EMPIRICS OF ECONOMIC GROWTH IN TURKEY

A Master's Thesis

by
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To my family

EMPIRICS OF GROWTH IN TURKEY

The Graduate School of Economics and Social Sciences
of
Bilkent University

by

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I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Economics.

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ABSTRACT

EMPIRICS OF GROWTH IN TURKEY

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In the empirics of growth literature method proposed by Mankiw et al. (1990) has been widely used to test the determinants of economic growth and the speed of convergence. This framework, however, considers technological progress as constant and idencital across countries and/or regions. In this study, I propose a production function that uses electricity as a factor of production to produce output and check the speed of convergence of per capita output. Electricity is regarded to be produced from clean and dirty sources given an elasticity of substitution. Electricity output is weighted by these elasticities in order to see their effect on convergence. Based on the appilication of the system GMM approach contrasted with the Within Group and OLS results, I key out conditional convergence analysis over 2002-2013 based on regional data for Turkey. Econometric results indicate overall convergence of per capita income across regions in general, noting that each development region converges to its own steady state. Results obtained from OLS and Within Group regressions fail to be significant. I have also found out that the non-thermal electricity production has a significantly positive effect on growth rate when GMM method is applied, wheras electricity production by thermal sources has no significant effect on the growth rate. Finally, I have also found that the share of specialized lending in credit demand tends to increase the growth rate.

Keywords: Conditional Convergence, Electricity Production, Growth

ÖZET

TÜRKİYE'DE BÜYÜMENİN AMPİRİK BİR ANALİZİ

Sündal, Doğuhan
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Mankiw et al. (1990) tarafından önerilen çerçeve, yakınsama hızının tespiti ve iktisadi büyümenin kaynaklarının tespiti için kullanılagelmiştir. Bu çerçevede teknolojik gelişme bir sabit kabul edilirken ülkeler ve bölgeler arasında da homojen olduğu varsayılır. Bu çalışmada kullandığım üretim fonksiyonu, elektrik kullanımını bir girdi olarak kabul ederken, çalışmamıda yakınsama hızının nasıl etkilendiği kontrol ettim. Elektrik enerjisinin termik ve termik olmayan kaynaklardan elde edildiğini varsayan modelde, iki enerji kaynağı arasındaki elastisite bölgesel olarak hesaplanırken, elastisiteler ile ağırlıklandırılmış üretimlerin yakınsamaya etkisi ölçtüm. Analizimde 2002-2013 yılları arasında koşullu yakınsamayı OLS, gruplariçi ve GMM metodları ile test ederken, termik santraller dışındaki enerji üretiminin ve ihtisas kredilerinin tüm krediler içerisindeki payının büyümeyi olumlu etkilediğini tespit ettim.

Anahtar kelimeler: Büyüme, Elektrik Üretimi, Koşullu Yakınsama.

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CHAPTER I

INTRODUCTION

Income differences across countries and regions are still an important issue that developed and underdeveloped economies are facing. As Solow (1956) introduced in his growth model the classical view's focus has been on the tendencies of economies towards convergence to a so called "steady state" . This approach explains differences in income levels by examining different technology levels across countries and/or regions. If the technology were available to all countries and regions, differential countries with different capital per capita levels would converge to the same steady state where output growth per capita is zero. This assessment, however, is based on a treatment that regards a particular country as an aggregate economy on an alleged balanced growth path and suggests tha per capita income in all countries would grow at the same, exogenously determined rate of technology as stated in Fagerberg (1994). Yet, the dualistic patterns of growth change this perception completely and the convergence issue is very important to pursue under these conditions.

As stated in Barro (1989), in the growth models of Solow (1956), Cass (1965) and Koopmans Koopmans et al. (1965) where returns to factors of production are diminishing one expects to observe a country's per capita growth rate to be inversely related to its starting level of income per person. Barro however states that there is no evidence of a correlation between per capita growth and initial level of per capita output. The cross-state evidence for USA as found out by Sala-i Martin

(1996) however shows that the convergence coefficient is signicantly positive for seven of the ten subperiods. This evidence is important since it states classical growth theory could hold within a country, for different regions whereas the technological differences may be too large to overcome in between different countries.

