The Regional Dynamics of Economic Growth: A Case Study on NUTS 2 Regions in Turkey

Mustafa Gömleksiz[1], Şerife Özşahin[2]

Abstract

Recently, a substantial body of literature has examined the interregional growth differences in the context of growth-oriented policies. Thus, it can be argued that such differences mostly arise from the regional characteristics related to economic sphere. This paper studies possible factors affecting regional economic growth in Turkey. In this respect, we examine the effects of human capital, R&D, exports, public investments, inflation, and unemployment on per capita regional income across the 26 NUTS 2 regions for the 2008-2014 period. The results of the difference and the system GMM estimations show that human capital, R&D, exports, public investments and inflation have a significant positive effect on regional economic growth. Also, empirical results indicate a significantly negative relationship between regional growth and unemployment.

Keywords: Regional Economic Growth, Human Capital, R&D, Public Investments, GMM.

JEL Codes: R11, O47, C36.

1**Corresponding Author** Necmettin Erbakan University, Konya, Turkey, mgomleksiz@konya.edu.tr

2Necmettin Erbakan University, Konya, Turkey, sozsahin@konya.edu.tr

1.Introduction

In recent years, differences in welfare and growth among regions have been the center of attention for both researchers and policy-makers. In this respect, the concept of regional growth and development have often discussed in a variety of branches in economics such as theory of economic growth, new economic geography and regional economics (Capello and Nijkamp, 2009: 1). According to the discussions, a central dilemma concerning the regional aspect of the economic theory is the causes of regional disparities (Antonescu, 2012). In the context of growth theories, neo-classical approach focuses on why disparities between regions increase and why regions economically diverge from each other in order to provide a long-run improvement in per capita income and output inequalities (Pike et al., 2006: 62). Barro and Sala-i-Martin (1991) extend the empirical evidence on regional growth differences suggesting a low speed of convergence (approximately 2% annually) between regions worldwide. Also, recent theories examine the endogenous dynamics of economic growth in a particular space (national, regional or firm level) 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 economics (Izushi, 2008; Roberts and Setterfield, 2010). Moreover, according to new economic geography approach, Krugman (1991, 1995) refers some advantages of regional economies in the context of 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 in regional level rather than national or international context (Krugman, 1991, 1994). 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 (Huggins et al., 2014).

Despite the fact that existing empirical studies often investigate determinants of growth in national or cross-country level, there is a growing body of literature that attaches a 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 regional level (Karlsson et al. 2001: 3; Crespo-Cuaresma et al., 2011: 810). Regional economies are often characterized by a variety of macroeconomic, structural and institutional factors such as physical and human capital, infrastructure, innovation and policies. Also, most of these factors could interact with each other (OECD, 2009: 3; Pires Manso et al., 2015: 11).

In this paper, our aim is to investigate possible factors affecting regional growth in Turkey. In this respect, we analyze 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 2 regions for the 2008-2014 period. In the analysis, we use difference GMM (Arellano and Bond,1991) and system GMM (Arellano and Bover, 1995; Blundell and Bond,1998) procedures. All data are based on Turkish Statistical Institute (TurkStat), Republic of Turkey Ministry of Economy and Turkish Patent and Trademark Office (TPTO). The remainder of the paper proceeds as follows. Section 2 discusses factors affecting regional growth and some empirical evidence. Dataset and descriptive statistics are given in section 3. Section 4 presents econometric model used in the analysis. Section 5 summarizes empirical results and section 6 concludes the paper.

2. Dynamics of Regional Economic Growth

In the context of economic literature, determinants of growth have been widely examined within different aspects. At regional level, income and productivity changes depend on various socio-economic, political and structural factors including human capital, R&D, trade, investments, and some factors of economic stability. In this respect, differences in human capital at the regional level can also explain differences in regional economic development (Rutten and Boekema, 2007). Human capital is generally 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: 19). According to new models of growth theory, advancements in knowledge and technology as main sources of growth take place in a process involving human interactions and activities (Freeman, 1995: 17; Howells, 2005: 1221). In this process, a higher stock of knowledge which is embodied in the form of human capital or capital goods can enable a greater level of technology (Baetjer, 2000). Thus, human capital contributes indirectly to productivity growth and employment by means of learning and increasing level of skill and talent (Mathur, 1999: 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 economic system, in a system where technology is limited, realization of crucial innovations and, thus, growth will decrease after a certain period of time. In such a case, the success of the system can be achieved by directing existing capital into physical and human factors and incorporating it into R&D (Aghion and Howitt, 1992: 349). Also, it is often recognized that investment in basic R&D and applied research will lead to an increase in

