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CONVERGENCE IN AN ENLARGED EUROPE: THE TURKISH CASE

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Abstract

This paper examines the process of convergence in relative GDP per capita across EU countries and Turkey and investigates the effects of openness, economic activity and human capital investment in the growth process. The presence of convergence was found to be higher for EU countries. We apply panel data tests of convergence with annual data available from 1998 to 2007. We have constructed the European Union data set to include Turkish data. The results have some important policy implications for the European Union and Turkey.

Keywords: convergence; Turkey; economic growth; panel data.

JEL codes: O47; O33; C23; O11

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Introduction

From the 1950s up until the mid-1980s, the literature concerned with long run growth was dominated by the Neoclassical Growth Model- a la Solow (Solow,R,1956). According to this theory, the economy - due to diminishing returns on investment in physical capital, converges towards a steady state conditioned upon the behavioural and technological parameters in the model. After the mid-1980s, the Endogenous Growth Theory [EGT] seeks to explain the causes of *technical progress* as a driver of economic growth. However, early versions of EGT did not predict the conditional convergence that characterises the Neoclassical Growth Model. For example, Barro and Sala-i-Martin (1997) extend the EGT model and added the diffusion of technology and human capital to account for economic growth. When imitation tends to be cheaper than innovation, the diffusion models predict a form of conditional convergence that resembles the predictions of the Neoclassical Growth Model. This framework combines the long-run growth features of EGT with the convergence behaviour of the Neoclassical Growth Model (Barro, 1997: ch.7).

The effects of technological diffusion on economic growth have been analysed by Grossman and Helpman (1991, Chs. 9 and 11) and Rivera-Batiz and Romer (1991). Also, Bernard and Jones (1996) suggest that differences in technologies across countries can have implications for convergence. Similarly, Keller (2001) and Bloom et al. (2002) argue that strong technology diffusion is a major force towards convergence.

In this paper, we analyse the convergence of per capita GDP across existing European Union (EU) countries and Turkey, which is a candidate for admission to the EU.

We specifically test the extent to which convergence is derived from human capital investment, nature of economic activity, trade openness which partially capture the process of technology diffusion. These conditioning variables have been selected because they reflect an openness to technical progress.

We apply panel data tests of convergence with annual data available from 1998 to 2007. We have expanded the EU data set to include Turkish data and the results have some important policy implications for the European Union and Turkey. The rest of the paper is organised as follows: Section 2 comprises the literature review. Section 3 discusses the theoretical model of convergence. Section 4 explains the empirical specifications, data set and results for unconditional and conditional convergence. Section 5 concludes.

2. Literature review for Turkey

In recent years, several studies have considered the convergence between EU countries and candidate countries. For example, Saracoglu and Dogan (2005) analyse the convergence hypothesis for EU countries and candidate countries including Turkey. Using panel unit root tests, they find that Turkey converged to the EU during 1985-2004. Altin et al. (2006) analyse the convergence hypothesis for the period 1970- 2004 and find that enlargement positively affects convergence.

Dogan and Saracoglu (2007) used panel unit root tests to investigate income convergence for the EU and candidate countries. Using quarterly data for the period 1990-2004, they found that there is no income convergence among established EU countries but that evidence of convergence exist for an expanded group that includes candidate countries. Some candidate countries, including Turkey, appear to be converging on the EU average. Also, Atalay (2007 finds convergence for new EU countries and candidate country Turkey relative to the EU-15 countries between 1993 and 2004.

Yigit and Kutan (2007) construct an EGT model to investigate the consequences of economic integration for convergence and productivity growth. Their empirical results suggest that accession to the EU is a potential, though not guaranteed, opportunity for faster growth and convergence.

3. A theoretical model of convergence

A theoretical model of convergence in per capita output can be developed from the neo-classical model of growth, as developed by Solow (1956). Following Barro and Sala-i-Martin (1995), the production function can be rewritten as:

$$\hat{y} = f(\hat{k}) \Rightarrow f'(k) > 0, f''(\hat{k}) < 0 \qquad (1)$$

where Y is the total output while A is an efficiency parameter. And $\hat{y} = Y / L$ and $\hat{k} = K / L$, where K is capital and L is units of effective labour.

There are two exogenous sources of growth in effective labour units: the rate of technical progress, x, and the rate of growth of working population, n. Hence, we have

$$L = Ne^{xt} = N_0 e^{(n+x)t} \qquad (2)$$

where N_0 is initial population.

