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The Regional Dynamics of Economic Growth: Evidence from GMM Estimation in Turkey

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Abstract

Recently, a growing body of research has dealt with the causes of growth differences in the context of regional economies. It can be argued that such differences mostly arise from a variety of economic and structural determinants pertain to regional characteristics. This study investigates the effects of potential determinants of regional economic growth in Turkey. In this respect, we examine the impact of human capital, R&D, exports, public investments, inflation and unemployment on per capita regional income across the 26 NUTS 2 regions for the

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2008-2014 period. The results of the difference and the system GMM estimations show that human capital and R&D are essential for economic growth at a regional level. According to the results, exports, public investments, and inflation are also important determinants of regional economic growth. However, empirical results indicate an inverse relationship between regional growth and unemployment.

Keywords: Regional economic growth, human capital, R&D, public investments, GMM, Turkey.

JEL Classification: R11, O47, C36.

Introduction

The spatial aspect of the economy has long been the center of attention for both researchers and policy-makers. In this context, the dynamics of regional growth have been discussed by a variety of fields in economics such as economic growth theory (Richardson, 1973; von Böventer, 1975), new economic geography approach (Krugman, 1991, 1995; Fujita et al., 1999) and urban economics (Nijkamp and Mills, 1986; Miyao, 1987; Camagni, 1992; Capello and Nijkamp, 2004). According to the discussions, one of the main dilemmas is the causes of regional disparities (Barro and Sala-i-Martin, 1991; Quah, 1996). In regard to providing a long-run improvement in per capita income and output inequalities, Neo-classical theory focuses on why disparities increase among regions and why regions economically diverge from each other over time (Pike et al., 2006; Alexiadis, 2013). Barro and Sala-i-Martin (1991) extend the empirical evidence on such disparities suggesting a low speed of convergence (approximately 2% annually) between regions worldwide. Also, recent growth theories examine the endogenous dynamics

of economic growth in a particular space (in national, regional or firm levels) as a source of social (Romer, 1986, 1990) or a unique and specialized stock of knowledge (Lucas, 1988) and innovations (Aghion and Howitt, 1992) establishing an explicit linkage with regional economy (Izushi, 2008; Roberts and Setterfield, 2010). Moreover, in the context of new economic geography approach, Krugman (1991, 1995) refers some advantages of regional economies related to competitive components of productivity and growth. In this point of view, concentration of economic activities which result in specialization and externalities of knowledge are likely to be realized at regional level rather than national or international context (Krugman, 1991, 1995). In addition to the discussions above, it is possible to conclude that there is a need for a more sophisticated insight into regional patterns of growth in economic theory (Storper, 2011; Huggins et al., 2014).

Despite the fact that existing empirical studies often investigate determinants of growth in the national or cross-country level, there is a growing body of research that attaches strategic importance to the regions in the global economic system. As a part of this literature, a majority of empirical results shows that the pace of global and national economic growth primarily depends on local dynamics acting at a regional level (Karlsson et al., 2001, p. 3; Crespo-Cuaresma et al., 2011, p. 810). Regional economies are often characterized by a variety of macroeconomic, microeconomic, structural and institutional factors such as physical and human capital, infrastructure, trade, innovation, and public policies. Also, most of these factors interact with each other at regional level (OECD, 2009, p. 3; Pires Manso et al., 2015, p. 11).

Turkish economy has some distinct regional characteristics pertain to its geopolitical position. The western part of the country is socio-economically more developed with the diversified industrial sector and a high level of commercial activities. While the economy of the region called Central Anatolia is mostly based on agriculture, livestock and manufacturing industry, tourism has an important share in the economies of southern coastal regions. Due to the geographical and infrastructural constraints in the Black Sea region, the development of industry is at an insufficient level. Similarly, deficiencies in transportation, irrigation, and labor markets are an important obstacle for the industry and agriculture in the regions covering Eastern and South-Eastern Anatolia, despite quite rich reserves in terms of underground resources and vast territory. Considering the regional economic characteristics, it can be stated that the high value-added production, investments, local and international competitiveness, qualified labor supply and income distribution are the main policy priorities in Turkey.

In this study, our aim is to investigate a set of potential factors that can be effective in regional economic growth in Turkey. In this respect, we examine the effects of human capital, research and development (R&D), exports, public investments, inflation, and unemployment on per capita regional income across the 26 NUTS (Nomenclature of Territorial Units for Statistics) 2 regions for the 2008-2014 period. In the analysis, we use the difference GMM (Arellano and Bond,1991) and the system GMM (Arellano and Bover, 1995; Blundell and Bond,1998) estimation methods. The primary contribution of our study is to combine the main determinants of the endogenous growth with fundamental structural variables so as to shed further light on the growth dynamics. All the data used in analysis are based on Turkish Statistical Institute (TurkStat), Turkish Patent and Trademark Office

(TPTO) and Republic of Turkey, Ministry of Economy. The remainder of the paper proceeds as follows. Section 2 discusses factors affecting regional growth and development. A review of empirical literature is given in section 3. Section 4 presents dataset and econometric model used in the analysis. Section 5 summarizes empirical results and section 6 concludes the paper.

Dynamics of Regional Economic Growth

In the context of economic literature, determinants of growth have been examined in a broad sense within different aspects. Although there is no consensus about the main determinants of regional growth, income and productivity changes are referred to various socio-economic, political and structural factors including human capital, R&D, trade, investments, and some macroeconomic variables. In this respect, differences in human capital at the regional level can also explain differences in regional economic growth (Rutten and Boekema, 2007; Sterlacchini, 2008). Human capital is defined as accumulation of time spent in education and training and, thus, the individuals can increase their human assets unlimitedly for a lifetime (Grossman and Helpman, 1993, p. 19). According to new models of endogenous growth, advancements in knowledge level and technology as main sources of growth take place in a process involving human interactions and activities (Freeman, 1995, p. 17; Howells, 2005, p. 1221). In this process, a higher stock of knowledge which is embodied in the form of human capital or capital goods can also enable a greater level of technology (Baetjer, 2000). Thus, human capital indirectly contributes to productivity and growth by means of learning and increasing level of skill and talent (Mathur, 1999, p. 210).