inventions which in turn stimulate innovation and growth (Rodríguez-Pose and Crescenzi, 2008: 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 affects both regional and national economies positively in terms of investments in infrastructure, education and health sectors. In this respect, the role of central government in reallocating investment among regions might induce aggregate efficiency and regional equity in welfare (Wu, 1987: 5). Moreover, Aschauer (1989) concludes that a good planned public investment decision significantly contributes to economic growth and productivity improvement (Aschauer, 1989: 197).

Trade is also an important driver of the short and long-run growth particularly through the links between local and global (Farole, 2013: 22). The effect of international trade on regional economic growth occurs by various forms including efficient reallocation of resources, transfer of technology-intensive knowledge, emergence of economies of scale and specialized production of competitive goods (Soukiazis and Antunes, 2011: 1364; D'Costa et al. 2013: 5). Boschma and Iammarino (2009) assert that a better integration of the regions into global economic system diversifies inward flows of knowledge and contributes a higher level of growth. Thus, trade plays a crucial role in technological change through promoting a competitive manner of learning and accelerating emergence of innovations (Boschma and Iammarino, 2009: 294-296).

The nexus between growth and unemployment is another issue discussed in the current growth literature. Disparities in unemployment often leads to a deterioration in national and regional economies. A high rate of unemployment 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 main causes of poverty and economic growth (Thirlwall, 2001: 39; Van Dijk et al., 2009: 461). Reinstadler and Ray (2010) conclude that the unemployment at regional level is likely to negatively affect individuals with low level of income by means of diminishing labor demand and downward pressure on wages. Besides, on the one hand, in their study Aghion and Howitt (1994) propound that a low level of unemployment stimulates growth, despite high unemployment slows down growth process (Aghion and Howitt, 1994: 491). Similarly, on the other hand, Eriksson (1997) argues that changes in exogenous parameters of growth that decrease unemployment also allow a more successful growth in the case where the growth occurs endogenously (Eriksson, 1997: 78).

Regarding factors affecting regional growth, inflation can lead to an 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 and Scarpetta (2001) indicate 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 a sufficiently low inflation helps to enable adjustment of relative wages and prices in labor and financial markets. Also, a moderate inflation can enhance a higher steady-state level of output per person, stability of the economy and a higher rate of employment (Marty and Thornton, 1995: 27; Poole and Wheelock, 2008: 5).

3. Data and Preliminary Tests

This study employs the difference GMM dynamic panel estimation method developed by Arellano and Bond (1991) and system GMM estimator introduced by Arellano and Bover (1995) and Blundell and Bover (1998) to investigate the regional dynamics of economic growth in Turkey. The dataset used in the analysis consists of 26 regions[3] based on the classification of Nomenclature of Territorial Units for Statistics (NUTS) and the period 2008-2014. The choice of the time period depends on the availability of data sources. Also, all the data are expressed in Turkish Lira (TL) and used in logarithmic form. Abbreviations, definitions and data sources of the variables in the empirical analysis are given in Table 1.

