K. Y. CELIK

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Tez Başlığı: **Does Education have an Impact on GDP in Turkey?**

Tezi Hazırlayan: **Kübra Yeşim Çelik**

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ÇANKAYA ÜNİVERSİTESİ

SOSYAL BİLİMLER ENSTİTÜSÜ MÜDÜRLÜĞÜ'NE

Bu belge ile, bu tezdeki bütün bilgilerin akademik kurallara ve etik davranış ilkelerine uygun olarak toplanıp sunulduğunu beyan ederim. Bu kural ve ilkelerin gereği olarak, tez çalışmamda bana ait olmayan tüm veri, düşünce ve sonuçları bilimsel etik kurallar gözeterek ifade ettiğimi ve kaynağını gösterdiğimi ayrıca beyan ederim.

Adı, Soyadı: Kübra Yeşim Çelik

İmza: 

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Özet

Bu araştırmanın amacı Türkiye için eğitimin üç seviyesinin GSYİH ile ilişkisini araştırmaktır. Yıllık veriler 1971-2011 yıllar için geçerli olup birincil, ikincil ve üçüncü seviyede eğitim, gayri safi sermaye oluşumunu, GSYİH ve işgücünü kapsamaktadır. Ampirik analiz ARDL sınır testi ile gerçekleştirilmiştir ve ek olarak Toda ve Yamamoto nedensellik yaklaşımı kullanılmıştır. Eğitim ve GSYİH arasında ARDL sınır testinde eşbütünleşme ve Toda ve Yamamoto yaklaşımı ile nedensellik bulunamamıştır .

Abstract

The aim of this study has been to investigate whether education affects GDP in Turkey for the period of 1971-201 using annual data for three levels of education. The data for education consist of primary, secondary and tertiary enrollment rates. The analysis is based on the ARDL bounds testing approach in order to examine the co-integration between education and GDP and the Toda and Yamamoto approach to test for Granger causality. The empirical analysis showed that for the case of Turkey there is no co-integration and no Granger causality between education and GDP.

Table of Contents

CHAPTER 1

INTRODUCTION

The education and economic wealth relationship is regarded as an essential area of investigation. Educational attainment is an indicator of a more productive and more skilled labor force, which increase the economy's output of goods and services. That is why education is considered an important determinant of economic progress (Barro&Lee, 2000).

Robert J. Barro (1991), Sala-i-Martin (1997), and many others have found a positive relationship between schooling and GDP per capita growth amongst several countries. Alternatively, hand Bils and Klenow (2000) investigated whether or not the positive relationship between schooling and GDP per capita growth found in the literature really reflects causality from education to economic growth. They say that a channel from education to GDP per capita growth shows too thin results as to explaining a third of the investigated relations. Their investigation of the reverse channel going from expected growth to education leads them to conclude that such a reverse channel has a higher capability as to finding an empirical relationship compared to ordinary channel going from education to GDP per capita (Bils&Klenow, 2000).

The study tests the relationship between human capital and GDP by using data on Turkey. Since the empirical results on this relationship are mixed and inconclusive it is of high interest to investigate the relationship between human capital using school enrollment rates as proxy and GDP for the case of Turkey.

1.1 Problem Statement

Accordingly to the area of interest mentioned in the introduction the thesis problem statement is as follows:

The aim of this study is to examine the effect of human capital, proxied by school enrollment rates, on GDP for Turkey. This relationship will be investigated by using ARDL modelling in order to obtain co-integration results, and Toda and Yamamoto approach to investigate the causality.

It is important to underline the fact that the proxies used for human capital, which are school enrollment rates, do not take *the quality of education* into account. Thus, constructing an empirical analysis entailing a measure of education quality could be interesting in this field of study. In order to do such an analysis, it would be needed to look into not only the output of education e.g. in the form of test results but also in inputs into education such as teachers and textbooks. This would mean a difference in the quality of schooling i.e. between regions, cities, districts etc. would show that school enrollment rates used as proxies for human capital may most likely understate the true difference in the level of human capital.

1.2 Structure

The study is divided into five chapters. Chapter 2 presents the literature reviewed regarding the topic as well as similar topics and their respective empirical methods and results. Chapter 3 presents the methodology and data which will be used in the empirical analysis. The methods chosen as to examine the education and GDP relationship are described, and the descriptive data is included. The empirical analysis is outlined in chapter 4. The education and GDP relationship is investigated using the ARDL approach supplemented by the Toda and Yamamoto approach to causality. Chapter 5 consists of conclusions of the study. Comments concerning the implications and limitations of the study, and a discussion of the empirical results obtained in chapter 4 using the literature from chapter 2 is also in chapter 5.

1.3 Education in Turkey

Turkey consists of 81 provinces distributed across seven regions. After the Republic was founded in 1923, Mustafa Kemal Atatürk established a singular secular system of education in order to obtain qualified workers (Clark & Mihael, 2012). Changes in the compulsory education occurred first in 1997 where it was raised from five to eight years and later extended to 12 years in 2012. Before the legislation of the 12 years compulsory education primary education was continuous for the whole eight years. The compulsory education consists of three divisions; the first being four years of primary school, the second is four years of middle school, and finally four years of secondary schooling (Clark & Mihael, 2012).

Regarding the administration within education, all the stages of pre-tertiary education is administered by the Ministry of National Education and higher education is administered by the Council for Higher Education (YÖK).

Turkey, where half of the inhabitants are below the age of 28, is the nation with the youngest population among the top 20 economies (Clark & Mihael, 2012). According to an OECD report attainment rates for secondary and tertiary education amongst 25-34 year-olds in Turkey were 43% and 19% in 2011, which were significantly lower than the corresponding OECD averages (82% and 39% respectively). The graduation rate at the upper secondary level in Turkey, being 56% percent, is lower than the OECD average of 83%. The number of students (age of 15-19) is still below the OECD average of 84%, but have doubled to 64% since 2000 (2011 rates) (OECD, 2013).

In Turkey students must take tests in order to gain entrance to secondary education. The competition for the selective elite schools is highly intense, as parents prefer these schools to ensure their children a higher possibility of being placed in a university once they graduate (OECD, 2013).

Turkey has made it a priority to better align tertiary education with the standards of the European Union member countries. In Turkey graduates from tertiary education can expect to earn 56% more than those with upper secondary or post-secondary non-tertiary educated, which is above the OECD average of 40% (2011 rates). The graduation rate for academic programs of 23% is below the OECD average of 39% and the graduation rate for technical programs is at 17% which is above the OECD average of 11%. Also, it should be noticed that Turkey shows a remarkable difference regarding the sex of graduates. In OECD countries women show a higher graduation rate, whereas male students show a higher graduation rate in Turkey (OECD, 2013).

CHAPTER 2

LITERATURE REVIEW

Earlier studies show the use of several approaches regarding education and economic growth relationship. It is highly significant to consider not only the method one uses in own study but also other commonly used techniques. Hence, chosen literature will be reviewed in this chapter as to gather knowledge concerning the different approaches and their respective outcomes. Mainly before reviewing the approach used in this study, being the ARDL model, other methods are taken into consideration as they are quite relevant when investigating education and economic growth relationship. This will give an overall insight of the subject as well as be a reflection of reasons to why the ARDL model is chosen. All studies mentioned below are summarized in Appendix A, stating the author, year, dependent variables, independent variables and their respective findings.

2.1 Earlier Studies using Alternative Approaches

Özsoy (2008) investigated the effects of the higher education system to the economic growth performance in Turkey during 1970-2006. The purpose of the study was the inquiry of the higher education and economic growth relationship using the VAR model. Inputs used in the study were enrollments for primary, secondary, technical and tertiary education. Whereas, the data used for output was real gross national product (1987 prices). According to the findings retrieved from the VAR model there was found a stable long-term relationship between education and economic growth. The causality test outcome displayed that a higher education level showed to cause a larger influence on economic growth. As no signs regarding causality were found between primary education and the real BNP, unidirectional causality was found between technical education and real BNP. The results for secondary and tertiary education as to growth showed bidirectional causality. By all means, the higher education and growth relationship was empirically proved. According to Özsoy (2008); while developments in higher education affect the growth, as the country grows higher education will develop further. As a conclusion a positive relationship for the case of Turkey was found when investigating the higher education and economic growth.

Solaki (2013) investigated the long- and short-run relationship between human capital and economic growth, using the co-integration method of analysis. The sample period in the paper was from 1961 to 2006. The empirical analysis was conducted with the use of annual data. The enrollment rates for primary, secondary and tertiary education were proxies for human capital. As to investigate public expenditures on education impact on economic growth an additional variable, public expenditures on education relative to total public expenditures, was included. The variable representing the proxy of economic development in the analysis was the real GDP per capita. The empirical findings obtained by Solaki (2013) indicates that the real GDP per capita is influenced by alterations in tertiary, secondary, primary education as well as public expenditures on education in the long-run. The error-correction estimation suggests a direction of causality running from tertiary education and educational public expenditures to real GDP per capita. Whereas, the causality is found to be in the opposite direction concerning primary and secondary education, going from real GDP per capita to education. Estimations showed that unidirectional causality exists between human capital and economic growth.

