it is assumed that the random variables μ_i and ε_{it} are independent of each other. The spatial Hausman test, which has null hypothesis that the random effects model is consistent, can be used to define these specific effects.

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). A related problem of controlling for spatial fixed effects is that any variable that does not change over time or only varies a little cannot be estimated, because it is wiped out by the demeaning transformation. This is the main reason for many studies not controlling for spatial fixed effects. In spatial econometric models, time fixed effects get special attention because there can be common shocks across time that would lead to an upward bias in the interested spatial parameter estimates. (41) remark that time FEs may be specifically associated with growth theory, while FEs remove the effect of time-invariant characteristics. The methods of (22) and (42) will be pursue to determine the appropriate spatial model.

3.4 Model Selection Process

There are two approaches in the spatial econometrics literature for selecting the best model. The first one is the specific-to-general approach which is developed by (28) using Lagrange Multiplier tests based on the estimated non-spatial model and it is against a spatially lagged dependent variable and spatial error correlation. The second case is a general-to-specific approach,herein if the non-spatial model is rejected, then the most general model Spatial Durbin Model is estimated to test whether it can be simplified to the spatial lag or the spatial error model using both hypotheses above. As (21) notes, if both approaches, namely, the specific-to-general and general-to-specific, point to the same model, then it is safe to choose that model as the best model. On the contrary, if non-spatial model versions of the model such as SAR or SEM are rejected while the SDM is not, then the SDM may be selected as the preferred model.

The use of Lagrange Multiplier tests provides a good guide to decide which specification of spatial models is the most appropriate according to the specific-to-general selection criteria. (28) develop model selection criteria using Lagrange Multiplier tests with LM_ρ and LM_λ for a spatially lagged dependent variable and spatial error correlation, respectively. They also present robust versions of these tests that control for local mis-specification. Denote the robust version of the Lagrange multiplier test for spatial lagged dependence in the presence of spatial error autocorrelation by L^*_ρ and the robust version of the Lagrange multiplier test for spatial error autocorrelation in the presence of spatially lagged dependent variable by L^*_λ. Following (28), a hybrid specification strategy that combines the classical and robust tests may be implemented as follows:

1. Estimate the initial model $g_{it} = \alpha + X_{i,t}\beta + \epsilon_{it}$ by OLS.

2. Test the hypothesis of no spatial dependence due to an omitted spatial lag or due to spatially autoregressive errors, using LM_ρ and LM_λ.

3. If both tests are insignificant, then I cannot reject the hypothesis of no spatial lags and no spatial error term.

4. If both tests are significant, then estimate the specification pointed to by the more significant of the *robust* tests. For example, if $L^*_\rho > L^*_\lambda$, then select SAR. If $L^*_\rho < L^*_\lambda$, then select SEM.

5. If LM_ρ is significant but LM_λ is not, then select SAR. Otherwise, select SEM.

(28) also show how similar specification strategies may be implemented using only the classical or robust versions of the LM tests. They further compare the classical, robust and hybrid LM based strategies to a so-called Hendry strategy that uses the general-to-specific approach and show that the LM based strategies dominate with respect to detecting spatial dependence.

Secondly, the general-to-specific approach starting with the SDM also allows us to implement model selection criteria to select the most appropriate model. The hypothesis $H_0 : \Gamma = 0$ can be tested to investigate whether this 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 test whether the model is can be simplified to the SEM; see ((14)). To see this last point, substitute for $\Gamma = -\rho\beta$ in the regression equation as

$g_t = \rho W g_t + X_t\beta + W X_t(-\rho\beta) + \mu + \epsilon_t$.

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. Both tests follow a chi-square distribution with K degrees of freedom. If both models are estimated, then these tests can take the form of a likelihood ratio (LR) test. Otherwise, they can only take the form of Wald test. It is another advantage of estimating models by Maximum Likelihood estimation.

Chapter 4

DEFINING SPACE

The uncertainties can be arises from both variable and model selection, that I mentioned in the second and third chapters, respectively. Additionally, here I will touch on the importance of defining the appropriate spatial weight matrix describing connectivity between countries used to specify the structure of spatial dependence. I introduce a number of neighborhood concepts, which are based on non-geographic notion. The concept of "space" should not be restricted only to geography, while countries are connected to each others in several ways. I will use geographic as well as several suitably defined non-geographic notions of distance.

By imposing on the model a predefined spatial weight matrix, which incorporates the topology of the system and establishes the spatial linkages among countries. Mainly using geographical weights, the key advantage is its exogeneity. However, they fail to captures distances that are not geographically based and can also play an important role in shaping economic behavior.

Here I will prefer to use the deeper determinants of economic growth, that (59) defines, for the connectivity of the countries. Figure 2.1 shows that income is affected by geography but also by trade and institutions, which may themselves depend on the nature of the geographic environment. In what follows, I will use these as factors of relatedness of countries' growth rate in my spatial estimation. The economic growth of a given country depends on growth observations of its geographical neighbors, cultural neighbors, institutional neighbors and trade neighbors.

The main goal is to determine whether the estimates of inter-dependencies between countries' growth rates are consistent with different kinds of spatial weighting matrices.

4.1 Spatial Weighting Matrices

The problem of technically incorporating spatial dependence into the model is a major issue in spatial econometrics. The spatial weighting matrices are the formal expression of spatial dependence between observations. They impose a structure with regard to each location's neighborhood and assign weights that measure the intensity of the relationship among pairs of spatial units.

The spatial weighting matrix, W, is a square $(N \times N)$, non-stochastic and symmetric matrix, whose elements w_{ij} measure the intensity of the spatial interaction between units i and j and take on a finite and non-negative value. A typical element, w_{ij}, has a value greater than 0 if the observations i and j are connected. By convention, $w_{ii} = 0$ for the diagonal elements to rule out an own effect.

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 non-geographical distances. As (12) note, generally the notion of observations being "nearby" one another is determined purely by physical distance in a weighting matrix. However, there is no reason why I cannot use any concept of nearness that makes theoretical sense so long as it does not violate any of the assumptions about the weighting matrices. (22) 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. Therefore, I will do the estimations with a suitably well-defined non-geographic notion of distance as well. It can be much more effective by allowing for variants of interactions that go beyond geography. However, preserving the exogeneity of the weights is important in order to avoid identification problems, when considering such alternative specifications of weighting matrices.

4.1.1 The geographical weighting matrix

Geographical weighting matrices are clearly exogenous to the growth process, which is important for regression analysis. The use of physical distance between countries as a measure of proximity has the advantage in that it may unambiguously be considered as exogenous to the model. Therefore, it can avoid estimation problems due to identification. Most of the studies are based on geographical spatial dependence, though none of them has proved that the use of geographical distances is optimal.

The most common definition for the neighborhood is the contiguity weighting matrix, which can be defined as a common boundary relationship between two countries. However, this structure of spatial-weighting matrices has limited dependence. Therefore, I will use the physical distance between countries as a measure of geographical relatedness. (49) construct geodesic distances, d_{ij}, that are calculated following the great circle formula using latitudes and longitudes of the most important cities. I use the inverse of the distance $\frac{1}{d_{ij}}$ should be used as elements of the matrix, because in the distance matrix, a larger value implies a greater weight. Therefore, inverting the bilateral distances to get a larger value for the variable w_{ij} implies that country i is closer to country j in terms of the transformed weighting matrix.

$$w_{ij}^{GEO} = \frac{1}{d_{ij}} \,/\, \left[\sum_{j} \frac{1}{d_{ij}}\right] \tag{4.1}$$

In order 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. 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. Moreover, the mutual proportions between the elements of W remain unchanged, and do not lose their property of symmetry as a result of these normalizations.

4.1.2 The institutional weighting matrix

The impact of institutions on economic growth and its determinants is a topic of interest in the literature on new growth empirics. As (1) note, institutions are the result of initial conditions like climate, location, natural sources abundance, amongst other factors. Hall and Jones (1999) argue that a country's social infrastructure, which is defined as "institutions and the government policies that determine the economic environment within which individuals accumulate skills, and firms accumulate capital and produce output" is a key determinant of cross-country differences in productivity levels; see also (55). (2) use the colonialization experience as a natural experiment and examine the relationship between institutions and long-run economic growth by instrumenting institutions with settler mortality rates. They find that early institutions affect current institutions, which have a significant effect on economic growth. (60) argue for the primacy of institutions over geography and trade as a determinant of economic growth.

According to these views, I expect that the intensity of the spillover effect across countries may be related to institutional proximity. The idea is that countries sharing the similar institutions may be characterized by stronger linkages, so that spillover effects are more likely to occur among them. However, in this case, I must consider the endogeneity of institutional matrix: if the weighting matrix is constructed from time-varying institutional indicators scores, it could possibly bias the spatial estimators.

Following (4), I integrate institutional distance into the spatial estimation by using a weighting matrix constructed from a notion of cultural distance as in (39). According to their specification, the cultural distance (CD) index is calculated as

$$CD_{ij} = \frac{\sum_{i=1}^{n} \left[(I_{ij} - I_{ik})^2 / V_i \right]}{n} \tag{4.2}$$

where I_{ij} is the index value for cultural dimension i for country j, I_{ik} is the index value for cultural dimension i for country k, V_i is the variance of the index of the cultural dimension i, and n is the number of cultural dimension i. I also replace the cultural dimension i with institutional dimensions.