Table 1. Definition of Variables

Variable	Abbreviation	Indicator	Source
Regional Economic Growth	*lpcgdp*	Regional 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)
Export	*lex*	Total volume of exports	TurkStat (2017)
Inflation	*linf*	Percentage change in CPI	TurkStat (2017)
Unemployment	*lunmp*	Unemployment rate	TurkStat (2017)
Public Investment	*lpcinvs*	Per capita public investments	Republic of Turkey Ministry of Development (2015)

As seen in Table 1, we use regional GDP per capita $(lpcgdp)$ as dependent variable in the analysis. In empirical literature, the level of domestic knowledge is usually measured by innovative activities in terms of R&D and patenting (Rodríguez-Pose and Crescenzi, 2008; Sterlacchini, 2008). Also, despite the fact that direct measurement of human capital is a controversial topic, a variety of studies (OECD, 2004) often use educational indicators. Thus,

3 Regional context and NUTS 2 codes are given in the appendix.

we prefer patent applications (lrd) and the share of tertiary education graduates in total population $(lhum)$ in the long-run equation. Besides, we use total volume of exports (lex) and public investments ($lpcinvs$) as potential determinants 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 of Variables

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	-2.750	0.454	-4.081	-1.731	0.0008	0.170	13.93*
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
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

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

We use some preliminary tests in order to choose appropriate panel data technique. Table 2 reports a summary of descriptive statistics and results of normality test. The results show that the mean values for all 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 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).

$$lgrowth_{it} = \alpha_0 + \alpha_1 lgrowth_{i,t-1} + \alpha_2 lrd_{it} + \alpha_3 lhum_{it} + \alpha_4 linf_{it} + \alpha_5 lunmp_{it} + \alpha_6 lex_{it} + \alpha \quad (1)$$

In equation (1), i denotes cross-section units, t represents time and ε_{it} is 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. $lgrowth_{i,t-1}$ 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 software program.

4. Econometric Model

In dynamic panel data analysis, estimators require to use one or more instrumental variables as lagged form of endogenous variables in the estimated model (Guetat and Sridi, 2017: 91). These estimators are the most appropriate methods in case that there is a linear functional relationship between variables, the present value of the dependent variable depends on its past values or the independent variables are not strictly exogenous (Roodman, 2009: 86).

Arellano and Bond (1991) suggest an estimator which considers unobserved heterogeneity and predetermined regressors. This method has a good estimation power when the time dimension is relatively larger than the cross section unit (Moral-Benito et al., 2017: 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 as difference GMM method (Roodman, 2009: 86). In this context, the dynamic growth model as given in the first-differenced regression equation is shown in equation (2).

$$lgrowth_{it} - lgrowth_{i,t-1} = \mu_t - \mu_{t-1} + \alpha_1 \Delta lgrowth_{i,t-1} + \alpha_2 \Delta lrd_{it} + \alpha_3 \Delta lhum_{it} + \alpha_4 \Delta \quad (2)$$

Arellano and Bover (1995) and Blundell and Bond (1998) criticize the difference GMM method due to the biased results in small samples with weak instrumental variables. Thus, Arellano and Bond (1991) expand the difference GMM method by adding some hypothesis to estimation. Arellano and Bover (1995) and Blundell and Bond (1998) suggest a method based on two equations which are –"the original equation and the transformed one in differences"-. Therefore, this method is called as system GMM (Roodman, 2009: 86-87). The system GMM uses the lagged differences of explanatory variables in the level equation, while it uses the lagged levels of explanatory variables in the first difference equation as the instrumental variable (Guetat and Sridi, 2017: 91). Compared with the difference GMM, this estimator allows the use of more instrumental variables and, thus, improves the power of estimation (Roodman, 2009: 86). The first equation used in the system GMM estimator is same with the first-difference GMM method. The level equation used in the analysis is given in equation (3).

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

The consistency of the GMM results is examined by two tests. One of those investigates the existence of the autocorrelation problem in differenced residuals, while the other tests the over-identifying restrictions and, thus, the validity of the instrumental variables (Roodman, 2009: 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: 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: 188). In order to test the validity of the instrumental variables, Sargan test is often used in the analysis conducted by Arellano and Bond (1991) difference GMM non-robust estimator. In Sargan test, the higher values of the probability of Sargan statistics indicate the validation of instrumental variables (Mileva, 2007: 7). Also, Hansen-J test (Hansen, 1982) is used in difference and system GMM robust estimation methods. Similarly, Hansen-J test examines the validation of instrumental variables (Oseni, 2016: 108).