With a closed economy, the rate of investment is equal to the rate of saving which is Y-C, where Y is income and C is consumption. Thus,

$$\dot{K} + \delta K = Y - C \qquad (3)$$

where $\dot{K}$ is change in capital stock while δ is depreciation. The capital accumulation growth path then is

$$\dot{\hat{k}} = f(\hat{k}) - \hat{c} - (\delta + n + x)\hat{k} \qquad (4)$$

where $\hat{c} = C / L$. The representative household maximises utility by

U=u(c), u'(c)>0, u" (c) <0 (5)

where c=C/N.

Instantaneous social utility is defined as the product of the population size and the utility-from-consumption of the representative consumer. The social objective function to be maximised is the discounted future time path of social utility, discounting representing time preference.

$$u = N_0 \int_0^{\infty} u(c)^{-(\rho - n)t} dt \qquad (6)$$

The optimal growth path, therefore, maximises the above objective, subject to the capital accumulation constraints. The current value Hamiltonian is

$$H = u(c) + m[f(\hat{k}) - \hat{c} - (\delta + n + x)\hat{k}] \tag{7}$$

The maximum principle requires

$$\frac{\partial H}{\partial c} = u'(c) - m = 0 \tag{8}$$

$$\frac{\partial H}{\partial m} = f(\hat{k}) - \hat{c} - (\delta + n + x)\hat{k} = \dot{\hat{k}} \tag{9}$$

$$\frac{\partial H}{\partial k} = m[f'(\hat{k}) - (\delta + n + x)] - (\rho - n)m = -\dot{m} \tag{10}$$

Differentiate equation (8) with respect to time

$$u''(c)\dot{c} = \dot{m} \tag{11}$$

Use equations (6) and (9) to eliminate m and $\dot{m}$ in equation (10).

$$\dot{c} = \frac{u'(x)}{u''(x)}[f'(\hat{k}) - (\delta + x + \rho)] \tag{12}$$

$$\dot{\hat{k}} = f(\hat{k}) - \hat{c} - (\delta + n + x)\hat{k} \tag{13}$$

The above equation can be linearised using the Taylor expansion theorem. But the characteristic roots cannot be compared unless special functional forms are assumed for u(c) and f (k).

Following Barro and Sala-i-Martin (1995), we assume that the utility function takes the form

$$u(c) = \frac{c^{1-\theta} - 1}{1 - \theta} \tag{14}$$

Since $u'(c) = c^{-\theta}$ and $u''(c) = -\theta c$, equations (14) and (13) become

$$\dot{c} = \frac{c}{\theta}[f'(k) - (\delta + x + r)] \tag{15}$$

Equations (13) and (15) provide steady state growth paths for k and c. In the steady state, y, k, and c grow at the rate of x. To show the stability of the model, we can linearise in the zone of steady state equilibrium ($\bar{c},\bar{k}$). This yields

$$\begin{bmatrix} \dot{k} \\ \dot{c} \end{bmatrix} = \begin{bmatrix} \psi & -1 \\ \frac{c}{\theta} f'(k) & 0 \end{bmatrix} \begin{bmatrix} k & -\bar{k} \\ c & -\bar{c} \end{bmatrix} \tag{16}$$

where $\psi = \rho - n - (1-\theta)x$

which is regarded as positive and in the steady state,

$$f'(k) = \delta + \rho + (1+\theta)x$$

Thus the last term in the 2×2 matrix is zero. The system shows saddle path stability because the trace and determinants of A are positive and negative respectively, i.e.

$$Tr(A) = \Psi \rangle 0$$

$$Det(A) = -(c/\theta) f'(k) \langle 0 \tag{17}$$

The stable root, β, is given by

$$\beta = -Tr(A) + \{Tr(A)^2 - 4Det(A)^2 - 4Det(A)\}^{1/2}$$

given a Cobb-Douglas production function (CDPF), i.e.

$$\hat{y} = f(\hat{k}) = A\hat{k}^{\alpha}$$

This yields

$$\beta = \frac{1}{2}\{\psi^2 + 4(\frac{1-\alpha}{\theta})(\rho + \delta + \theta x)[\frac{\rho + \delta + \theta x}{\alpha} - (n + \delta + x)]\}^{1/2} - \frac{\psi}{2} \tag{18}$$

