Tuğrul Çınar¹

Spatial Dimensions of Sectoral Labor Productivity Convergence in Turkey: A Spatial Panel Data Approach

¹ Department of Economics, Faculty of Economics and Administrative Sciences, Dumlupınar University, 43100, Kütahya, Turkey, E-mail: tugrul.cinar@dpu.edu.tr

Abstract:

The purpose of this study is to investigate spatial dimensions of interregional labor productivity convergence in Turkey between 2005 and 2011 period in three sector disaggregation. We employed spatial panel data approach to investigate the absolute and conditional beta convergence. Annual gross value added per worker data has been used as labor productivity proxy for 26 sub-regions. Analysis results show us that absolute and conditional convergence is highly significant for all agriculture, industry and services sector and also in sectors total. We also found that, while industry, services and sectors total show significant spatial dependency, there is no strong evidence of spatial interaction in agriculture sector for Turkey. Structural problems of Turkish agriculture sector are considered to be the main reasons behind this finding.

Keywords: regional convergence, labor productivity, beta convergence, spatial panel data analysis

DOI: 10.1515/rmeef-2017-0006

1 Introduction

The Turkish economy recovered swiftly from 2001 financial crisis and became an upper middle income country, which led to rising prosperity in the country. Despite of this rise in welfare, ongoing income disparity over the last three decades among the regions and provinces of Turkey has not changed significantly. Even though income disparities in the country have long been an issue in the literature, there are very few studies that have examined the post 2000 period. While Karaman and Doğruel (2011) and Abdioğlu and Uysal (2013) examine convergence for 26 sub-regions according to Nomenclature of Territorial Units for Statistics (NUTS) level 2 between 2004 and 2008 period, Akçagün (2016) examines 2002–2009 period, and Birkan and Akdoğu (2016) examine 2004–2011 period. There are even fewer studies dealing with the sectoral income or labor productivity convergence at the regional or provincial level.

Starting from the 2000s, the spatial econometric approach has increasingly been used in convergence studies for Turkey (Gezici and Hewings 2004; Yıldırım 2005; Yıldırım and Öcal 2006; Aldan and Gaygısız 2006; Akçagün 2016; Birkan and Akdoğu 2016). Dall’erba (2005) points out three important reasons for integrating spatial interdependence into beta convergence analysis. The first reason is an econometric issue. Standard Ordinary Least Squares (OLS) approach assumes that the error terms are independent from each other. However, spatial interaction among cross sections will bring about correlations between the error terms. Therefore, statistical inference based on them will not provide reliable results. Second, incorporating spatial effects into convergence models enables us to capture interregional spillover effects. Thereby, connections with the neighbors, as Tobler (1970) stated as the first law of geography which is “everything is related to everything else, but near things are more related than distant things”, can be integrated into the analysis. Third, spatial autocorrelation allows us to eliminate omitted variable bias. In this respect, spatial convergence studies for Turkey did not take sectoral decompositions into account. Baypinar (2010) who examines convergence by employing a cross-sectional spatial analysis for 67 provinces in agriculture, industry and services between 1990 and 2000 period is an exception.

Almost all empirical studies in the literature dealing with sectoral convergence incorporating spatial dimensions have been conducted on developed countries (Dall’erba 2005; James and Campbell Jr 2014; Le Gallo and Dall’erba 2008; Villaverde and Maza 2008) which found that sectoral spatial effects were statistically significant. However, one has to take into consideration that the structure of agriculture, industry and services sectors in developed countries differ from developing countries like Turkey. This difference shows itself especially in agriculture. The agriculture sector shows a very weak profile compared to other sectors in the country. According

to Budak et al. (2007, 4), research-extension-farmer linkage is very poor for effective technology transfer in the Turkish agriculture sector. In addition to poor knowledge and technology transfer, limited labor and capital mobility in the sector cause regions in Turkey to become as if they were “isolated islands”.

This study will make a contribution to the convergence literature by answering the question whether spatial interactions are an important in sectorally decomposed regional convergence for Turkey. This study can provide policy makers with the tools for the adoption of regional and sectoral development strategies and policies.

The rest of the paper is organized as follows: Section 2 provides an overview of the main sectors in Turkey. Section 3 provides some insights into the empirical studies of sectoral and spatial convergence analysis in general and also into the convergence literature, specifically for Turkey. Section 4 presents the data and spatial weight matrix used in the study. Section 5 gives a brief overview of beta convergence and spatial panel data models. Estimation results are reported and interpreted in Section 6. Finally, Section 7 provides conclusions and recommendations.

2 An Overview of Sectoral Disparities in Turkish Economy

The share of the agriculture sector in the economy has decreased over the course of economic development in Turkey. Such a structural transformation is a common feature for developing countries. In addition, once a structural transformation begins, there seems to be no turning back (Gürsel and İmamoğlu 2013, 2).

Despite this decline in sectoral share of Gross Domestic Product (GDP), as shown in Figure 1,² agriculture is still a major sector in Turkey (Gürsel and İmamoğlu 2013). Agricultural production is carried out by small-scaled and partitioned farms in general. About 90% of employment in agriculture is comprised of self-employed and unpaid family workers as opposed to sectors total, in which salaried or paid workers form 60% of total employment (see Table 1). The reason is that agricultural activity is mostly carried out on inherited farms and in the homelands of farmers (Öztürk 2012). This structure of employment in agriculture causes a strong immobility of labor in the sector, compared to industry and services sectors.

Figure 1: Sectoral breakdown of gross domestic product in Turkey: 1950–2010 (%).

Table 1: Employment status by occupation: 2008–2011 (1.000).

		2008	%	2009	%	2010	%	2011	%
Agriculture	Salaried or paid workers	434	8.7	454	8.7	527	9.3	623	10.1
	Employer and self-employed	2316	46.2	2371	45.2	2513	44.2	2653	43.2

All Sectors	Unpaid family worker	2266	45.2	2416	46.1	2643	46.5	2866	46.7
	Total	5016	100.0	5240	100.0	5683	100.0	6143	100.0
	Salaried or paid workers	12937	61.0	12770	60.2	13762	60.9	14876	61.7
	Employer and self-employed	5573	26.3	5638	26.6	5750	25.4	5931	24.6
	Unpaid family worker	2684	12.7	2870	13.5	3083	13.6	3303	13.7
	Total	21194	100.0	21227	100.0	22594	100.0	24110	100.0

Source: Turkish Agriculture Report 2013, Turkish Union of Chambers and Commodity Exchanges.

The immobility of labor in agriculture does not preclude the fact that agricultural labor in one region tends to migrate other regions in order to participate in industrial or services sectors. As it can be seen from Table 2, while the employment rate in agriculture declined by 8% from 2004 to 2014, employment rate in industry and services sectors increased by 3% and 5% respectively.

Table 2: Employment by sectors: 2004–2014 (%).

	Agriculture	Industry	Services
2004	29.1	24.9	46
2009	24.7	25.3	50
2014	21.1	27.9	51

Source: Turkish Statistical Institute.