I also constructed a measure of institutional proximity using the Worldwide Governance Indicators (WGI) from the World Bank database. WGI reports aggregate and individual governance indicators for over 200 countries and territories over the period 1996–2015, for six dimensions of governance; these are Voice and Accountability, Political Stability and Absence of Violence, Government Effectiveness, Regulatory Quality, Rule of Law and Control of Corruption. I compute the institutional distance index ID_{ij} using these six dimensions of governance indicators for the year 2006 to avoid endogeneity problems. As in the construction of geographical distance, I use the inverse of institutional distance to obtain a value for institutional proximity between entities i and j. Thus, $\frac{1}{ID_{ij}}$ is used as elements of the weighting matrix, which implies a larger value the greater the weight. Additionally, the weighting matrices are row normalized for the spatial estimation.

$$w_{ij}^{INST} = \frac{1}{ID_{ij}} \bigg/ \left[\sum_j \frac{1}{ID_{ij}} \right] \tag{4.3}$$

4.1.3 The cultural weighting matrix

(6) incorporate spatial externalities by means of a non-conventional spatial weight matrix built from geo-institutional distances, which they define as countries being institutionally similar. To further avoid endogeneity problems in the construction of the weighting matrix, they use a proxy for the institutional heterogeneity index given by linguistic distance. However, in my analysis, I employ exogenous linguistic distance directly as a measure of the cultural closeness of the countries in question, as opposed to using it to instrument institutional proximity, and I denote the resulting weighting matrix as the cultural weighting matrix.

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. (50) construct measures of Linguistic Proximity, which 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).[1]

The CL ranges between 0 and 1. It takes a value equal to zero if the degree of

[1]Data on Common Language is available at;
$http://www.cepii.fr/cepii/en/bdd_modele/presentation.asp?id = 19$

linguistic proximity between two countries is null, whereas CL tends to 1 when the linguistic proximity between these two countries is high.

$$w_{ij}^{CUL} = 0 \quad \text{if } i = j \tag{4.4}$$

$$0 < w_{ij}^{CUL} = \frac{CL_{ij}}{\sum_{i \neq j} CL_{ij}} \leqslant 1, \tag{4.5}$$

where CL_{ij} represents the Common Language Index (CL) between countries i and j.

4.1.4 The trade weighting matrix

The relationship between international trade and growth has been the topic of much attention in the literature. Yet a simple positive relation between countries' income and trade shares cannot establish causality, as countries that have higher income or better policies may trade more.[2] As an alternative approach, (29) use the predictions of the gravity model, which posits that bilateral trade flows depend on economic size and the distance between two units. They argue that geographic variables may be used to create a valid instrument for international trade and find that trade raises growth. However, I could surmise that the relationship between trade and growth could also be indicative of explicit cross-correlations in economic growth across countries.

To analyze such potential spillover effects, (52) use a measure of proximity based on a country's direction of trade. For each country, they weigh each foreign growth rate by the amount of trade between two countries (the sum of exports and imports), normalized by the total trade of the country in question. (7) constructs a spatial weighting matrix based on trade flows between countries, which is expressed as a proportion of total exports and imports. Likewise, (25) use bilateral trade flows to form the spatial weighting matrix as well, but they compute trade flows as an

[2]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. Since these policies are likely to lead to higher incomes, countries' trade policies are likely to be correlated with factors that are typically omitted from trade equations.

average over the period 1990-2000 to avoid endogeneity problems. (35) show that the economic growth of a country is positively affected by the economic growth of its trade partners through bilateral trade flows instead of that of its nearby countries using a sample of 26 OECD countries over the period 1970–2005.

The trade weighting matrix is constructed as;

$$w_{ij}^{TRA} = 0 \quad \text{if } i = j \tag{4.6}$$

$$w_{ij}^{TRA} = \frac{m_{ij} + x_{ij}}{\sum_{i \neq j} m_{ij} + x_{ij}} \tag{4.7}$$

where m_{ij} is imports between country i and j while x_{ij} shows exports.

Here, because GDP growth may affect the trade flow in time t, I use the average of trade flows between period 1990-2014 to avoid endogeneity problems as in (25).

Chapter 5

EMPIRICAL APPLICATIONS

In this chapter, I will examine the role of spillovers in economic growth by focusing on the experience of different grouping of countries. Together with the continuing process of globalization, the interactions among countries has become more important. Many existing papers use panel data sets which contain information on the growth experience of a large cross-section of countries of over time, or they focus on regional groupings where spatial effects are likely to be localized. I will introduce an alternative way of clustering the countries.

5.1 Emerging Market Economies

I begin with focusing on Emerging Market Economies (EME, henceforth), which have been achieving rapid growth and are likely to interact with each on the basis of trade, investment and finance as well as with developed economies. Thus, I ask whether such interactions are likely to matter for growth externalities and spillover effects alongside of geographic or other non-geographical proximities and seek to determine how interdependent the growth rates of Emerging Market Economies are with each other.

Initially, I will present an appropriate restriction and choice of the countries under consideration. Although there are many approaches to classify the group of emerging market economies, there is no commonly accepted definition of it. The term "Emerging Market" was used firstly by World Bank economist Antoine W. Van Agtmael in 1981, and defined as an developing economy with low to middle per capita income. In the last thirty years, EME have undertaken economic development and market-oriented reform programs and have begun to 'emerge' as significant players in the global economy. Although there are not a unified bloc of countries, they are becoming increasingly important global players.

The essential features of EMEs are their high degree of volatility and their transitional character. They have high rates of return due to high level of risk and hence, they are characterized as extremely volatile. Economic performance in EMEs is a key driver of global growth, given that EMEs now account for more than 60 per cent of global gross domestic product (GDP) and 75 per cent of its growth. (See (8).)

EME become more integrated into global trade and financial system. As (48) argue that the only major component about EME is not rapid growth but also the economic integration through trade and investment occurring between emerging economies. They suggest that intra emerging economy integration will have just as far reaching an impact on the global competitive landscape as emerging markets' explosive growth. Their integration will powerfully influence the nature of international competition. Even they have strong historic trade links with developed economies are becoming more integrated with other emerging economies.

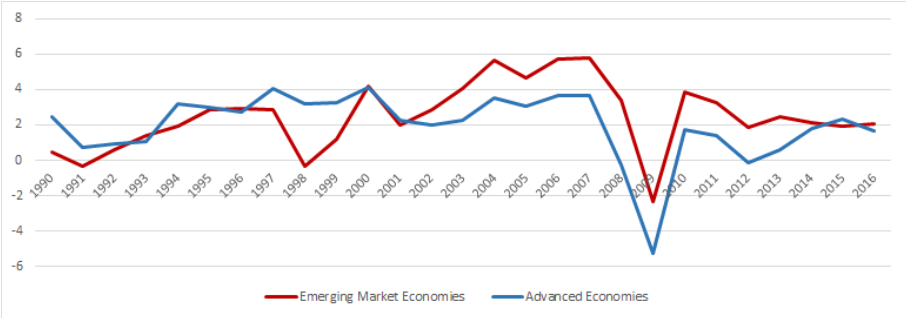
Additionally, EME tend to experience higher levels of political and economic instability, therefore there are always risks involved in any investment. It would make sense that investors should be able to expect higher returns with EME due to increased risks. Generally, investing in developed markets means you can benefit from more reliable accounting and financial reporting. In most cases, developed markets offer less risk of sudden political and economic instability. The investors prefer to invest EME.

As it is difficult to make an exact list of EMEs, I will consider the emerging countries that are labeled so by being classified as an Emerging Market Economy at least by two of the three stock indexes of S&P, IMF, and MSCI. Thus, according to data availability, the countries in the sample are: Argentina, Bangladesh, Bulgaria, Brazil, Chile, China, Colombia, Czech Republic, Egypt, Greece, Hungary, Indonesia, Korea, Malaysia, Mexico,Pakistan, Peru, Philippines, Poland, Romania, Russia, South Africa, Turkey and Ukraine. For the specification of the time span,these 24 EMEs have complete data since 1991. Note that being classified as as Emerging Market Economy is not based on a country's geographical region, but on its level of development. Therefore, I can hypothesize that the primary mechanism driving spillovers between EMEs are likely to be related to other kind of linkages rather than geography.

Figure 5.1 shows the average GDP per capita growth rates between 1991-2016 of advanced economies and emerging market economies. The graph shows that Emerging Markets provide an interesting case study because of their remarkable growth performance after the 1990's. The growth rates of EME suddenly picked up during the boom years of 2003-07, which is when the differential in growth rates between the emerging and advanced economies was the highest. After the financial crisis, the difference between emerging markets and advanced economies' growth rates continues to be substantial. Figure 5.2 shows that while investment as a percentage of GDP has come down in the advanced economies, it has increased in the emerging markets after 2007. EME have also become more attractive as their inflation rates with Figure 5.3 have come down. That reduces the concern investors have about exchange rate depreciation. As chart shows the threat of deflation is also one that hangs over the advanced economies and there is no such concern about emerging markets in general. Finally, Figure 5.4 shows that while global trade as a whole has slowed, in the past couple of years growth in the volume of exports from emerging markets has been lower than the volume of exports from the advanced economies.