Note with CDPF, the dynamic time paths of y and k are identical. Hence, in discrete time, the solution for $\log[\hat{y}(t)]$ is

$$\log[y(t)] = \log[y(0)]e^{-\beta t} + \log(\bar{y})(1 - e^{-\beta t}) \tag{19}$$

The greater the value of β, the greater the responsiveness of the average growth rate to the gap between $\log(\bar{y})$, long run equilibrium level, and the initial level of income, i.e. log[y(0)]. The model implies conditional convergence in that for given values of x and $\bar{y}$. The growth rate is higher the lower is log [y(0)]. This is the standard β convergence process (see Barro and Sala-i-Martin, 1995).

For empirical estimation, we follow

$$\log\left(\frac{y_{it_0+T}}{y_{it_0}}\right) = \theta - (1-e^{-\beta t})\log(y_{it_0}) + u_{i,t_0,t_{0+T}} \tag{20}$$

where $\theta = x + [(1-e^{-\beta t})][\log(\bar{y}) + xt_0]$, $u_{i,t0,t0+T}$ is the error term and i indices of the countries. Eq (21) is $Y_{i,t0+T} - Y_{i,t0} = a + b_0 Y_{i,t0} + v_{it}$, in which the coefficient on $\log(y_{it0})$ - i.e. on $Y_{i,t0}$, is constant.

4 Empirical specifications and results

To test our convergence hypotheses, we use the specifications derived from the previous section. Equation (21) implies the test for unconditional convergence while equation (22) specifies conditional convergence.

The empirical models for the estimation at a given time are thus

$$Y_{i,t} - Y_{i,t0} = a + b_0 Y_{i,t0} + v_{it} \tag{21}$$

and

$$Y_{i,t} - Y_{i,t0} = a + b_0 Y_{i,t0} + b_1 TRADE_{it} + b_2 AGRI_{it} + b_3 HC_{it} + v_{it} \tag{22}$$

where T= number of years in the period from 1998 to 2007 and i = 1, 2, ..., and 26 European Union countries and Turkey. *a* and b_0, b_1, b_2 and b_3 are the parameters to be estimated.

Here, $Y_{i,t}$ is the natural logarithm of real GDP per capita in country *I* at time *t*, relative to the inter-country mean at that date. This specification investigates convergence between countries.

The model considers three other explanatory variables, which are expected to control for the effects of technology diffusion: an open trade policy, change in economic activities and accumulation of human capital. It is now generally acknowledged that a relatively liberal trade regime along with accumulation of human capital as knowledge industry and structural economic changes are the main vehicles of technology diffusion. These variables are demeaned before estimation for the purpose of removing some of the correlations that may exist across the error terms (see Lee, Pesaran and Smith, 1997).

Thus, equation (22) tries to show how income per capita depends on trade, structural change and human capital. We assume that trade could be the engine of economic growth; although some argue that causality could be bi-directional (Ghatak, S and S Wheatley-Price, 1997). Trade is also important, because a higher degree of integration with the world market means higher level of technology. Some researchers believe that limitations in trade slow down the speed of growth. TRADE is the difference between the natural logarithms of the ratio of imports and exports to GDP. We use AGRI as the percentage of GDP that is produced by the agricultural sector to capture the impact of structural change.

The final explanatory variable in our growth equation is a proxy for the ratio of human capital investment to GDP. We use logarithms of the percentage of the working age population that is enrolled in secondary schools (HC). It is now well known that human capital accumulation is a prime driver of technical progress and diffusion.

4.1. Econometric Background and Data

The panel data method is used in this study. Panel data consists of time series and cross-sectional data. In panel data, which has the same problems with time series, it is essential to determine whether variables include unit root, or not. It is also important to investigate whether there is co-integration between variables which have unit roots of the same value. If the variables are not stationary, regression estimates obtained may be spurious. Therefore, in order to obtain correct estimate values, panel unit roots tests are applied.

In recent years some tests for unit root within panels have been developed in the literature. Unit-root tests examine the unit-root null hypothesis based on a single equation method. However, it is well known that these tests have low power when the root is close to one (Wu J.L. 2000: 216). Levin and Lin (1992, 1993), Im, Pesaran and Shin (IPS), (1997, 2003), Maddala and Wu (1999), Kao (1999), Quah (1994), Choi (1999, 2001) have all developed panel unit-root tests, but in this study IPS (2003) was used.