In addition to labor force immobility, R&D Statistics in OECD countries reveal that the ratio of R&D expenditures to GDP in Turkey is one of the lowest in OECD. We also expect that such expenditures are even lower for the agricultural sector. According to Turkish Agriculture Report 2013 by the Turkish Union of Chambers and Commodity Exchanges (TOBB), in Turkey, unlike developed countries, in which agricultural R&D activities are mostly carried out by the private sector, agricultural R&D activities are carried out by universities which would make us conclude that agricultural producers in Turkey suffer from a serious lack of R&D capacity. As a counteracting factor, increasing Foreign Direct Investment (FDI) inflows could have been a way of increasing the R&D capacity of the sector. However, as it can be seen from Table 3, the share of FDI inflows in agriculture is far below the industry and services sectors.

Table 3: Foreign direct investment inflows by sectors (Million Dollars).

	Agriculture	%	Industry	%	Services	%	Total
2005	5	0.06	908	10.64	7622	89.30	8535
2006	6	0.03	2988	16.94	14645	83.03	17639
2007	9	0.05	5037	26.32	14091	73.63	19137
2008	41	0.28	5187	35.17	9520	64.55	14748
2009	48	0.77	3887	62.03	2331	37.20	6266
2010	81	1.29	2887	46.15	3288	52.56	6256
2011	32	0.20	8040	49.83	8064	49.98	16136

Source: The Central Bank of the Republic of Turkey.

When all these reasons are taken into consideration, we can conclude that the conditions in the agriculture sector in Turkey are not conducive to the generation of spillover effects.

3 A Brief Survey of the Empirics of Convergence

The literature on convergence showed a remarkable growth after the pioneering study of Baumol (1986). Baumol (1986) has put forth the importance of studying absolute convergence. After that, the distinction between absolute convergence and conditional convergence has emerged after the studies of Mankiw, Romer, and Weil (1992) and Barro and Sala-i-Martin (1992). Both studies used Solow (1956) Neoclassical growth model as a basis for their models which were the first structural forms of convergence analysis (Delvecchio 2014). They emphasized that countries would reach their respective steady states (Islam 1995) which are states of conditional convergence versus absolute convergence where all countries reach an absolute steady-state level.

In addition to the vast literature on aggregate convergence analysis (Abramovitz 1986; Barro and Sala-i-Martin 1992; Baumol 1986; Baumol and Wolff 1988; Bernard and Durlauf 1995; De Long 1988; Dowrick and Nguyen 1989; Evans and Karras 1996; Grier and Tullock 1989; Islam 1995; Mankiw, Romer, and Weil 1992; Quah 1993; Sala-i-Martin 1996a; 1996b), Bernard and Jones (1996) conducted an empirical investigation of convergence on a sectoral level. This study was followed by more sectoral convergence studies in developed countries (Bernard and Jones 1996; Frantzen 2004; Mahmood 2012; Ulusoy and Yalçın 2011). For developing countries, Castellacci, Los, and De Vries (2014) expand the Bernard and Jones (1996) dataset from 14 to 65 countries to include developing nations. Their findings suggest that convergence is an exception more than a rule (Castellacci, Los, and De Vries 2014).

In addition, the inclusion of spatial effects in convergence analysis was advanced in the literature. De Long and Summers (1991) in a seminal paper highlighted the importance of spatial and neighborhood effects in convergence analysis. Their work was followed by the work of Armstrong (1995), Rey and Montouri (1999), Lopez-Bazo et al. (1999), Arbia and Paelinck (2003), Le Gallo and Ertur (2003), and Dall'erba (2005) who made valuable contributions to spatial convergence literature. Nevertheless, spatial convergence analysis goes one step further with the studies of Lopez-Bazo, Vaya, and Artis (2004), Fingleton and Lopez-Bazo (2006) and Ertur and Koch (2007) which according to Elhorst, Piras, and Arbia (2010) have put spatial convergence framework on a theoretical basis.

Starting from 1990s, empirical studies tackled the issue of convergence in Turkey. While some studies find no evidence of convergence (Abdioğlu and Uysal 2013; Aldan and Gaygısız 2006; Gezici and Hewings 2004; Karaca 2004; Temel, Tansel, and Albersen 1999; Temel, Tansel, and Güngör 2005), others find such evidence (Kılıçaslan and Özatağan 2007; Yıldırım 2005; Yıldırım and Öcal 2006; Yıldırım, Öcal, and Özyıldırım 2008; Önder, Deliktaş, and Karadağ 2010; Özgül and Karadağ 2015; Zeren and Yılancı 2011).

Two points in the convergence literature in Turkey draw particular attention. First, almost all studies have addressed the convergence issue in the aggregate. However, Baypinar (2010), Filiztekin (2009), Temel, Tansel, and Albersen (1999), and Temel, Tansel, and Güngör (2005) studied convergence at disaggregated levels with Baypinar (2010) study, to the best of our knowledge, being the only study dealing with spatial dimensions of sectoral convergence. He analyzed productivity convergence among 67 provinces of Turkey by employing cross-section analysis for 1990–2000 period. Even though he argues that different sectors show different spatial spillover effects, he doesn't explicitly show the degree of spatiality of sectors. Second, econometric methodologies used in convergence studies for Turkey so far can be specified as: OLS estimation with cross-section and panel data, standard and spatial Markov chain approach, spatial analysis with cross-section data, and time series approach. While spatial panel data approach shows growing prominence in the convergence literature worldwide, none of the studies so far employed the spatial panel approach for Turkey.

4 Data and the Spatial Weight Matrix

Our sample is determined by the data availability for the 26 Turkish regions over the 2005–2011 period. We used sectoral Gross Value Added (GVA) per worker as labor productivity proxy. The data on GVA and employment come from the Turkish Statistical Institute. As mentioned in Papalia and Bertarelli (2009) various measures of output and various measures of input can be used to measure productivity. Most commonly used indicators of productivity are GDP per capita, GDP per worker and Value Added per worker. The choice of the indicator depends on the level of analysis and the availability of data (Papalia and Bertanelli 2009, 59). Dall'erba (2005) uses per capita GDP and per worker GVA as a proxy for labor productivity. He argues that regional policies implemented in backward regions act directly on the production function of firms and thus may favor the productivity levels in the poor regions but not necessarily their per capita income levels (Dall'erba 2005, 208). In addition, Le Gallo and Dall'erba (2008) also use value added per worker as a proxy for labor productivity.

We used four different variable sets, three of them are sectoral disaggregations; namely agriculture, industry and services. We call these variables namely *Tarint*, *Sanint* and *Hizint*, respectively. Our fourth variable is

aggregated data which is basically a total of agriculture, industry and services data. In order to get aggregated data we used total GVA in region i for period t divided by total number of employment in corresponding region i and period t . We call this aggregated variable sectors total and labelled as $Tpint$ in tables. Due to the data availability constraints, we could not use more detailed sectoral decomposition. Descriptive statistics on these data is given in Table 4.

Table 4: Descriptive statistics.