In my analysis, I also include the standard variables used in growth regressions to control for model mis-specification. As (37) argue that the appropriate time span for studying growth convergence in the panel data may be five-year periods. The macroeconomic variables included in the right-hand side are: initial GDP per capita, $GDPpc_{i,t-5}$, where the gross domestic product divided by midyear population and it expressed in logarithmic units. The initial year is taken as the beginning of the period and that variable is included to consider the conditional convergence. Population growth rate, $POP_{i,t}$, as an annual percentage of logarithmic difference growth rate of population and the investment share, $INV_{i,t}$, which measured as gross fixed capital formation of GDP, are included since these variables are important factors

Figure 5.1: Annual percentage change of GDP growth



determining economic growth. As a proxy for government expenditure, $GOV_{i,t}$, the government consumption spending in percentage of GDP is included. To account for macroeconomic conditions, the foreign trade, $TRADE_{i,t}$, measured by the trade openness (export plus import) relative to GDP, that promotes the efficient allocation of resources and leads to the dissemination of technical progress and raises the competition in markets ((30)). Additionally, the macroeconomic stability also fosters economic growth because it reduces uncertainty. As proxy, the inflation rate, $INF_{i,t}$, that measured by the annual growth of the GDP implicit deflator shows the rate of price change in the economy as a whole. The dependent variable, GDP per capita growth rate, $GDPgrowth_{i,t}$, is determined as the difference of the natural logarithm of GDP per capita at the end of period t and the beginning of a period $t-5$. [1] As I mentioned in growth theories, in Section 2, there are many different variables that one can introduce to control GDP growth rate. Here, I prefer to select most suitable ones for my sample with respect to EME's characteristics. Table 5.1 gives an overview of the selected variables of this study. The annual data on all of the variables are collected from World Development Indicators (WDI) online database (World Bank, 2017) for five periods between 1991 - 2016.

[1] A measure of human capital is also included, however due to the lack of data availability, it dramatically reduces N and makes the estimation unreliable.

Figure 5.2: Investment % of GDP

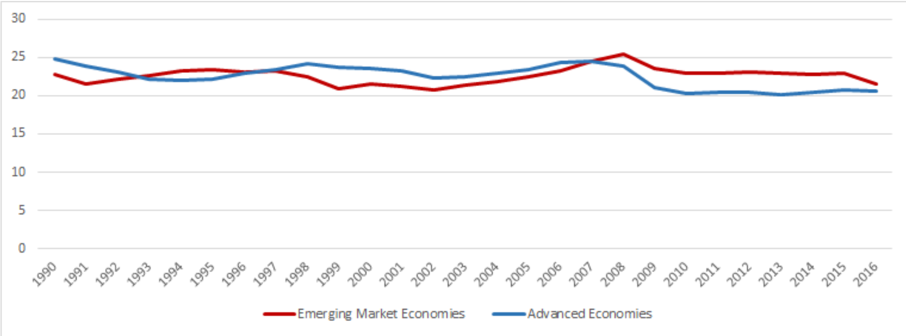


Figure 5.3: Inflation as a GDP deflator

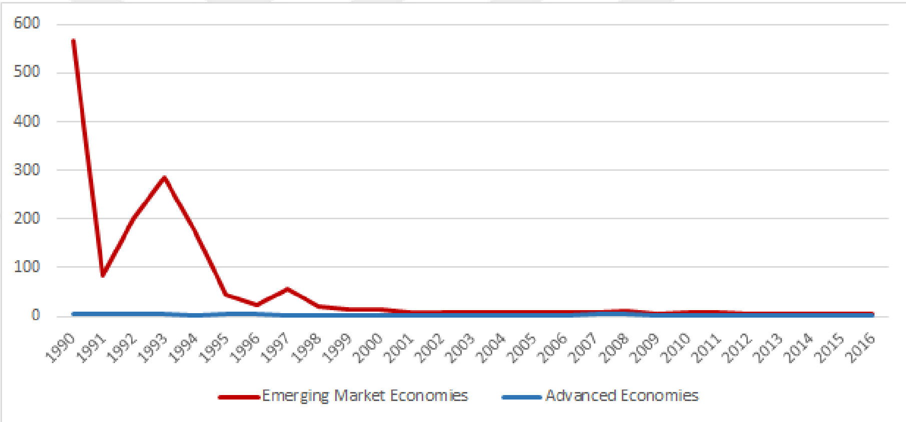


Figure 5.4: Exports of goods and services (annual % growth)

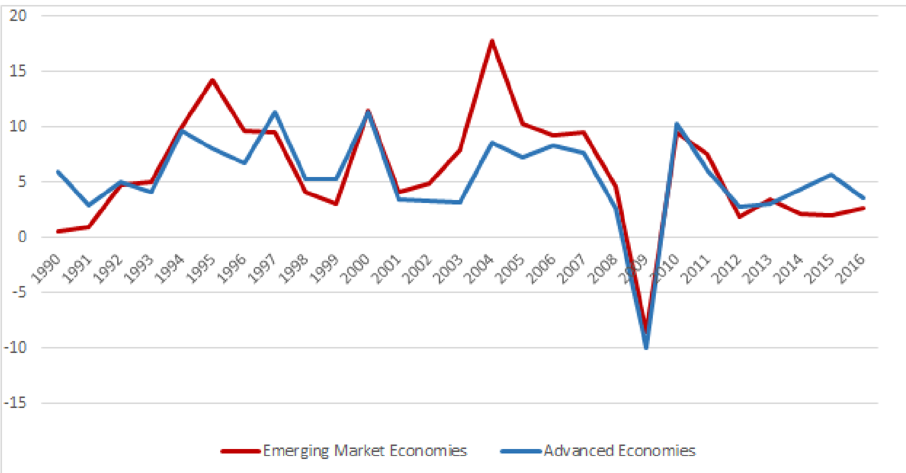


Table 5.1: Descriptive statistics of variables for EME

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
$GDPpc_{growth}$	120	2.673	3.047	−13.497	1.059	4.000	11.141
$logGDPpc_{initial}$	120	8.105	1.071	5.652	7.289	8.896	10.163
POP	120	0.914	0.957	−1.292	−0.016	1.613	2.633
INV	120	22.631	5.893	12.637	18.793	24.716	44.895
GOV	120	14.538	4.491	4.611	11.205	18.566	25.381
$TRADE$	120	65.034	37.731	16.523	39.125	78.363	202.980
INF	120	55.979	240.709	−0.464	3.381	13.956	1,761.243

5.2 Testing Spatial Effect

Firstly, I will test whether there is spatial dependence across countries' economic growth with spatial exploration analysis. Global Moran's I index allows us to estimate the effects of spatial proximity by computing an index of spatial autocorrelation that measures the interrelationship of economic growth across neighboring countries. As I mentioned in the Chapter 3.3, Moran's I is testing the null hypothesis of no global autocorrelation over a variable. Here, the spatial autocorrelation indices make it possible to assess spatial dependence between values of the GDP per capita growth in different places in space and test the significance of the identified spatial structure. In the presence of spatial autocorrelation, it is observed that the economic growth for a country is linked to the economic growth for the neighboring countries. Spatial autocorrelation will be positive when similar values of the GDP per capita growth are grouped geographically. Otherwise, spatial autocorrelation will be negative when the dissimilar values of the GDP per capita growth come together geographically, which means nearby locations are more different than remote locations. This type of situation is usually found in the presence of spatial competition. In the absence of spatial autocorrelation, it can be considered that the spatial distribution of the GDP per capita growth is random.

The other tests are an extension of the Moran's I to measure spatial autocorrelation in regression residuals, which concerns the spatial error case and two Lagrange Multiplier tests for both spatial error and spatial lag dependence with their respective robust versions. These tests are based on the regression of GDP per capita growth rate on log of initial per capita GDP, population growth, investment-GDP ratio, government expenditure, trade openness and inflation. The benchmark regression using the information of 24 EME countries over 1991-2016 presented in Table 5.2. The second column of the table gives the fixed effects results with respect the Hausman Test results.

The results reported in Table 5.3 shows that the Moran's I index and its expectation and the p-value from directly observed on the rates of GDP per capita growth and also the OLS regression residuals are insignificant which confirms the absence of spatial autocorrelation. The spatial independence is when there is no obvious pattern in the spatial distribution of the data values. I cannot reject null hypothesis, as all the p-values in the table are not statistically significant even with using geographical or trade or cultural weighting matrices. It is quite possible that the spatial distribution of economic growth is the result of random spatial processes. Without the presence of a significant autocorrelated process, the spatial structure cannot be empirically observed for Emerging Market Economies' economic growth process.

In my analysis, I prefer to use EME as they become important global players and I expect to see more integration within the Emerging Market Economies and their growth spillovers with each other as well. However, the results cannot show any spillover effects among them. Although they are interested to develop and modernize their economies and societies, the reality is that each of them faces their own different conditions and domestic challenges. Their interests diverge greatly on different subjects, therefore they do not necessarily share a common agenda or even similar economic, political, social and cultural features. However, they are more

Table 5.2: OLS estimates

Dependent variable	$g_{it} = \ln(Y_{it} - Y_{i,t-5})/5$	
Constant	9.955 ***	
	(1.8951)	
$logGDPpc_{initial}$	-0.856^{***}	-1.533^{***}
	(0.219)	(0.373)
POP	-0.907^{***}	-2.524^{***}
	(0.255)	(0.603)
INV	0.115^{**}	-0.016^{*}
	(0.035)	(0.050)
GOV	-0.100^{*}	-0.262^{**}
	(0.057)	(0.098)
TRA	-0.004	0.005
	(0.006)	(0.011)
INF	-0.007^{***}	-0.006^{***}
	(0.0008)	(0.0008)
Fixed effects	No	Yes
R^2	0.479	0.553
Observations	120	120

Note: * denotes $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Standard errors in parentheses.

worthy for advanced economies to consolidate or increase their influence and power on the world stage. Additionally, most of the EME's trade with other EME is with BRICS (Brazil, Russia, India, China, and South Africa). To sum up, I can conclude that with respect to my spatial explanatory analysis for the growth rate of GDP per capita and also the residuals from the growth regression have no spatial pattern. Therefore, it is not convenient to use the geographical, cultural or trade relations for

Table 5.3: Spatial Exploratory Tests

Weight matrix	W^{GEO}	W^{CULT}	W^{TRADE}
Moran's I for $GDPpc_{growth}$	-0.0005	0.0247	-0.0001
E(I)	-0.0122	-0.0120	-0.0123
p-value	*0.293*	*0.119*	*0.286*
Moran's I statistic for ϵ	0.0140	0.0096	-0.0197
E(I)	-0.0084	-0.0084	-0.0084
p-value	*0.169*	*0.287*	*0.682*

Emerging Market Economies to identify the growth spillovers. As noted earlier EME have become more integrated into global trade and financial systems as well. refer that the importance of financial factors in explaining spillovers has grown relative to that of trade linkages. They also remark that more than its economic size, the degree of financial integration matters for a country's importance as a receiver and transmitter of spillovers. It can be more convenient to use financial proximities of the countries for their growth spillover effects.