The combination of human capital and learning also provides the formation of R&D which is another triggering factor in economic growth. Considering the fact that innovations have an essential role in the economic system, the realization of crucial innovations and growth will decrease over time in a system with insufficient technology level. Therefore, the success of the system might be achieved by directing existing physical and human assets into R&D capital (Aghion and Howitt, 1992, p. 349). Also, it is often recognized that investment in basic and applied research leads to an increase in innovations which in turn stimulate productivity and growth (Rodríguez-Pose and Crescenzi, 2008, p. 53). Another influencing factor of growth is related to public intervention which basically aims to ensure a higher and equal growth within regions. Hirschman (1958) argues that government has a positive impact on economy through infrastructure, education and health investments. In this respect, the role of central government in reallocating investment among regions might induce aggregate efficiency and regional equality in welfare (Wu, 1987, p. 5). Aschauer (1990) asserts that public investment is a stimulative factor behind the private sector outputs through increasing rate of return to private capital and, thus, private investment expenditures. Moreover, a good planned public investment decision may significantly contribute to economic growth and productivity improvements (Aschauer, 1989, p. 197).

Trade is also an important driver of the short and long-run growth in terms of local and global value chains (Farole, 2013, p. 22). The effect of international trade on regional economic growth occurs by various forms including efficient reallocation of resources via specialization, emergence of economies of scale, better transfer of technology-intensive knowledge, and increasing production of

competitive goods (Soukiazis and Antunes, 2011, p. 1364; D'Costa et al., 2013, p. 5). Boschma and Iammarino (2009) suggest that better integration of the regions into global economic system diversifies the flows of knowledge and contributes a higher level of growth. Thus, trade plays a crucial role in technological progress through promoting a competitive manner of learning and accelerating emergence of innovations (Boschma and Iammarino, 2009, p. 294-296).

The nexus between economic growth and unemployment is a much-debated issue in the literature. A high rate of unemployment may bring about a deterioration in national and regional economies. It also indicates an inefficient use of the resources and a loss of potential output in a country or a region. In this context, unemployment can be regarded as one of the main causes of poverty and insufficient economic growth (Thirlwall, 2001, p. 39; Van Dijk et al., 2009, p. 461). Reinstadler and Ray (2010) conclude that unemployment at a regional level is likely to negatively affect individuals with low levels of income due to diminishing labor demand and downward pressure on wages. Besides, in their study Aghion and Howitt (1994) propound that a low level of unemployment stimulates growth, despite a high unemployment rate slows down the growth process (Aghion and Howitt, 1994, p. 491). Similarly, Eriksson (1997) argues that indirect changes in exogenous parameters of growth which decrease unemployment also allow a higher level of endogenous growth (Eriksson, 1997, p. 78).

In regard to factors affecting regional growth, inflation can also lead to uncertainty in decisions of economic agents (Briault, 1995). Friedman (1977) refers a negative effect of inflation on welfare and growth based on nominal variability of prices. Fischer (1993) states that inflation hampers growth by reducing investments

and productivity. Bassanini et al. (2001) indicate a detrimental effect of high inflation on capital accumulation. However, some economists suggest that a low or "moderate" inflation could be beneficial to the economy. This view asserts that sufficiently low inflation helps to enable adjustment of relative wages and prices in labor and financial markets. Also, moderate inflation can enhance a higher steady-state level of output per capita, a higher rate of employment and a more stable economy (Marty and Thornton, 1995, p. 27; Poole and Wheelock, 2008, p. 5).

Review of Empirical Literature

Following both classical and new theories of growth, numerous empirical studies deal with the components of income and productivity growth at regional level. It is seen that most of these studies are related to developed countries and country groups as well as some developing economies. As a seminal paper discussing patent applications as an output of R&D activities, Pakes (1985) shows that current and past changes in R&D have a significant effect on the counts of patent applications in U.S for the 1968-1975 period. In the context of the European Union, Kaldewei and Walz (2001) examines the growth determinants across the NUTS 2 regions in 11 member countries for the 1980-1996 period. The study indicates a significantly positive relationship between average growth rate of GDP per capita and patents as an output of R&D. The results of their analysis also revealed that the share of employment in financial sector and high intensity of human capital have a positive impact on regional growth. These results are confirmed by study of Rodríguez-Pose and Crescenzi (2008) which attempts to explore growth determinants of NUTS 1 and NUTS 2 regions in Europe for the 1995-2003 period. Their findings show that intra-regional R&D activities and educational

endowment of human resources have a significantly positive impact on regional growth. In another study concerning Europe (197 NUTS 2 regions), Sterlacchini (2008) deals with intellectual capital as human capital and knowledge (R&D) capital endowments. According to the analysis conducted for the 1995-2002 period, there is a positive and significant relationship between human capital and regional growth, while the positive effect of R&D is significant only for relatively high-income regions. On the contrary, D'Costa et al. (2013) obtain some contradictory results in OECD sample. Their findings obtained from the panel data of 217 regions in 22 countries indicate a significantly negative impact on productivity growth in terms of human capital measured by labor force with tertiary education and inflation, while the effect of patent intensity measured by total number of patent applications per thousand inhabitants is negative and insignificant. However, the results show that trade-openness is an important determinant of regional productivity growth and it is more beneficial to lagging regions in growth process.