Hussin (2012) studied the causality and long-run relationship between government expenditures on education and economic growth in Malaysia for the time period of 1970-2010, utilizing the VAR method. With all the data being annual, the proxy for the Malaysian economic growth used in the study was real gross domestic product. The human capital proxy was accordingly government expenditure on education. Labor participation was used as the proxy for the labor in Malaysia. Also Hussin (2012) wanted to use a proxy for the net investment in the economy being gross fixed capital formation. By using the VAR model, a positive long-run relationship between GDP and fixed capital formation, labor force participation and government expenditures on education was revealed. By all means, the results confirm the hypothesis that higher education standards improve the productivity and efficiency within the labor force thereby affecting the economic development in the long-run. Hence, Hussin (2012) argues the essentiality of educational quality as to increase the human capital and economic growth of a country.

Babalola (2011) implemented causality tests and error correction terms as to evaluate educations impact on economic growth in Nigeria regarding the years 1977-2008. Two variables, GDP and expenditure on education, were included in this paper. The co-integration test results confirmed that a long-run relationship between economic growth and education exists. Thus, Babalola (2011) concludes that a uni-directional causality going from economic growth to education was found also that convergence to equilibrium after short-run disturbance was found to be evident.

Pradhan (2009) underlined, referring to Dahlin (2005), the importance of investments in education as it is advantageous at the micro and macro level. As investments have a direct and indirect effect on the system. The direct effect, referenced from Heckman end Klenow (1997), being the increase in individual's wage and the indirect effect explained to be the increasing externalities associated to education. Implementing error correction modeling, Pradhan (2009) investigated the education and economic growth causality. The data used consists of GDP and government expenditure on education for 1951-52 to 2001-2 for India. The main findings were firstly that both education and economic growth are integrated of first order. Secondly, the co-integration test had indicated that regarding the two variables a long-run equilibrium relationship exists. Finally, the existence of a unidirectional causality from economic growth to education was confirmed, although a reverse causality going from education to economic growth was not found. Pradhan (2009) suggests the necessity to strengthen the GDP in the Indian economy. Enhancing the GDP will lead to an outcome to education as human capital, which can contribute to the GDP indirectly.

Babatunde (2005) emphasizes the importance of generating economic growth in Nigeria as previous attempts to change the focus from the oil industry to alternative economics activities had failed. A largely unskilled labor force was one of the reasons behind the failure of such attempts together with corruption and low investment. Babatunde (2005) underlines the poor sufficiency of the education offered. Why, education is a source of enhancing economic growth. Education is considered by Babatunde (2005) to not only help a notable number of subjects living in poverty but also to enable opportunities regarding employment and for skilled workers to gain higher wages. Why, the purpose of the study was to explore the long-run relationship between education and economic growth for the case of Nigeria for the period of 1970-2003, implicating the vector error correction method. Data used in study were; primary, secondary and tertiary gross enrollment ratios, labor force, general strikes, capital per worker, government expenditures on education and GDP per worker. In the study two channels of the effect of human capital on growth were analyzed. The first channel consists of human capital as a direct input in the production function. In the second channel the effect of human capital on the technology parameter is computed. Though difficulty separating the two channels from one another, obtained results displayed that a well-educated labor forces' impact on economic growth was significant and positive. Babatunde (2005) concluded that a well-developed base for human capital may lead to good performance in per capita growth. Thereby, suggesting politicians that increasing the level of human capital is beneficial for the case of Nigeria.

In the paper written by Abhijeet (2010), linear and non-linear Granger causality methods have been used for data regarding India in the time period of 1951-2009. The purpose was to ascertain the causal relationship between education spending and economic growth. The variables included in the paper were government expenditure on education and GDP at current prices. The aim of the study by Abhijeet (2010) was to compute the direction of causality between the above mentioned variables. The study resulted in firstly that the variables were integrated of first order. A bi-directional causality running from economic growth to education expenditure and the other way around was found. Furthermore, test results showed that investments made in education is rather anticipated to impact the economic growth after five or six years. Referring to relevant literature Abhijeet (2010) emphasizes economic growth to have always been a major determining factor as to education expenditure. Abjiheet (2010) concluded the importance of education as human capital given the fact that it certainly influences the economic growth of a nation. Why, the proposition that governments should emphasize on extended investments within education, thereby both directly and indirectly contributing to the economic growth, was given.

Khattak (2012) focused on the benefaction of education to economic growth for the case of Pakistan in the time period from 1971 to 2008, using OLS and Johansen Co-integration test. The data used in the study were gross fixed capital formation, elementary and secondary enrollments used separately, labor force participation rate and GDP. The OLS results supported the hypothesis that education contributes to economic growth was supported, showing that both elementary and secondary levels of education affect the economic growth. Given the Johansen Co-integration test, a long-run relationship between education and economic growth was found. The necessity of having education as a top priority in public policies is highly underlined by Khattak (2012).

In their paper Deniz and Dogruel (2008) research the relationship between economic growth and education. The VAR model is chosen to compute the model. The model is consisting of data for Turkey and the MENA region. Data for GDP, primary, secondary and high school along with high-technical school and university were used in the VAR model. The education series consisted of a level indicator being “graduates and enrollment over population” and the quality indicator “graduates and enrollment over teacher”. The analyses obtained in the study showed that most indicators related to education quality of all the levels showed to entail invigorating impact on economic development. Thereby, Deniz and Dogruel (2008) conclude that investing education in all levels affects economic growth in the MENA region. Regarding Turkey a little change was made in educational levels as eight-year education was referred to as primary and ninth to 11th year as secondary, excluding technical schools. Results for Turkey were the finding of a long-run effect of the educational quality in both primary and secondary levels of schooling on economic growth.

Caliskan et al (2013) displayed the relationship between education and economic growth aiming to investigate the impact education had on economic growth in Turkey in the period of 1923-2011. In their study data for gross enrollment ratios for primary schooling, secondary schooling, technical school, high school and data for GDP were used as variables in the model. Using co-integration analysis the results found were that development in education proved to positively affect the economic growth. The model consisting of student numbers at different levels of education showed that increases in number of enrolled students at high schools and higher education institutions lead to significant and positive effects on economic growth. Caliskan et al (2013) concluded that the allocation of more resources in especially higher education contribute to the process of economic growth.

Blankenau et al (2007) emphasize that most models based on economic growth with public education expenditures as fuel can create a rather non-monotonic relationship between education expenditures and growth. As public expenditures on education increases growth, taxes on the other hand may lead to a decrease resulting in an equivocal net effect. Blankenau et al (2007) used data for government spending net of education, federal government budget surplus, gross enrollment ratios for primary schooling and GDP when implementing the Ordinary Least Squares method. The data used in the study were for 23 developed countries during the time period of 1960-2000. The test results revealed a positive relationship between public expenditures on education and long-term growth given that the government budget constraint was controlled. Interpreting the results Blankenau et al (2007) highlights the necessity to restraint the procedure of finance as failing to do so will cause an underestimation concerning the role of public expenditures.

Using the method of co-integration Huang et al (2009) investigated the problems of long- and short-term interaction between higher education and economic growth in China. Data used in the VECM analysis were enrollment in higher education and GDP. Regarding the data for higher enrollment and economic growth the existence of a long-term steady relationship was found. The result obtained according to the VECM analysis was that the self-adjustment ability of the Chinese system was found to be somewhat weak. Finally, with the use of the impulse response function it was found that education had a severe lagging effect on the economy.

Cooray (2009) examined the education expressed in quality and quantity and the effect of these on economic growth. The study consists of a large number of variables as proxies for education quantity and quality. The empirical analysis is performed on 46 low and middle income economies for the period of 1999 to 2005. The variable for economic growth used was GDP. As to the proxies for education were share of investment to GDP, population growth rate, enrollment ratio and repetition rates for levels of education, expenditure as a percentage of GDP, public expenditure, survival rate to grade five, schooling life expectancy, trained teacher (primary education), employment to population ratio and finally test scores. Cooray (2009) concluded that the measure of human capital is important regarding the analysis of the impact of such on economic growth. Regarding economic growth the findings showed the enrollment rates to be positive and significant. Whereas, the effect of government educational expenditures weren't found to be direct but rather contingent as to its interaction with the quality variables. Furthermore, Cooray (2009) underlines the complications regarding the role of investment in education and education quality as economic growth determinants. It is emphasized upon the fact that, as expenditure to education increases it is argued to lead to enhancements in education quality which then leads to enhancements in economic growth. Conversely increases in quality may lead to expenditure on education increases which again leads to economic growth. Why, Cooray (2009) draws attention to the inter-relationship between government expenditure and education quality as an important aspect when formulating education policy as to promoting economic growth.