5.3 Middle East and North Africa

This section examines the role of spillovers in economic growth by focusing on the Middle East and North Africa (MENA) region. In the last section I was focused another class of countries, that are Emerging Market Economies. However, I cannot find any significant spatial pattern between these countries' GDP growth rates. The analysis of spillovers effects in growth for the MENA region has received less attention. In this section, I examine the role of spillovers in economic growth for the MENA region by explicitly accounting for spatial effects. I prefer to examine the MENA region because it has different economic structure. This region covers a large geographical area and the public sector plays dominant role in their devel-

Figure 5.5: MENA region

opment process, most of them have anti colonial struggles and deficient political system. Additionally, they are natural-resource abundant countries, while their top five export items are primary products. MENA countries are expected to interact with each on the basis of geography, bilateral trade, cultural and institutional similarities. Thus, I ask whether such interactions are likely to matter for growth externalities and spillover effects alongside of geographic or other non-geographical proximities, and seek to determine how interdependent the growth rates of MENA are with each other.

There is no agreed upon definition of MENA countries as well. Here, with the available data, I 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). I use a panel of nine periods based on 5-year averages of real GDP growth rates between 1970 - 2014.

The Middle East region has failed to take advantage of the expansion in world trade and foreign direct investment in the past two decades, and in fact has become one of the least integrated regions in the global economy. Although the region has 5.5 percent of the world's population (on average for 2008-10) and 3.9 percent of the world's domestic product (GDP), the region's share of non-oil world trade is only 1.8 percent; see (63).

The MENA area is characterized by a high level of volatility, due to many factors such as oil price fluctuations, climatic conditions, remittances and capital movements, political instability and regional conflicts. As (54) mention, most economies in the region have been characterized by extremely high volatility, a condition only partly attributable to the fluctuating price of oil. Other reasons for such volatility range from the presence of dictatorships, civil wars, terrorism, and water shortages to economic problems arising from barriers to trade and foreign investment, dominance of public enterprises, and low-skilled work forces.

There are three main arguments for considering the spillover effects of growth in the MENA region. Firstly, as can be seen from the Figure 5.5 the MENA region 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. Countries of the region differ considerably in economic size, population, standards of living, public/private sector balance, natural resource endowments, external indebtedness, and trade and financial links with the rest of the world; (20). The region was once an example of highly successful economic integration. (26) mention in their discussion of the Golden Age of Islam (8th - 13th centuries) that the exchange in goods, techniques, ideas as well as movement of people was flourishing. Arab trade routes stretched from West Africa to China and India and long distance travel of final goods and raw materials took place. However, a geopolitical fragmentation of the Middle East contributed to the sunset of the Golden Age of Islam and eroded its contribution to science and trade. It is claimed that the region has never achieved the same nor even close degree of economic integration. Nowadays, intra-regional interaction is small, being heavily weighted toward labor flows between certain countries, with rather limited trade in goods, and inadequate integration of capital markets.

Secondly, the public sector plays a dominant role in the development process in the region, where remnants of anti-colonial struggles continue and political systems are deficient. Most of the countries in the region did not become independent states until the mid-twentieth century, when the British and French colonial powers withdrew. Central authorities have historically played a significant role in the economic life of the MENA societies. The large size of the public sector in the MENA region can be deduced from the share of public expenditures in GDP.

Thirdly, countries in the MENA region are natural-resource abundant countries and their top five export items are primary products. Integration within the MENA region remains low, particularly compared with other middle- and high-income regions of the world. Intra-regional exports have averaged less than 8 percent of total exports in the MENA region over the period 2008–10. The MENA region as a whole is characterized by exports of primary commodities, largely oil and gas (76 percent in 2008–10). Manufactured goods account for 11.4 percent, and other sectors account for the remaining 13 percent; (63).

Other papers that have examined spillover effects for the MENA region include (5), who examine the process of β-convergence for a sample of 26 MENA countries that covers the period 1950 to 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. (33) 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. (53) examines the 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. However, unlike my analysis, these studies do not include an explicit spatial dimension and preclude a direct analysis of the interaction of geographical, institutional, cultural and trade-specific factors on regional growth.

I also include the standard variables used in growth regressions to control for model mis-specification and to obtain the net effects of the economic performance of the neighbors. 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 5-year average growth rate as $g_{it} = (\ln(Y_{it}) - \ln(Y_{i,t-5}))/5$.[2] The set of macroeconomic variables are selected according to factors that might affect the economic growth in the empirical literature; see (10). They include $\ln Y_{i,t-5}$ (log of the initial value of the per capita GDP for a particular period); POP (the mean logarithmic growth rate of population as an annual percentage); INV (the share of investment in real GDP to proxy for the saving rate); GOV (government consumption spending as a percentage of GDP as a proxy for government expenditure); and TRA (trade balance as export minus imports as a share of GDP to control for openness).[3] I also tried including a measure of human capital. However, due to the lack of data availability, this dramatically reduces N and makes the estimation unreliable.

In addition to accounting for the relative location effect of institutions through the institutional weight matrix, I seek to control for the absolute location effect of institutions by including an index of Political Rights from the Freedom House database. While, 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." However, it does not have a significant effect for MENA countries cause there is not much variation for this variable in my sample and almost all of the countries have degree of 5.

Table 5.4 gives an overview of the selected variables of this study. The annual

[2] I follow (37) in choosing a 5-year interval to study the implications of the standard growth model augmented with spatial effects.

[3] 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. While I tried using this variable in my spatial model in place of the trade deficit, the coefficient on both the investment and trade variables became insignificant, though the spatial autoregressive parameter ρ increased slightly.

Table 5.4: Descriptive statistics of variables for MENA

Statistic	N	Mean	St. Dev.	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
POP	162	0.033	0.029	−0.038	0.017	0.040	0.177
INV	162	0.255	0.105	0.033	0.180	0.321	0.599
GOV	162	0.215	0.110	0.031	0.148	0.263	0.613
TRA	162	−0.015	0.236	−0.810	−0.115	0.124	0.830

Table 5.5: Correlation between spatial matrices

	$W^{GEO}u$	$W^{INST}u$	$W^{CULT}u$	$W^{TRA}u$
$W^{GEO}u$	1			
$W^{INST}u$	0.0160	1		
$W^{CULT}u$	0.1861	0.2097	1	
$W^{TRA}u$	0.0247	0.0321	0.1615	1

data on all variables are collected from Penn World Table for the sample period between 1970 - 2014.

5.4 Model Selection Process

For the MENA region, I will use four different weighting matrices that I have explained in the Section 4. Because for this region the institutional similarities make more sense, therefore I also introduce the institutional weighting matrix as well.

Table 5.5 shows the correlation measure between all weighting matrices constructed from the product of each interaction matrix with standard normal random variable, u, following (42). If the correlation between spatial weights are high, then the choice of any of them should not affect the results. However, as (17) argue, if these correlations are weak, then they can taken to represent different interaction schemes. As it can be seen from Table 5.5 that the correlation between the institutional and cultural spatial weights are the highest, suggesting that such measures are relatively similar across the regions. However, the correlations between the trade [4] and geographical weighting matrices, on the one hand, and the cultural and institutional weighting matrices, on the other, are much smaller, which allows us the to make inference about the different spatial interactions.

First, I will test for the presence of spatial dependence using Moran's I test. The approach is to start with a non-spatial linear regression model using OLS (which includes fixed effects) and then test whether or not the model needs to be extended with spatial interaction effects. Moran's I test adapted to OLS regression residuals indicates the existence of spatial dependence in the growth regression. Table 5.6 shows that the Moran's I test against spatial dependence strongly rejects the null hypothesis, regardless of the spatial weight matrix that is used. Therefore, I carry out the modelling of economic growth in the presence of spatial effects. Additionally, I rely on the spatial Hausman test, which has the null hypothesis that the random effects model is consistent. I reject the null hypothesis with highly significant p-value, and a fixed effects model is thus chosen for the rest of this empirical analysis.

To select the most appropriate specification, I first apply the specific-to-general approach and start from the model without spatial autocorrelation and implement Lagrange multiplier tests. Table 5.6 shows the results of the Lagrange multiplier and their robust versions tests for testing the null hypothesis of no spatial lags against the alternatives of spatial lagged dependence and spatial error autocorrelation due to (28). Denote the test statistic for spatial lagged dependence by LM_ρ and the test statistic for spatial error correlation by LM_λ, and their robust versions by L^*_ρ and L^*_λ, respectively.[5] The second and third rows of Table 5.6 show that I can reject the

[4]In the spatial econometrics literature, the weighting matrix is assumed to be exogenous to the dependent variable. Here, because GDP growth may affect the trade flow in time t, I use the average of trade flows between period 1990-2014 to avoid endogeneity problems as in (25).