Variable	Observation	Mean	Standard deviation	Minimum	Maximum
Tarint	182	9.55	0.60	7.90	11.50
Sanint	182	10.45	0.26	9.75	11.02
Hizint	182	10.52	0.29	9.82	11.31
Tpint	182	10.24	0.36	9.33	11.10
pubgskd	182	0.02	0.01	0.00	0.07
academy	182	-7.49	0.83	-11.90	-6.04

Mankiw, Romer, and Weil (1992) augmented the Solow model by including the accumulation of human capital as well as physical capital. Following their study, we used two additional variables to analyze conditional convergence. One is a proxy for human capital which comes from the Turkish Statistical Institute and measured as the natural logarithm of ratio of total number of professors, associate professors and assistant professors to non-institutional population over the age of 15 years. Since the total population data for provinces and regions in Turkey were not released for 2001–2007 period, we used non-institutional population data. Barro and Lee (2013) and Miller and Upadhyay (2002) define the stock of human capital as average years of schooling per adult. Since this data is not available at the regional level in Turkey, we used the natural logarithm of the ratio of total number of university professors to the non-institutional population over 15 years old as a proxy for the stock of human capital. This variable is labeled as *academy* in the models. Following Filiztekin (1998), we used central government's investment allocations divided by GVA as a proxy for physical capital for each region i and period t in order to estimate the effect of public investments on convergence. This data comes from Republic of Turkey Ministry of Development and labeled as *pubgskd* in the models. Actually, central governments investment allocations data is released for provinces, but we sum up the data for provinces to reflect NUTS level 2 regional allocations.

The focal point in spatial econometrics is the relation of observations in space. This relationship relies on a square matrix called spatial weight matrix W , which shows the neighborhood relations between spatial units. If we have n different regions, then the dimension of the spatial weight matrix would be $n \times n$. In panel data analysis, if one has n cross sections and t periods, then the dimension of the spatial weight matrix should be $NT \times NT$. Each row in the spatial weight matrix shows the relationship with the regions in the columns. In this respect, there are two basic approaches for defining neighborhood. One is contiguity and the other is distance. Contiguity-based weight matrices include *queen*, *rook* and *bishop*. Distance-based weight matrices include *k nearest neighbors* and *distance bands*. While distance-based weight matrices use centroid distances between each pair of spatial units, contiguity-based weight matrices use shared boundaries. Most common used contiguity-based weight matrices in the literature are *queen* and *rook*. For computational simplicity, most of the time standardized weight matrices are used in applied studies.

One of the most important issue in applied spatial studies is the specification of spatial weight matrices. As Anselin, Le Gallo, and Jayet (2008) noted *unless the weights are based on a formal theoretical model for social or spatial interaction, their specification is often ad hoc. In practice, the choice is typically driven by geographic criteria, such as contiguity (sharing a common border) or distance, including nearest neighbor distance*. For example Gezici and Hewings (2004, 2007) used contiguity-based spatial weight matrix in their studies for Turkey. They also noted that in Turkey, all neighbors have common boundaries rather than nodes. So the results would not be affected by using either rook or queen for the spatial weight matrix. Following Gezici and Hewings (2004, 2007), we used queen contiguity as spatial weight matrix.³ Queen contiguity simply indicates whether spatial units share a boundary or not.

$$w_{ij} = \begin{cases} 1, & \text{if } i \text{ and } j \text{ shares a common border} \\ 0, & \text{otherwise} \end{cases} \quad [1]$$

where $w_{ij} \in W$. Since our spatial weight matrix is row standardized then $\sum_{j=1}^n w_{ij} = 1$.

5 Beta Convergence and Spatial Panel Models

We used the beta convergence model which was developed and extended by Mankiw, Romer, and Weil (1992) and Barro and Sala-i-Martin (1992) based on Solow (1956) model.

$$\ln\left(\frac{y_{t,i}}{y_{t-1,i}}\right) = \beta_0 + \beta_1 \ln(y_{t-1,i}) + \varepsilon_i \quad [2]$$

$$\ln\left(\frac{y_{t,i}}{y_{t-1,i}}\right) = \beta_0 + \beta_1 \ln(y_{t-1,i}) + \beta_2 \text{pubgskd}_{t,i} + \beta_3 \text{academy}_{t,i} + \varepsilon_i \quad [3]$$

Here $y_{t,i}$ is the sectoral GVA divided by corresponding sectoral employment in region i and period t . $y_{t-1,i}$ is the lagged value of $y_{t,i}$. Our independent variable $\ln(y_{t-1,i})$ is labeled as *Sanint*, *Hizint*, *Tpint* and *Tarint* for industry, services, sectors total and agriculture sectors, respectively. β_1 is the convergence coefficient. If it is negative and statistically significant, we can argue that the regions exhibit convergence. In eq. 3), we used two additional variables to analyze conditional convergence. One is *pubgskd* _{t,i} , and the other one is *academy* _{t,i} .

Models in eqs 2 and 3 rely implicitly on the assumption that regions are independent of each other. And it can be argued that this assumption is very strong for regional convergence within a country. Therefore, it is more plausible to assume spatial dependency among the regions in a country and hence employing spatial econometric models will be more realistic. But in the case of spatial dependency, OLS estimates turn out to be biased. In OLS estimation, temporal autocorrelation problem violates standard statistical techniques which assume independence among observations. This violation yields unreliable significance test results and parameter estimates. Thus, other estimation methods such as Maximum Likelihood (ML) would be more suitable (Rey and Montouri 1999; Piras and Arbia 2007; Ertur and Koch 2007). From this point of view, we used ML estimation procedure for our spatial analysis. Thereby, it would be appropriate to view spatial autocorrelation as a source of information rather than something to be corrected.

In Table 5, four different specifications of spatial models and a non-spatial model are shown. These models are the estimated spatial and non-spatial models of absolute convergence. In order to test for conditional convergence *pubgskd* and *academy* variables have also been added to these models and thus, a total of ten models have been estimated for each sector in the study.

Table 5: Spatial and non-spatial model specifications for absolute convergence.

Name	Specification
Non-spatial Convergence Model (AFR)	$\ln\left(\frac{y_{t,i}}{y_{t-1,i}}\right) = \beta_0 + \beta_1 \ln(y_{t-1,i}) + \varepsilon_i$
Spatial Lag Model (SAR)	$\ln\left(\frac{y_{t,i}}{y_{t-1,i}}\right) = \beta_0 + \rho W \ln\left(\frac{y_{t,i}}{y_{t-1,i}}\right) + \beta_1 \ln(y_{t-1,i}) + \varepsilon_i$
Spatial Error Model (SEM)	$\ln\left(\frac{y_{t,i}}{y_{t-1,i}}\right) = \beta_0 + \beta_1 \ln(y_{t-1,i}) + \varepsilon_i; \quad \varepsilon_i = \lambda W \varepsilon_i + v_i$
Spatial Durbin Model (SDM)	$\ln\left(\frac{y_{t,i}}{y_{t-1,i}}\right) = \beta_0 + \rho W \ln\left(\frac{y_{t,i}}{y_{t-1,i}}\right) + \theta W X_{t,i} + \beta_1 \ln(y_{t-1,i}) + \varepsilon_i$
Spatial Autocorrelation Model (SAC)	$\ln\left(\frac{y_{t,i}}{y_{t-1,i}}\right) = \beta_0 + \rho W \ln\left(\frac{y_{t,i}}{y_{t-1,i}}\right) + \beta_1 \ln(y_{t-1,i}) + \varepsilon_i; \quad \varepsilon_i = \lambda W \varepsilon_i + v_i$

According to Elhorst (2014), researchers are mainly interested in SAR, which incorporates spatially lagged variable on the right-hand side of the model specification, and SEM, which includes spatiality in the error term of the model. But these approaches are too limited that the focus should shift to the SDM model (Elhorst 2014, 33). In this respect, we used SAR and SEM models as well as a SAC model, which is basically a combination of the SAR and SEM models. Following Elhorst (2014) we also employed SDM model, which considers both a spatially lagged dependent and independent variables on the right-hand side of the model. In addition to spatial models we estimated a non-spatial convergence AFR model (Arellano 1987; and Froot 1989) as a robust estimator since test results show statistically significant autocorrelation and heteroskedasticity. The AFR estimator is a heteroskedasticity and serial correlation consistent estimator of a linear regression model on panel data (Arellano 1987)⁴. In addition, we only report fixed effect estimation results since all NUTS level 2 regions are considered and included in the sample.

