HIGHER EDUCATION AND ECONOMIC GROWTH: AN EMPIRICAL INVESTIGATION OF COINTEGRATION AND CAUSALITY FOR TURKISH ECONOMY

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ABSTRACT

Recently, studies about the effects of higher education on economic growth in developing countries are taking more attention. In this paper, long-run and causal relationships between higher education and economic growth in Turkish economy over 1970–2008 period were analysed. For this purpose, two higher education indicators were regressed over real GDP using ARDL (Autoregressive Distributed Lag) bounds testing approach and the causality between these variables was investigated by Dolado and Lütkepohl's style Granger causality test. Results showed that, higher education is cointegrated to economic growth and either higher education or economic growth has significant causal effects on each other.

Keywords: Higher Education, Economic Growth, Cointegration, Causality.

YÜKSEKÖĞRETİM VE EKONOMİK BÜYÜME: TÜRK EKONOMİSİ İÇİN BİR EŞBÜTÜNLEŞME VE NEDENSELLİK ARAŞTIRMASI

ÖZ

Son yıllarda gelişmekte olan ülkelerde yüksek öğretimin ekonomik büyüme üzerindeki etkilerini konu alan çalışmalar daha fazla ilgi çekmektedir. Bu çalışmada Türk ekonomisinde 1970-2008 döneminde yüksek öğretim ve ekonomik büyüme arasındaki uzun dönemli ve nedensel ilişkiler analiz edilmiştir. Söz konusu amaç için iki yüksek öğretim göstergesi ARDL sınır testi yaklaşımı kullanılarak reel GSYİH üzerine regrese edilmiş ve değişkenler arasındaki nedensellik ilişkisi Dolado ve Lütkepohl tarzı Granger nedensellik testi ile araştırılmıştır. Sonuçlar Türk ekonomisinde yüksek öğretim ile ekonomik büyümenin eşbütünleşik ve hem yüksek öğretimin hem de ekonomik büyümenin birbirleri üzerinde anlamlı nedensel etkileri olduğunu göstermiştir.

Anahtar Kavramlar: Yüksek öğretim, Ekonomik Büyüme, Eşbütünleşme, Nedensellik.

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INTRODUCTION

In this study, the long-run and causal relationships between higher education the integral part of human capital and economic growth in Turkish economy over the period 1970-2008 were investigated using recently developed cointegration and causality techniques.

The relationship between human capital and economic growth was seriously taken into account by Adam Smith (1776) at first, followed by Schulz (1962) who brought a systematic perspective to human capital, and Denison (1967) who argued that investing in human capital is vital for economic growth. Afterwards, the rising importance of new growth theories (e.g. Lucas, 1988; Romer, 1990; Rebelo, 1991; Mankiw et al., 1992) made a huge contribution to the value of human capital in the economic growth process of the economies. Following these basic theories, this paper focuses on human capital as a determinant of economic growth. Although human capital includes education, health and aspects of social capital, the main focus of the present study is on education, particularly higher education.

Education is widely accepted as a leading instrument for promoting economic growth at all levels. It contributes to economic growth through imparting general attitudes, discipline and specific skills necessary for a variety of workplaces. If one look at the researches which take education into account as a determinant of economic growth, it can easily be seen that huge part of the literature is composed of cointegration, causality and simple regression analysis which try to find out the long-run and causal relationships between education and economic growth. This literature can also be devided into two groups. First group of researches consists of studies which examine the interaction between overall education and economic growth. Using Johansen cointegration and Granger causality analysis, while Babatunde and Adefabi (2005), Sari and Soytas (2006), Taban and Kar (2006) found cointegration and bi-directional causality between education and economic growth; Asteriou and Agiomirganakis (2001) and Pradhan (2009) found education is cointegrated with economic growth, but there exists uni-directional causality form economic growth to education. In addition, using Engle-Granger methodology, Francis and Iyare (2006) and Kui (2006) proved the cointegration relation and uni-directional causality from education to economic growth too. On the other hand, employing simple regression analysis, while Barro and Salai-Martin (1995) and Keller (2006), showed education has significant and positive growth effects; using VAR, Deniz and Dogruel (2008) found overall education stimulates economic growth in MENA countries, but only primary and secondary education levels have long-run positive effects on economic growth in Turkey.