Regarding the country studies in Europe, Soukiazis and Antunes (2011) show that human capital and exports are relevant factors in explaining regional growth and convergence in Portuguese NUTS 3 regions during the 1996–2005 period. Also, Pires Manso et al. (2015) reach similar results indicating a positive and significant relationship between GDP per capita and employment, exports and educational infrastructure for the 1999-2010 period in Portugal. In another European country, Bere et al. (2014) examine the determinants of growth in Romanian cities for the 1996-2010 period. They find that unemployment has a negative impact on GDP per capita, while R&D expenditures positively affect economic growth at a

regional level. Shevchuk (2014) investigates the sources of regional growth in 26 Ukrainian regions for the 2002-2012 period. The results of the difference GMM estimations reveal that per capita exports of goods and stock of physical capital have a positive impact on regional output per capita. Besides, results point out a significantly negative effect of inflation and per capita exports of services on per capita output. In their study, Mikuli**ć** and Nagyszombaty (2015) obtain the same findings within Croatian counties for the 2000-2011 period. They conclude that per capita exports and investments in fixed assets such as infrastructure are essential factors behind the regional economic growth. In addition, they do not find any significant evidence for positive effect of education variable represented by the share of population in tertiary education.

In the context of developing countries, Chen and Wu (2005) point out a negative effect of investment in fixed assets on the growth of 29 provinces in China for the 1988-1998 period. Their results based on the error components model (ECM) indicate that number of government researchers in R&D sector and human resources measured by participation rate to primary education have a negative impact on real growth rate of income per capita. The findings also demonstrate that the growth rate of total employment with all educational levels affects regional growth positively. The latter result is in line with Rodríguez-Oreggia (2005) who investigates the 32 Mexican states. The results of the study reveal that the share of the labor in medium skill occupations as a proxy for human capital is likely to be essential for improvements in regional growth and disparities. Also, Pernia and Quising (2003) conclude that improvements in volume of exports and human capital measured by average year of schooling appear to be beneficial to regional

economic growth in Philippines for the1988-2000 period. In another study, Cravo et al. (2015) explore the determinants of growth in a panel of 508 Brazilian micro-regions for the period 1980–2004. They find that the level of human capital is an important growth determinant in terms of SMEs in manufacturing industry and human capital embodied in SMEs is more influential than the size of the sector for regional growth.

As part of empirical literature concerning the regional growth dynamics in Turkey, Gezici and Hewings (2004) examine income convergence within provincial regions for the 1987-1997 period. The findings of the estimated conditional model indicate a positive relationship between public investments and per capita regional income. Similarly, Yildirim et al. (2009) investigate the income inequality across various regional levels for the 1987-2001 period. Results of the spatial analysis reveal that a higher level of education enhances the regional growth equally, whereas the positive effect of per capita government expenditures is more appreciable in the western part of Turkey. In another recent study concerning Turkish regions, Mıhçı and Köksal (2010) examine the growth differences in a panel of 65 NUTS 3 regions (provinces) for the 1980-2000 period. The results of the analysis conducted by the OLS method with two-way fixed effects model imply that the share of industry in total employment and human capital measured by secondary school enrolment rate are significant determinants of growth in per capita regional income. However, it is concluded that per capita public investments have a negative and insignificant impact on regional growth. This result differs from the findings of Önder et al. (2010) in the context of NUTS 2 regions for the same

period. The results of the dynamic analysis with GMM estimation reveal that per capita public capital stock has a positive and significant effect on output per capita. In this regard, it can be argued that these results arise from stock and flow variables related to public investments and preferred estimation procedure.

Dataset and Econometric Model

This study employs the difference GMM (Generalized Method of Moments) dynamic panel estimation methods (Arellano and Bond, 1991) and the system GMM estimator (Arellano and Bover, 1995; Blundell and Bover, 1998) in order to investigate the regional dynamics of economic growth in Turkey. The dataset used in the analysis consists of 26 NUTS 2 regions[3] based on the period 2008-2014. The choice of the time period depends on the availability of data sources. In addition, all the data are obtained from regional level and used in logarithmic form. Abbreviations, definitions and data sources of the variables are given in Table 1.

In Table 1, Real GDP per capita $(lpcgdp)$ is employed as a dependent variable and expressed in Turkish Lira (TL). Since the consumer price index (CPI) values could not be reached at the regional level, we use national CPI in order to obtain per capita GDP in real terms. Regarding R&D activities, we consider an output-based approach to the purpose of better measuring the effective use of innovative inputs. According to empirical literature, patent statistics are regarded as one of the main outputs of R&D activities (Pakes, 1985; Acs et al., 2002; Pandit et. al., 2011). Despite the fact that direct measurement of human capital is a controversial topic, a variety of studies often use educational indicators (OECD,

[3] The list of NUTS 2 regions is given in the appendix.

2004). Thus, we examine patent applications (lrd) and the share of tertiary education graduates in total population $(lhum)$ in the long-run equation.

Table 1. Definitions and Sources of Variables

Variable	Abbreviation	Indicator	Source
Economic Growth	$lpcgdp$	Real GDP per capita	TurkStat (2017)
Research and Development	lrd	Patent Applications per 100,000 persons	TPTO (2017)
Human Capital	$lhum$	Share of tertiary education graduates in total population	TurkStat (2017)
Exports	lex	Total volume of exports	TurkStat (2017)
Public Investment	$lpcinvs$	Per capita public investments (current TL)	Republic of Turkey Ministry of Development (2015)
Inflation	$linf$	Percentage change in CPI	TurkStat (2017)
Unemployment	$lunmp$	Unemployment rate	TurkStat (2017)

In respect to international trade, Turkey has an import-dependent economy, especially due to intensive requirements for intermediate inputs in manufacturing industry and energy sector. In developing countries such as Turkey, export activities can encourage the firm-level production of competitive goods for international markets and emerging of scale economies in industrial level. Therefore, we prefer total volume of exports (lex) in order to investigate effect of competitive performance of the regions on growth, instead of openness measured by total volume of international trade. Besides, we use public investments $(lpcinvs)$ as another potential determinant of regional growth.