6 Estimation Results

First we perform the heteroskedasticity and autocorrelation tests for our non-spatial fixed effect model. According to Table 6, the Wooldridge autocorrelation test and the Modified Wald test for heteroskedasticity show strong autocorrelation and heteroskedasticity for our panel data. So it would be appropriate to use heteroskedasticity and autocorrelation consistent robust AFR estimator for our non-spatial fixed effect model.

Table 6: Heteroskedasticity and autocorrelation tests for non-spatial models.

	Agriculture	Manufacturing	Services	Sectors Total
Modified Wald Test for Heteroskedasticity	215.48 (0.000)***	963.03 (0.000)***	475.86 (0.000)***	277.91 (0.000)***
Wooldridge Autocorrelation Test	32.945 (0.000)***	28.723 (0.000)***	26.665 (0.000)***	8.085 (0.008)***

Probabilities are given in parenthesis.

* shows significance at 0.10

** shows significance at 0.05

*** shows significance at 0.01 respectively.

In multiple regression analysis, it is important to check for linear relationship among the explanatory variables. High pairwise correlations among the explanatory variables can cause multicollinearity problem. In Table 7, correlation among the variables is presented.

Table 7: Correlations among explanatory variables.

	Tarint	Sanint	Hizint	Tpint	pubgskd	academy
Tarint	1.000					
Sanint	0.178	1.000				
Hizint	0.471	0.565	1.000			
Tpint	0.792	0.510	0.853	1.000		
pubgskd	−0.361	−0.014	−0.373	−0.447	1.000	
academy	0.211	0.179	0.486	0.359	−0.444	1.000

According to Table 7, *Tpint* variable shows strong correlation (0.50 or above) with *Tarint*, *Sanint* and *Hizint* variables. *Hizint* variable also shows strong correlation with *Sanint* variable. Since these four variables will be employed in different models with *pubgskd* and *academy* variables, it can be said that our models would not suffer from multicollinearity problem.

Our empirical analysis starts with estimation of absolute and conditional convergence models for industry sector in the period of 2005–2011 for 26 regions.

As it can be seen from Table 8, the coefficient of *Sanint* is negative and highly significant for all absolute and conditional convergence models. Hence, we can argue that there is a strong evidence of convergence for the industrial sector in Turkey. In addition to that, when we look at the spatial coefficients (ρ and λ) it can clearly be seen that for different spatial models of absolute and conditional convergence, these coefficients are also highly significant which indicates a strong evidence of spatiality. In Table 8, we used Akaike Information Criterion, Schwartz Information Criterion (AIC and SIC, respectively) and Likelihood Ratio (LR) tests to compare goodness of fit for the models. SAC models show the smallest AIC and SIC both for absolute and conditional convergence. Also LR test statistics seems to work in favor of the SAC model. According to SAC model, we can assert that the industry sector in Turkey shows strong evidence in favor of the absolute and conditional convergence and also strong spatiality. Similar inferences can be made for the services sector.

From Table 9, it can be seen that coefficient of *Hizint* is negative for all absolute and conditional convergence models. In most of the models *Hizint* is also very significant except for the SAR models. In SAR model, coefficient of *Hizint* is significant at 5% level for absolute convergence, and it is significant at 10% level for conditional convergence. AIC, SIC and LR tests show similar results to that of industry sector and all signing in favor of the SAC model, which indicates strong evidence of absolute and conditional convergence and also spatial interactions among the regions of Turkey for the services sector.

Table 8: Estimation results of the beta convergence model for industry sector in Turkey (2005–2011).

N: 182	Absolute convergence					Conditional convergence				
	AFR	SAR	SEM	SDM	SAC	AFR	SAR	SEM	SDM	SAC
Con- stant	2.43 (0.00)***					2.27 (0.00)***				
Sanint	−0.27 (0.00)***	−0.20 (0.00)***	−0.31 (0.00)***	−0.41 (0.00)***	−0.31 (0.00)***	−0.22 (0.00)***	−0.21 (0.00)***	−0.31 (0.00)***	−0.43 (0.00)***	−0.32 (0.00)***
pub- gskd						1.06 (0.63)	1.57 (0.19)	1.91 (0.08)*	2.93 (0.01)**	1.93 (0.03)**
academy						−0.01 (0.82)	−0.01 (0.96)	−0.03 (0.30)	−0.05 (0.09)*	−0.05 (0.04)**
W* Sanint				0.09 (0.00)***					0.10 (0.00)***	
W* pub- gskd									−0.91 (0.07)*	
W* academy									0.01 (0.70)	
λ			0.08 (0.00)***		0.16 (0.00)***			0.09 (0.00)***		0.16 (0.00)***
ρ		0.27 (0.00)***		0.27 (0.00)***	−0.15 (0.00)***		0.27 (0.00)***		0.27 (0.00)***	−0.16 (0.00)***
Log L	155.73	108.90	162.55	122.28	168.79	156.22	109.78	164.45	127.91	172.69
AIC	−309.47	−211.80	−319.10	−236.56	−329.58	−306.44	−209.56	−318.89	−239.83	−333.38
SIC	−306.27	−202.19	−309.49	−223.75	−316.76	−296.83	−193.54	−302.87	−214.19	−314.15
df	1	3	3	4	4	3	5	5	8	6
LR Test SAC	26.12 (0.00)***					32.94 (0.00)***				
LR Test SDM	−66.9 (0.99)					−56.62 (0.99)				

Note: Probabilities are in parenthesis.

* show significance at 0.10

** show significance at 0.05

*** show significance at 0.01, respectively.

STATA 13 have been used for analysis. Log L: Log Likelihood, df: degrees of freedom, LR Test SAC: Unrestr. Model: SAC, Restr. Model: AFR, LR Test SDM: Unrestr. Model: SDM, Restr. Model: AFR.

Table 9: Estimation results of the beta convergence model for services sector in Turkey (2005–2011).