Mankiw et al. (1990) have tried to explain the income differences between countries using an augmented Solow growth model. They have found out the determinants of steady state income are much more effective than the predictions from a standart Solow model. While the savings increase total factor productivity they also found out that the accumulation of the capital stock has a positive effect on the income level at a much more higher rate than expected from a standart Solow model. They also stated that the population growth rate has a greater effect on the income per capita than generally expected.

Likewise, income differences across different regions of Turkey have been an issue for long. The question of differential rates of growth across different regions of Turkey has been asked and there has been a number of studies that tested the prediction of neoclassical growth theory. Tansel and Güngör (1999) found in their study that there has been convergence in per worker GDPs across Turkey's 67 provinces in both the 1975-1995 and 1980-1995 periods. They found out there has been convergence even without checking for steady-state factors, when differences in these factors are accounted for, the speed of convergence they found increased. When checked for human capital in the regressions, they found out human capital increases the convergence rate among Turkey's provinces.

Gezici and Hewings (2004) have done an analysis between 1980-1997 and found out growth rates and initial levels of income are basically uncorrelated across provinces. In addition to that they state adding some explanatory variables did not change their results. They also found out GDP per capita is not randomly distributed but highly clustered and spatially dependent in terms of level. They also conducted a spatial analysis where they found out althought GDP per capita and public investment ratio has significant neighborhood effects in them, diagnostic tests for spatial dependence does not highlight any spatial model. As a result they have found out both evidence for β *Convergence* and against it so they tend to explain the income differences between provinces of Turkey with so called "development clubs". By arguing there exist development clubs in Turkey what is essentially stated is that Turkey, while trying to become a member of European Union, have generated privileges to the metropolitan cities and beign a member of a specific development club simply means beign located in either east or west, according to their findings.

Yildirim et al. (2009) have conducted an analysis using province level data from 1990 to 2001. They have employed a traditional $\beta - Convergence$ analysis and taking spatial dimension into account have done a geographically weighted regression analysis. They argued the spatial lag model is to be selected to do such an analysis since they have found least squares regional convergence model is misspecified. They found out, at national level, evidence for convergence althought the policy variables are insignificant meaning that the regional policy has no significant effect on convergence. They also found out that the speed of convergence of the provinces differ dramatically.

Last but not least Önder et al. (2010) have estimated the effects of public capital stock on regional convergence at NUTS 2 level regions in Turkey. Their study is based on panel data of 26 regions of Turkey focusing on time periof of 1980 to 2001. Their dynamic panel estimations' results show there exists evidence for $\sigma - Convergence$ and conditional convergence for the selected time period. They also argued that the estimation results by LSDV and GMM methods are more reliable in measuring the effects of per capita public capital stock. One of their key findings is that transportation capital stock has a negative and significant sign in all of the models estimated. And they concluded transport infrastructure investment cause regional disparity rather than convergence in Turkey.

In our study we aim to look for conditional convergence for 26 development regions as done by Önder et al. (2010). Our GDP data is from 1987 to 2015 whereas conditioning variables usually exist for a limited and more narrow time period. Our aim is to extend the classical Solow (1956) model and add electiricity production by clean and dirty inputs in it. While doing so we are going to conduct the analysis done by Mankiw et al. (1990) to such a production function and examine the effects of electricity production by clean and dirty inputs to speed of convergence in between different regions of Turkey. The remainder of this paper is organised as follows. Chapter 2 introduces the model. In chapter 3, data and estimation results are debated and chapter 4 concludes.