Ageli (2013) used OLS and ECM analysis methods in order to investigate the Keynesian Relations and education expenditures impact on real oil GDP and non-oil GDP in Saudi Arabia. The data used in the analysis were for the period 1970-2012 and consisted of education expenditure, real oil GDP and non-oil GDP. The overall findings of the analysis showed the existence of co-integration between the share of education expenditure and per capita income. Hence, the importance of education expenditure was emphasized upon regarding economic development. Especially regarding of Saudi Arabia as a late developing country, as the Keynesian relation was proved significant by the study.

Ak and Bingül (2012) focused on education expenditure and studied annual data for GNP and education expenditure using the co-integration method. The data was related to the period of 1968 to 2010 and the analysis was focusing on the Turkish economy. The empirical analysis results showed the existence of a long-term relationship between economic growth and education expenditure. Ak and Bingül (2012) stresses on examples from countries that could bring the level of education under better conditions as they would experience positive impacts on economic growth. Furthermore, Ak and Bingül (2012) underlines the rate of return of the investments made in health and education have proven a higher return rate in the long-run compared to the rate of return of physical capital.

Kiran (2013) used data for 18 Latin American countries during 1970-2009 using co-integration test procedure. The aim was to examine the educational expenditures effect on economic growth. Kiran (2013) found it highly necessary taking structural breaks into consideration as reforms were implemented in the Latin American countries in order to extend the educational systems, why such adjustments may influence the co-integrating relationship. The variables used within the study were educational expenditures per capita and gross national income per capita. Given the series being $I(1)$ of integrating order Kiran (2013) implemented the co-integration procedure and the results obtained showed proof of a co-integrating relationship between educational expenditures and economic growth regarding data for all of the countries with the exception of Chile, Guyana, Jamaica, Nicaragua, Paraguay, Peru and Uruguay.

Another angle of the education and economic growth relationship is investigated by Tamang (2011) as it is strived to research the education expenditure impact on India's economic growth. The data in the model ranges from 1980-2008 and include gross fixed capital formation per labor, government expenditure per labor and GDP per labor. A long-run relationship has been found between education expenditure and economic growth, using the error correction model. Yet when comparing education expenditure and fixed capital formation, it was a smaller impact. A one percent increase in gross fixed capital formation per labor causes 0.28% increase in GDP per labor, where the same increase in education expenditure per labor merely leads to a 0.11% increase in GDP per labor. Conclusively, though the education expenditure effect on economic growth may be less than the effect of gross fixed capital formation, a positive long-run relationship between education expenditure and economic growth has been found.

Hammeken (2014) brings an interesting perspective to the subject being education and economic growth. The relationship between female human capital and economic growth is the subject of the study. Hammeken (2014) uses data ranging from 1950 to 2010 for Scandinavia (Denmark, Norway, Sweden, and Finland). The proxy for female human capital is the percentage of females aged 25 and over in total tertiary education and the proxy for economic growth is PPP converted GDP (constant 2005 prices). Using the least squares method Hammeken (2014) reveals the findings which indicate a negative and insignificant effect from female human capital on economic growth. A one percent increase in the percentage of females in tertiary education was found to be followed five years later by an insignificant decrease of 0.72 percent points in real GDP per capita. A range of potential explanations has been listed as one of the possibilities or a combination of more can be responsible for the negative and insignificant effects. Besides the known data limitations, one of the potential explanations is that females may take longer than five years as to integrate efficiently into the workforce. A second one being that, females tend to gravitate to low-wage sectors. The third potential explanation is that if females are gender discriminated and the education is assumed to act merely as a screening function, females may not benefit from the screening function. A fourth potential explanation is about opportunity costs and time limits. If women take long maternity leave or leave their jobs after pregnancy the opportunity costs may outweigh the benefits. Fifth but not least, the explanation is that if females take part in an education and afterwards leave the country (sample country) it results in data limitations.

Johansen (2014) investigates the effect of human capital on income inequality carrying out OLS, fixed effects and instrumental variable estimations. The data set consists of 123 countries and ranges from 1960-2010. The empirical results in the study show that improved educational attainment leads to a decrease in income inequality. Since the factors affecting income inequality may differ from one country to another, the fixed effects model was estimated. The results derived showed to differ slightly from the OLS and IV (instrumental variable estimations), yet supports the education has a positive impact on income inequality. The problem regarding the

OLS and fixed effects is that neither addresses causality. By all means, both estimations don't show whether the effect is from human capital. Why, the instrumental variable estimation is carried out. Conclusively, the IV shows the effects of improving education to be positive. By all means, improving education leads to a more equally distributed income.

2.2 Literature using ARDL

Erdem & Tugcu (2011) analyzed the long-run and causal relationship between higher education and economic growth in Turkey regarding the years 1970-2008. Using the bounds testing approach, the study computed regressed higher education indicators over real GDP. The causality was analyzed with the use of Granger causality tests. Variables used in the analysis consisted of gross fixed capital, total workforce, total higher education stock, higher education graduate, and GDP. The results obtained by Erdem & Tugcu showed that higher education stock or higher education graduate to be a positive stimulus as to achieve a rise in the Turkish GDP. Why, the authors highly suggest investments in higher education as this will improve the growth performance of the Turkish economy in the long-run. Furthermore, of causality test the existence of a unidirectional causality going from either higher education to economic growth or the other way around was found.

Cetin et al (2014) investigated education and productivity per employee relationship in Turkey for the period of 2001-2013, using four educational levels of employment. The quarterly data used in the study were fixed capital formation, illiterate, primary schooling, secondary schooling, tertiary schooling, and GDP. Using the ARDL bounds testing approach, co-integrating relationship between illiterates, and high school level of education and GDP was found. Regarding primary and tertiary schooling no evidence of co-integration was found. The illiterate in Turkey was found to have a negative effect on GDP while the high school level of education was found to impact GDP positively.

The objective in the study by Riasat et al (2011) was to investigate the education expenditures effect on economic growth. The analysis was computed using the bounds testing approach for Pakistan over the period of 1972-2010. The variables included in the analysis were gross fixed capital formation, total employment, government expenditures per worker and GDP. According to Riasat et al (2011) the results confirmed the education expenditure had a significant impact on economic growth. By all means an increase of one percent in capital formation causes an increase in GDP up to 0.04 percent in the short-run and 0.34 percent in the long-run. As to an increase of one percent in employment rates leads to a 0.15 percent increase in the short-run and 0.74 percent increase in the long-run. In the short-run education expenditure was insignificant, a percent increase in education expenditure increases GDP by up to 0.039 in the long-run.

Afzal et al (2014) aimed to bring information regarding education and economic growth for the case of Pakistan by computing the school education and economic growth short- and long-run. Annual data given regarding 1970-2008 for real GDP, real physical capital, inflation and general school enrollment were used in the study. Using the bounds testing approach Afzal et al (2014) confirmed that the school education and economic growth relationship existed both in the short-run and long-run. Furthermore, Afzal et al (2014) found a surprising result concerning poverty and school education. The long-run relationship between poverty and school education was investigated and findings showed that poverty’s effect and school education was significant and positive while the short-run relationship yielded results that poverty affected school education in significant and negative terms.

Beskaya et al. (2010) researched educations effect on economic growth in Turkey, with data for the time period of 1923-2007. The approach used being ARDL included per capita enrollments in primary-, secondary-, high-l, technical school, and higher education as proxy for education. The proxy for economic growth in the model is the rate of growth per capita real GDP. Beskaya et al. (2010) found a long-run relationship between economic growth and education. Nevertheless, a bidirectional long-run Granger causality was found. Unidirectional causality going from secondary, high school and technical school to economic growth was found in the short-run. Why, Beskaya et al (2010) found evidence to substantiate the hypothesis of a positive effect in the long-run of education on economic growth in Turkey.

Shaihani et al. (2011) aimed to examine the long- and short-run effects on education levels. Using data for Malaysia for the time period being 1978-2007 an ARDL model is constructed. The data consists of enrollment rates in primary, secondary and tertiary education, real GDP per capita and control variables, the control variables being trade openness and foreign direct investment. Interesting results was found by Shaihani et al. (2011) as the ARDL results exhibited that in the short-run primary and tertiary education were negatively significant, as to secondary education which was found to be positively significant. In the long-run the results derived from the ARDL model showed that only one variable impacts the economic growth in Malaysia significantly and positively, being tertiary education. Regarding the control variables both in the short- and long-run the variables were found to be significant.