IPS presented a method to test for the presence of unit roots in a dynamic heterogeneous panel. They considered a sample of N cross section units observed over T time periods (Otero J. et al. 2005: 230). IPS allowed for a heterogeneous coefficient of y_{it-1} and proposed an alternative testing procedure based on averaging individual unit root test statistics. IPS suggested an average of the ADF tests when u_{it} is serially correlated with different serial correlation properties across cross-sectional units (Baltagi, 1988: 242). The power of ADF tests is low with short time spans. The null hypothesis is that each series in the panel contains a unit root and the alternative hypothesis allows for some (but not all) of the individual series to have unit roots (Baltagi, 2005: 242).

The IPS statistic is defined as:

$$\bar{Z} = \sqrt{N}\left[\bar{t} - E(\bar{t})\right] / \sqrt{Var(\bar{t})}$$

Where $\bar{t} = (1/N)\sum_{t=1}^{N} t_i$, t_i is t statistics of $\hat{\beta}_i = 0,$ $E(\bar{t})$ and $Var(\bar{t})$ are the mean and variance of $\bar{t}$, respectively.

If there is a unit root in the series, panel co-integration tests should be used in order to get a long run relationship between series. The Pedroni (1995, 1997,1999) panel co-integration test is used widely in the literature. Pedroni (1999) improved a residual based panel co-integration test. He introduced panel co-integration tests for a model which has more than one independent variable in the regression equation. Using this method, firstly the co-integration regression is estimated by OLS for each cross section:

$$y_{i,t} = \alpha_i + \delta_i t + \beta_{1i} x_{1i,t} + \beta_{2i} x_{2i,t} + \ldots + \beta_{Mi} x_{Mi,t} + \varepsilon_{it}$$

$$t = 1,\ldots,T\,; \quad i = 1,\ldots,N; \qquad m = 1,\ldots,M$$

T is the number of observations over time, N is the number of individual members in the panel, M is the number of independent variables, $\beta_{1i}, \beta_{2i}, ..., \beta_{Mi}$ are the slopes of coefficients, α_i is the member specific intercept or fixed effect parameter, and $\delta_i t$ is the deterministic time trend.

Then panel-ρ and panel-t statistics are computed by taking the first difference of the original series and estimating the residuals of the following regression:

$$\Delta Y_{i,t} = b_{1i}\Delta\chi_{1i,t} + b_{2i}\Delta x_{2i,t} + ... + b_{Mi}\Delta x_{Mi,t} + \pi_{i,t}$$

Following regression

$$\hat{e}_{i,t} = \hat{\gamma}_i \hat{e}_{i,t-1} + \hat{u}_{i,t}$$

is estimated by using the residuals $\hat{e}_{i,t}$ from the co-integration regression ($y_{i,t} = \alpha_i + \delta_i t + \beta_{1i} x_{1i,t} + \beta_{2i} x_{2i,t} + ... + \beta_{Mi} x_{Mi,t} + \varepsilon_{it}$). The null hypothesis of no co-integration for the panel co-integration test:

$H_0 : \gamma_i = 1$ for all $i : 1,..., N$

The alternative hypothesis for the between-dimension-based statistic is

$H_0 : \gamma_i < 1$ for all $i : 1,..., N$ a common value for $\gamma_i = \gamma$ is not required

$H_0 : \gamma_i = \gamma < 1$ for all $i : 1,..., N$ assumes a common value for $\gamma_i = \gamma$

In this study, the data set is from World Bank, Eurostat, Turkish Statistical Institute and Penn World Tables (PWT). We applied panel data tests of convergence with the annual data available from 1998-2007. The model is based on European Union countries and Turkey. We have constructed the European Union data set to include Turkish data. We have excluded Malta because there is not enough data on their agricultural sector. Therefore we have used 27 countries.

4.2. Estimation results on unconditional convergence

To determine the unit root we used the IPS unit root test for each series.

Table 1 Im, Pesearan and Shin (2003) Panel Unit Root Test Results

Variable		Statistic	Probability
lhc	level	2.19503	0.9859
	first difference	-3.94562	0.0000
lagri	level	-0.89488	0.1845
	first difference	-12.4104	0.0000
ltrade	level	1.71947	0.9572
	first difference	-2.49774	0.0062
lY	level	2.55246	0.9947
	first difference	-2.46768	0.0068

lhc is natural logarithm of human capital; lagri is natural logarithm of agriculture; ltrade is natural logarithm of trade, and *lY* is the natural logarithm of real GDP per capita. According to the IPS panel unit root test results, all series have unit roots.