CHAPTER II

THE MODEL

We begin with changing classical Solow growth model in such a way that it captures the electiricity usage as a scale parameter;

$$Y_t = K_t^{\alpha} E_t^{\beta} L_t^{1-\alpha-\beta} \tag{1}$$

If we turn the variables in per capita terms we would have

$$y_t = k_t^{\alpha} \eta_t^{\beta} = f(k_t, \eta_t) \tag{2}$$

Where k_t stands for capital per capita and η_t stands for electricity production per capita. The accumulation rule for capital is given by

$$\dot{k} = sq_t f(k_t, \eta_t) - k_t(\delta + n) \tag{3}$$

Where q_t is a function that turns a fraction of investment, namely $sf(k_t, \eta_t)$, into capital which behaves as $q_t = q_0 e^{gt}$ where $s \in (0,1)$ is the saving rate $\delta \in (0,1)$ is the depreciation and $n \in (0,1)$ is the population growth rate. For electiricity production we do not have a accumulation rule but the electiricity is produced in each province from clean and dirty sources where a CES type function characterizes the overall energy production as

$$E_{it} = [\phi E_{dit}^{\frac{\epsilon-1}{\epsilon}} + (1-\phi) E_{cit}^{\frac{\epsilon-1}{\epsilon}}]^{\frac{\epsilon}{\epsilon-1}} \tag{4}$$

E_{it} is the total electricity production in province i at time t, where E_{cit} and E_{dit}

stand for clean and dirty energy production at the same time and province respectively; ϵ stands for elasticity of subsitution between clean and dirty energy sources in this setup and $\delta \in (0,1)$. If we turn electiricity production in per capita terms as we did for capital we obtain

$$\eta_{it} = [\phi \eta_{dit}^{\frac{\epsilon-1}{\epsilon}} + (1-\phi)\eta_{cit}^{\frac{\epsilon-1}{\epsilon}}]^{\frac{\epsilon}{\epsilon-1}} \tag{5}$$

As before, we argue $\eta_t = \eta_0 e^{\gamma t}$ and for the steady state we would have

$$k_t(\delta + n) = sq_0 e^{(g+\beta\gamma)t} k_t^{\alpha} \eta_0^{\beta} \tag{6}$$

Along the *Balanced Growth Path* we would have $g = -\beta\gamma$, which implies

$$k_{ss} = (\frac{sq_0\eta_0^{\beta}}{\delta + n})^{\frac{1}{1-\alpha}} \tag{7}$$

Now to deterimine the steady state level of income, from Mankiw et al. (1990) we know that

$$\frac{dln(y_t)}{dt} \simeq \lambda[ln(y^*) - ln(y_{t-1})] \tag{8}$$

Which implies

$$ln(y_t) \simeq (1 - e^{-\lambda t})ln(y^*) + e^{-\lambda t} ln(y_{t-1}) \tag{9}$$

Subtracting $ln(y_{t-1})$ from both sides we obtain

$$g_{t,t-1} = (1 - e^{-\lambda t})ln(y^*) - (1 - e^{-\lambda t})ln(y_{t-1}) \tag{10}$$

Where $g_{t,t-1} = ln(y_t) - ln(y_{t-1})$, meaning the per capita output growth from time $t-1$ to time t and y^* is the steady state level of income per capita. Now applying the steady state level of capital here results with the following

$$g_{t,t-1} = (1 - e^{-\lambda t})ln((\frac{sq_0\eta_0^{\beta}}{\delta + n})^{\frac{\alpha}{1-\alpha}}) + (1 - e^{\lambda t})ln(\eta_t^{\beta}) - (1 - e^{-\lambda t})ln(y_{t-1}) \tag{11}$$

If we assume $\eta_0^{\beta} = 1$, we obtain the following

$$g_{t,t-1} = (1 - e^{-\lambda t})\frac{\alpha}{1-\alpha}ln(s) + (1 - e^{-\lambda t})\frac{\alpha}{1-\alpha}ln(q_0) + (1 - e^{-\lambda t})\frac{\alpha}{1-\alpha}ln(\frac{1}{\delta + n})$$

$$+(1-e^{-\lambda t})\beta ln(\phi\eta_{dit}^{\frac{\epsilon-1}{\epsilon}}+(1-\phi)\eta_{cit}^{\frac{\epsilon-1}{\epsilon}})^{\frac{\epsilon}{\epsilon-1}}-(1-e^{-\lambda t})ln(y_{t-1}) \quad (12)$$