N: 182	Absolute convergence					Conditional convergence				
	AFR	SAR	SEM	SDM	SAC	AFR	SAR	SEM	SDM	SAC
Con- stant	1.83 (0.00)***					1.60 (0.02)**				
Hizint	−0.12 (0.00)***	−0.06 (0.02)**	−0.20 (0.00)***	−0.35 (0.00)***	−0.27 (0.00)***	−0.16 (0.00)***	−0.05 (0.09)*	−0.18 (0.00)***	−0.34 (0.00)***	−0.25 (0.00)***
Pub- gskd						−2.53 (0.00)***	2.05 (0.00)***	−2.19 (0.00)***	−1.44 (0.04)**	−1.60 (0.00)***
Academy						0.02 (0.67)	0.01 (0.87)	0.01 (0.61)	0.01 (0.54)	0.01 (0.60)
W*Hizint				0.08 (0.00)***					0.08 (0.00)***	
W* pub- gskd									0.36 (0.22)	
W*academy									−0.01 (0.56)	
λ			0.10 (0.00)***		0.16 (0.00)***			0.09 (0.00)***		0.16 (0.00)***
ρ		0.27 (0.00)***		0.27 (0.00)***	−0.15 (0.00)***		0.27 (0.00)***		0.27 (0.00)***	−0.14 (0.00)***
Log L	239.46	192.94	248.13	215.64	257.28	246.52	196.75	253.59	218.60	261.31
AIC	−476.92	−379.88	−490.25	−423.28	−506.55	−487.04	−383.49	−497.19	−421.20	−510.61

SIC	−473.71	−370.27	−480.64	−410.46	−493.73	−477.42	−367.47	−481.17	−395.56	−491.39
df	1	3	3	4	4	3	5	5	8	6
LR Test SAC	35.64					30.22				
	(0.00)***					(0.00)***				
LR Test SDM	−47.64					−55.84				
	(0.99)					(0.99)				

Note: Probabilities are in parenthesis.

* show significance at 0.10

** show significance at 0.05

*** show significance at 0.01, respectively.

STATA 13 have been used for analysis. Log L: Log Likelihood, df: degrees of freedom, LR Test SAC: Unrestr. Model: SAC, Restr. Model: AFR, LR Test SDM: Unrestr. Model: SDM, Restr. Model: AFR.

In Table 10, estimation results for sectors total are given. Coefficient of $Tpint$ variable is negative for all absolute and conditional models. And also it is highly significant for all models except for SAR models. SAR models show convergence at 5% significance level. Spatial coefficients (ρ and λ) are also highly significant for all spatial models except for the SEM, which shows significant spatial effect at 10% level. According to AIC, SIC and LR tests, the best fitting model seems to be SAC model as in industry and services sectors, and again it shows strong evidence of absolute and conditional convergence and also a high significance level of spatiality for sectors total.

Table 10: Estimation results of the beta convergence model for sectors total in Turkey (2005–2011).

N: 182	Absolute convergence					Conditional convergence				
	AFR	SAR	SEM	SDM	SAC	AFR	SAR	SEM	SDM	SAC
Con- stant	2.19 (0.00)***					2.58 (0.00)***				
$Tpint$	−0.20 (0.00)***	−0.06 (0.03)**	−0.23 (0.00)***	−0.42 (0.00)***	−0.34 (0.00)***	−0.22 (0.00)***	−0.07 (0.05)**	−0.24 (0.00)***	−0.42 (0.00)***	−0.34 (0.00)***
pub- gskd academy						−0.45 (0.64)	−0.52 (0.54)	−0.41 (0.56)	−0.20 (0.80)	−0.09 (0.88)
						0.02 (0.58)	0.01 (0.65)	0.02 (0.33)	0.01 (0.69)	0.01 (0.57)
W^*				0.10 (0.00)***					0.10 (0.00)***	
$Tpint$									0.30 (0.37)	
W^*									−0.01 (0.51)	
pub- gskd W^* academy										
λ			0.06 (0.07)*		0.14 (0.00)***			0.04 (0.09)*		0.14 (0.00)***
ρ		0.27 (0.00)***		0.27 (0.00)***	−0.16 (0.00)***		0.27 (0.00)***		0.27 (0.00)***	−0.15 (0.00)***
Log L	239.26	171.39	240.81	198.38	250.16	240.01	171.64	241.41	199.04	250.33
AIC	−476.49	−336.77	−475.53	−388.76	−492.31	−474.03	−333.29	−472.82	−382.09	−488.65
SIC	−473.29	−327.16	−466.01	−375.94	−479.50	−464.42	−317.27	−456.80	−356.45	−469.43
df	1	3	3	4	4	3	5	5	8	6
LR Test SAC	21.8 (0.00)***					20.64 (0.00)***				
LR Test SDM	−81.76 (0.99)					−81.94 (0.99)				

Note: Probabilities are in parenthesis.

* show significance at 0.10

** show significance at 0.05

*** show significance at 0.01 respectively.

STATA 13 have been used for analysis. Log L: Log Likelihood, df: degrees of freedom, LR Test SAC: Unrestr. Model: SAC, Restr. Model: AFR, LR Test SDM: Unrestr. Model: SDM, Restr. Model: AFR.

As it can be seen from the tables above, spatial model estimations more or less show similar results, which can be summarized as strong absolute and conditional convergence and also strong spatiality. While same inference for strong convergence can also be made for the agriculture sector, strong spatiality among the regions of Turkey seems not so apparent in agriculture and results are substantially different from other sectors.

Table 11 shows test results for the agriculture sector. The spatial coefficients (ρ and λ) are not statistically significant for the SEM model in absolute and conditional convergence and for the SAC in conditional convergence. Also ρ is significant at 5% level in SAC model for absolute convergence. According to AIC, SAC is the best fitting model for industry, services and sectors total in absolute convergence models, but for conditional convergence models AIC and SIC both show the non-spatial AFR model as the best model. In all other sectors, LR test shows that the best fitting model is the SAC model, but in the agriculture sector it appears to be the non-spatial AFR model.

Table 11: Estimation results of the beta convergence model for agriculture sector in Turkey (2005–2011).

N: 182	Absolute convergence					Conditional convergence				
	AFR	SAR	SEM	SDM	SAC	AFR	SAR	SEM	SDM	SAC
Con- stant	4.91 (0.00)***					6.72 (0.00)***				
Tarint	−0.51 (0.00)***	−0.34 (0.00)***	−0.52 (0.00)***	−0.67 (0.00)***	−0.58 (0.00)***	−0.58 (0.00)***	−0.44 (0.00)***	−0.58 (0.00)***	−0.67 (0.00)***	−0.61 (0.00)***
pub- gskd						1.74 (0.48)	0.23 (0.92)	1.76 (0.31)	0.87 (0.68)	1.86 (0.29)
academy						0.15 (0.00)***	0.21 (0.00)***	0.15 (0.00)***	0.09 (0.12)	0.13 (0.01)**
W*				0.18 (0.00)***					0.19 (0.00)***	
Tarint									0.30 (0.73)	
W*										
pub- gskd										
W*										
academy									−0.04 (0.16)	
λ			0.01 (0.65)		0.08 (0.00)***			−0.01 (0.83)		0.05 (0.27)
ρ		0.26 (0.00)***		0.27 (0.00)**	−0.09 (0.01)**		0.26 (0.00)***		0.27 (0.00)***	−0.06 (0.19)
Log L	64.39	−10.35	64.50	15.38	67.44	70.68	−4.31	70.70	17.52	71.57
AIC	−126.78	26.70	−122.99	−22.76	−126.88	−135.36	18.61	−131.40	−19.05	−131.13
SIC	−123.58	36.32	−113.38	−9.95	−114.06	−125.74	34.63	−115.38	6.58	−111.91
df	1	3	3	4	4	3	5	5	8	6
LR Test SAC	6.1 (0.11)					1.78 (0.99)				
LR Test SDM	−98.02 (0.99)					−106.32 (0.99)				

Note: Probabilities are in parenthesis.