Second group of researches consists of studies which investigate the interaction between each levels of education and economic growth separately. Since

the aim of this paper is to find out the long-run and causal relationships between higher education and economic growth, brief literature will be given appropriately for this purpose. Meulemeester and Rochat (1995), examined the causal relationships between higher education and economic growth using Engle-Granger cointegration and Granger causality analysis. They found that strong uni-directional causality exists from higher education to economic growth in Japan, France, UK and Sweden, but no causality in Italy and Australia. Jaoul (2002), searched for the causal relationships between higher education and economic growth in France using Johansen cointegration and Granger causality analysis and showed that higher education and economic growth are cointegrated and bi-directional causality exists between them. Narayan and Smyth (2006), examined the long-run and causal relationships between higher education, real income and real invesment in China employing ARDL approach and Granger causality analysis. They found that when real investment is depended variable, all of them are cointegrated. But there is no cointegration if dependent variable changes. According to causality analysis, both higher education and real income cause real investment. They concluded that higher education has indirect effects on economic growth via its effects on real investment. Khorasgani (2008), examined the long-run relationship between higher education and economic growth in Iran using ARDL methodology. He stated that higher education has positive and significant effects on economic growth both in the short and the long-run. In addition, while Lin (2004) and Bloom et al. (2005) investigated the effects of higher education curricula on economic growth using simple regression analysis and proved that higher education has positive and significant growth effects; Sanders et al. (2003) and Bhandari and Curs (2007) examined the impact of higher education expenditures on economic growth using simple regression analysis in U.S. and found no significant relationship from higher education expenditures to economic growth. On the contrary, economic growth fosters higher education expenditures.

This study differs from the previous studies in several respects. First, most of the previous studies used Johansen or Engle-Granger techniques for investigating the long-run relationships between education and economic growth. In this study, recently developed ARDL approach to cointegration was employed for this purpose. Second, studies which used ARDL approach to cointegration for determination of long-run relationships, also used the simple Granger analysis for testing the causality between education and economic growth. In this paper, because of some imperfections of simple Granger methodology, a new causality technique which was developed by Dolado and Luthkepohl (1996) was utilized. Third, the interaction between higher education and economic growth has never been studied in Turkey, separately. This paper aims to partially fulfill this gap and contribute the empirical literature. The final difference of the present study stems from its capability of checking the stability of the
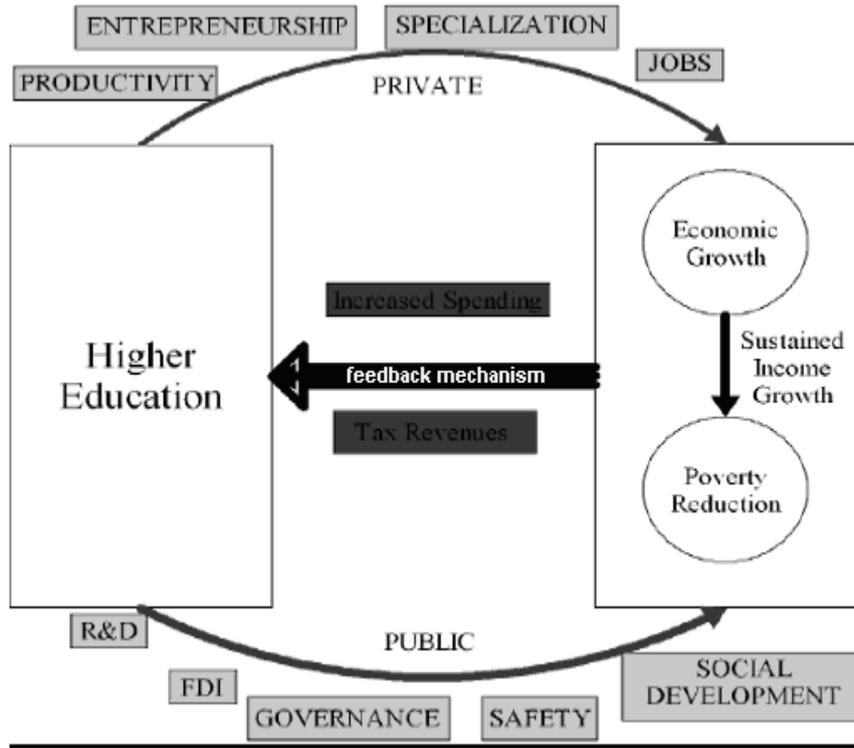
parameters in order to avoid from invalid political implications. For this purpose stability tests which were pioneered by Brown et al. (1975) were used.