The other variables are the inflation rate $(linf)$ which represents price stability measured by Consumer Price Index (CPI), and the unemployment rate $(lunmp)$ that could be effective in the production capacity of a region. The data

for $lpcgdp, lhum, lex, linf$ and $lunmp$ are collected from the Turkish Statistical Institute (TurkStat, 2017), while lrd and $lpcinvs$ are compiled from the Turkish Patent and Trademark Office (2017) and the Republic of Turkey, Ministry of Development (2015), respectively.

Table 2. Descriptive Statistics and Normality Test Results

Variable	Mean	Std.Deviation	Minimum	Maximum	Skewness	Kurtosis	Jarque-Bera
$lpcgdp$	9.565	0.448	8.546	10.683	0.981	0.255	1.174
lrd	0.604	1.213	-3.001	2.765	0.005	0.428	8.361
$lhum$	-2.75	0.454	-4.081	-1.731	0.0008	0.170	13.93*
lex	14.10	1.613	10.25	18.22	0.445	0.638	0.591
$lpcinvs$	5.603	0.470	4.497	6.804	0.255	0.350	2.127
$linf$	2.059	0.244	1.232	2.598	0.941	0.475	0.640
$lunmp$	2.220	0.402	1.223	3.178	0.764	0.107	1.945

Note: * denotes the null hypothesis of a normal distribution is rejected at %99 significance level.

We conduct some preliminary tests in order to choose an appropriate panel data estimation method. Table 2 reports a summary of descriptive statistics and results of normality test. The results show that the mean values of the variables in the long-run equation are within the maximum and minimum limits and all the variables are positively skewed. According to Jarque-Bera statistics, the null hypothesis, which states that each variable has a normal distribution, cannot be rejected at 99% significance level for all the variables except the $lhum$. Thus, we conclude that $lpcgdp, lrd, lex, linf, lunmp$ and $lpcinvs$ have a normal distribution. The dynamic panel data regression model is given in equation (1).

$$lpcgdp_{it} = \alpha_0 + \alpha_1 lpcgdp_{i,t-1} + \alpha_2 lrd_{it} + \alpha_3 lhum_{it} + \alpha_4 lex_{it} + \alpha_5 lpcinvs_{it} + \alpha_6 linf_{it} + \alpha_7 lunmp_{it} + \eta_i + \mu_t + \varepsilon_{it} \quad (1)$$

In equation (1), i denotes the cross-section units, t represents the time dimension and ε_{it} is the error term. η_i is the individual-specific effect which takes the unobservable heterogeneity between the cross-section units into account, and μ_t is the time-specific effect. $lpcgdp_{i,t-1}$ is the one year lagged of GDP per capita in logarithmic form. This variable is also included in the long-run equation as the instrumental variable in order to eliminate endogeneity problem in the regression. In the analysis, we prefer xtabond2 command in STATA 14.

In dynamic panel data analysis, estimators require to use one or more instrumental variables as a lagged form of endogenous variables in the estimated model (Guetat and Sridi, 2017, p. 91). These estimators are preferred in case (i) there is a linear functional relationship between variables, (ii) the present value of the dependent variable depends on its past values or (iii) the independent variables are not strictly exogenous (Roodman, 2009, p. 86). Arellano and Bond (1991) suggest an estimation method that considers unobserved heterogeneity and predetermined regressors. This method has a good estimation power when the cross-section unit is relatively larger than the time dimension (large N, small T) (Moral-Benito et al., 2017, p. 7-8). The estimation process initially requires to take first difference of the equation in order to eliminate unobserved individual-specific effects (η_i) in the long-run regression. Because of this feature, Arellano and Bond (1991) estimator is called a difference or 1-step difference GMM method (Roodman, 2009, p. 86). The dynamic growth model as a first difference regression is shown in equation (2).

$$lpcgdp_{it} - lpcgdp_{i,t-1} = \mu_t - \mu_{t-1} + \alpha_1 lpcgdp_{i,t-1} + \alpha_2 lrd_{it} + \alpha_3 lhum_{it} + \alpha_4 lex_{it} + \alpha_5 lpcinvs_{it} + \alpha_6 linf_{it} + \alpha_7 lunmp_{it} + \varepsilon_{it} \quad (2)$$

The difference GMM method is criticized due to some biased results in small samples. If the variables are close to a random walk, the lagged levels are often weak instruments for first differences. Following the study of Arellano and Bond (1991), the system GMM estimator (Arellano and Bover, 1995; Blundell and Bond, 1998) includes some additional moment conditions based on two equations which are –"the original equation" and "the transformed one in differences"-. These methods are also called as 2-step difference GMM and 2-step system GMM estimators (Roodman, 2009, p. 86-87). The system GMM method uses the lagged differences of explanatory variables in the level equation, while it suggests the lagged levels of explanatory variables in the first difference equation as the instrumental variable (Guetat and Sridi, 2017, p. 91). Bond et al. (2001) argue that if the time series is persistent and the number of time series observations is small, the first-differenced GMM estimator is poorly behaved, especially in the context of empirical growth models. Also, they refer that the one-step and two-step GMM estimators are asymptotically equivalent for the first-differenced estimator in the special case of spherical disturbances. Otherwise the two-step estimator is more efficient, and this is always true for system GMM. However, it is seen that the two-step GMM estimator has the disadvantage of converging to its asymptotic distribution slowly with respect to Monte Carlo experiments. Thus, the two-step GMM estimators might be seriously downward biased and lead to underestimated inferences (Bond et al., 2001, p. 3-18).