Because all series have the same degree of unit root, we investigated whether there is a co-integration between variables.

Table 2. Pedroni (1999) Panel Cointegration Test Results

Dependent variable lY	Independent variable Yito		Independent variable (Included Turkey)Yito	
Panel ADF	1.8731	-5.1969	-0.8476	-4.7149
	(0.9695)	(0.0000)	(0.1983)	(0.0000)
Group ADF	3.8225	-11.5826	-3.5122	-10.6401
	(0.0001)	(0.0000)	(0.0002)	(0.0000)

Pedroni (1999) panel-t and group-t co-integration tests are one-sided tests and have critical values of -1.645.

We used Pedroni (1999) panel co-integration test. The reported values of this test in Table 2 are less than the critical value. This means the rejection of the null hypothesis of non co-integration. There is a co-integrating relationship between the variables.

Table 3 Estimates of the growth model (21)

	1998-2007 (included Turkey) fixed effect	1998-2007 fixed effect
Constant	0.0632 (39.9854)	0.0635 (44.3958)
Yito	-0.0221 (-1.6215)	-0.0091 (-1.728)
Implied λ	0.00242	0.00102
Obs.	243	234
Adj. R^2	0.46	0.61
Hausman Test	$\chi^2(1)=7.9176$	$\chi^2(1)=7.4221$

Note: Values in brackets are t-ratios

Our regression results for 1998-2007 using panel data analysis are presented in Table 3.

The investigation of unconditional convergence requires a restrictive assumption that there is no difference in preference, technology and steady state across countries. When we included Turkey, Hausman test yields a statistic of 7.9176, which is Chi-squares distributed with a degree of freedom equal to one. As we can reject the null hypothesis ($H_0 : E(\varepsilon_i / x_{it}) = 0$), we used the fixed effect model.

There is an absolute unconditional convergence observed because the coefficient of the initial level of real GDP per capita, Yito, is negative and statistically significant. Countries with lower initial levels of relative GDP per capita tend to grow 0.0221 percent faster than rich ones.

On the basis of $-(1-e^{\lambda T}) = -0.0221$ the implied value of the rate of convergence is 0.00242. It implies that 0.242 percent of the gap of initial levels of real relative GDP per capita between the rich and the poor vanishes in a year if their steady states are identical. Given that λ = 0.00242, the time for an economy to move halfway to national steady state is 286 years from the half life formula, $t = \ln 2/\lambda$.

In this study, when we excluded Turkey from the analysis, the Hausman test yields a statistic of 7.4221, which is Chi-squares distributed with a degree of freedom equal to one. The null hypothesis proved invalid so the fixed effect model was used. An absolute unconditional convergence was observed. Countries with lower initial levels of relative GDP per capita tend to grow 0.0091 percent faster than rich ones. The estimated value for the speed of convergence is 0.00102. It implies that 0.102 percent of the gap of initial levels of real relative GDP per capita between rich and poor vanishes in a year if their steady states are identical. Given that λ = 0.00102, the time for an economy to move halfway to national steady state is 679 years from the half life formula, $t = \ln 2/\lambda$.

4.3. Estimation results on conditional convergence

As it has been indicated earlier, to control for the difference in technologies, TRADE, AGRI and HC are included.

TRADE is included under the assumption that there is a correlation between higher degrees of integration with the world market and higher levels of technology. Countries with more exports and imports are likely to have used their resources more efficiently and imitated foreign advanced technology.

AGRI is included to allow for the differing composition of economic activities within European Union countries and Turkey. Economic development literature has long assumed that different components of economic activity have different levels of technology (Ghatak and Li, 2006). Thus, countries with a higher percentage of GDP in agriculture are expected to have lower level of technology.

HC is included on the basis that education and knowledge accumulation boosts output growth rates.