2.3 Summary

As seen above, literature on the investigation of education and GDP relationship give mixed results. Some researchers find strong positive evidence of such a relationship while others find the opposite. For example, Jorgenson et al. (2000) find that the benefaction of education on GDP to be positive, while Benhabib and Spiegel (1994) find that alterations in education lead to insignificant and at times negative coefficients. Studies by Islam (1995) and Caselli et al. (1996) get signs of the education variables wrong. Pritchett (2001) found that alterations in schooling yielded no effect on economic growth. On the other hand Temple (2001) reevaluates the results obtained by Pritchett (2001), and concludes that uncertainty clouds the results for a substantial representative of countries.

The systematic failure to find a relationship between education and GDP has led some authors to start questioning the data for education regarding quality. For instance, Krueger and Lindahl (2001) emphasize upon the fact that one proxy used in the literature, the numerical value of years of schooling, may be measured with errors, and therefore be a crucial explanation for the insufficiency of significance of the educational proxies (Beskaya, 2010).

Thus, even though this topic has been thoroughly investigated by many researchers, the issue has not been settled yet. This is why, the education and GDP relationship is still a topic of interest within economic analysis.

CHAPTER 3

METHODOLOGY AND DATA

The methodology used in the empirical analysis has been described in this chapter. The descriptive data was included to introduce the data used in the study. The ARDL model and the Toda and Yamamoto approach to Granger causality were presented and discussed.

3.1 Theoretical Model

One of the most central topics in economic analysis is the investigation of education and GDP relationship. By researchers such as Romer (1990) it has been emphasized that education is of importance as an educated population will lead to the creation of new ideas, which will promote technological progress and thereby economic growth. Thus, human capital can be acknowledged as a means to facilitating the adaption of technology and a necessity in the use of it (Romer, 1990).

The model used in this study is a Cobb-Douglas function including human capital (Cetin, et al., 2014). The model is a revised version of the augmented Solow model of economic growth presented by Mankiw et al. (1992) is stated as follows:

$$Y = A \times K^{\alpha} \times H^{\beta} \times L^{1-\alpha-\beta} \qquad \text{(Model 1)}$$

With Y being the production, A is the technology, K is the physical capital stock, L is the labor and H is the human capital. α, β and (1- α - β) are the respective shares.

Thus, when rewriting model 1 using data series obtained the following models for all three level of education are obtained:

$$RGDP = A \times GCFP^{\alpha} \times ENROLP^{\beta} \times LF^{1-\alpha-\beta} \qquad \text{(Model 2)}$$

$$RGDP = A \times GCFP^{\alpha} \times ENROLS^{\beta} \times LF^{1-\alpha-\beta} \qquad \text{(Model 3)}$$

$$RGDP = A \times GCFP^{\alpha} \times ENROLT^{\beta} \times LF^{1-\alpha-\beta} \qquad \text{(Model 4)}$$

In Table 3.1 below, the different variables used in the empirical analysis are presented. The left column presents the variables as they will be presented in the empirical analysis in chapter 4. The right columns present the description of the data and their sources.

Table 3.1: Data Description.

Variables	Description	Source
RGDP	GDP (Constant, 2005 $US)	World Bank Database
GCFP	Gross capital formation (% of GDP)	World Bank Database
LF	Labor force, total, thousands	World Bank Database
ENROLP	School enrollment, primary (% gross)	World Bank Database
ENROLS	School enrollment, secondary (% gross)	World Bank Database
ENROLT	School enrollment, tertiary (% gross)	World Bank Database

3.2 Empirical Methodology

Using variables for education, labor force, gross fixed capital formation and GDP the following models are stated for all three levels of enrollment:

$$RGDP = f(GCFP, LF, ENROLP) \qquad \text{(Model 5)}$$

$$RGDP = f(GCFP, LF, ENROLS) \qquad \text{(Model 6)}$$

$$RGDP = f(GCFP, LF, ENROLT) \qquad \text{(Model 7)}$$

3.2.1 ARDL Modelling

Peseran et al. (2001) developed a unification of autoregressive models and distributed lags models also called ARDL approach in order to analyze co-integration. Co-integration can shortly be defined as the equilibrium, in other words long-term relationship between two series. A time series is a function of its own lagged values and the lagged values of one or several explanatory variables, in any given ARDL model (Peseran S. S., 2001).

In the ARDL approach it is distinguished between dependent and independent variables, thereby avoiding endogeneity problems. By using this approach one can simultaneously compute and estimate long-run and short-run components of a model. Unbiased and efficient estimates are obtained when using the ARDL approach, as it avoids the problems that can occur due to serial correlation and endogeneity (Peseran S. S., 2001).

The ARDL approach to co-integration is superior to other co-integration techniques, as it can be applied regardless of the integrating order of the regressors. Regressors can be of different integrating orders. Though, it is limited with the requirement that the regressors are not I(2) or higher. By all means, bounds test investigates the co-integration relationship between data which does not have to be of same order. Data can be I(0) and/or I(1). Furthermore, it is noticeable that bounds test also yields superior properties in small sample sizes.

From Pesaran and Pesaran (1997), Pesaran and Shin(1999), Pesaran et al. (2001), and Afzal et al. (2010), the error correction version of the ARDL models 5, 6 and 7 can be written as follows:

$$\begin{aligned}\Delta(LNRGDP)_t = {} & \alpha + \sum_{i=1}^{n} b_i \, \Delta\,(LNRGDP)_{t-i} + \sum_{i=0}^{n} c_i \; \Delta\,(LNGCFP)_{t-i} \\ & + \sum_{i=0}^{n} d_i \; \Delta\,(LNLF)_{t-i} + \sum_{i=0}^{n} e_i \, \Delta\,(LNENROLP)_{t-i} \\ & + \delta_1\,(LNRGDP)_{t-1} + \delta_2\,(LNGCFP)_{t-1} + \delta_3\,(LNLF)_{t-1} \\ & + \delta_4\,(LNENROLP)_{t-1} \\ & + \varepsilon_t \qquad\qquad (Model\ 8)\end{aligned}$$

$$\Delta(LNRGDP)_t = \alpha + \sum_{i=1}^{n} b_i \Delta (LNRGDP)_{t-i} + \sum_{i=0}^{n} c_i \; \Delta (LNGCFP)_{t-i}$$
$$+ \sum_{i=0}^{n} d_i \; \Delta (LNLF)_{t-i} + \sum_{i=0}^{n} e_i \Delta (LNENROLS)_{t-i}$$
$$+ \delta_1 (LNRGDP)_{t-1} + \delta_2 (LNGCFP)_{t-1} + \delta_3 (LNLF)_{t-1}$$
$$+ \delta_4 (LNENROLS)_{t-1}$$
$$+ \varepsilon_t \qquad (Model\ 9)$$

$$\Delta(LNRGDP)_t = \alpha + \sum_{i=1}^{n} b_i \Delta (LNRGDP)_{t-i} + \sum_{i=0}^{n} c_i \; \Delta (LNGCFP)_{t-i}$$
$$+ \sum_{i=0}^{n} d_i \; \Delta (LNLF)_{t-i} + \sum_{i=0}^{n} e_i \Delta (LNENROLT)_{t-i}$$
$$+ \delta_1 (LNRGDP)_{t-1} + \delta_2 (LNGCFP)_{t-1} + \delta_3 (LNLF)_{t-1}$$
$$+ \delta_4 (LNENROLT)_{t-1}$$
$$+ \varepsilon_t \qquad (Model\ 10)$$

In ARDL modelling there is a three-step procedure. The first step is dynamic analysis, the second long-run relationship and the third ECM analysis. The above models show both the short-run and the long-run dynamics. Whereas, the coefficients b, c, d and e of the first part of models 8, 9 and 10 measure the short-run dynamics of the models and all the δs represent the long-run relationship (Afzal, Farooq, Ahmad, Begum, & Quddus, 2010).

3.3 Toda & Yamamoto Approach to Causality

When investigating the causal relationships between time series a technique offered by Granger (1969) and Sims (1972), known as Granger causality, is commonly used. The underlying assumption of the approach being, that the future can be caused by the past and the present although the past cannot be caused by the future (Granger, 1980). However, shortcomings in Granger causality, such as model specification and number of lags problems, and spurious regression, exist according to Gujarati (1995) (Huang, Kao, & Chiang, 2004).

Toda and Yamamoto (1995) propose a technique that eliminates above shortcomings. Using the Toda and Yamamoto approach to causality, it is not required that all variables to be stationary at level or first difference. The Toda and Yamamoto Granger causality test is valid regardless of series being I(0) or I(1). Furthermore, it does not require the series to be co-integrated (Wolde-Rufael, 2005).

Specifically due to the fact that the Toda and Yamamoto Granger causality test does not require time series to be stationary at level or first difference, this approach is chosen to be useable for this study. This approach is explained in detail in the empirical section.