[5]The degrees of freedom is 1 in this case because the only excluded variable is on the spatial

Table 5.6: Tests for Spatial Dependence

Weight matrix	W^{GEO}	W^{INST}	W^{CULT}	W^{TRADE}
Moran's I statistic	0.1134***	0.1559***	0.1312***	0.1322***
L_ρ: no spatial lag	15.0290***	10.9683***	25.5415***	6.8920***
L_λ: no spatial error	9.2308***	2.9652*	17.5903***	2.9652*
L_ρ^*: no spatial lag	9.6459***	6.7906***	8.7273***	7.1462***
L_λ^*: 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	9.562	5.1520	7.0678	12.2369*
LR: spatial error	10.4205	4.9199	7.5507	11.4217*

Note: * denotes $p < 0.1$, ** denotes $p < 0.05$, *** denotes $p < 0.01$.

null hypothesis of no spatial lags and no spatial error term for the classical version of the LM test using L_ρ and L_λ at the 1% level. Since both tests are significant, I choose the specification pointed to by the more significant of the robust tests. The LM test statistics given by L_ρ^* and L_λ^* show that the SAR model dominates the SEM for capturing spatial dependence since $LM_\rho^* > LM_\lambda^*$ for the geographical and trade weighting matrices and LM_λ^* 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 Spatial Durbin model. According to the general-to-specific approach, if the non-spatial model is rejected, then the most general model Spatial Durbin Model 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 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

lag or spatial error.

to determine whether the model can be simplified to the SEM; see (14).[6] 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 can take the form of a likelihood ratio (LR) test. Otherwise, they take the form of Wald test.

I present the results of estimating the Spatial Durbin Model. The second part of Table 5.6 reports Wald and LR tests to test for the correct specification, which show reject the null hypotheses that the SDM is simplified to SAR and SEM models for the case with the two types of institutional weight matrices cannot be rejected. However, there is some evidence against the SAR and SEM specifications based on the Wald test for the case with the geographical matrix. This evidence becomes stronger when I 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.

Table 5.7 reports the coefficient estimates for the SDM model, which shows that the spatial dependence parameter ρ becomes negative for the cases with the cultural, institutional and trade weighting matrices and positive but insignificant for the case with the geographical weighting matrix. The main finding from Table 5.7 is that the spatial interaction term with the trade balance is positive and significant for all weighting matrices. In the next section, I 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.

[6] 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 $g_t = X_t\beta + (I - \rho W)(\mu + \epsilon_t)$, which is the SEM specification.

Table 5.7: The Spatial Durbin Model

Dependent variable	$g_{it} = (\ln(Y_{it}) - \ln(Y_{i,t-5}))/5$			
	W^{GEO}	W^{INST}	W^{CULT}	W^{TRA}
$\ln Y_{i,t-5}$	-0.052^{***}	-0.058^{***}	-0.054^{***}	-0.049^{***}
	(0.011)	(0.012)	(0.011)	(0.012)
POP	-0.464^{**}	-0.397^{*}	-0.446^{**}	-0.382^{*}
	(0.245)	(0.248)	(0.242)	(0.24)
INV	0.149^{***}	0.163^{**}	0.157^{***}	0.071
	(0.069)	(0.071)	(0.070)	(0.069)
GOV	-0.043	-0.142^{**}	-0.119^{*}	-0.018
	(0.062)	(0.069)	(0.066)	(0.061)
TRA	0.124^{***}	0.140^{***}	0.142^{**}	0.125^{**}
	(0.045)	(0.046)	(0.044)	(0.044)
$W * \ln Y_{i,t-5}$	-0.358^{***}	0.001	-0.009	0.006
	(0.029)	(0.022)	(0.28)	(0.017)
$W * POP$	$-$ 3.317	-0.183	0.129	0.146
	(0.96)	(0.573)	(0.646))	(4.98)
$W * INV$	0.001	-0.086	-0.308	-0.413
	(0.333)	(0.224)	(0.318)	(0.759)
$W * GOV$	-0.333	-0.157	-1.148^{***}	0.143
	(0.210)	(0.172)	(0.336)	(0.270)
$W * TRA$	0.320^{***}	0.136	0.452^{**}	0.505^{***}
	(0.25)	(0.168)	(0.19)	(1.01)
ρ	-0.007	-0.069	-0.579^{*}	-0.216^{*}
	(0.237)	(0.176)	(0.131)	(0.112)
R^2	0.435	0.392	0.421	0.449

Note: * denotes $p < 0.1$, ** denotes $p < 0.05$, *** denotes $p < 0.01$.
Standard erros in parentheses.

5.5 Estimation of Models with Spatial Dependence

My analysis so far suggests that the best model that captures my data is the SAR model. The key result in my estimation of this model in Table 5.8 that differentiates my analysis from the standard growth regression results has to do with the spatial effects captured through the weighted GDP growth of neighboring countries. I start with OLS estimation as a benchmark specification for ease of comparison. Table 5.8 shows that the coefficients of growth determinants are not considerably changed by the inclusion of spatial variables. The coefficients for the logarithm of initial GDP per capita are consistently negative and statistically significant across all estimations. This supports the conditional convergence hypothesis postulated in the growth literature. The convergence speed is 4%, which is comparable to the values obtained by (37) and others in models with fixed effects.[7] The remaining results are standard: population growth is found 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.

Next, Table 5.8 reports the estimates for the SAR model using the four different weight matrices. The coefficient on 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 my analysis from the standard growth regression, which 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 ρ implies that part of the economic growth of each of the investigated countries is through the spatial effect of neighboring countries' growth. The parameter ρ indicates that a 1-percent increase in the weighted average of neighbor growth rates increases a MENA country's domestic growth by 0.44%, 0.40%, 0.42% and 0.25% with geographical, institutional, cultural and trade

[7] The convergence speed is defined as $\lambda = -\ln(1 + 5\gamma)/5$, where γ is the coefficient on initial lagged GDP. (23) 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 5.8: Spatially autoregressive models

Dependent variable	$g_{it} = (\ln(Y_{it}) - \ln(Y_{i,t-5}))/5$				
Weight matrix	OLS	W^{GEO}	W^{INST}	W^{CULT}	W^{TRA}
$\ln Y_{i,t-5}$	-0.037^{***}	-0.039^{***}	-0.038^{***}	-0.037^{***}	-0.036^{***}
	(0.011)	(0.010)	(0.010)	(0.010)	(0.010)
POP	-0.671^{**}	-0.568^{***}	-0.61^{***}	-0.602^{***}	-0.617^{***}
	(0.251)	(0.225)	(0.224)	(0.222)	(0.227)
INV	0.149^{*}	0.167^{**}	0.156^{**}	0.159^{**}	0.165^{**}
	(0.079)	(0.071)	(0.070)	(0.070)	(0.072)
GOV	-0.111^{*}	-0.080	-0.087	-0.076	-0.087
	(0.079)	(0.071)	(0.07)	(0.07)	(0.072)
TRA	0.180^{***}	0.141^{***}	0.162^{***}	0.152^{***}	0.159^{***}
	(0.048)	(0.044)	(0.043)	(0.043)	(0.044)
ρ	-	0.442^{***}	0.400^{***}	0.426^{***}	0.253^{**}
		(0.130)	(0.109)	(0.118)	(0.105)
Observations	162	162	162	162	162
R^2	0.195	0.318	0.327	0.335	0.305
AIC	-431.72	-468.46	-463.01	-465.62	-459.67
BIC	-413.19	-446.85	-441.40	-444.01	-438.06

Note: * denotes $p < 0.1$, ** denotes $p < 0.05$, *** denotes $p < 0.01$.

Standard errors in parentheses.

weighting matrices, respectively.[8]

Despite evidence of a significant effect from spatial lagged dependent variables, Table 5.8 shows that the estimated coefficient of the spatial lag term using trade weights is nearly half of the estimated coefficients with geographical, cultural or in-

[8]Unlike some other analyses (see, for example, (35)), however, the inclusion of spatial effects does not affect the convergence speed, which only changes with the inclusion of fixed effects.

stitutional weights. This finding may be attributed to the weakness of intra-regional trade of MENA countries. As is well known, many of these countries are natural resource abundant, and export mostly oil and oil-related products and generally import foodstuffs. Therefore, my results indicate that intra-regional trade has proved ineffective at promoting growth spillovers within the MENA region.[9]

The main objective of the W matrix is measuring the strength of interaction between spatial units. Here, these units are countries within the MENA region. Comparing only the estimated results of different Ws is not the significant way, therefore I will determine which W gives best performance using my dataset. I also use the information criteria to select best spatial weighting matrix for my data set. As (34) mention that there are different ways to select the most adequate weighting matrix, their results suggest that their own approach, which called entrophy, is the best criterion. Secondly Bayesian approach and AIC information criteria have very similar effects, while the MJ test is the worst alternative among these four criteria. In the selection process of the best weighting matrix, I prefer to use Information Criteria that are the most common procedures as AIC (Akaike, 1973) and the Bayesian BIC criteria (Schwarz et al, 1978). Because they lead to single expressions that depend on the accuracy of the ML estimation of the models plus penalty term related to the number of parameters entering the model. The first compare the models on equal basis whereas the second incorporates the notion of model of the null. Even though (17) use the MJ test which is based on the GMM estimation, I prefer to use AIC and BIC with ML estimation results. Considering the last 2 rows of the Table 5.8, I can say that geographical weighting matrix is the best one which is followed by cultural and institutional weighting matrices, whereas the trade weihgting matrix is the worst one with respect to AIC and BIC.