Thus in this setup the growth of output per capita is a function of the determinants of the steady state level of output per capita. The steady state level of output per capita is composed of the savings, the initial level of the the function q_t, depreciation and population growth which are denoted with δ and n respectively, past periods' level of output per capita and electricity production weighted with the elasticity of clean and dirty energy input.

Now instead of $ln(\phi\eta_{dit}^{\frac{\epsilon-1}{\phi}}+(1-\delta)\eta_{cit}^{\frac{\epsilon-1}{\epsilon}})$ we are going to use

$$(\epsilon-1)[\phi ln(\eta_{dit})+(1-\phi)ln(\eta_{cit})] \quad (13)$$

Realize the statement above is obtained by using a first order Taylor series expansion to the logarithm part at the point $\epsilon=1$. As a result what is to be estimated is the following statement

$$g_{t,t-1}=(1-e^{-\lambda t})\frac{\alpha}{1-\alpha}ln(s)+(1-e^{-\lambda t})\frac{\alpha}{1-\alpha}ln(q_0)+(1-e^{-\lambda t})\frac{\alpha}{1-\alpha}ln(\frac{1}{\delta+n})$$

$$+(1-e^{-\lambda t})\beta\epsilon(\phi ln(\eta_{dit})+(1-\phi)ln(\eta_{cit}))-(1-e^{-\lambda t})ln(y_{t-1}) \quad (14)$$

CHAPTER III

DATA AND ESTIMATION

1 Data

We estimate the equation derived in the last chapter. Instead of overall saving rate Mankiw et al. (1990) used investment to GDP ratio. Anxo and Sterner (1994), however, suggested with direct measures a new method based on the demand for electric power (the use of electricity per hour) to measure capital utilization. Thus, we are going to use such a measure for investment, whereas we care for the utilized capital but not unutilized physical capital, which is included in investment. The electricity consumption for each province is gathered from Ministry of Development, the data is available from 2002 to 2013. Likewise, the gross regional product data of each province is gathered from Ministry of Development which is available for 1987 to 2012. The data is converted to 2012 dollars, data for 1987 to 2001 is deflated and 2002 onwards is forecasted by the experts from the Ministry of Development. We have aggregated the data in accordance with Ministry of Developments NUTS 2 levels as listed in Appendix, Table 1.

Population of provinces are made available from 2007 onwards by TURKSTAT. We gathered the population growth rate of Turkey from World Bank (2016), and using that data, for each province we have estimated population from 2007 to 1987 by assuming an exponential growth in population and taking logarithmic difference of each province's population for each year. By doing so we obtained 2002-2013 population for each province and thus obtained gross regional product per capita. Data of credit share is taken from The Banks Association of Turkey (2016); we obtained the specialized lendings' share to all credits by adding up the specialized lendings in each province and dividing them into all credit demands reported. This data is going to used as a proxy for q_t, although the estimation should be done by using an initial level specialized lendings' share data, since these data are not available for all provinces for the same years, determining a meaningful common initial level is not possible. Therefore we are going to use all data available for this variable.

Electricity production data is estimated. Ministry of Energy provided the data for thermal power plants and their electricity production at 2011. By finding their locations we have come up with "total electiricity production from dirty sources" data for each province and each development region. The total electiricity production however, is estimated by using the data available in Enerji Atlasi (2016). We have used the shares of total electricitiy production of each province (Enerji Atlasi (2016)) and multiplied each share with the electricity production announced total by TEDAS (2016).