3.4 Data

In order to examine the education and GDP relationship concerning Turkey, annual time series data for the period 1971-2011 are used. The largest sample size available when using all four variables dates to 2013, though given the fact that the educational system was changed as of September 2012 the data after 2011 could not be submitted in the analysis. As of the new school year in September 2012, the compulsory education was expanded from being eight to twelve years (Sabah 09.16.2012 & Hurriyet 09.14.2013). The data is obtained from World Bank and OECD data bases.

In this section the descriptive statistics are presented, as to provide a quantitative description of the main features of the time series used. Table 3.2 provides the descriptive statistics regarding the mean, median, minimum observation, maximum observation, the standard deviation and number of observations. All variables consist of 41 observations.

Table 3.2: Descriptive Statistics.

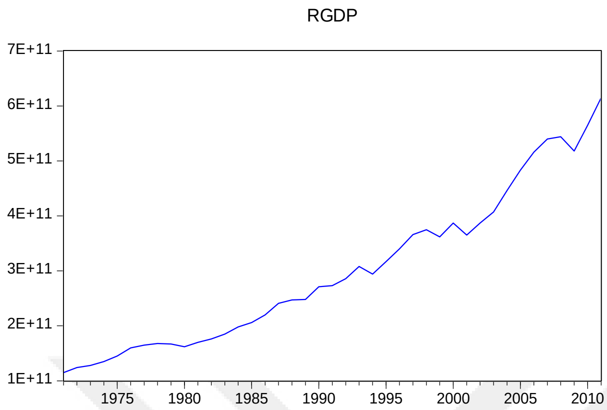
	Mean	Median	Maximum	Minimum	Std.Dev.	Obs.
LNRGDP	26.31816	26.33136	27.14436	25.46955	0.482609	41
LNGCFP	2.975795	2.971615	3.281498	2.622724	0.181231	41
LNLF	9.921802	9.988058	10.09901	9.618535	0.152216	41
LNENROLP	4.639453	4.642008	4.681974	4.589148	0.026541	41
LNENROLS	3.961441	3.950928	4.498624	3.262599	0.393154	41
LNENROLT	2.679552	2.641644	4.105674	1.548590	0.747877	41
RGDP	3.01E+11	2.73E+11	6.15E+11	1.15E+11	1.42E+11	41
GCFP	19.91902	19.52343	26.61561	13.77320	3.570283	41
LF	20449.69	20814.00	24378.00	14706.00	3053.693	41
ENROLP	103.5232	103.7524	107.9830	98.41052	2.737462	41
ENROLS	56.53848	51.98358	89.89339	26.11732	21.48032	41
ENROLT	19.05587	14.03626	60.68360	4.704830	14.34957	41

The statistics show that RGDP (real GDP) has a minimum observation value of 1.15E+11 and maximum observation value of 6.15E+11 with an average value (mean) of 3.01E+11 and standard deviation of 4.42E+11. GCFP shows a minimum of 13.77320 and a maximum of 26.61561 with a standard deviation of 3.570283. LF, being labor force has a minimum of 14706 and a maximum of 24378 with a standard deviation of 3053.693.

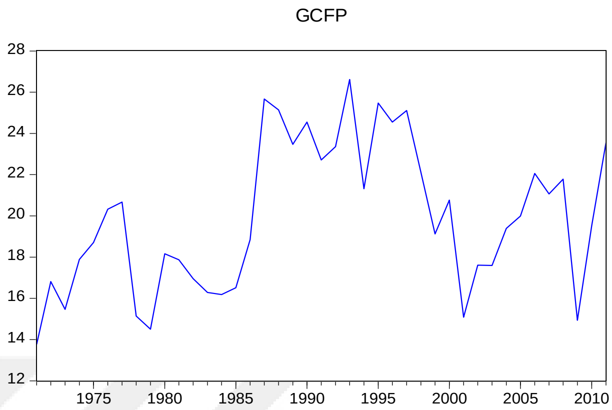
When looking at the levels of education it can be seen that the rate of enrollment for primary education is higher, 98.41052 (minimum), than the ones of rate of enrollment for secondary (26.11732) and tertiary schooling (4.704830).

Graphs 3.1-3.6 show the respective plots of each series. Looking at Graph 3.1 showing the plot of RGDP, it can be seen that there is not as many fluctuations as to GCFP in Graph 3.2. GCFP shows fluctuations but RGDP can be seen to be increasing throughout the years. The labor force (LF) in Graph 3.3 show a steady growth up to 1992 where fluctuations start but an overall growth is observed. Primary enrollment in Graph 3.4 shows a drop from 107.98 in 1973 to 99.31 in 1981. The lowest drop in primary enrollment can be observed in 1998, being 98.41. Secondary and tertiary enrollments show a more steady growth compared to primary enrollment, where secondary enrollment shows a few fluctuations between 2000 and 2011 and tertiary enrollment show a higher growth after 2005.

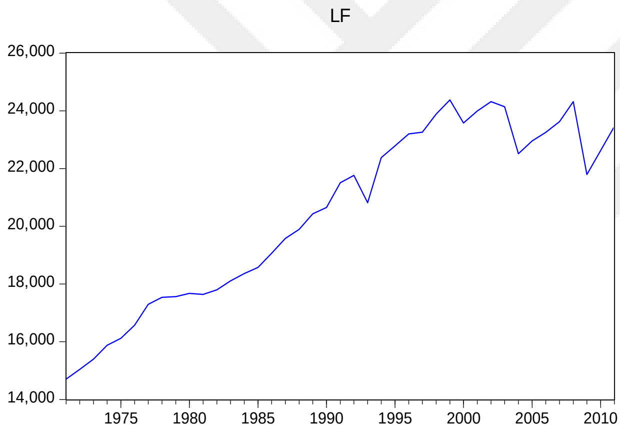
Graph 3.1: RGDP.



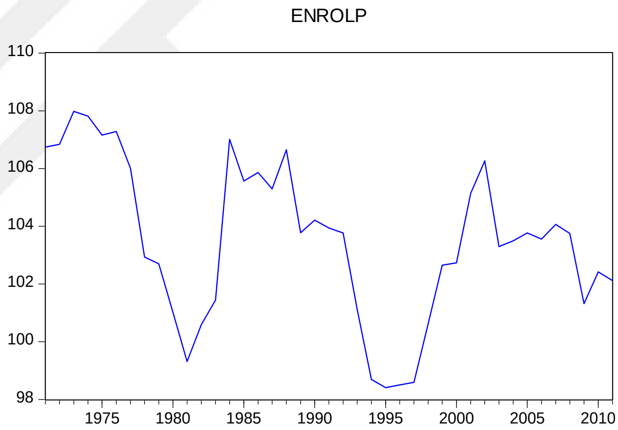
Graph 3.2: GCFP.



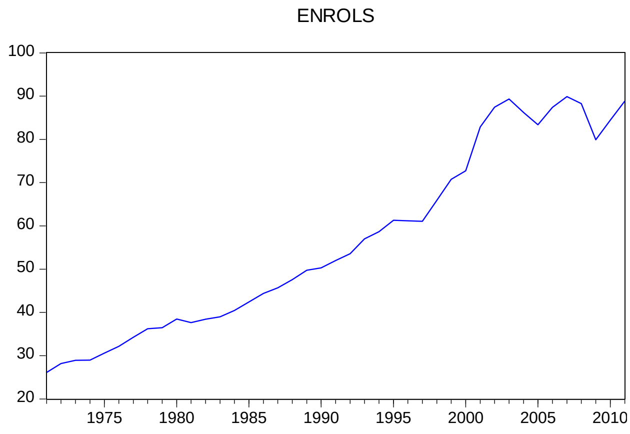
Graph 3.3: LF.



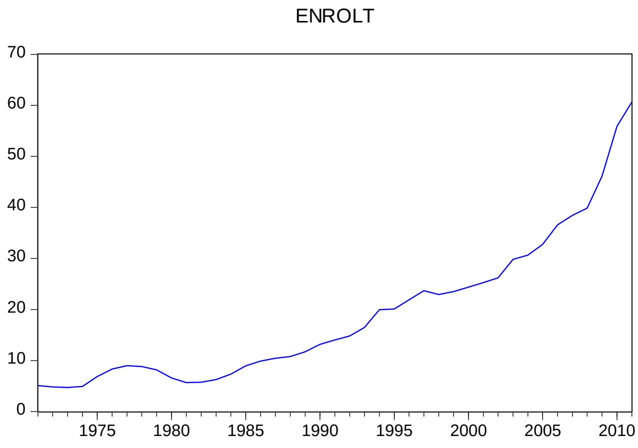
Graph 3.4: ENROLP.



Graph 3.5: ENROLS.



Graph 3.6: ENROLT.



CHAPTER 4

EMPIRICAL ANALYSIS

The analysis and empirical results, obtained by using the methodology described in Chapter 3, ARDL models and the Toda and Yamamoto approach to causality, are presented in this chapter. Starting with the ARDL modelling, the co-integration between school enrollment rates for primary, secondary, and tertiary schooling and GDP is investigated. In order to achieve a more rounded analysis, the Toda and Yamamoto approach to Granger causality is included hereafter.