[9]In unreported results, I also obtained estimates of the model with spatially autocorrelated errors (SEM). I found that the magnitude and sign of the coefficients on the explanatory variables are very similar to those for the model with spatially lagged dependent variables and also corroborated the finding that the magnitude of the spatial autocorrelation on the error terms, λ, using trade weights is nearly half of the estimated coefficients with geographical, institutional or cultural weights.

The results of Table 5.8 indicate that growth spillovers in the MENA region tend to occur through geographical, cultural and institutional proximity rather than trade. The trade channel for generating spillover effects is especially weak in the MENA region. These findings have ramifications for growth in the MENA region, as trade is known to enhance productivity growth through economies of scale, increased competition, knowledge acquisition, innovation, to name a few. Furthermore, as Karam and Zaki (38) note, more liberalized trade may allow countries to move up the value chain. On the other hand, institutional factors may enhance growth through the observance of a rules-based regime, greater inclusiveness through the creation of democratic institutions of governance, the decline in corruption and other forms of rent-seeking activities. In the literature, (52) suggest that proximity matters for more reasons than just trade, while focusing on 93 countries. Also, the results of (35) indicate an evidence for spatial spillover through trade linkages instead of geographical distance using a sample of 26 OECD countries. However, for the sample of MENA region countries, my results suggest 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 and cultural characteristics rather than through the GDP growth of its trade partners.

5.6 Direct and Indirect Effects

In a traditional non-spatial model, the partial derivative associated with X is simply going to be the parameter β. However, in a SAR model, it is more complicated. In matrix form, equation (3.16) becomes

$$g = \rho W g + X\beta + \epsilon, \tag{5.1}$$

which can be written as $(I_n - \rho W)g = X\beta + \epsilon$, implying

$$g = (I_n - \rho W)^{-1} X\beta + (I_n - \rho W)^{-1}\epsilon,$$

Thus,

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

where the $N \times N$ matrix G denoted as the impact matrix has the form $G = (I_n - \rho W)^{-1} = I_n + \rho W + \rho^2 W^2 + \rho^3 W^3 + ...$

The magnitude of the change in X on the elements of g will depend on (1) the degree of friction between countries which is governed by the W matrix used in the model, (2) the parameter ρ measuring the strength of spatial dependence between countries and (3) the estimated parameter β. This is because the change in X in country i not only has a primary effect on g in country 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. (42) show how to compute the statistical measures of dispersion for these effects. These measures allow inferences regarding the statistical significance of the direct, indirect and total impacts that arise from changes in the explanatory variables. 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.

The diagonal elements of the matrix $G = (I_n - \rho W)^{-1}$ contain the direct impacts, and the off-diagonal elements represent indirect impacts. As (17) 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 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 1 unit change in X in all of the countries in the sample. The sum of column j gives the total impact on the dependent variable of all the countries of a 1 unit change of X in country j.

The direct effect can be used to test the hypothesis as to whether a particular variable has a significant effect on the dependent variable in itself. This direct effect would be analogous in interpretation to the single parameter β associated with the explanatory variable X in a non-spatial framework. However, the magnitude of the direct effects can slightly change across countries due to feedback effects. As (17) note: "The own derivative for country i includes feedback effects, where country i affects country j and also country j also affects country i as well as longer paths which might go from country i to j to k and back to i." By contrast, the indirect effect is measured by the average of either the row sums or the column sums of the non-diagonal elements and shows the changes in the average effect that comes from all other countries. In the spatial autoregeressive model (SAR), the indirect effect can be used to test whether spatial spillovers exist.[10]

Table 5.9 gives the average impact measures of all explanatory variable in my analysis.[11] It implies that the growth rate of GDP per capita in each country depends not only on the values of the explanatory variables in that country, but also on the values of the explanatory variables in the other countries. The first part of Table 5.9 gives the measure of *average direct effect*, which summarizes the impact of changes in the explanatory variables using an average across the entire sample of countries. The direct effects of an increase in the explanatory variables except for government expenditures GOV are quite significant, mirroring the results in Tables 5.7 and 5.8 regarding the individual coefficient for this variable. As shown in the second part of Table 5.9, there are almost no significant indirect effects on neighboring growth rates. However, it is not unusual to observe such insignificant results for the indirect effects, as the statistical inference for the impact estimates are based on simulation results.

I also provide estimates of the direct and indirect effects implied by the SDM. Recall that the SDM has the general representation in matrix form as

$$g = \rho W g + X\beta + WX\Gamma + \mu + \epsilon,$$

which can be written as $(I_n - \rho W)g = (\beta + W\Gamma)X + \mu + \epsilon$.

Defining $V(W) = (I_N - \rho W)^{-1} = I_N + \rho W + \rho^2 W^2 + \rho^3 W^3 + ...$ and $S_r(W) =$

[10]By contrast, in spatial error models (SEM), only the direct effect exists.

[11]200 simulations are used to compute the distributions for the impact measures.

Table 5.9: Impact measures with all weighting matrices

	W^{GEO}	W^{INST}	W^{CULT}	W^{TRADE}
Direct Effects				
$\ln Y_{i,t-5}$	-0.037^{***}	-0.041^{***}	-0.038^{***}	-0.038^{***}
POP	-0.585^{**}	-0.624^{***}	-0.622^{***}	-0.613^{***}
GOV	-0.08	-0.093	-0.087	-0.077
INV	0.161^{**}	0.159^{***}	0.159^{***}	0.159^{**}
TRA	0.141^{***}	0.167^{***}	0.165^{***}	0.160^{***}
Indirect Effects				
$\ln Y_{i,t-5}$	-0.027^{*}	-0.028^{*}	-0.013	-0.028
POP	-0.427	-0.436	-0.206	-0.439
GOV	-0.0604	-0.057	-0.029	-0.064
INV	0.1255	0.114	0.060	0.114
TRA	0.106^{*}	0.109	0.057	0.108

Note: * denotes $p < 0.1$, ** denotes $p < 0.05$, *** denotes $p < 0.01$.

The total effect is the sum of direct and indirect effects.

$V(W)(I_N\beta_r + W\Gamma_r)$, the SDM has the representation

$$g = \Sigma_{r=1}^{k} S_r(W)X_r + V(W)\mu + V(W)I\epsilon.$$

Thus, the impact on country i's growth of a change in the explanatory variable r of country j may be computed as

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

The terms that differentiates this from the standard non-spatial regression coefficient β are the impact of the endogenous spatial lag, ρ, which also arises in SAR model, as well as the exogenous spatial lag parameter, Γ_r.

Table 5.10: Effects of SDM with W^{TRA}

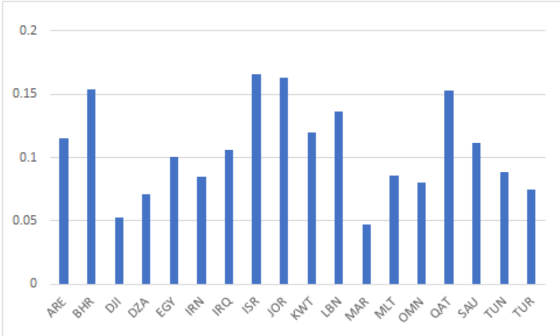
	Direct Effects	**Indirect Effects**	**Total Effects**
$\ln Y_{i,t-5}$	-0.049^{***}	0.015	-0.033^{**}
POP	-0.369	0.206	-0.163
INV	0.087	-0.323^{*}	-0.236
GOV	-0.016	0.118	0.101
TRA	0.121^{***}	0.412^{***}	0.534^{***}

Note: * denotes $p < 0.1$, ** denotes $p < 0.05$, *** denotes $p < 0.01$.

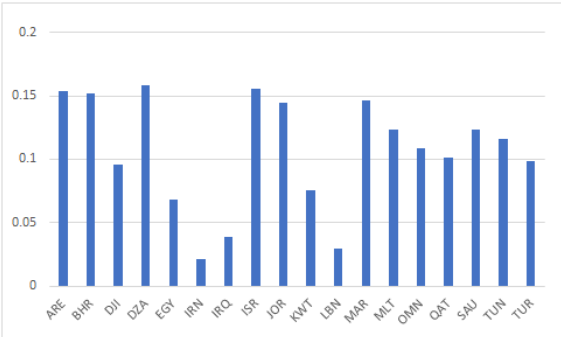
The second part of Table 5.9 shows the indirect effects of a change in the explanatory variable X_r. This table shows that aside from the initial level of income $Y_{i,t-5}$, there are almost no significant indirect effects of a change in the explanatory variables on neighboring countries' growth rates. There is some evidence of the positive indirect effects of the trade balance for the geographical and institutional weight 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.

Figure 5.6 presents the indirect effects of trade balance on GDP growth rate that are generated as the multiplication of the estimated coefficient of the trade balance variable (TRA) from Table 5.9 and the sum of the corresponding columns of the simulated G matrices excluding the diagonal elements.[12] 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, the United Arab Emirates as well as Israel. Based on a notion of geographical proximity displayed in Figure (5.6a), countries like Bahrain and Qatar, one to 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

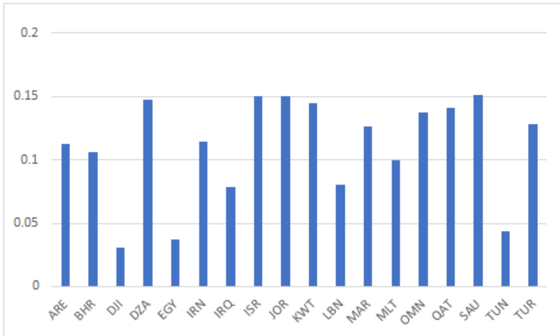
[12]The shape of the indirect effects of all variables are same, however the magnitudes change with respect to their estimated coefficients.