The paper is organized as follows. In the next section, conceptual framework is summarized. In section 3, model specification and the data are presented. In section 4, methods and findings are explained. Finally, section 5 concludes.

I. CONCEPTUAL FRAMEWORK

Most of the recent studies showed that higher education is an important stimulus for economic development and has bi-directional causality with economic growth. According to Bloom et al. (2005), this interaction can be represented as shown below:

Figure 1: Conceptual Framework Of Higher Education And Economic Growth

According to Bloom et al. (2005), higher education can lead to economic growth through both private and public channels. The private benefits for individuals are well established and include better employment prospects, higher salaries and a greater ability to save and invest. These benefits may result in better health and improved quality of life, thus setting off a virtuous spiral in

which life expectancy improvements enable individuals to work more productively over a longer time further boosting lifetime earnings.

Public benefits are less widely recognized, which explain many governments' neglect of higher education as a vehicle for public investment. But individual gains can also benefit society as a whole. Higher earnings for well-educated individuals raise tax revenues for governments and ease demands on state finances. Higher education can also improve a nation's health, contribute to reduced population growth, improve technology and strengthen governance. It also translates into greater consumption, which benefits producers from all educational backgrounds (Bloom et al., 2005: 16).

II. MODEL AND THE DATA

Since it is relatively easy to be augmented by adding various dynamics, the existing economic growth literature usually employs Cobb–Douglas production function. In this paper the relationship between higher education and economic growth was examined by using an augmented Cobb-Douglas production function which was linearized by Lin (2004: 357):

$$\ln Y_t = \ln A + \beta \ln I_t + \delta \ln L_t + \gamma \ln HE_t + \varepsilon_t \tag{1}$$

where Y represents the real income, A represents the combination of technology and knowledge, I represents physical capital, L represents labor, HE represents the higher education indicators, ϵ represents the error term and t represents time trend.

For the analysis, while GDP in constant local currency unit with 1998 prices is the proxy for real income, the physical capital is proxied by gross fixed capital formation which was measured in constant local currency unit with 1998 prices and the labor is proxied by the total workforce who is 15 years old and older; HE contains two different higher education indicators. One of them is total higher education stock (STOCK) which is the sum of the students who enrolled in one of the higher education institutions. The second one is higher education graduate (GRAD) which represents the people who graduated from a higher education institution. While selecting these indicators, previous studies (e.g. Sanders et al., 2003; Lin, 2004; Narayan and Smyth, 2006; Khorasgani, 2008) were referenced.

The study is based on annual data covering the time period 1970-2008. The data for real income, physical capital and labor were downloaded from OECD Stat database. The data for higher education indicators were derived from Statistical Indicators 1923-2008 of Turkish Statistical Institute.

III. METHODS AND FINDINGS

A. STATIONARY ANALYSIS

In order to avoid spurious regression results and achieve consistent and efficient coefficients, it is necessary to check the stationary of the variables and find whether the variables in question have unit root or not. Since most of the macroeconomic variables are driven by non-stationary process, the analysis should start with investigating the unit root properties.