* show significance at 0.10

** show significance at 0.05

*** show significance at 0.01 respectively.

STATA 13 have been used for analysis. Log L: Log Likelihood, df: degrees of freedom, LR Test SAC: Unrestr. Model: SAC, Restr. Model: AFR, LR Test SDM: Unrestr. Model: SDM, Restr. Model: AFR.

Moreover, the *pubgskd* and *academy* variables are not statistically significant. From the chosen SAC models, coefficient of *pubgskd* is significant at 1% level for the services sector but does not have the expected positive sign. Also it is not significant for both the agriculture sector and sectors total. It is only significant at 5% level and has the expected sign in industry sector. We achieved similar complicated results for the *academy* variable. While coefficient of *academy* variable is significant at 5% level for industry sector, it hasn't got the expected positive sign. It is also insignificant for services sector and sectors total. We can only reach expected positive sign and significant coefficient at 5% level for agriculture sector.

Relying on these test results, we can argue that absolute and conditional convergence hypothesis holds in all sectors and sectors total. We can also argue that industry, services and also sectors total show strong spatial interactions but there is no sufficient evidence on the existence of spatiality among the regions of Turkey for the agriculture sector.

One interesting result in the analysis above is that the SAC models show statistically significant and both negative (ρ) and positive (λ) spatial dependence for industry, services and sectors total. As Kao and Bera (2016) pointed out, while most methodological papers are concerned with positive spatial dependence, the prevalence of negative spatial dependence is not uncommon in many applied papers. For example Filiztekin (2009) studied regional unemployment disparities in Turkey by using spatial parametric and non-parametric techniques. He

showed that the spatially lagged unemployment variable is significant and negative in Turkey. In our analysis, negative spatial dependence can be interpreted that regions surrounded with relatively lower labor productivity observe higher labor productivity. One reason for this negative autocorrelation could be the existence of competition between regions rather than cooperation. According to our SAC models, regions in Turkey show a mixture of both competitive and cooperative labor productivity relationship.

It can also be said that the convergence pace will accelerate if spatial interactions are considered in the models. As it can be seen from Table 8 to Table 11, SAC models have bigger convergence coefficients than AFR models for both absolute and conditional convergence. Nevertheless, the difference between convergence coefficients between SAC models and AFR models is smaller in the agriculture sector.

Our results are robust to the choice of the spatial weight matrix. We also used row standardized rook contiguity, k-3 nearest neighbors and inverse distance matrix as spatial weight matrices. Rook contiguity gives the same coefficients and significance levels for all the analysis in the study. This supports the argument of Gezici and Hewings (2007) that using queen or rook contiguity does not affect the results since all neighbors in Turkey have common boundaries rather than nodes. For k-3 nearest neighbors and inverse distance matrices, the agriculture sector still does not show strong evidence of spatiality while the absolute and conditional convergence hypotheses still hold.

7 Conclusions and Recommendations

Regional disparities in Turkey have long characterized the economic and social landscape. Even as the country nearly tripled its per capita income in less than a decade, regional income disparities remained unresolved. However, the ongoing convergence process among the regions may help in reducing the severity of this regional disparity problem.

In this respect, we have investigated the spatial dimensions of sectoral absolute and conditional labor productivity convergence in Turkey. We have shown that there are significant spatial effects among the regions of Turkey except for the agriculture sector. The reasons for this weak or non-existence of spatial effects are the structural problems that the Turkish agriculture sector faces. First of all, unlike developed countries, the organizational structure of agriculture sector in Turkey can be described as rudimentary. The Turkish agricultural labor force is immobile due to the fact that agricultural activity is mostly carried out on inherited farms and in the homelands of farmers. In addition, small-scale and partitioned land use, limited amount of research and development activities, and very little, if any, technology and knowledge transfer in the sector may also be among the main reasons for the non-existence of spatial interactions in the sector. Our models, on the other hand, have confirmed that the agricultural sector in Turkey is convergent. As Filiztekin (1998) noted, migration from regions with lower capital-labor ratio and low wages to regions where capital-labor ratio and wages are high have been occurring since the 1950s. As we mentioned earlier the agricultural labor force in one region does not migrate to other regions in order to be employed in agriculture again. In fact, the agricultural labor force in one region, tends to migrate other regions to participate in the industrial or services sectors. In this respect, when the agricultural labor force exits from the sector and participates in the industrial or services sectors, the output/input ratio in agriculture increases. These effects could be the main reasons behind the convergence process in the agriculture sector in Turkey.

An interesting point to mention here also is that both *pubgskd* and *academy* variables have insignificant coefficients which means that public expenditures and human capital have no effects. One possible reason for the insignificance of *pubgskd* is that the data seems to underestimate the true value of public investments. Our data reflects only central government's investment allocations and ignores investments carried out by local municipalities or other public institutions. Also our data classifies an investment project as "miscellaneous provinces" if the investment project covers more than one province. The insignificance of *academy* variable may be the result of its inadequacy as a measure of human capital.

In the area of public policies, for many years, policy makers believed that spatial effects are somehow arbitrary. But it is now widely accepted that space really matters. Knowing that policies may have spatial effects should push policy makers to take into account spatial interactions when devising their policies. Without such knowledge on spatiality of sectors among the regions of Turkey, all efforts to reduce disparities in the country will be greatly fizzled. Only by considering whether spatial effects are important or not, such a successful implementation of regional and sectoral development strategies in Turkey will be realized.

Notes

¹Dall'erba (2005) attributed the term to Mankiw (1995) and Quah (1995).

²Industry Sector: Mining, Quarrying, Manufacturing and Energy production; Other Sectors: Construction, Real Estate Activities, Sewerage, Waste Management, Trade, Transport, Communication, Education, Financial Institutions, Ownership of Dwelling, Business and Personnel Services, Private Non Profit Institutions, Government Services, Import Duties.

³In particular, we have considered three more specifications such as rook contiguity, k-3 nearest neighbors and inverse distance matrix. Complete results are available from the corresponding author upon request.

⁴Since Rogers (1993) introduced this estimator in the Stata software, we prefer to use AFR (Arellano-Froot-Rogers) abbreviation for this estimator in our study.