Compared to the difference GMM, this estimator allows more instrumental variables and, thus, improves the power of estimation (Roodman, 2009, p. 86). The first equation used in the system GMM estimator is the same with the 1-step difference GMM method. The level equation is given in equation (3).

$$lpcgdp_{it} = \alpha_1 lpcgdp_{i,t-1} + \alpha_2 lrd_{it} + \alpha_3 lhum_{it} + \alpha_4 lex_{it} + \alpha_5 lpcinvs_{it} + \alpha_6 linf_{it} + \alpha_7 lunmp_{it} + \eta_i + \mu_t + v_{it} \quad (3)$$

We examine the consistency of the GMM results in terms of two tests. The first test investigates the existence of the first and second-order autocorrelation problems in differenced residuals, while the second one checks the over-identifying restrictions and the validity of the instrumental variables (Roodman, 2009, p. 98-119). In the context of autocorrelation problem, the difference GMM method often rejects the null hypothesis that the first differences of residuals are serially uncorrelated in AR(1) process (Mileva, 2007, p. 7). Considering the consistency of the GMM estimator, it is suggested that the first differences of residuals are not correlated in the AR(2) process (Hou and Chen, 2013, p. 188). Also, Hansen-J test (Hansen, 1982) is another tool for exploring the validation of instrumental variables in the difference and the system GMM robust estimations (Oseni, 2016, p. 108).

Empirical Results

Table 3 reports the robust estimations from the panel GMM method. Firstly, it is shown that all the variables are important determinants of regional economic growth and coefficients are consistent with the economic theory. According to the results obtained from the difference GMM estimator (Arellano and Bond, 1991), the lagged value of the dependent variable $lpcgdp_{it-1}$ and lrd_{it} have significantly positive effect on regional economic growth. Also, coefficients of human capital

$(lhum_{it})$, inflation $(linf_{it})$, exports (lex_{it}) and public investment $(lpcinvs_{it})$ variables have significantly positive signs. However, we find that unemployment rate $(lunmp_{it})$ negatively impacts regional economic growth in related period. This result reveals the disruptive effect of unemployment in regional economies.

When we evaluate the findings of the system GMM (Arellano and Bover, 1995; Blundell and Bond, 1998) together, it is seen that the lagged value of per capita income $lpcgdp_{it-1}$, $lhum_{it}$, $linf_{it}$, and $lpcinvs_{it}$, are the variables that affect regional growth positively at 99% significance level. Moreover, lex_{it}, which represents total exports is found significantly positive in both estimations. Similarly, the System GMM estimator reveals that unemployment $(lunmp_{it})$ affects regional growth negatively at the 99% significance level. However, the coefficient lrd_{it} has a positive sign in both estimations but it is found statistically insignificant according to Blundell and Bond (1998) estimator.

Table 3. Results of Panel GMM Estimation

	Arellano and Bond (1991) The Difference GMM	Arellano and Bover (1995) The System GMM	Blundell and Bond (1998) The System GMM
$lpcgdp_{it-1}$	0.477***	0.398***	0.789***
lrd_{it}	0.090***	0.097***	0.053
$lhum_{it}$	0.363**	0.441***	0.140***
lex_{it}	0.070**	0.042*	0.021***
$lpcinvs_{it}$	0.044*	0.056***	0.038***
$linf_{it}$	0.060**	0.054***	0.097***
$lunmp_{it}$	-0.085***	-0.091***	-0.049***
AR(1)	-2.55 (0.011)	-2.27 (0.023)	-3.48 (0.001)
AR(2)	-0.90 (0.370)	-0.97 (0.334)	1.08 (0.279)

Hansen-J test	13.26 (0.103)	21.81 (0.058)	24.50 (0.139)

Notes: First column- 1-step difference GMM, with robust standard errors and lag (0 to 6)
Second column- 2-step difference GMM, with robust standard errors and lag (0 to 6)
Third column- 2-step system GMM, with robust standard errors and lag (0 to 6)
***, ** and * denote the significance level at 1%, 5% and 10%, respectively.
p-values are given in the parentheses.

As seen in Table 3, all usual diagnostic tests confirm the robustness of the estimation results. In table 3, we also check the existence of the first and second-order autocorrelation problem within AR(1) and AR(2). Thus, we conclude that there is no evidence of autocorrelation in the residuals of the sample. Besides, the results of the Hansen-J test validate the instrumental variable used in the model.

Concluding Remarks

This paper shows that recent regional economic growth in Turkey has been positively and significantly affected by human capital, R&D, international trade, public investments, and some other economic variables. However, it does not focus on the existence or extent of regional economic disparities. Instead, we examine the factors that could be possible causes of economic disparities at a regional level. We find that impact of human capital on growth is a crucial element of regional growth in Turkey. This result indicates the boosting effect of human capital on growth and productivity as emphasized in endogenous growth models. Also, the findings shed light on the stimulating role of R&D in regional growth through both inventions and innovations. Moreover, combination of human capital and learning may enhance the formation of R&D and, thus, a higher stock of knowledge at a regional level.

According to GMM results, another influencing factor of regional growth in international trade. International trade enables the economies of scale, producing more competitive goods, and transfer of knowledge particularly in technology-intensive sectors. Regional economies can benefit from international trade by means of static and dynamic advantages. Furthermore, the dynamic effects of the integration with global markets can lead a catching-up effect for lagged regions and provide an equal distribution of wealth. When we evaluate the current state of regional trade in Turkey, it is seen that the integration of local firms with global markets is not at a sufficient level. In order to achieve higher gains from international trade, strategic sectors that have the potential to develop and compete in foreign markets should be encouraged and supported through an effective trade regime, taxation policy and incentives in the long term. In this respect, an export policy based on international specialization in prominent goods and services may provide a significant expansion in trade activities by both industry and agriculture, as well as reducing the import dependency on intermediate goods. Such an expansion can also help solve the problem of scale effect which is one of the most important challenges in small and medium-size agricultural enterprises. The analysis has also an important implication for public investments. In this context, a well-designed regional policy may induce a more effective reallocation of investments among regions and ensure a higher and equal growth within regions.