4.1 Stationarity

In order to do the ARDL modelling it is highly important to check the stationarity of the series. Since, ARDL modelling can be performed only when the series are I(0) or I(1), so it is checked that there are no series that are I(2).

In this study the approach used to test stationarity is the Phillips-Perron (PP) test. Although, the test is very similar to the ADF test, an automatic correction to the DF procedure is incorporated into the Phillips-Perron (PP) test, allowing autocorrelated residuals. The PP test often yields same results as the ADF test (Brooks, 2008).

Table 4.1 presents the unit root tests with the intercept included in the model. The results show that all three enrollment rates, and the real GDP are I(1), while gross fixed capital formation and the labor force are I(0).

Table 4.1: Phillips-Perron Tests for Unit Roots Test with Intercept.

Variables	Level	First difference	5% critical value	1% critical value	Integrating order
LNENROLP	-2.306755	-5.764085	-2.938987	-3.610453	I(1)
LNENROLS	-1.508021	-5.167509	-2.938987	-3.610453	I(1)
LNENROLT	0.372084	-3.623222	-2.938987	-3.610453	I(1)
LNRGDP	-0.413868	-6.277304	-2.938987	-3.610453	I(1)
LNGCFP	-3.206264	-8.768486	-2.936942	-3.605593	I(0)
LNLF	-3.801913	-6.999548	-2.936942	-3.605593	I(0)

The tests are also performed including a trend in the model. Results reported in Table 4.2 show that all variables are I(1). From the results shown in both Table 4.1 and Table 4.2 it can be concluded that there are no series that are of I(2) or higher and thereby these time series can be used to perform ARDL modeling.

Table 4.2: Phillips-Perron Tests for Unit Roots Test with Intercept and Trend.

Variables	Level	First difference	5% critical value	1% critical value	Integrating order
LNENROLP	-2.379200	-5.702255	-3.529758	-4.211868	I(1)
LNENROLS	-1.757490	-5.134567	-3.529758	-4.211868	I(1)
LNENROLT	-2.150589	-3.584360	-3.529758	-4.211868	I(1)
LNRGDP	-3.355991	-6.152750	-3.529758	-4.211868	I(1)
LNGCFP	-3.258383	-8.613403	-3.529758	-4.211868	I(1)
LNLF	-1.375425	-10.20634	-3.529758	-4.211868	I(1)

4.2 Co-integration (The ARDL Bounds Testing Approach)

In order to check for co-integration between RGDP, GCFP, LF, and the education indicators (primary, secondary, or tertiary enrollments), four ARDL models must be estimated for each indicator, with each variable as the dependent variable in turn. For example, following four models must be run when the tertiary school enrollment (LNENROLT) is taken to be the education indicator:

Model 1.1

$$LNRGDP = f(LNGCFP, LNLF, LNENROLT)$$

Model 1.2

$$LNENROLT = f(LNGCFP, LNLF, LNRGDP)$$

Model 1.3

$$LNLF = f(LNGCFP, LNRGDP, LNENROLT)$$

Model 1.4

$$LNGCFP = f(LNRGDP, LNLF, LNENROLT)$$

A similar procedure must be followed for the remaining two indicators. To save space we report the results from the first model above (model 1.1) in detail here, relegating the reporting of the detailed results from the remaining 11 models to section 4.2.2 below.

4.2.1 Tertiary School Enrollment and Real GDP

ARDL Model

We set the maximum lags to four since the data is annual. The model selection criteria used is Akaike info criterion (AIC). In Table 4.3 below the ARDL (1, 1, 4, 1) model estimated by Eviews9, selected out of 500 models evaluated, is presented.

Table 4.3: The ARDL Estimation for Tertiary Enrollment (Model 1.1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNRGDP(-1)	0.892154	0.073438	12.14836	0.0000
LNGCFP	0.223447	0.039656	5.634571	0.0000
LNGCFP(-1)	-0.150438	0.043313	-3.473263	0.0018
LNLF	-0.232737	0.235927	-0.986479	0.3330
LNLF(-1)	0.060268	0.247755	0.243256	0.8097
LNLF(-2)	-0.305304	0.234495	-1.301960	0.2043
LNLF(-3)	0.147230	0.246361	0.597620	0.5553
LNLF(-4)	0.382994	0.233856	1.637733	0.1135
LNENROLT	0.155242	0.054157	2.866499	0.0081
LNENROLT(-1)	-0.117328	0.056579	-2.073712	0.0481
C	2.043832	1.473359	1.387192	0.1772

R-squared	0.996801	Mean dependent var	26.40088
Adjusted R-squared	0.995570	S.D. dependent var	0.431659
S.E. of regression	0.028731	Akaike info criterion	-4.019933
Sum squared resid	0.021462	Schwarz criterion	-3.541012
Log likelihood	85.36877	Hannan-Quinn criter.	-3.851091
F-statistic	810.0305	Durbin-Watson stat	2.387696
Prob(F-statistic)	0.000000		

Notes:
*: P-values and any subsequent tests do not account for model selection
Dependent Variable: LNRGDP
Sample (adjusted): 1975- 2011
Included observations: 37 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): LNGCFP LNLF LNENROLT
Fixed regressors: C
Number of models evalulated: 500
Selected Model: ARDL(1, 1, 4, 1)

Diagnostics

In this section the diagnostics of all three models concerning the three levels of education are checked. This is of relevance as the model must not show autocorrelation, heteroscedasticity or entail misspecification. Furthermore, the model must be stable.

In order to check whether serial correlation exists in the models, the Breusch-Godfrey Lagrange multiplier test is used. When autocorrelation is found in a model, the results obtained using that model cannot be trusted. Hence, it is important to test for the autocorrelation before moving forward with the analysis.

Jarque-Bera residual normality test is performed to check whether the residuals of the models are distributed normally or not. In order to determine whether or not there is a heteroscedasticity problem Breusch-Pagan-Godfrey test is done. Finally, the Ramsey's RESET test provides information regarding the model specification (functional form).

Table 4.4: Diagnostic Tests for Model 1.1.

Test	Type	Test Stat.	d.f.	Prob.
A: Serial Correlation	χ^2	3.771655	2	0.1517
B: Normality	χ^2	3.443881		0.1787
C: Heteroscedasticity	χ^2	9.963118	10	0.4437
D: Functional Form	F	0.257372	(1,25)	0.6164

Notes:
A: Breusch-Godfrey Lagrange multiplier test of residual serial correlation
B: Jarque-Bera residual normality test
C: Breusch-Pagan-Godfrey test of heteroscedasticity
D: Ramsey's RESET test

Above are the serial correlation estimations for model 1.1. As can be seen from the p-value (Prob.), which is higher than the five percent significance level, there is no auto correlation. Given the probability of 0.1787 for the normality which is above the five percent significance level it shows that the residuals of the model are normally distributed. The heteroscedasticity with the probability of 0.4437 is above the five percent significance level the model does not have heteroscedasticity problems. The Ramsey reset test provides information regarding the model specification. The test results in Table 4.4 show that there is no misspecification within the model.

Stability Conditions

Cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) methods are used to check the stability conditions. The null hypothesis, that all coefficients are stable, cannot be rejected if the two plots of the CUSUM and CUSUMSQ remain within the critical bounds of a five percent significance level.

Figure 4.1: CUSUM and CUSUMSQ tests for Model 1.1

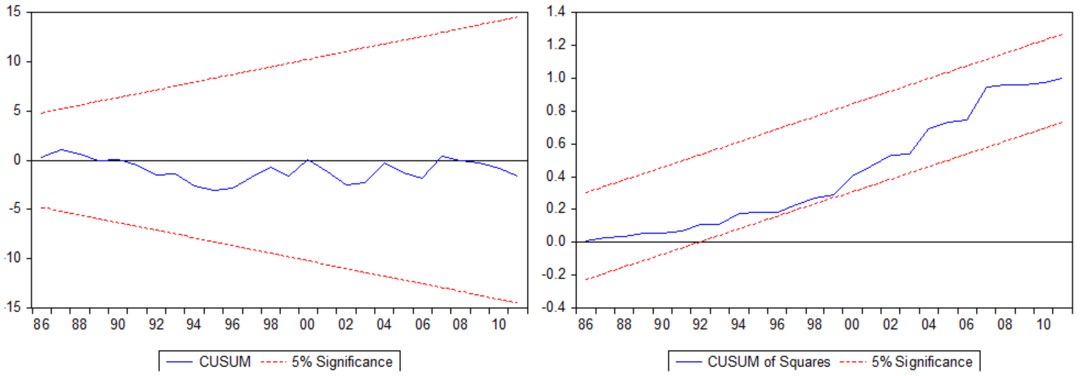


Figure 4.1 illustrates the cumulative sum and cumulative sum of squares for model 1.1. As can be seen above, both the CUSUM and the CUSUM of squares are within the five percent significance level. Hence, the model does not have stability issues.