The present study employs two different unit root tests (i.e. augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP)). According to findings which were exhibited in Table 1, while real income (lnY), physical capital (lnI) and labor (lnL) have unit root at the level (i.e. difference stationary), higher education indicators (lnSTOCK and lnGRAD) do not (i.e. level stationary).

Table 1: Results For Unit Root Tests

Level	Variables	Test ADF		Test PP	
Constant	lnY	-0.548		-0.549	
	lnI	-0.819		-0.811	
	lnL	-2,012		-2.403	
	lnSTOCK	-0.538		-0.219	
	lnGRAD	0.055		0.246	
Constant and Trend	lnY	-2.913		-2.994	
	lnI	-2.639		-2.664	
	lnL	-1.347		-1.347	
	lnSTOCK	-3.418	*	-1.895	
	lnGRAD	-2.120		-3.223	*
First-Difference					
Constant	lnY	-6.195	***	-6.195	***
	lnI	-6.792	***	-6.792	***
	lnL	-6.958	***	-6.966	***
	lnSTOCK	-3.601	**	-3.530	**
	lnGRAD	-2.450		-6.618	***
Constant and Trend	lnY	-6.110	***	-6.110	***
	lnI	-6.688	***	-6.688	***
	lnL	-7.673	***	-7.860	***
	lnSTOCK	-3.549	**	-3.477	*
	lnGRAD	-3.520	*	-6.537	***

*** significant at 1% level; ** significant at 5% level; * significant at 10% level.

The findings also support the fact that employing cointegration analysis is a good choice for investigating the long-run relationships between real income and independent variables. Because under the non-stationary conditions, OLS estimation may have some inconveniences for the considered purpose.

B. COINTEGRATION ANALYSIS

There are several approaches which are used for investigating the long-run relations (cointegration) among time-series variables (e.g. Engle and Granger (1987), Johansen and Juselius (1990)). However these methods concentrate on the cases in which underlying variables are integrated of order one. Since the findings of stationary analysis showed that the considered variables have different integration orders, it is decided to employ a new cointegration method known as the Autoregressive Distributed Lag (ARDL) approach (i.e., the bounds testing approach) to cointegration developed by Pesaran et al. (2001).

The importance of the ARDL approach stems from its applicability without checking the integration order of the variables. But if the order of integration is I(2), this method will not be suitable for testing cointegration relationship. The unit root test results support the fact that the considered variables are I(0) and I(1) and this method is thereby appropriate for the analysis.

The ARDL representation of equation (1) which should be estimated for the bounds testing approach is as follows:

$$\Delta \ln Y_t = a_0 + \sum_{i=1}^{p} a_{1i} \Delta \ln Y_{t-i} + \sum_{i=0}^{p} a_{2i} \Delta \ln I_{t-i} + \sum_{i=0}^{p} a_{3i} \Delta \ln L_{t-i} + \sum_{i=0}^{p} a_{5i} \Delta \ln HE_{t-i} \quad (2)$$

$$+ \theta_1 \ln Y_{t-1} + \theta_2 \ln I_{t-1} + \theta_3 \ln L_{t-1} + \theta_4 \ln HE_{t-1} + u_t$$

where Δ is the difference operator, p is the lag length, and u is serially uncorrelated error term.

There are two stages that the ARDL procedure has. In the first one, the null hypothesis of no-cointegration $H_0: \theta_1 = \theta_2 = \theta_3 = \theta_4 = 0$ is tested against $H_1: \theta_1 \neq 0, \theta_2 \neq 0, \theta_3 \neq 0, \theta_4 \neq 0$. Testing cointegration relationship is based on F-statistic which is non-standard irrespective of whether the variables are I(0) or I(1) and the critical values for this test were tabulated by Pesaran *et al.* (2001). These critical values create a bound which covers all possible classifications of the variables. If the calculated F-statistic lies above the upper level of the bound, the H_0 is rejected, supporting cointegration relationship in the long-run. If the calculated F-statistic lies below the lower level of the bound, the H_0 cannot be rejected, indicating no cointegration. If the calculated F-statistic falls between the bounds, the error-correction term in this case is used to determine the existence of cointegration. If a negative and significant error-correction term is obtained, the variables are said to be cointegrated.