Following these steps we realized the electricity production by thermal plants in Ankara and Van provinces are too large to be true when their share in total production is kept in mind. Therefore we have used the average shares of İstanbul (TR10); İzmir (TR31); Bursa, Eskişehir, Bilecik (TR41) and Kocaeli, Sakarya, Düzce, Bolu, Yalova (TR42) for Ankara (TR51). Similarly we have used for Van, Muş, Bitlis, Hakkari (TRB2) region the average of Ağrı, Kars, Iğdır, Ardahan (TRA2); Malatya, Elazığ, Bingöl, Tunceli (TRB1); Gaziantep, Adıyaman, Kilis (TRC1); Mardin, Batman, Şırnak, Siirt (TRC3). The chosen regions are determined considering their relative wealth with Ankara (TR51) and Van, Muş, Bitlis, Hakkari (TRB2) regions. With the new shares, we normalized the total electricity production by each region using yearly electiricity production announced by TEDAS (2016). If we subtract the electricity production from thermal sources data that we obtained from Ministry of Energy, from our estimated total production, we would have electricity production in each development region by non-thermal sources. By doing so and aggregating the data in NUTS 2 level, we have obtained the total electricity production in each development region from non-thermal sources.

This data will be used instead of η_{cit} whereas the data obtained from the Ministry of Energy is going to be used instead of η_{dit}. To be able to fit the data into the model to be estimated, namely equation (14), we are going to use the method of Kmenta (1967). Realize while Kmenta (1967) takes the logarithm of the function to be estimated and then applies a second order Taylor Series on the logarithm part, we are going to apply a first order Taylor Series at $\epsilon = 1$. If this process is done, we would have equation (5) as

$$ln(\eta_{it}) = \epsilon\phi ln(\eta_{dit}) + \epsilon(1-\phi)ln(\eta_{cit}) \tag{15}$$

As Kmenta (1967) stated, this equation can easily be estimated and ϵ and ϕ can be obtained. By doing so we obtained the elasticity of substitution vector between clean and dirty energy input weighted electricity production from thermal and non-thermal sources as independent variables, as we have desired.

Lastly, depreciation is taken as $\delta = 0.03$ as done by Mankiw et al. (1990) and the population growth rate is calculated by using available data announced by the World Bank (2016).

2 Estimation

The model can be turn into following in order to be estimated

$$g_{t,t-1} = \beta_1 ln(s) + \beta_2 ln(q_0) + \beta_3 ln(\frac{1}{\delta+n}) +$$
$$\beta_4\epsilon\phi ln(\eta_{dit}) + \beta_5\epsilon(1-\phi)ln(\eta_{cit}) + \beta_6 ln(y_{t-1}) + \mu_i + \rho_t + \zeta_{it} \tag{16}$$

Where μ_i, ρ_t and ζ_{it} are shocks to development region, time and both respectively. To estimate the parameters $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6$ of a dynamic panel, like equation

(15), we utilize OLS, Fixed Effects and system GMM estimation methods. However realize that Within Group estimators and OLS are biased and inconsistent estimates for a dynamic panel as stated by Hsiao (2014) and Nickell (1981). Also, by Bond et al. (2001) and Hoeffler (2002) we can argue estimates obtained from OLS estimator can be regarded as an upper bound, whereas estimates obtained from LSDV estimator regarded as a lower bound.

Due to the existance of biased estimates from OLS and Within Group estimators, in order to estimate the parameters of the above equation, system GMM estimator will be adopted as proposed by Arellano and Bover (1995) and Blundell and Bond (1998). System GMM is a helpful method since it is going to provide consistent and efficient estimates under endogeneity and measurement errors too and highly recommended Bond et al. (2001). Last but not least, Bayraktar-Sağlam and Yetkiner (2014) suggest that system GMM suits in short time dimension panel sets and Blundell and Bond (1998); Blundell and Bond (2000) and Blundell et al. (2001) argue system GMM has a much larger efficiency compared with difference GMM in dynamic panel data as lagged leves in the difference GMM can be weak instruments.