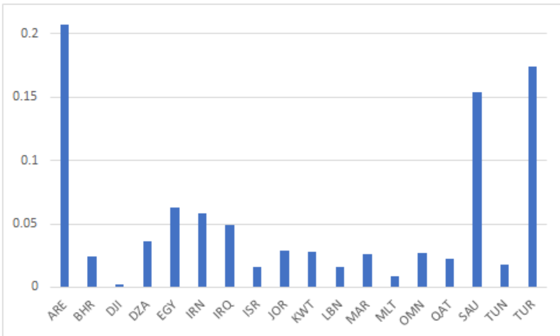
(a) Geographical



(b) Institutional



(c) Cultural



(d) Trade

Figure 5.6: Average Indirect Effects of Trade Balance on GDP growth

based on cultural proximity in Figure (5.6c) show that the oil exporting countries have larger spillover effects while the oil importing countries like Djibouti, Egypt and Tunisia have the smallest spillover effects. Thus, the spillover effects of growth are mainly due to economic activities in countries that trade in oil.

While my analysis does not admit a time dimension, (46) argues that political and economic developments since the 1990's have reduced the impact of such factors for growth in the MENA region. Specifically, beginning with the invasion of Kuwait by Iraq, the oil-rich Gulf countries have taken measures such as expelling massive numbers of immigrants from other Arab countries and creating the Gulf Cooperation Council (GCC)[13] as a way of furthering their own economic agenda. He further argues that the cycle of low oil prices in the 1990's and 2000's reverting back to higher oil prices since 2004 also contributed to the worsening of the income distribution in the MENA region without contributing significantly to growth. These considerations point to the detrimental role that reliance on resource based economies plays for generating growth in the region.

Surprisingly, Figure 5.6 shows that the pattern of indirect effects based on the bilateral trade weighting matrix reported in Figure (5.6d) is completely different from the pattern reported in Figures (5.6a), (5.6b) and (5.6c) for the geographical, institutional and cultural weight matrices, which are quite similar to each other. In particular, Figure (5.6d) 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 it shows 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 2000's imply that it has followed a different growth trajectory than the other non-oil exporting countries of the MENA region.

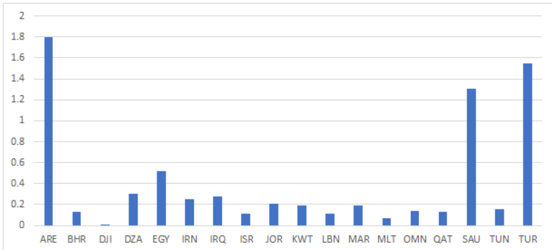
To check the robustness of these results, I also calculate the direct and indirect effects of the different explanatory variables using the estimates of the SDM based on the trade weighting matrix in Table 5.7. These are reported in Table 5.10 and show considerable differences with results in Table 5.9. First I find that the indirect effects of the trade balance increase in value and become highly significant.[14] However,

[13]GCC countries are Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and United Arab Emirates

[14]That the indirect effects increase in magnitude for the SDM can be understood by noting that

Figure 5.7 shows that the pattern of indirect effects across the different countries is virtually identical to those in Figure (5.6d) except for the increase in the magnitudes.

Figure 5.7: SDM indirect effects on trade balance variable



These results suggest that the trade effects of growth for a country i may operate through the exogenous effect of trade captured by the term $W\Gamma_r$ as opposed to endogenous spillovers occurring through the weighted growth $\sum_{j=1}^{N} w_{ij} g_{jt}$ of the remaining countries. 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 economies and conduct their trade with the rest of the world.[15] Hence, one conclusion I may draw from these findings is the importance of trade liberalization and diversification for the MENA region, as no substantial spillover effects exist due to bilateral trade weights except for three outliers. As (38) have argued, another explanation may have to do with the lack of trade liberalization and the restrictive trade practices in the MENA region, especially

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 under the SAR model by the addition of the term $W\Gamma_r$.

[15] (38) analyze the impact of trade in goods services for the MENA countries using a growth regression framework that also allows for an interaction between the two at the aggregate and sectoral level. They find a positive association between trade in goods and services on growth but show that the interaction effect between the two is negative, although the overall effect of services on growth is positive. However, they do not consider the spillover effects of trade between countries.

trade in services, which limit the scope for trade among the MENA countries. (3) examine this issue by considering the role of non-oil GDP spillovers, who examine real and financial spillovers of Saudi Arabia's non-oil GDP for other GCC countries. Using a panel regression with fixed effects and controlling for the impact of the US real interest rate and real GDP growth, they find that growth spillovers from Saudi Arabia to Bahrain are sizable and significant but those to other GCC countries are not. They also find small but statistically significant effects from the Saudi equity market to the other GCC equity markets but no spillover effects into the regional bond markets. These authors conclude by noting that "increased GCC trade and financial linkages in the context of diversification initiatives" could enhance the role of growth spillovers in the region, which is also consistent with my findings.

The final set of results refers to the differences in the direct effects across individual countries, which arise from the feedback effects. Table 5.11 shows the average of the direct impact by country according to the different weighting matrices.[16] Here oil-rich countries have higher feedback effects while the oil-poor countries have smaller than average direct effects based on the geographical and cultural weighting matrices. This is similar to the indirect effects that I reported in Figures (5.6a) - (5.6b) . However, based on the trade impact matrix, in addition to Saudi Arabia, the United Arab Emirates and Turkey which generate the highest indirect effects, Iran also has feedback effects higher than the average direct effect for the trade balance variable that is reported in Table 5.11. 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.

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

Table 5.11: Direct impact effects by country

Country	W^{GEO}	W^{INST}	W^{CULT}	W^{TRADE}
ARE	1.0292	1.0217	1.0174	1.0270
BHR	1.0463	1.0216	1.0162	1.0063
DJI	1.0093	1.0258	1.0055	1.0003
DZA	1.0216	1.0291	1.0234	1.0070
EGY	1.0206	1.0191	1.0067	1.0064
IRN	1.0162	1.0040	1.0178	1.0138
IRQ	1.0202	1.0048	1.0126	1.0083
ISR	1.0556	1.0286	1.0239	1.0047
JOR	1.0541	1.0200	1.0239	1.0045
KWT	1.0249	1.0260	1.0230	1.0040
LBN	1.0359	1.0043	1.0130	1.0017
MAR	1.0131	1.0326	1.0198	1.0035
MLT	1.0262	1.0508	1.0153	1.0013
OMN	1.0188	1.0448	1.0215	1.0073
QAT	1.0474	1.0160	1.0223	1.0040
SAU	1.0233	1.0195	1.0241	1.0176
TUN	1.0300	1.0235	1.0076	1.0039
TUR	1.0136	1.0285	1.0201	1.0200

Chapter 6

CONCLUSION

I investigate the existence of growth spillovers within some group of countries with respect to different kind of connectivities among them. I use the spatial econometric techniques to explore and understand possible linkages between integration and economic growth within the selected group of the countries. My first group of countries are the Emerging Market Economies (EME), which have been achieving rapid growth and they are in the process of becoming a developed economy. Even they are separate from each other; means they are not clustered in a particular area, they have similar kind of characteristics with their development process. Thus, I ask whether geographic or non-geographic proximities are likely to matter for growth externalities and spillovers effects and seek to determine how interdependent the growth rates of EME are with each other. My spatial explanatory analysis for the growth rate of GDP per capita shows that there is no spatial pattern and it is not possible to identify any spillover effects among their economic growth rates. Although they are interested to develop and modernize their economies and societies, the reality is that each of them faces their own different conditions and domestic challenges. Their interests diverge greatly on different subjects, therefore they do not necessarily share a common agenda or even similar economic, political, social and cultural features. For this reason, I cannot find any spillover effects among the growth rates between EME even using geographical proximity or cultural or bilateral trade relations. After the EME's non-spatial outcome, I prefer to focus another kind of grouping of countries, which are Middle East and North Africa (MENA) region. As the countries in that region are also not developed countries, that makes more interesting. But in this case, they share a common large geographical area. I investigate the existence of growth spillovers among MENA countries with respect to geographical, institutional, cultural and trade characteristics. The MENA region comprises a geographic area that give better view on localized spillovers than an analysis of divergent countries. My results suggest that the economic growth of MENA countries is positively affected by the economic growth of a country with institutional, cultural and geographical proximity. However, trade linkages among the different partners matter less. This may have to do 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.

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 them for the individual country and the region. I have taken an alternative approach and examined the role of growth interdependence in the MENA region. While the role of geography and culture seems more straightforward to explain, the fact that institutional characteristics may be a source of regional interdependence is a novel result that bears further analysis. My results suggest that the changing face of governance in the region may be an important determinant of how growth from one country spills over to another. Combining this finding with the finding that trade linkages contribute little to generating such spillovers, my 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. The benefits from following such a strategy may yield great dividends in view of the spillover effects involved.