Table 4. Estimates of the growth model (22)

	1998-2007 (including Turkey) Fixed effect	1998-2007 Fixed effect
Constant	0.0597 (31.1679)	0.05925 (34.816)
Yito	-0.0217 (-1.7007)	-0.0081 (-1.8205)
TRADE	0.0688 (2.7342)	0.0769 (3.3997)
AGRI	0.0144 (0.9481)	0.0056 (0.04109)
HC	-0.1975 (-5.0709)	-0.2091 (-6.1389)
Implied λ	0.00244	0.00090
Obs.	243	234
Adj. R^2	0.54	0.6105
Hausman Test	χ^2 (4)=22.1295	χ^2 (4)=28.9726

Note: Values in brackets are t-ratios

In this study, when Turkey was included, Hausman test yields a statistic of 22.1295, which is Chi-square distributed with a degree of freedom equal to four. Rejecting the null hypothesis, the fixed effect model was used.

An absolute conditional convergence is observed because the coefficient on the initial level of real GDP per capita, Yito, is negative and statistically significant. Countries with lower initial levels of relative GDP per capita tend to grow 0.0217 percent faster than rich ones.

The speed of convergence is $-(1-e^{\lambda T})=-0.0217$. The 0.244 percent gap of initial levels of real relative GDP per capita between rich and poor vanishes in a year if their steady states are identical. Given that λ= 0.00244, the time for an economy to move halfway to national steady state is 284 years from the half life formula, $t=\ln 2/\lambda$.

In this study, when we exclude Turkey, the Hausman test yields a statistic of 28.9726. Again, the null hypothesis can be rejected and the fixed effect model employed. An absolute conditional convergence is observed, and countries with lower initial levels of relative GDP per capita tend to grow 0.0081 percent faster than rich ones.

The estimated value for the speed of convergence is 0.00090. It implies that the gap of 0.09 percent of initial levels of real relative GDP per capita between rich and poor vanishes in a year if their steady states are identical. Given that λ = 0.00090, the time for an economy to move halfway to national steady state is 770 years from the half life formula, $t = \ln 2 / \lambda$.

Knight, Loayza and Villanueva (1993) and Islam (1995) use a similar method, but different conditional variables. Knight et al. (1993) estimate the speed of convergence is 6.26 percent for 98 countries, including developing ones, in the period 1960-1985.

Islam (1995) estimates that the speed of convergence for 22 OECD countries (which are relatively homogenous) over the same period is 9.26 percent. Islam (1995) argues that the high speed of convergence is consistent with the prediction of the Solow-Cass-Koopmans model because an open economy version of the growth model predicts a speedy convergence.

5 Conclusions

This paper examines the tendency towards convergence in relative GDP per capita across EU countries and Turkey and investigates the effects of openness, economic activity and human capital investment in the growth process. Our panel data analysis with the annual data available from 1998 to 2007 confirms the presence of greater convergence for EU countries when Turkey is included. These results show that Turkish accession to the EU will be important both for EU countries and Turkey. Our results are in accord with the studies of Dogan and Saracoglu (2007) and Borys et al. (2008).

As regards conditional convergence, we find that openness and human capital investment are positively and significantly related to subsequent economic growth rates. When Turkey is included they affect the convergence speed more than the data from EU countries alone. However, the coefficient on the percentage of activity in agriculture is statistically insignificant. This situation is not really important for either EU countries or Turkey, because of the declining role of agricultural sectors in these economies.

References

Altin, O., Demirci S., Cakir, O. and Semiz, H. (2006). “AB Genisleme Surecinin Uye Ulkelerin Iktisadi Buyumesi, ve Dis Ticareti Uzerine Etkileri: Panel Veri Analizi”, http://www.tcmb.gov.tr/yeni/iletisimgm/O_Cakir-O_Altin-S_Demirci-H_Semiz.pdf (September 2010).

Atalay, Serpil (2007). “Yeni Avrupa Birligi Ulkelerinde ve Turkiye’de Reel Yakinsama”. Ankara: Turkish Central Bank General Directorate of Foreign Relations Specialism Efficiency Thesis.

Baltagi, B. H (2005), *Econometric Analysis of Panel Data*, Third Edition, John Wiley and Sons, Ltd., England.

Barro, R. J. and Sala-i-Martin, X (1995), *Economic Growth*, McGraw- Hill, Inc.

Barro R.J and Sala-i-Martin,X (1997), “Technological Diffusion, Convergence, and Growth”, *Journal of Economic Growth*. 2. 1 (March). pp.1-27.