The research findings confirm the contractionary effect of the unemployment on regional income per capita in both the difference GMM and the system GMM estimators. In this respect, a high rate of unemployment can hamper the effective use of resources and potential output in a region. Hence, policymakers should aim

to constitute more effective labor market institutions in order to facilitate wage adjustments, protect labor force against market conditions, and promote labor mobility for priority regions, especially in manufacturing industry. A proper way of inducing regional employment also associates with increasing capital inflows, particularly in medium and high-tech sectors, as well as improving training and new skills. Moreover, a well-established incentive system may attract private investments that have the potential to reduce unemployment at a regional level.

In the context of consumer prices, hyperinflation was one of the main economic issues during the 1990s., However, anti-inflation policies implemented in Turkey at the beginning of the 2000s led to a rapid decrease in inflation. Thus, the rate of inflation in Turkey between 2008-2014 has raised at a single-digit annually. Regarding positive coefficients of inflation, it can be concluded that a moderate level of inflation positively impacts the real growth of regional GDP per capita via increasing level of savings and investments. Thus, moderate inflation can enhance the productive capacity of the regions through inducing capital accumulation, which in turn increases the capital/labor ratio.

References

Acs, Z. J., Anselin L., & Varga A. (2002). Patents and innovation count as measures of regional production of new knowledge. *Research Policy*, 31, 1069-1085.

Aghion, P., & Howitt, P. (1992). A Model of Growth through Creative Destruction. *Econometrica*, 60(2), 323-351.

Aghion, P., & Howitt, P. (1994). Growth and Unemployment. *Review of Economic Studies*, 61(3), 477-494.

Alexiadis, S. (2013). *Convergence Clubs and Spatial Externalities: Models and Applications of Regional Convergence in Europe*. Berlin, Heidelberg: Springer-Verlag.

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *Review of Economic Studies*, 58, 277-297.

Arellano, M., & Bover, O. (1995). Another look at the instrumental variable estimation of error components models. *Journal of Econometrics*, 68, 29-51.

Aschauer, D. A. (1989). Is Public Expenditure Productive?. *Journal of Monetary Economics*, 23, 177-200.

Aschauer, D. A. (1990). Is Government Spending Stimulative?. *Contemporary Economic Policy*, 8, 30–46.

Baetjer, H. (2000). Capital as Embodied Knowledge: Some Implications for the Theory of Economic Growth. *Review of Austrian Economics*, 13, 147-174.

Barro R. J., & Sala-i-Martin, X. (1991). Convergence across States and Regions. *Brookings Papers on Economic Activity*, 1, 107-182.

Bassanini, A., Scarpetta, S., & Hemmings, P. (2001). *Economic Growth: The Role of Policies and Institutions: Panel Data. Evidence from OECD Countries* (OECD Economics Department Working Papers No. 283). Retrieved from OECD ilibrary website: https://www.oecd-ilibrary.org/economics/economic-growth-the-role-of-policies-and-institutions_722675213381

Bere, R. C., Otoiu, A., & Bucerzan, I. (2014). Determinants of economic growth in cities acting as growth poles in regions from Romania. *Procedia Economics and Finance*, 10(2014), 357-365.

Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, 87, 115-143.

Bond, S., Hoeffler, A., & Temple, J. (2001). *GMM Estimation of Empirical Growth Models* (CEPR Discussion Paper No. 3048*)*. Retrieved from SSRN website: https://ssrn.com/abstract=290522

Boschma, R., & Iammarino, S. (2009). Related Variety, Trade Linkages, and Regional Growth in Italy. *Economic Geography*, 85(3), 289-311.

Briault, C. (1995). The Costs of Inflation. *Bank of England Quarterly Bulletin*, 35, 33-44.

Camagni, R. (1992). *Economia Urbana*. Rome: Nuova Italia Scientifica.

Capello R, & Nijkamp P. (2004). The theoretical and methodological toolbox of urban economics: from and towards where? In: R. Capello, P. Nijkamp (Eds.), *Urban dynamics and growth: advances in urban economics* (pp. 1–30). Amsterdam: Elsevier.

Chen C-H., & Wu, H-L. (2005). Determinants of regional growth disparity in China's transitional economy. *Journal of Economic Studies*, 32(5), 406-419.

Cravo, T. A., Becker, B., & Gourlay, A. (2015). Regional Growth and SMEs in Brazil: A Spatial Panel Approach. *Regional Studies*, 49(12), 1995-2016.

Crespo-Cuaresma, J., Foster, N., & Stehrer, R. (2011). Determinants of Regional Economic Growth by Quantile. *Regional Studies*, 45(6), 809-826.

D'Costa, S., Garcilazo, E., & Oliveira Martins, J. (2013). *The Impact of Structural and Macroeconomic Factors on Regional Growth* (OECD Regional Development Working Papers, 2013/11). Retrieved from OECD library website:https://www.oecd-ilibrary.org/urban-rural-and-regional-development/the-impact-of-structural-and-macroeconomic-factors-on-regional-growth_5k451mplq9lw-en.

Eriksson, C. (1997). Is there a Trade-Off Between Employment and Growth?. *Oxford Economic Papers*, 49, 77-88.

Farole, T. (2013). Trade, Location and Growth. In T. Farole (Ed.), *The Internal Geography of Trade: Lagging Regions and Global Markets* (pp.15-32). The International Bank for Reconstruction and Development, Washington DC: The World Bank.

Fischer, S. (1993). The role of macroeconomic factors in growth. *Journal of Monetary Economics*, 32(3), 485-512.

Freeman, C. (1995). The 'National System of Innovation' in Historical Perspective. *Cambridge Journal of Economics*, 19, 5-24.

Friedman, M. (1977). Nobel lecture: inflation and unemployment. *Journal of Political Economy*, 85, 451-472.

Fujita, M., Krugman, P., & Venables, A. (1999). *The Spatial Economy. Cities, Regions, and International Trade*. Cambridge, Mass.: MIT Press.