As stated by Bayraktar-Sağlam and Yetkiner (2014), system GMM procedure is a joint estimation of the equation in first-difference and in levels. For the equation in first-differences, used instruments are the lagged levels of the regressors whereas for the equations in levels, the lagged first-difference of the explanatory variables are used. In order to have consistent system GMM estimators we should have no serial correlation in the error term and the instruments should not be correlated with the error term. There are two key two diagnostics two check: the Arellano-Bond test for serial correlations examines the first and second order correlation of the first and second order correlations of the first differenced residuals while the conventional Hansen test of over-identifying restrictions checks the correct specification and validity of the insturments. Note that we should have the number of cross section units larger than the number of instruments.

We checked for fixed effects and have obtained the results in the Appendix, Table 2. The results show us the specification of the model calls for a fixed effect model. Recall that the Within Group estimates are biased. In addition to that we have conducted a Hausman test to be sure of using the fixed effects model. In Appendix, Table 3 we reject the hypothesis that random effects model may be a relevant one. And when a modified Wald test is applied for groupwise heteroskedasticity in fixed effect model, we found evidence for heteroskedasticity.

Appendix, Table 4 summarizes our findings. One could immediatly realize that the results obtained from OLS are rarely significant but have the expected signs. Althought not significant, we happen to have a negative sign on $ln(y_{t-1})$ and implied speed of convergence is 0.0035. As it was stated by Arellano and Bover (1995); Blundell and Bond (1998), the OLS and Within Group estimates have biases and System GMM would be more appropriate in this case. But one should realize the estimates from Within Group estimation are in general more significant comparing with OLS and there is a significant increase in the speed of convergence to 0.16 from 0.004.

System GMM and Arellano-Bover/Blundell-Bond results are much more promising. The significance level of depreciation and population growth and its' effect on growth had increased in System GMM. Realize this effect is actually a negative effect on growth rate due to the logarithm, as expected. Increase in creditshare has a significantly positive effect on the growth rate as expected. The specialized lendings cover the lendings that are for project finances and we expect them to increase the growth rate in development regions. Arellano-Bover/Blundell-Bond test had included elasticities weighted electricity production and have shown that the electricity production from non-thermal sources, weighted with elasticities of each development region, has a significantly positive effect on the convergence. Whereas Arellano-Bover/Blundell-Bond estimation had used $ln(s)$, $ln(y_{t-1})$, $ln(\frac{1}{n+\delta})$ and $ln(q_t)$ as instruments with 2 lags, system GMM had used once lagged versions of

$ln(y_{t-1})$ and $ln(s)$. Hansen test states that the instruments are valid for system GMM. As shown in Appendix, Table 5 for System GMM results we fail to reject the null hypothesis stating there exists first and second order autocorrelation. System GMM estimates implies the fastest rate of convergence and the most significant one, however we were not able to see the effect of electricity production in that model due to collinearity in these variables.

System GMM aprroach can be used with a code which requires manuel application and those results are different from Arellano-Bover/Blundell-Bond results although both are system GMM tests. The Arellano-Bover/Blundell-Bond test uses first difference of predetermined or endogenous variables as instruments in the level equation. Realize as we have elasticities weighted electricity production data available for only 2011, the Arellano-Bover/Blundell-Bond results are exclusively identified based on the first-differenced equation. While we get coefficient estimates for time-invariant regressors, namely coefficient estimates of elasticity weighted electricity production from thermal and non-thermal sources, these estimates result from a finite-sample correlation between the first differences of time-varying regressors and the time-invariant regressors. This correlation is, however, needs to be justified. In addition to that, since the reported standart errors in Appendix, Table 4 are heteroskedasticity consistent, we are not able to apply a Sargan test for instruments validity. However realize the manuel application of System GMM test omits time invariant variables, namely, elasticity weighted electricity production from thermal and non-thermal sources. This result indicates a much more negative effect of depreciation and population growth on growth rate of output per capita at the same significance level with Arellano-Bover/Blundell-Bond test. Also we are informed that the instruments are highly valid.