Barro, Robert J. (1997). *Determinants of Economic Growth: A Cross-Country Empirical Study*. Cambridge, England: The MIT Press.

Bernard, Andrew B. and Charles I Jones (1996),“Technology and Convergence”, *The Economic Journal,* 106 : 437. pp.1037-1044.

Borys M.M., Polgár E.K. and Zlate A. (2008). “Real Convergence and the Determinants of Growth in the EU Candidate and Potential Candidate Countries: A Panel Data Approach”. European Central Bank Occasional Paper Series. 86.

Choi, I. (2001). “Unit Root Tests for Panel Data”, *Journal of International Money and Finance*. 20. pp. 249-272.

Dogan, Nukhet and Bedriye Saracoglu (2007). “Income Convergence of European Union and Candidate Countries: Are they all the Same?”, *International Research Journal of Finance and Economics*. ISSN 1450-2887. Issue 12.

Ghatak, Subrata and Stephen Wheatley Price (1996), "Export Composition and economic Growth: Cointegration and Causality Evidence for India", *Review of World Economics*, Vol. 133. No: 3. pp.538-552.

Ghatak, S and Li, Hong (2006), “Economic growth and convergence in China’s provinces: theory and evidence”, *International Journal of Economic Research*. 3(1). pp.1-15.

Grossman, Gene M. and Elhanan Helpman (1991), *Innovation and Growth in the Global Economy*. Cambridge, MA: MIT Press.

Im, K.S., M.H. Pesaran and Y. Shin (2003),“Testing for unit roots in heterogeneous panels’’, *Journal of Econometrics* 115(1). pp. 53-74.

Islam, N., (1995), “Growth empirics: A panel data approach”, *Quarterly Journal of Economics*. 110, 4(November). pp. 1127-1170.

Kao, C. (1999), “Spurious Regression and Residual Based Tests for Cointegration in Panel Data”, Working Paper, Center of Policy Research, Syracuse University. New York.

Knight, M., N. Loayza and D. Villanueva (1993). “Testing the Neoclassical Theory of Economic Growth”, IMF Staff Papers. Vol. 40. No. 3.

Lee, K., M. H. Pesaran and R. Smith (1997),“Growth and Convergence in a Multi-country Empirical Stochastic Solow Model”, *Journal of Applied Econometrics*. Vol. 12. pp. 357-392

Levin, A. and C.F. Lin (1992), “Unit Root Tests in Panel Data: Asymptotic and Finite Sample Properties”, Discussion Paper. No 92–93. University of San California, San Diego.

Levin, A. and C.F. Lin (1993), “Unit Root Test in Panel Data: New Results”. Discussion Paper No 93–56. University of San California. San Diego.

Maddala, G. S and S. Wu (1999), “A Comparative Study of Unit Root Tests with Panel Data a New Simple Test”, *Oxford Bulletin of Economics and Statistics.* Special Issue, Vol. 61, pp.631–652.

Otero J., J. Smith and M. Giulietti (2005), “Testing for Seasonal Unit Roots in Heterogeneous Panels”, *Economics Letters.* 86. 229–235

Pedroni, P. (1999), “Critical values for cointegration tests in heterogeneous panels with multiple regressors”, *Oxford Bulletin of Economics and Statistics*. 61. pp.653-670.

Quah, D. (1994), “Exploiting Cross-section Variation for Unit Root Inference in Dynamic Data, *Economic Letters.* 44. pp. 9–19.

Rivera-Batiz, Luis A. and Paul M. Romer (1991),“International trade with endogenous technological change”, *European Economic Review,*Vol: 35(4). pp. 971-1001.

Saracoglu, Bedriye and Nukhet Doğan (2005), “Avrupa Birligi Ulkeleri ve Avrupa Birligine Aday Ulkelerin Yakinsama Analizi”, Istanbul University, *VII. Ulusal Ekonometri ve Istatistik Sempozyumu.*

Solow, R. M. (1956), “A Contribution to the Theory of Economic Growth”, *Quarterly Journal of Economics*, 70(1), pp. 65-94.

Yigit, M. Taner and Ali M. Kutan (2007), “European integration, productivity growth and real convergence”, *European Economic Review*: 51(6). pp. 1370-1395.

Wu, J. L. (2000). “Mean Reversion of the Current Account: Evidence from the Panel Data Unit-root test”, *Economics Letters*. 66, 215–222.