Gezici, F., & Hewings, G. J. D. (2004). Regional Convergence and Economic Performance of Peripheral Areas in Turkey. *Review of Urban and Regional Development Studies*, 16, 113–132.

Grossman, G. M., & Helpman E. (1993). *Endogenous Innovation in the Theory of Growth* (NBER Working Paper No. 4527). Retrieved from National Bureau of Economic Research website: http://www.nber.org/papers/w4527.pdf.

Guetat, I., & Sridi, D. (2017). Institutional quality effect on remittances in MENA region. *Middle East Development Journal*, 9(1), 84-100.

Hansen, L. P. (1982). Large sample properties of generalized method of moments estimators. *Econometrica*, 50(4), 1029-1054.

Hirschman, A. (1958). *The Strategy of Economic Development*. New Haven: Yale University Press.

Hou, N., & Chen, B. (2013). Military expenditure and economic growth in developing countries: evidence from System GMM estimates. *Defense and Peace Economics*, 24(3), 183-193.

Howells, J. (2005). Innovation and Regional Economic Development: A Matter of Perspective?. *Research Policy*, 34, 1220-1234.

Huggins, R., Izushi, H., Prokop, D., & Thompson, P. (2014). Regional competitiveness, economic growth and stages of development. *Zb. rad. Ekon. fak. Rij.*, 32(2), 255-283.

Izushi, H. (2008). What Does Endogenous Growth Theory Tell about Regional Economies? Empirics of R&D Worker-based Productivity Growth. *Regional Studies*, 42(7), 947-960.

Kaldewei, C., & Walz, U. (2001). *The Determinants of Regional Growth in Europe: An Empirical Investigation of Regional Growth Models* (Working Paper). Retrieved from Goethe University website: https://www.wiwi.uni-frankfurt.de/profs/walz/REGGRO4.pdf

Karlsson, C., Johansson, B., & Stough, R. (2001). Introduction: Endogenous Regional Growth and Policies. In B. Johansson, C. Karlsson, R.R. Stough (Eds.), *Theories of Endogenous Regional Growth: Lessons for Regional Policy* (pp. 3-16). Heidelberg: Springer.

Krugman, P. (1991). *Geography and Trade*. Cambridge: MIT Press.

Krugman, P. (1995). *Development, Geography and Economic Theory*. Cambridge: MIT Press.

Lucas, R. (1988). On the Mechanics of Economic Development. *Journal of Monetary Economics*, 22, 3-42.

Marty, A. L., & Thornton, D. L. (1995). Is There a Case for "Moderate" Inflation?. *Federal Reserve Bank of St. Louis Review*, 77(4), 27-37.

Mathur, V. K. (1999). Human Capital-Based Strategy for Regional Economic Development. *Economic Development Quarterly*, 13(3), 203-216.

Mıhçı, S., & Köksal, M. Z. (2010). Determinants of Cross-Regional Income Differentials: The Case of Turkey. *H.Ü. Iktisadi ve Idari Bilimler Fakültesi Dergisi*, 28(2), 71-94.

Mikuli**ć**, D., & Nagyszombaty, A. G. (2015). Does international trade cause regional growth differentials in Croatia?. *Zb. rad. Ekon. fak. Rij.*, 33(1), 81-102.

Mileva, E. (2007). Using Arellano – Bond Dynamic Panel GMM Estimators in Stata. Economics Department, Fordham University. Retrieved from https://www.researchgate.net/file.PostFileLoader.html?id=575fcb0a217e200cb31d2f1f&assetKey=AS%3A372807700631552%401465895690276.

Miyao, T. (1987). "Urban growth and dynamics", pp. 1–41, in: E. Mills, editor, Urban Economics. Handbook of Regional and Urban Economics, Amsterdam: North-Holland

Moral-Benito, E., Allison, P., & Williams, R. (2017). *Dynamic panel data modelling using maximum likelihood: an alternative to Arellano-Bond* (Documentos de Trabajo No.1703). Retrieved from Banco de Espana website: http://www.bde.es/f/webbde/SES/Secciones/Publicaciones/PublicacionesSeriadas/DocumentosTrabajo/17/Fich/dt1703e.pdf.

Nijkamp, P. & Mills, E. S. (eds.) (1986). *Handbook of Regional and Urban Economics*. Amsterdam: Elsevier.

OECD (2004). *The Sources of Economic Growth in OECD Countries*. Paris: OECD Publishing.

OECD (2009). *How Regions Grow* (Policy Brief, March 2009). Retrieved from OECD website: http://www.oecd.org/regional/searf2009/42576934.pdf.

Önder, A. Ö., Deliktas, E., & Karadag, M. (2010). The Impact of Public Capital Stock on Regional Convergence in Turkey. *European Planning Studies*, 18, 1041–1055.

Oseni, I. O. (2016). Exchange rate volatility and private consumption in Sub-Saharan African countries: A system-GMM dynamic panel analysis. *Future Business Journal*, 2(2), 103-115.

Pakes, A. (1985). On patents, R & D, and the stock market rate of return. *Journal of Political Economy*, 93(2), 390-409.

Pandit, S., Wasley, C. E., & Zach, T. (2011). The Effect of Research and Development (R&D) Inputs and Outputs on the Relation between the Uncertainty of Future Operating Performance and R&D Expenditures. *Journal of Accounting, Auditing & Finance*, 26(1), 121-144.

Pernia, E. M., & Quising, P. F. (2003). *Economic Openness and Regional Development in the Philippines*. (ERD Working Paper Series No. 34). Retrieved from Asian Development Bank website: https://www.adb.org/sites/default/files/publication/28327/wp034.pdf.

Pike, A., Rodríguez-Pose, A., & Tomaney, J. (2006). *Local and Regional Development*. Routledge, London.