CHAPTER IV

CONCLUSION

In this thesis I have tried to conduct an emprical analysis of GDP per capita growth in Turkey. Whereas the classical approach takes the savings of the society, depreciation and population growth rate, the initial level of income per capita and a technology constant into account as the determinants of growth, I have included several new variables. In this thesis, I have included the thermal and non-thermal power plants' electricity production into account and try to explain the elasticity weighted thermal and non-thermal electricity production's effect on the growth rate. The OLS and Within Group estimators are known to be biased thus I have applied GMM method. My findings reveal that the estimates are much more accurate when GMM is applied and speed of convergence increases.

I also have found out that the non-thermal electricity usage has a significantly positive effect on growth rate when GMM method is applied, wheras electricity usage from thermal sources has no significant effect on the growth rate. Although the results from Arellano-Bover/Blundell-Bond estimation are not as accurate as System GMM results, it can be argued that the elasticity weighted electricity production from non-thermal sources have a positive effect on the growth rate of GDP per capita. As it was stated, data availability for electricity production forces us to narrow our scope of analysis to only one year and to omit these variables. But if not omitted, although with bias, we can conclude the electricity production from non-thermal sources has a positive effect on the growth. This result should be interpreted in a policy related way. The subsidy policy towards the power plants using thermal sources should be reviewed. The amount spent on the thermal power plants by the government should be examined and the susbsidies for the non-thermal power sources may be increased.

In addition to this result, I have also found that the share of specialized lendings in credit demand tends to increase the growth rate. This is an expected result and relevant in quite a few ways. While the monetary policy and its effectiveness is on debate, this result provides some insight on what kind of fiscal and monetary tools are necessary for improving the growth rate. While the decrease in the interest rates and the decrease in the cost of borrowing from the banks is thought to be helpful to improve or at least sustain the growth rates, this result also implies the types of credits given, the types of borrowing also matters at a significant level. While the specialized lendings have a significantly positive effect on the growth rate this analysis can be extended to see if which sectors are promoting more output.

There are several important results that need to be kept in mind, however. Our independent variable, logratihm of the sum of growth rate of population and the depreciation rate, was expected to have a negative sign. The reason that I always have a positive and significant result is that the statement is expressed as a division. As you use transform the variable into the logarithm of the population growth rate and the depreciation rate you would have expected negative sign.

Logarithm of capital utilization rate had a negative sign, which may seem to be uncommon and it is. The difference with the savings in an economy and the capital utilization, as we mentioned before, is that the capital utilization rate does not take existance of unused physical capital's existance into account. Realize as the utilization of the capital increase, it is expected to have diminishing effect on the growth rate. The results obtained from OLS and Arellano-Bover/Blundell-Bond estimation have significantly negative signs and this result is legitimate when the diminishing returns are considered.

As a last comment, one should realize although the conducted tests state at some level of significance convergence occurs for development regions in Turkey, this result should be interpreted carefully. As we conducted the tests between 2002-2013 for each region, the results imply the convergence occur for each region by itself. The steady state for a development region is reached at a implied speed of convergence but the reached steady states may be different. Keeping in mind that the initial levels of income and the speed of convergence differ from region to region, the steady state levels of income may be different. In that case, if there are no external shocks on productivity of some factor in some region when the steady state level of income per capita for different regions reached, the expected difference between levels of income per capita would be sustained.