References

- Abdioğlu, Zehra, and Taner Uysal. 2013. "Türkiye'de Bölgeler Arası Yakınsama: Panel Birim Kök Analizi." *Atatürk Üniversitesi İktisadi ve İdari Bilimler Dergisi* 27 (3): 125–143.
- Abramovitz, Moses. 1986. "Catching Up, Forging Ahead, and Falling Behind." *The Journal of Economic History* 46 (2): 385–406.
- Akçagün, Pelin. 2016. "Provincial Growth in Turkey: A Spatial Econometric Analysis." *Applied Spatial Analysis and Policy*. 20February2016. DOI:10.1007/s12061-016-9183-5.
- Aldan, Altan, and Esma Gaygısız. 2006. *Convergence across Provinces of Turkey: A Spatial Analysis*. Turkey: Central Bank of the Republic of Turkey Paper No: 06/09.
- Anselin, Luc, Julie Le Gallo, and Hubert Jayet. 2008. "Spatial Panel Econometrics." In *The Econometrics of Panel Data Fundamentals and Recent Developments in Theory and Practice*, edited by L. Matyas, and P. Sevestre, 625–660. Berlin: Springer-Verlag.
- Arbia, Giuseppe, and Jean H. P. Paelinck. 2003. "Economic Convergence or Divergence? Modeling the Interregional Dynamics of EU Regions, 1985-1999." *Journal of Geographical Systems* 5: 291–314.
- Arellano, Manuel. 1987. "Computing Robust Standard Errors for Within-groups Estimation." *Oxford Bulletin of Economics and Statistics* 49 (4): 431–434.
- Armstrong, Harwey W. 1995. "Convergence among the Regions of the European Union, 1950–1990." *Papers in Regional Science* 74 (2): 143–152.
- Barro, Robert J., and Jong-Wha Lee. 2013. "A New Data Set of Educational Attainment in the World, 1950–2010." *Journal of Development Economics* 104: 184–198.
- Barro, Robert J., and Xavier Sala-i-Martin. 1992. "Convergence." *The Journal of Political Economics* 100 (2): 223–251.
- Baumol, William J. 1986. "Productivity Growth, Convergence, and Welfare: What the Long-Run Data Show." *The American Economic Review* 76 (5): 1072–1085.
- Baumol, William J., and Edward N. Wolff. 1988. "Productivity Growth, Convergence, and Welfare: Reply." *The American Economic Review* 78 (5): 1155–1159.
- Baypınar, Mete B. *Economic Globalization and Regional Inequalities in Turkey: A Spatial Analysis on Productivity Growth and Convergence*. Turkey: Istanbul Technical University, 2010. PhD diss.
- Bernard, Andrew B., and Steven N. Durlauf. 1995. "Convergence in International Output." *Journal of Applied Econometrics* 10 (2): 97–108.
- Bernard, Andrew B., and Charles I. Jones. 1996. "Productivity Across Industries and Countries: Time Series Theory and Evidence." *The Review of Economics and Statistics* 78 (1): 135–146.
- Birkan, Ayşe O., and Serpil K. Akdoğan. 2016. "The Geography of Financial Intermediation in Turkey: 1988–2013." *Annals of Regional Science*. Accessed 16 April 2016. DOI:10.1007/s00168-016-0759-4.
- Budak, Dilek B., Fahri Yavuz, and Aykut Gül. (2007). Rural Technology Transfer in Transition Economies in Turkey. 2016.. CEEC AGRI POLICY Project. Fourth 6 Monthly Report No: 513705. Accessed 20 April 2016. <http://www.euroqualityfiles.net/cecap/Report%204/Section%202%20country%20report/CEECAP%20report%204%20section%202%20overview.pdf>.
- Castellacci, Fulvio, Bart Los, and Gaaitzen J. De Vries. 2014. "Sectoral Productivity Trends: Convergence Islands in Oceans of Non-Convergence." *Journal of Evolutionary Economics* 24: 983–1007.
- Dall'erba, Sandy. 2005. "Productivity Convergence and Spatial Dependence among Spanish Regions." *Journal of Geographical Systems* 7: 207–227.
- De Long, J. Bradford 1988. "Productivity Growth, Convergence, and Welfare: Comment." *The American Economic Review* 78 (5): 1138–1154.
- De Long, J. Bradford, and Lawrence H. Summers. 1991. "Equipment Investment and Economic Growth." *The Quarterly Journal of Economics* 106 (2): 445–502.
- Delvecchio, Micah. *The Use of Conditional Convergence between Economies to Estimate Steady State Incomes within Economies*, Colorado State University, 2014. PhD Diss.
- Dowrick, Steve, and Duc-Tho Nguyen. 1989. "OECD Comparative Economic Growth 1950–1985: Catch-Up and Convergence." *The American Economic Review* 79 (5): 1010–1030.
- Elhorst, J. Paul. 2014. *Spatial Econometrics from Cross-Sectional Data to Spatial Panels*. Groningen, The Netherlands: Springer.
- Elhorst, J. Paul, Gianfranco Piras, and Giuseppe Arbia. 2010. "Growth and Convergence in a Multiregional Model with Space-Time Dynamics." *Geographical Analysis* 42: 338–355.
- Ertur, Cem, and Wilfried Koch. 2007. "Growth, Technological Interdependence and Spatial Externalities: Theory and Evidence." *Journal of Applied Econometrics* 22 (6): 1033–1062.
- Evans, Paul, and Georgios Karras. 1996. "Convergence Revisited." *Journal of Monetary Economics* 37: 249–265.
- Filiztekin, Alpay. 1998. *Convergence Across Industries and Provinces in Turkey*. Koç University Working Papers.. DOI:Paper No: 1998/08.
- Filiztekin, Alpay. 2009. "Regional Unemployment in Turkey." *Papers in Regional Science* 88 (4): 865–878.