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Appendix A

CONVERGENCE IN THE MODEL WITH TFP SPILLOVERS

Proceeding as before, I can show that the capital-output ratio for country i is constant at the steady state value of capital as $(k_i/y_i)^* = s_i/(n_i+g+\delta)$, which implies that

$$k_{it}^* = \Omega_t^{\frac{1}{(1-\gamma)(1-u_{ii})}} \left(\frac{s_i}{n_i+g+\delta}\right)^{\frac{1}{1-u_{ii}}} \prod_{j\neq i} (k_{jt}^*)^{\frac{u_{ij}}{1-u_{ii}}}, \tag{A.1}$$

where $g = \mu/[(1-\alpha)(1-\gamma)-\phi]$. Writing the the logarithm of output per worker as $y = A + \alpha k$, replacing A by equation (3.10), and pre-multiplying both sides by $(I - \gamma W)$ yields $y = \Omega + (\alpha+\phi)k - \alpha\gamma W k + \gamma W y$. Re-writing this equation for country i and substituting for the steady-state capital-output ratio in logarithms implies

$$\begin{aligned}\ln(y_{it}^*) &= \frac{1}{1-\alpha-\phi}\ln(\Omega_t) + \frac{(\alpha+\phi)}{1-\alpha-\phi}\ln\left(\frac{s_i}{n_i+g+\delta}\right) \\ &+ \frac{\gamma\alpha}{1-\alpha-\phi}\sum_{j\neq i}^{N} w_{ij}\ln\left(\frac{s_j}{n_j+g+\delta}\right) + \frac{\gamma(1-\alpha)}{1-\alpha-\phi}\sum_{j\neq i} w_{ij}\ln(y_{jt}^*).\end{aligned}$$

Consider the fundamental dynamic capital equation implied by the Solow neoclassical model as $\dot{k}_{it} = s_i y_{it} - (n_i+\delta)k_{it}$. Using the definition of output in country i given by (3.12), I have that

$$\frac{\dot{k}_{it}}{k_{it}} = s_i \Omega_t^{\frac{1}{1-\gamma}} k_{it}^{-(1-u_{ii})} \prod_{j\neq i}^{N} k_{jt}^{u_{ij}} - (n_i+\delta) \tag{A.2}$$

As before, the transitional dynamics of the model may be represented using a log-linear approximation to equation (A.2) around the steady state as

$$\frac{d\ln(k_{it})}{dt} = g-(1-u_{ii})(n_i+g+\delta)[\ln(k_{it})-\ln(k*_{i,t})]+\sum_{j\neq i} u_{ij}(n_j+g+\delta)[\ln(k_{jt})-\ln(k_{j,t}^*)].$$

$$\tag{A.3}$$

However, this system of differential equations does not admit an easy solution. Hence, I consider the relations showing the gaps between countries relative to their own steady states as

$$\begin{aligned} \ln(k_{it}) - \ln(k^*_{i,t}) &= \Phi_j[\ln(k_{jt}) - \ln(k^*_{j,t})] && \text{(A.4)} \\ \ln(y_{it}) - \ln(y^*_{i,t}) &= \Theta_j[\ln(y_{jt}) - \ln(y^*_{j,t})]. && \text{(A.5)} \end{aligned}$$

Now substitute equation (A.3) for $i = 1, \ldots, N$ into the production function by writing it as

$$\frac{d\ln(y_{it})}{dt} = \frac{1}{1-\gamma}\frac{d\ln(\Omega_t)}{dt} + u_{ii}\frac{d\ln(k_{it})}{dt} + \sum_{j\neq i} u_{ij}\frac{d\ln(k_{jt})}{dt}.$$

This yields

$$\begin{aligned} \frac{d\ln(y_{it})}{dt} &= \frac{\mu}{1-\gamma} + u_{ii}\left[g - (1-u_{ii})(n_i+g+\delta)[\ln(k_{it}) - \ln(k^*_{i,t})] + \sum_{j\neq i} u_{ij}(n_j+g+\delta)[\ln(k_{jt}) - \mathrm{l} \right. \\ &\quad + \sum_{j\neq i} u_{ij}\left[g - (1-u_{jj})(n_j+g+\delta)[\ln(k_{jt}) - \ln(k^*_{j,t})] + \sum_{k\neq j} u_{jk}(n_k+g+\delta)[\ln(k_{kt}) - \ln(k^*_{k,t})]\right] \end{aligned}$$

or

$$\begin{aligned} \frac{d\ln(y_{it})}{dt} &= \frac{\mu}{1-\gamma} + g - u_{ii}(n_i+g+\delta)[\ln(k_{it}) - \ln(k^*_{i,t})] + u_{ii}^2(n_i+g+\delta)\ln(k_{it} - \ln(k^*_{i,t})] \\ &\quad + u_{ii}\sum_{j\neq i} u_{ij}(n_j+g+\delta)[\ln(k_{jt}) - \ln(k^*_{jt})] - \sum_{n\neq j} u_{ij}u_{ij}(n_j+g+\delta)[\ln(k_{jt}) - \ln(k*_{j,t})] \\ &\quad + u_{jj}\sum_{j\neq i} u_{ij}[\ln(k_{jt}) - \ln(k^*_{jt})] + \sum_{j\neq i} u_{ij}\sum_{k\neq j} u_{jk}(n_k+g+\delta)[\ln(k_{jt}) - \ln(k*_{j,t})], \end{aligned}$$

where $\sum_{j=1}^N u_{ij}g = g$ since $\sum_{j=1}^N u_{ij} = 1$.

Then

$$\begin{aligned} \frac{d\ln(y_{it})}{dt} &= \frac{\mu}{1-\gamma} + g\sum_{j=1}^N u_{ij} - \sum_{j=1}^N u_{ij}(n_j+g+\delta)[\ln(k_{jt}) - \ln(k^*_{j,t})] \\ &\quad + \sum_{j=1}^N u_{ij}\sum_{k=1}^N u_{jk}(n_k+g+\delta)[\ln(k_{kt}) - \ln(k^*_{k,t})] \end{aligned}$$

or

$$\frac{d\ln(y_{it})}{dt} = \frac{\mu}{1-\gamma} + g - \sum_{j=1}^{N} u_{ij}(n_j + g + \delta)[\ln(k_{jt}) - \ln(k^*_{j,t})]$$
$$+ \sum_{j=1}^{N} u_{ij}[\ln(k_{jt}) - \ln(k^*_{j,t})] \sum_{k=1}^{N} u_{jk}(n_k + g + \delta)\frac{1}{\Phi_k}$$

or

$$\frac{d\ln(y_{it})}{dt} = \frac{\mu}{1-\gamma} + g - [\ln(k_{it}) - \ln(k^*_{i,t})] \sum_{j=1} u_{ij}(n_j + g + \delta)\frac{1}{\Phi_j}$$
$$+ \Bigg[u_{ii}[\ln(k_{it}) - \ln(k^*_{i,t})] \sum_{k=1}^{N} u_{ik}(n_k + g + \delta)\frac{1}{\Phi_k} + \sum_{j\neq i} u_{ij}[\ln(k_{jt}) - \ln(k^*_{j,t})] \sum_{k=1}^{N} u_{jk}(n_k + g + \delta)\frac{1}{\Phi_k}$$

or

$$\frac{d\ln(y_{it})}{dt} = \frac{\mu}{1-\gamma} + g - [\ln(k_{it}) - \ln(k^*_{i,t})] \sum_{j=1} u_{ij}(n_j + g + \delta)\frac{1}{\Phi_j}$$
$$+ [\ln(y_{it}) - \ln(y^*_{it})] \sum_{k=1}^{N} u_{ik}(n_k + g + \delta)\frac{1}{\Phi_k}$$

But

$$\begin{aligned} [\ln(k_{it}) - \ln(k^*_{i,t})] \sum_{j=1} u_{ij}(n_j + g + \delta)\frac{1}{\Phi_j} &= \frac{\sum_{j=1}^{N} u_{ij} \sum_{k=1}^{N} u_{jk}(n_k + g + \delta)[\ln(k_{kt}) - \ln(k^*_{kt})]}{\sum_{j=1}^{N} u_{ij}\frac{1}{\Phi_j}} \\ &= \frac{[\ln(y_{it}) - \ln(y^*_{it})] \sum_{k=1} u_{ik}(n_k + g + \delta)\frac{1}{\Phi_k}}{\sum_{j=1}^{N} u_{ij}\frac{1}{\Phi_j}}. \end{aligned}$$

Therefore,

$$\frac{d\ln(y_{it})}{dt} = \frac{\mu}{1-\gamma} + g - [\ln(y_{it}) - \ln(y^*_{i,t})] \left(\sum_{j=1} u_{ij}(n_j + g + \delta)\frac{1}{\Phi_j} \right) / \left(\sum_{j=1}^{N} u_{ij}\frac{1}{\Phi_j} \right)$$
$$+ [\ln(y_{jt}) - \ln(y^*_{j,t})] \sum_{k=1}^{N} u_{jk}(n_k + g + \delta)\frac{1}{\Phi_k}$$

or

$$\frac{d\ln(y_{it})}{dt} = \frac{\mu}{1-\gamma} + g - \Lambda_i[\ln(y_{it} - \ln(y^*_{i,t})] + [\ln(y_{jt} - \ln(y^*_{j,t})] \sum_{k=1}^{N} u_{jk}(n_k + g + \delta)\frac{1}{\Phi_k}$$

where

$$\Lambda_i = \left(\sum_{j=1}^{N} u_{ij}\frac{1}{\Phi_j}(n_j + g + \delta) \right) / \left(\sum_{j=1}^{N} u_{ij}\frac{1}{\Phi_j} \right).$$

Likewise, imposing (A.5) yields

$$\frac{d\ln(y_{it})}{dt} = \frac{\mu}{1-\gamma} - \lambda_i[\ln(y_{it}) - \ln(y^*_{i,t})], \tag{A.6}$$

where

$$\lambda_i = \Lambda_i - \sum_{j=1}^{N} u_{ij}\frac{1}{\Phi_j}(n_j + g + \delta).$$