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APPENDIX

3 Table 1: Region Classifications at NUTS2 Level

Table 1

Region Classifications at NUTS2 Level

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

*TURKSTAT-Region Classifications

4 Table 2: Dependent Variable: log differences in gross regional product per capita

Table 2

Dependent Variable: log differences in gross regional product per capita

	Within Group	P>(t)
$\boldsymbol{ln(\frac{1}{n+\delta})}$	.068368	0.000
$\boldsymbol{ln(q_0)}$	.0800841	0.005
$\boldsymbol{\epsilon(1-\phi)ln(\eta_{cit})}$	(omitted)	
$\boldsymbol{\epsilon\phi ln(\eta_{dit})}$	(omitted)	
$\boldsymbol{ln(s)}$	-.0144428	0.474
$\boldsymbol{ln(y_{t-1})}$	-.1781029	0.000
Constant	2.754161	0.000

Note: Prob > F = 0.0000.
Note: $\epsilon(1-\phi)ln(\eta_{cit})$ omitted because of collinearity
Note: $\epsilon\phi ln(\eta_{dit})$ omitted because of collinearity

5 Table 3: Hausman Test

Table 3

Hausman Test

	Fixed (β_f)	**Random (β_r)**	**Standart Error**
$\boldsymbol{ln(\frac{1}{n+\delta})}$	.068368	.0351579	.0088643
$\boldsymbol{ln(q_0)}$	.0800841	.0235306	.0170574
$\boldsymbol{ln(s)}$	-.0144428	-.0288124	.0303247
$\boldsymbol{ln(y_{t-1})}$	-.1781029	-.0035366	.028787

$$\chi^2(4) = (\beta_f - \beta_r)'[(V_f - V_r)^{(-1)}](\beta_f - \beta_r) = 43.99$$
$$Prob > \chi^2 = 0.0000$$

6 Table 4: Dependent Variable: log differences in gross regional product per capita

Table 4

Dependent Variable: log differences in gross regional product per capita

	OLS	**Within Group**	**Sytem GMM**	**Arellano-Bover/ Blundell-Bond**
Constant	-.0568063	2.754161***		
	(.1221537)	(.2685229)		
$\boldsymbol{ln(\frac{1}{n+\delta})}$	.0351579**	.068368**	.1706615***	.0781434***
	(.0116214)	(0.0146212)	(.0385975)	(.0241594)
$\boldsymbol{ln(q_0)}$	.0235306	.0800841**	.3060065**	.2329836**
	(.0329218)	(.026029)	(.1310005)	(.1044502)
$\boldsymbol{\epsilon(1-\phi)ln(\eta_{cit})}$	-.0013937	(omitted)	(omitted)	.1298435**
	(.0043104)			(.0607294)
$\boldsymbol{\epsilon\phi ln(\eta_{dit})}$	.0137872	(omitted)	(omitted)	.0570105
	(.0112945)			(.1582293)
$\boldsymbol{ln(s)}$	-.0288124**	-.0144428	-.088069	-.111085**
	(.0117845)	(.0198448)	(0.207)	(.0513836)
$\boldsymbol{ln(y_{t-1})}$	-.0035366	-.1781029***	-.2333984***	-.1274375**
	(.0062539)	(.0161489)	(.0471082)	(.0472467)
Implied $\boldsymbol{\lambda}$	0.003530361	0.163905433	0.209773286	0.119947358
R^2	0.0308	0.1512		
Number of observations	312	312	286	312
Number of groups		26	26	26
Number of instruments			64	27
Hansen test $\boldsymbol{p}$ value			1	
Difference Hansen $\boldsymbol{p}$ value			1	

Note: Heteroskedasticity consistent standart errors are in parantheses.
*The coefficient is significant at 10%
**The coefficient is significant at 5%
***The coefficient is significant at 1%
For Arellano-Bover/Blundell-Bond first difference estimation, twice lagged versions of $ln(q_t)$, $ln(y_{t-1})$, $ln(s)$, $ln(\frac{1}{n+\delta})$ are used as instruments.
For System GMM results once lagged versions of $ln(y_{t-1})$ and $ln(s)$ are used as instruments.

7 Table 5: AR(1) and AR(2) results for System GMM app-proach

Table 5

AR(1) and AR(2) results for System GMM appproach

	z-value	**Pr > (z)**
Arellano-Bond test for AR(1) in first differences	-4.01	0.000
Arellano-Bond test for AR(1) in first differences	-2.13	0.033