- Fingleton, Bernard, and Lopez-Bazo Enrique. 2006. "Empirical Growth Models with Spatial Effects." *Papers in Regional Science* 85 (2): 177–198.
- Frantzen, Dirk. 2004. "Technological Diffusion and Productivity Convergence: A Study for Manufacturing in the OECD." *Southern Economic Journal* 71 (2): 352–376.
- Froot, Kenneth A. 1989. "Consistent Covariance Matrix Estimation with Cross-sectional Dependence and Heteroskedasticity in Financial Data." *Journal of Financial and Quantitative Analysis* 24 (3): 333–355.
- Gezici, Ferhan, and Geoffrey J. D. Hewings. 2004. "Regional Convergence and the Economic Performance of Peripheral Areas in Turkey." *Review of Urban & Regional Development Studies* 16 (2): 113–132.
- Gezici, Ferhan, and Geoffrey J. D. Hewings. 2007. "Spatial Analysis of Regional Inequalities in Turkey." *European Planning Studies* 15 (3): 383–403.
- Grier, Kevin B., and Gordon Tullock. 1989. "An Empirical Analysis of Cross-National Economic Growth, 1951–80." *Journal of Monetary Economics* 24: 259–276.
- Gürsel, Seyfettin, and Zümrüt İmamoğlu. 2013. *Why is Agricultural Employment Increasing in Turkey*. Bahçeşehir University, Turkey: BETAM Working Paper Series. DOI: Paper No.4.
- Islam, Nazrul. 1995. "Growth Empirics: A Panel Data Approach." *The Quarterly Journal of Economics* 110 (4): 1127–1170.
- James, Ryan D., and Harrison S. Campbell Jr. 2014. "The Impact of Space and Scale on Conditional Convergence: Test Results From the United States (1970–2004)." *Annals of GIS* 20 (1): 11–21.
- Kao, Sheena Yu-Hsien, and Anil K. Bera. 2016. *Spatial Regression: The Curious Case of Negative Spatial Dependence*. Urbana-Champaign, Mimeo: University of Illinois.
- Karaca, Orhan. 2004. *Türkiye’de Bölgeler Arası Gelir Farklılıkları: Yakınsama Var Mı?*. Turkish Economic Association Discussion Paper Paper No: 2004/7.
- Karaman, Fatma, and Fatma Doğruel. Regional Convergence in Turkey: The Role of Government in Economic Environment Augmenting Activities. 2011. Accessed 11 December 2015. No: 34271. Munich Personal Repec Archive <https://mpra.ub.uni-muenchen.de/34271>.
- Kılıçaslan, Yılmaz, and Güldem Özatağan. 2007. "Impact of Relative Population Change on Regional Income Convergence: Evidence from Turkey." *Review of Urban and Regional Development Studies* 19 (3): 210–223.
- Le Gallo, Julie, and Sandy Dall’erba. 2008. "Spatial and Sectoral Productivity Convergence between European Regions, 1975–2000." *Papers in Regional Science* 87 (4): 505–526.
- Le Gallo, Julie, and Cem Ertur. 2003. "Exploratory Spatial Data Analysis of the Distribution of Regional Per Capita GDP in Europe, 1980–1995." *Papers in Regional Science* 82: 175–201.
- Lopez-Bazo, Enrique, Esther Vaya, and Manuel Artis. 2004. "Regional Externalities and Growth: Evidence from European Regions." *Journal of Regional Science* 44 (1): 43–73.
- Lopez-Bazo, Enrique, Esther Vaya, Antonio J. Mora, and Jordi Surinach. 1999. "Regional Economic Dynamics and Convergence in the European Union." *Annals of Regional Science* 33: 343–370.
- Mahmood, Tahir. 2012. "Labor Productivity Convergence in 52 Industries: A Panel Data Analysis of Some European Countries." *International Journal of Economics and Financial Issues* 2 (3): 320–339.
- Mankiw, Gregory N. 1995. "The Growth of Nations." *Brookings Paper on Economic Activity* 1: 275–326.
- Mankiw, Gregory N., David Romer, and David N. Weil. 1992. "A Contribution to the Empirics of Economic Growth." *The Quarterly Journal of Economics* 107 (2): 407–437.
- Miller, Stephen M., and Mukti P. Upadhyay. 2002. "Total Factor Productivity and the Convergence Hypothesis." *Journal of Macroeconomics* 24: 267–286.
- Önder, A. Özlem, Ertuğrul Deliktaş, and Metin Karadağ. 2010. "The Impact of Public Capital Stock on Regional Convergence in Turkey." *European Planning Studies* 18 (7): 1041–1055.
- Özgül, Seda, and Metin Karadağ. 2015. "Regional Convergence in Turkey Regarding Welfare Indicators." *Sosyoekonomi* 23 (24): 38–50.
- Öztürk, Murat. 2012. *Agriculture, Peasantry and Poverty in Turkey in the Neo Liberal Age*. The Netherlands: Wageningen Academic Publishers.
- Papalia, Rosa Bernardini, and Silvia Bertarelli. 2009. "Decomposing Productivity Patterns in a Conditional Convergence Framework." *Journal of Productivity Analysis* 31 (1): 57–75.
- Piras, Gianfranco, and Giuseppe Arbia. 2007. "Convergence in Per-Capita GDP Across EU-NUTS 2 Regions Using Panel Data Models Extended to Spatial Autocorrelations Effects." *Statistika LXVII* (2): 157–172.
- Quah, Danny T. 1993. "Galton’s Fallacy and Tests of the Convergence Hypothesis." *The Scandinavian Journal of Economics* 95 (4): 427–443.
- Quah, Danny T. Regional Convergence Clusters across Europe. 1995. Accessed 20 April 2016. Paper No: 274. Centre for Economic Performance <http://cep.lse.ac.uk/pubs/download/DP0274.pdf>.
- Republic of Turkey Ministry of Development. 2015 Yılı Yatırım Programı Kamu Yatırımlarının İllere Göre Dağılımı. 2015. Accessed 12 November 2015. <http://www.kalkinma.gov.tr>.
- Rey, Sergio J., and Brett D. Montouri. 1999. "US Regional Income Convergence: A Spatial Econometric Perspective." *Regional Studies* 33 (2): 143–156.
- Rogers, William H. 1993. "Regression Standard Errors in Clustered Samples." *Stata Technical Bulletin* 13: 19–23.
- Sala-i-Martin, Xavier. 1996a. "Regional Cohesion: Evidence and Theories of Regional Growth and Convergence." *European Economic Review* 40: 1325–1352.
- Sala-i-Martin, Xavier. 1996b. "The Classical Approach to Convergence Analysis." *The Economic Journal* 106 (437): 1019–1036.
- Solow, Robert M. 1956. "A Contribution to the Theory of Economic Growth." *The Quarterly Journal of Economics* 70 (1): 65–94.
- Temel, Tuğrul, Aysit Tansel, and Peter J. Albersen. 1999. "Convergence and Spatial Patterns in Labor Productivity: Nonparametric Estimations for Turkey." *The Journal of Regional Analysis and Policy* 29 (1): 3–19.
- Temel, Tuğrul, Aysit Tansel, and Nil Demet Güngör. 2005. "Convergence of Sectoral Productivity in Turkish Provinces: Markov Chains Model." *International Journal of Applied Econometrics and Quantitative Studies* 2 (2): 65–98.
- The Central Bank of the Republic of Turkey Electronic Data Delivery System. 2016. Accessed 17 February 2016. <http://evds.tcmb.gov.tr>.
- Tobler, Waldo. 1970. "A Computer Movie Simulating Urban Growth in the Detroit Region." *Economic Geography* 46: 234–240.

- Turkish Statistical Institute. 2016. Accessed 20 April 2016. www.tuik.gov.tr.
- Turkish Union of Chambers and Commodity Exchanges. 2013. *Turkish Agriculture Report* Ankara, Turkey: Afşaroğlu Matbaası.
- Ulusoy, Veyssel, and Erkan Yalçın. 2011. "Convergence of Productivity Levels Among the EU Countries: Evidence From a Panel of Industries ." *Australian Economic Papers* 50 (2–3): 98–114.
- Villaverde, Jose, and Adolfo Maza. 2008. "Productivity Convergence in the European Regions, 1980–2003: A Sectoral and Spatial Approach ." *Applied Economics* 40: 1299–1313.
- Yıldırım, Jülide. 2005. "Regional Policy and Economic Convergence in Turkey: A Spatial Data Analysis." In *18th European Advanced Studies*. Poland: Institute in Regional Science.
- Yıldırım, Jülide, and Nadir Öcal. 2006. "Income Inequality and Economic Convergence in Turkey ." *Transition Studies Review* 13 (3): 559–568.
- Yıldırım, Jülide, Nadir Öcal, and Süheyla Özyıldırım. 2008. "Income Inequality and Economic Convergence in Turkey: A Spatial Effect Analysis ." *International Regional Science Review* 32 (2): 221–254.
- Zeren, Fatma, and Veli Yılancı. 2011. "Türkiye’de Bölgeler Arası Gelir Yakınsaması: Rastal Katsayılı Panel Veri Analizi Uygulaması ." *Business and Economics Research Journal* 2 (1): 143–151.