Bounds Testing

Table 4.5 shows the bounds test estimates for model 1.1. The F-statistic with the value of 1.290677 is under lower bound of the five percent significance level, or any other significance level for that matter. This results show that there is no co-integration in this model.

Table 4.5: ARDL Bounds Test for Model 1.1.

Test Statistic	Value	k
F-statistic	1.290677	3
	Critical Value Bounds	
Significance	I0 Bound	I1 Bound
10%	2.72	3.77
5%	3.23	4.35
2.5%	3.69	4.89
1%	4.29	5.61

Notes:
Sample: 1972- 2011
Included observations: 37
Null Hypothesis: No long-run relationships exist

4.2.2. Diagnostic Tests and Co-integration Results for All Models

The diagnostic tests results for all models are given in Table 4.6. The dependent and independent variables used in these models are listed in Table 4.7.

Table 4.6: Diagnostic Test Results for All Models.

Test	Models											
	1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	3.4
A	1	1	2	1	1	1	2	1	1	1	2	1
B	1	0	1	1	0	1	1	1	0	1	1	1
C	1	1	1	1	1	0	1	1	1	1	1	1
D	1	1	1	1	1	1	1	1	1	1	1	1
E	1	1	1	1	1	1	1	1	1	1	1	1
F	1	1	0	1	1	0	0	0	1	1	0	1

Notes:
A: Breusch-Godfrey Lagrange multiplier test of residual serial correlation
B: Jarque-Bera residual normality test
C: Breusch-Pagan-Godfrey test of heteroscedasticity
D: Ramsey's RESET test
E: CUSUM test
F: CUSUMSQ test
0:Problem,1:No problem, 2:Problem solved with additional lags

The diagnostics test results in Table 4.6 show that models 1.1, 1.2, 1.4, 2.1, 3.1, 3.2, and 3.4 are stable and reliable. Although models 1.2, 2.1 a 3.1 and show non-normality problems, the heteroscedasticity results show that the models can be used for further testing. The remaining models show several diagnostic problems, which means that they cannot give reliable results when used in co-integration analysis.

Table 4.7: Co-integration Results for All Models.

Model	Dependent variable	Independent variables	Lag length	F-stat.	Outcome
1.1	LNRGDP	LNGCFP, LNLF, LNENROLT	3	1.290677	No Co-integration
1.2	LNENROLT	LNGCFP, LNLF, LNRGDP	3	2.695100	No Co-integration
1.3	LNLF	LNGCFP,LNRGDP,LNENROLT	3	4.472365	Co-integration
1.4	LNGCFP	LNRGDP,LNLF, LNENROLT	3	2.261989	No Co-integration
2.1	LNRGDP	LNGCFP,LNLF,LNENROLS	3	1.741790	No Co-integration
2.2	LNENROLS	LNGCFP,LNLF, LNRGDP	3	2.451471	No Co-integration
2.3	LNLF	LNGCFP,LNRGDP,LNENROLS	3	7.683581	Co-integration
2.4	LNGCFP	LNRGDP, LNLF, LNENROLS	3	3.182685	No Co-integration
3.1	LNRGDP	LNGCFP,LNLF,LNENROLP	3	0.340250	No Co-integration
3.2	LNENROLP	LNGCFP,LNLF, LNRGDP	3	4.984161	Co-integration
3.3	LNLF	LNGCFP,LNRGDP,LNENROLP	3	6.664577	Co-integration
3.4	LNGCFP	LNRGDP,LNLF,LNENROLP	3	2.806492	No Co-integration

Notes:
The critical values for the lower and upper bounds for k= 3 and 1%, 5%,10% significance levels are 4.29-5.61, 3.23-4.35, 2.72-3.77 repectively.

Table 4.7 consists of the co-integration test results for all the models. The lag length and F statistics are computed, and it is stated whether or not co-integration has been found. The outcome of co-integration or no co-integration does not consider stability conditions, therefore one must look back at Table 4.6 before such conclusions are drawn.

In model 1.3 where the dependent variable is labor force and the independent variables are gross capital formation, real GDP, and tertiary enrollment co-integration has been found. Although looking at Table 4.6 it can be seen that model 1.3 does not pass the CUSUM of squares test, and hence the existence of co-integration cannot be concluded. Model 2.3 and 3.3 give the same results as model 1.3, and given the stability difficulties indicated by CUSUM of squares test, it cannot be concluded that the variables in these models are co-integrated. Model 3.2 computes an F statistics of 4.984161, which indicates that co-integration exists at a five percent significance level, as it is above the upper bound of 4.35.

4.3 The Toda and Yamamoto Approach to Causality

Toda and Yamamoto approach is used in this study because, unlike the classical Engle-Granger causality method, it does not require that the series used in the study to be of the same integrating order. It is only necessary to specify the maximum order of integration (d_{max}) among the series, which is one in our case (d_{max}=1) since there are no series with an order of integration higher than one.

The first step in the Toda and Yamamoto approach to causality is the lag selection. The AIC criterion is used as to select the lag length (*k*) of the model.

Primary School Enrollment

Table 4.8: Lag length Criteria.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	144.4938	NA	7.22e-09	-7.394413	-7.222035	-7.333082
1	301.9066	273.4012*	4.26e-12*	-14.83719*	-13.97530*	-14.53054*
2	311.7205	14.97902	6.08e-12	-14.51160	-12.96021	-13.95963
3	322.8153	14.59840	8.51e-12	-14.25344	-12.01253	-13.45614

Notes:
Endogenous variables: LNRGDP LNGCFP LNLF LNENROLP
Exogenous variables: Constant
Sample: 1971-2011
Included observations: 38

Given AIC criterion, the optimal lag length is one. By choosing one lag the estimations for the model with primary school enrollment rates were computed. However in order to proceed with the Toda and Yamamoto approach the model must meet the stability conditions. When testing for stability conditions in the model with one lag, the model showed a unit a root outside the unit circle. When such problems occur, one can try and check the stability conditions for the same model by choosing the next lag length. In this case a lag length of two (*k*=2) will be chosen, which meets the stability condition as can be seen below:

Table 4.9: Roots Table.

Root	Modulus
0.999551	0.999551
0.815894	0.815894
0.663453	0.663453
0.509119	0.509119
-0.476276	0.476276
0.239618 - 0.250648i	0.346758
0.239618 + 0.250648i	0.346758
-0.135104	0.135104

Notes:

No root lies outside the unit circle.

VAR satisfies the stability condition.

Table 4.9 shows the root table which consists of estimation concerning the stability conditions. As stated in the table, there are no roots outside the unit circle, confirming that the model satisfies the stability conditions. Furthermore the autocorrelation has been checked and made sure there is no autocorrelation in the model:

Table 4.10: Autocorrelation.

Lags	LM-Stat	Prob
1	8.096139	0.9460
2	22.91538	0.1160
3	10.11437	0.8606

When using the Toda and Yamamoto approach it is important to include an extra lag for all the variables in the model. The lag length is determined by maximum order of integration in the model (d_{max}). Since d_{max}=1, we estimate ($k + d_{max}$)th order VAR, which is a third order VAR in our case (see Toda and Yamamoto, 1995). This step is easily performed in Eviews9, by adding an extra lag on all the variables in the exogenous variables box (see Appendix B for the Eviews output). Now the Granger causality test can be performed by using the VAR Granger causality/Block

Exogeneity Wald Test in Eviews9. Note that the null hypothesis tested is X does NOT cause Y.

From Table 4.11 below, it can quickly be concluded that none of the variables in the model Granger cause any other variable, except for the case of gross capital formation and primary enrollment. Since p-value is below the five percent significance level, we can reject the null hypothesis and conclude that LNGCFP Granger causes LNENROLP.

Table 4.11: Granger causality test.

Dependent variable:	LNRGDP		
Excluded	Chi-sq	df	Prob
LNGCFP	0.132736	2	0.9358
LNLF	0.688542	2	0.7087
LNENROLP	0.087094	2	0.9574
All	0.954572	6	0.9873

Dependent variable:	LNGCFP		
Excluded	Chi-sq	df	Prob
LNRGDP	0.163469	2	0.9215
LNLF	0.035835	2	0.9822
LNENROLP	0.767049	2	0.6815
All	0.929923	6	0.9881

Dependent variable:	LNLF		
Excluded	Chi-sq	df	Prob
LNRGDP	1.840948	2	0.3983
LNGCFP	1.655550	2	0.4370
LNENROLP	4.117352	2	0.1276
All	13.88785	6	0.0309

Dependent variable:	LNENROLP		
Excluded	Chi-sq	df	Prob
LNRGDP	4.105911	2	0.1284
LNGCFP	6.115823	2	0.0470
LNLF	4.127573	2	0.1270
All	10.00624	6	0.1244

Secondary School Enrollment

From Table 4.12 the optimal lag order selection given AIC criteria is one. Again the model with one lag is computed and the stability conditions are tested. Given the estimations of the roots in Table 4.13, the model has no roots outside the unit circle and therefore does the model satisfy stability condition. Results in Table 4.14 indicate no autocorrelation in the model.