If the long-run relationship is supported, the error-correction model (ECM) from equation (2) is estimated as the second stage of the ARDL procedure. The ECM function is as follows:

$$\Delta \ln Y_t = \alpha + \sum_{i=1}^{p} \omega_k \Delta \ln Y_{t-i} + \sum_{i=0}^{p} \lambda_k \Delta \ln I_{t-i} + \sum_{i=0}^{p} \phi_k \Delta \ln L_{t-i} + \sum_{i=0}^{p} \gamma_k \Delta \ln HE_{t-i} \quad (3)$$

$$+ \psi EC_{t-1} + u_t$$

where ψ is the error-correction parameter and *EC* is the residual obtained from equation (2).

In order to start the ARDL procedure, it is necessary to apply F-test on the selected models considering appropriate lag lengths. To this end, maximum six lags were imposed on the level of variables and Schwarz Bayesian Criterion (SBC) was referenced for deciding the optimum number of lags. Panel A at Table 2 shows the F-statistics for cointegration analysis based on the selected ARDL models. Findings reveal that the calculated F-statistics represent cointegration for both models. In addition, significant negative error-correction parameters also support the existence of cointegration relationship which was defined as an alternative and an efficient way of testing cointegration by Bahmani-Oskooee and Brooks (1999). The meaning of the estimated cointegration relationship for the considered variables is that the Turkish economy is capable of correcting any departures from the long-run steady state equilibrium and there is no factor which has distorting effects over the long-run growth path of the economy.

Panel B at Table 2 exhibits the long-run cointegration estimates. Due to the aim of the study, the explanations are concentrated on the higher education indicators. It is clearly seen that either higher education stock (STOCK) or higher education graduate (GRAD) has statistically significant and positive coefficients and one percent increase in higher education stock and higher education graduate increase the real income by 0.15 and 0.05 percent, respectively.

Findings of the long-run analysis of higher education mean that tertiary enrollment and the graduates who could be treated as the output of higher education system are one of the most important inputs for the economic growth path of Turkish economy. Thus politicians should take these implications into account and go further into the higher education as an important growth dynamic of Turkish economy.

The ARDL procedure employs OLS estimator for estimating the cointegration vector, for this reason one should provide that the assumptions of the OLS methodology are supported. According to the diagnostic checking whose findings were presented in panel D at Table 2, both two models pass the assumptions of no-serial correlation, homoscedasticity, normality and regression specification error even at the 10% significance level. Moreover, since the stability of the parameters is not guaranteed by the cointegration relationship, one should

provide the stability of the cointegration parameters. In this paper the stability of the long-run parameters was tested by applying cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests which were developed by Brown et al. (1975). The stability test results summarized in panel D at Table 2 reveal that both two models have the stable parameters over the time, that is long-run coefficients do not have parameter instabilities..

Table 2: Results For Cointegration Analysis (Dependent Variable: lny)

	Higher Education Indicators	
	STOCK	GRAD
Panel A: Cointegration		
F-stat	7.07	6.18
Error-correction Parameter	-0.23 [0.006]	-0.25 [0.005]
Panel B: Long-run Coefficients		
Constant	4.21 [0.346]	2.05 [0.543]
lnI	0.41 [0.003]	0.47 [0.000]
lnL	0.10 [0.861]	0.41 [0.335]
lnHE	0.15 [0.012]	0.05 [0.076]
Panel C: Diagnostic Checking		
Adjusted-R^2	0.90	0.90
Serial Correlation[a]	3.504 [0.061]	4.181 [0.041]
Heteroscedasticity[b]	0.140 [0.708]	0.350 [0.554]
Normality[c]	0.080 [0.960]	0.164 [0.921]
Functional Form[d]	1.989 [0.158]	0.375 [0.540]
Panel D: Stability Checking		
CUSUM	Stable	Stable
CUSUMQ	Stable	Stable