Pires Manso, J. R., Fernandes de Matos, A. J, & Carvalho, C. C. M. (2015). Determinants of Regional Growth in Portugal: An Empirical Analysis. *Economics and Sociology*, 8(4), 11-31.

Poole, W., & Wheelock, D. C. (2008). *Stable Prices, Stable Economy*. The Regional Economist, Federal Reserve Bank of St. Louis. Retrieved from https://www.stlouisfed.org/~/media/Files/PDFs/publications/pub_assets/pdf/re/2008/a/inflation.pdf.

Quah, D. T. (1996). Empirics for economic growth and convergence, *European Economic Review*, 40, 1353–1375.

Reinstadler, A., & Ray, J-C. (2010). *Macro Determinants of Individual Income Poverty in 93 Regions of Europe* (CEPS Working Paper No. 2010-13) Retrieved from LISER website:

Republic of Turkey Ministry of Development (2015). 2005-2016 Yılları Kamu Yatırımlarının Illere Göre Dagılımı. Retrieved from http://www2.kalkinma.gov.tr/kamuyat/il/2005-2016-iller.xls.

Richardson, H. W. (1973). *Regional Growth Theory*. London: Macmillan.

Roberts, M., & Setterfield, M. (2010). Endogenous regional growth: a critical survey. In M. Setterfield (Ed.), *Handbook of Alternative Theories of Economic Growth* (pp. 431-450). Cheltenham: Edward Elgar Publishing.

Rodríguez-Oreggia, E. (2005). Regional disparities and determinants of growth in Mexico. *Annals of Regional Science*, 39, 207–220.

Rodríguez-Pose, A., & Crescenzi, R. (2008). Research and development, spillovers, innovation systems, and the genesis of regional growth in Europe. *Regional Studies*, 42(1), 51-67.

Romer, P. (1986). Increasing Returns and Long-Run Growth. *Journal of Political Economy*, 94(5), 1002-1037.

Romer, P. (1990). Endogenous technological change. *Journal of Political Economy*, 98, 71–102.

Roodman, D. (2009). How to do xtabond2: An introduction to difference and system GMM in Stata. *The Stata Journal*, 9(1), 86-136.

Rutten, R., & Boekema, F. (2007). Regional Social Capital: Embeddedness, Innovation Networks and Regional Economic Development. *Technological Forecasting & Social Change*, 74, 1834-1846.

Shevchuk, V. (2014). Regional Growth Determinants in Ukraine: Panel Data Estimates. *Acta Universitatis Lodziensis Folia Oeconomica*, 5(307), 113-124.

Soukiazis, E., & Antunes, M. (2011). Is foreign trade important for regional growth? Empirical evidence from Portugal. *Economic Modelling*, 28, 1363–1373.

Sterlacchini, A. (2008). R&D, higher education and regional growth: Uneven linkages among European regions. *Research Policy*, 37, 1096–1107.

Storper, M. (2011). Why do regions develop and change? The challenge for geography and economics. *Journal of Economic Geography*, 11(2), 333–346.

Thirlwall, T. (2001). The Euro and Regional Divergence in Europe. In M. Holmes (Ed.), *The Eurosceptical Reader 2* (pp. 25-49). New York: Palgrave.

Turkish Patent and Trademark Office (2017). Statistics. Retrieved from http://www.turkpatent.gov.tr/TurkPatent/statistics/.

TurkStat (2017). Regional Statistics. Retrieved from https://biruni.tuik.gov.tr/bolgeselistatistik/anaSayfa.do?dil=en.

Van Dijk, J., Folmer, H., & Oosterhaven, J. (2009). Regional policy: rationale, foundations and measurement of its effects. In R. Capello, P. Nijkamp (Eds.), *Handbook of Regional Growth and Development Theories* (pp.461-478). Cheltenham: Edward Elgar Publishing.

Von Böventer, E. (1975). Regional Growth Theory. *Urban Studies*, 12(1), 1–29.

Wu, J.-H. (1987). *Optimal Regional Growth and Public Investment Models: Theory and Application to the Efficiency-Equity Issue in Taiwan*. Retrieved from https://search.proquest.com/docview/303481385.

Yildirim, J., Öcal, N., & Özyildirim, S. (2009). Income Inequality and Economic Convergence in Turkey: A Spatial Effect Analysis. *International Regional Science Review*, 32(2), 221-254.

Appendix

Table A.1. List of NUTS 2 Regions in Turkey

NUTS Code	Provinces	NUTS Code	Provinces
TR10	Istanbul	TR71	Kırıkkale, Aksaray, Nigde, Nevsehir, Kırsehir
TR21	Tekirdag, Edirne, Kırklareli	TR72	Kayseri, Sivas, Yozgat
TR22	Balıkesir, Çanakkale	TR81	Zonguldak, Karabük, Bartın
TR31	Izmir	TR82	Kastamonu, Çankırı, Sinop
TR32	Aydın, Denizli Mugla	TR83	Samsun, Tokat, Çorum, Amasya
TR33	Manisa, Afyonkarahisar, Kütahya, Usak	TR90	Trabzon, Ordu, Giresun, Rize, Artvin, Gümüshane
TR41	Bursa, Eskisehir, Bilecik	TRA1	Erzurum, Erzincan, Bayburt
TR42	Kocaeli, Sakarya, Düzce, Bolu, Yalova	TRA2	Agrı, Kars, Igdır, Ardahan
TR51	Ankara	TRB1	Malatya, Elazıg, Bingöl, Tunceli
TR52	Konya, Karaman	TRB2	Van, Mus, Bitlis, Hakkari
TR61	Antalya, Isparta, Burdur	TRC1	Gaziantep, Adıyaman, Kilis
TR62	Adana, Mersin	TRC2	Sanlıurfa, Diyarbakır
TR63	Hatay, Kahramanmaras, Osmaniye	TRC3	Mardin, Batman, Sırnak, Siirt