5. Empirical Results

Table 3 reports the results of panel GMM estimation. Firstly, the findings show that all the variables are important determinants of regional economic growth and coefficients are significantly consistent with the economic theory. According to the results obtained from 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 $(linf_{it})$ and export (lex_{it}) and public investment $(lpcinvs_{it})$ have significantly positive signs. However, we find that unemployment rate $(lunmp_{it})$ negatively impacts regional economic growth in related period.

Table 3. Results of Panel GMM Estimation

	Arellano and Bond (1991) Difference GMM	Arellano and Bover (1995) System GMM	Blundell and Bond (1998) 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***
$linf_{it}$	0.060**	0.054***	0.097***
$lunmp_{it}$	-0.085***	-0.091***	-0.049***
lex_{it}	0.070**	0.042*	0.021***
$lpcinvs_{it}$	0.044*	0.056***	0.038***
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)
Sargan test	59.15 (0.000)	59.15 (0.000)	130.86 (0.000)
Hansen-J test	13.26 (0.103)	21.81 (0.058)	24.50 (0.139)

Note: ***, ** and * denote the significance level at 1%, 5% and 10%, respectively. p-values are given in the parentheses.

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 99% significance level. However, coefficient of lrd_{it} has a positive sign in both estimations but it is found statistically insignificant according to Blundell and Bond (1998) estimator.

Regarding table 3, we test the existence of the first- and second-order autocorrelation problem in AR(1) and AR(2) processes. Thus, we conclude that there is no evidence of auto-correlation in the residuals of the sample. Also, the results of Hansen-J test confirm the validity of instrumental variable used in the model.

6. Conclusion

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 structural factors. However, it does not focus on the existence or extend of regional economic disparities. Instead, we examine the factors that could be possible causes of economic disparities in regional context. We find that impact of human capital on growth is crucial and highly significant for the regions 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 level of regional knowledge stock.

According to GMM results, another influencing factor of regional growth is international trade. International trade enables economies of scale and transfer of knowledge particularly in technology-intensive sectors. Regional economies can benefit from international trade through static and dynamic advantages. Furthermore, the dynamic effects of the integration with global markets can lead a catching-up effect for lagged regions and, thus, equal distribution of wealth. The analysis also has an important implication for public investments. 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 difference GMM and system GMM estimators. In this respect, a

high rate of unemployment can hamper the effective use resources and potential output in a region. According to positive coefficients of inflation, it can be concluded that relatively high prices cause an increase in the cost of saving money. Thus, increased demand for money positively impacts aggregate demand and, thus, income level. Moreover, a moderate inflation can enhance a higher steady-state level of output through inducing capital accumulation and thus a higher level of capital/labor ratio increases regional economic output.

Appendix

Classification of NUTS 2 Regions in Turkey

NUTS Code	Provinces	NUTS Code	Provinces
TR10	İstanbul	TR71	Kırıkkale, Aksaray, Niğde, Nevşehir, Kırşehir
TR21	Tekirdağ, Edirne, Kırklareli	TR72	Kayseri, Sivas, Yozgat
TR22	Balıkesir, Çanakkale	TR81	Zonguldak, Karabük, Bartın
TR31	İzmir	TR82	Kastamonu, Çankırı, Sinop
TR32	Aydın, Denizli Muğla	TR83	Samsun, Tokat, Çorum, Amasya
TR33	Manisa, Afyonkarahisar, Kütahya, Uşak	TR90	Trabzon, Ordu, Giresun, Rize, Artvin, Gümüşhane
TR41	Bursa, Eskişehir, Bilecik	TRA1	Erzurum, Erzincan, Bayburt
TR42	Kocaeli, Sakarya, Düzce, Bolu, Yalova	TRA2	Ağrı, Kars, Iğdır, Ardahan
TR51	Ankara	TRB1	Malatya, Elazığ, Bingöl, Tunceli
TR52	Konya, Karaman	TRB2	Van, Muş, Bitlis, Hakkari
TR61	Antalya, Isparta, Burdur	TRC1	Gaziantep, Adıyaman, Kilis
TR62	Adana, Mersin	TRC2	Şanlıurfa, Diyarbakır
TR63	Hatay, Kahramanmaraş, Osmaniye	TRC3	Mardin, Batman, Şırnak, Siirt

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