The critical values for F-statistic are (2.72-3.77) for 10 percent, (3.23-4.35) for 5 percent, and (4.29-5.61) for 1 percent level of significance, obtained from Table CI(iii) Case III in Peseran *et al*. (2001: 300).
a: The Breusch–Godfrey LM test statistic for no serial correlation.
b: The Jarque–Bera statistic for normality,
c: The White's test statistic for homoscedasticity.
d: The Ramsey's Reset test statistic for regression specification error.
Numbers in brackets are p-values.

C. CAUSALITY ANALYSIS

Once a cointegration relation between variables is provided, causality could be searched at least for one direction (Engle and Granger, 1987). To this end, modified Granger causality test which was developed by Dolado and Lütkepohl (henceforth, DL) (1996) was utilized. The main advantage of this approach is that the estimated model is robust to the type of integration and cointegration properties exhibited by data (Booth and Ciner, 2005). In addition this

test overcomes the singularity problem, which is created by the zero restrictions of classical Granger causality test on VAR coefficients, by adding an additional lag to the true order of the VAR model. The testing procedure has two steps. In the first one, a VAR(p) is determined by a model selection criterion such as SBC. And in the second one, VAR(p+1) model is estimated by OLS and the standard zero restriction is put on the determined p lags in the model. The obtained statistic which is asymptotically distributed as chi-square was defined as Modified Wald (MWALD) by Dolado and Lütkepohl (1996).

The findings from causality analysis were reported in Table 3. Results show that higher education is either an input or an output for economic growth in Turkish economy. According to this, both the higher education stock (STOCK) and graduate (GRAD) have uni-directional causality with real income. The directions of causality are from STOCK to Y and from Y to GRAD. These results indicate that the larger tertiary enrollment is ensured by the economy, the more real income it generates; and the more real income it generates, the stronger the higher education system will be.

Table 3: Results For Causality Analysis

Hypothesis	p+1	MWALD	Causal
STOCK does not cause Y	3	6.57 [0.037]	Yes
Y does not cause STOCK	3	0.86 [0.647]	No
GRAD does not cause Y	3	3.56 [0.168]	No
Y does not cause GRAD	3	11.97 [0.002]	Yes

The SBC was used to determine the appropriate lag orders.
Numbers in brackets are p-values.

CONCLUSION

In this study, cointegration and causality between higher education and economic growth in Turkey were investigated using annual data covering the period 1970-2008. The study utilized both the ARDL approach to cointegration and the Dolado and Lütkepohl's Granger causality test. For these analyses, two different higher education indicators were used in order to avoid non-robust conclusions.

Although the covered period has restricted the analysis not to employ more than two indicators, investigation of cointegration relationship between higher education and economic growth revealed that Turkey should invest in higher education in order to improve growth performance of the economy in the long-run. According to the analysis, either higher education stock or higher education graduate are good stimulus for rising Turkish GDP.

As mentioned, supporting the cointegration relation reflects the existence of causality between variables. Thus, after proving the cointegration relation,

the causality between higher education and economic growth was analyzed. Depending to the selected indicator, findings showed that there exists uni-directional causality either from higher education to economic growth or from economic growth to higher education. This result is consistent with the situation which was figured by Bloom *et al.* (2005). Accordingly, the causality from higher education stock to real GDP reflects the first two channels (e.g. private and public channels) which support the higher education to lead economic growth. And the causality from real GDP to higher education graduate represents the feedback mechanism which in turn strengthens the higher education system.

Finally, combining the findings from cointegration and causality analysis summarizes that in Turkey higher education is beneficial for economic growth both in the short and in the long-run. Furthermore, the contribution of higher education system to economic growth in turn improves the efficiency of itself.

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