Table 4.12: Lag length criteria.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	110.3980	NA	4.35e-08	-5.599893	-5.427515	-5.538562
1	275.1179	286.0925*	1.74e-11*	-13.42726*	-12.56537*	-13.12060*
2	282.9409	11.94036	2.76e-11	-12.99689	-11.44549	-12.44491
3	290.0115	9.303422	4.78e-11	-12.52692	-10.28601	-11.72962

Notes:
VAR Lag Order Selection Criteria
Endogenous variables: LNRGDP LNGCFP LNLF LNENROLS
Exogenous variables: C
Sample: 1971-2011
Included observations: 38

Table 4.13: Roots Table.

Root	Modulus
0.992819	0.992819
0.787890 - 0.156758i	0.803333
0.787890 + 0.156758i	0.803333
0.381467	0.381467

Notes:
No root lies outside the unit circle.
VAR satisfies the stability condition.

Table 4.14: Autocorrelation.

Lags	LM-Stat	Prob
1	13.99921	0.5988
2	7.651028	0.9586

After checking for autocorrelation, the analysis can now proceed by adding extra lags as required by the Toda and Yamamoto approach. After adding one extra lag, the Granger causality test for the model with secondary enrollment rates is computed. The findings are very much similar to the model with primary enrollment. Thus, there appear to be reverse causality in the form that secondary enrollment does not Granger cause Real GDP, but Real GDP Granger causes secondary enrollment. The Real GDP also Granger causes the labor force. Furthermore, a Granger causality from gross capital formation on secondary enrollment has also been found.

Table 4.15: Granger causality test.

Dependent variable:	LNRGDP		
Excluded	Chi-sq	df	Prob
LNGCFP	0.038779	1	0.8439
LNLF	0.121546	1	0.7274
LNENROLS	0.000223	1	0.9881
All	0.239759	3	0.9709

Dependent variable:	LNGCFP		
Excluded	Chi-sq	df	Prob
LNRGDP	0.011311	1	0.9153
LNLF	0.010340	1	0.9190
LNENROLS	0.185974	1	0.6663
All	0.287223	3	0.9624

Dependent variable:	LNLF		
Excluded	Chi-sq	df	Prob
LNRGDP	4.144359	1	0.0418
LNGCFP	0.005469	1	0.9410
LNENROLS	1.861085	1	0.1725
All	9.735426	3	0.0210

Dependent variable:	LNENROLS		
Excluded	Chi-sq	df	Prob
LNRGDP	4.356357	1	0.0369
LNGCFP	3.904604	1	0.0482
LNLF	0.845208	1	0.3579
All	5.359439	3	0.1473

Tertiary School Enrollment

For tertiary enrollment, the lag length chosen by the AIC criteria is one (see Table 4.16). When one lag is used it is found that one or more roots lie outside the unit circle, so the model is rerun with the two lags, and the stability condition is checked. As can be seen from the roots are given in Table 4.17, the model satisfies the stability conditions, as no roots lie outside the unit circle. Table 4.18 shows that the model has no autocorrelation problems. As before an extra lag is added to the model in the exogenous box, adding up to a total of 3 lags, before estimating the Granger causality.

Table 4.16: Lag length criteria.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	75.48697	NA	2.73e-07	-3.762472	-3.590095	-3.701142
1	235.3961	277.7370*	1.41e-10*	-11.33664*	-10.47475*	-11.02999*
2	251.1408	24.03130	1.47e-10	-11.32320	-9.771802	-10.77122
3	259.9603	11.60463	2.33e-10	-10.94528	-8.704372	-10.14798

Notes:
VAR Lag Order Selection Criteria
Endogenous variables: LNRGDP LNGCFP LNLF LNENROLT
Exogenous variables: C
Sample: 1971-2011
Included observations: 38

Table 4.17: Roots Table.

Root	Modulus
0.987995	0.987995
0.889494	0.889494
0.721974 - 0.368251i	0.810466
0.721974 + 0.368251i	0.810466
0.509799	0.509799
-0.335221	0.335221
-0.066455 - 0.232820i	0.242119
-0.066455 + 0.232820i	0.242119

Notes:
No root lies outside the unit circle.
VAR satisfies the stability condition.

Table 4.18: Autocorrelation.

Lags	LM-Stat	Prob
1	10.52353	0.8379
2	15.08008	0.5188
3	9.037320	0.9119

Table 4.19 gives the Granger causality estimations for tertiary enrollment. Results show that none of the variables Granger causes any other variable.

Specifically, tertiary enrollment has not been found to Granger cause real GDP. The reverse Granger causality has not been found, either.

Table 4.19: Granger causality test.

Dependent variable:	LNRGDP		
Excluded	Chi-sq	df	Prob
LNGCFP	0.084939	2	0.9584
LNLF	0.377188	2	0.8281
LNENROLT	4.278304	2	0.1178
All	5.914272	6	0.4329

Dependent variable:	LNGCFP		
Excluded	Chi-sq	df	Prob
LNRGDP	0.876468	2	0.6452
LNLF	0.227400	2	0.8925
LNENROLT	1.823500	2	0.4018
All	2.689281	6	0.8467

Dependent variable:	LNLF		
Excluded	Chi-sq	df	Prob
LNRGDP	1.875180	2	0.3916
LNGCFP	1.167455	2	0.5578
LNENROLT	0.245981	2	0.8843
All	8.565597	6	0.1995

Dependent variable:	LNENROLT		
Excluded	Chi-sq	df	Prob
LNRGDP	1.272265	2	0.5293
LNGCFP	0.135847	2	0.9343
LNLF	0.627828	2	0.7306
All	3.139765	6	0.7911

4.4 ARDL using Proxies

In this section we present the results from the alternative ARDL models. GDP per capita (GDPC) is used instead of real GDP and data for worked hours (WH) are used as a proxy for labor force, in the alternative models. Nevertheless, the growth rate of real GDP (DRGDP) and the growth rate of GDP per capita (DGDPC) are also included in alternative scenarios, in accordance with the study by Barro (1991). Table 4.20 presents the results from these alternative models. All data are obtained from World Bank Databases except for Worked Hours (WH), which is obtained from the OECD Database.

Table 4.20: Co-integration results for alternative models.

Model	Dependent Variable	Independent Variable	F-Stat.	Lag Length	Outcome
4.1	LNRGDP	LNGCFP, LNWH,LNENROLP	0.555859	3	No Co-integration
4.2	LNRGDP	LNGCFP, LNWH,LNENROLS	2.038164	3	No Co-integration
4.3	LNRGDP	LNGCFP, LNWH,LNENROL*P*	0.512110	3	No Co-integration
5.1	LNENROLP	LNGCFP, LNWH,LNRGDP	1.794148	3	No Co-integration
5.2	LNENROLS	LNGCFP, LNWH,LNRGDP	4.007015	3	Inconclusive
5.3	LNENROLT	LNGCFP, LNWH,LNRGDP	3.812832	3	Inconclusive
6.1	LNGDPC	LNGCFP,LNLF,LNENROLP	0.446983	3	No Co-integration
6.2	LNGDPC	LNGCFP,LNLF,LNENROLS	1.737313	3	No Co-integration
6.3	LNGDPC	LNGCFP,LNLF,LNENROLT	1.114841	3	No Co-integration
7.1	LNENROLP	LNGCFP,LNLF, LNGDPC	4.788195	3	Co integration
7.2	LNENROLS	LNGCFP,LNLF, LNGDPC	2.392016	3	No Co-integration
7.3	LNENROLT	LNGCFP,LNLF, LNGDPC	4.145690	3	Inconclusive
8.1	LNGDPC	LNGCFP,LNWH,LNENROLP	0.722503	3	No Co-integration
8.2	LNGDPC	LNGCFP,LNWH,LNENROLS	2.633528	3	No Co-integration
8.3	LNGDPC	LNGCFP,LNWH,LNENROLT	0.851558	3	No Co-integration
9.1	LNENROLP	LNGCFP,LNWH, LNGDPC	1.799646	3	No Co-integration
9.2	LNENROLS	LNGCFP,LNWH, LNGDPC	3.506593	3	Inconclusive
9.3	LNENROLT	LNGCFP,LNWH, LNGDPC	4.566870	3	Co-integration
10.1	DRGDP	LNGCFP,LNLF,LNENROLP	6.224430	3	Co-integration
10.2	DRGDP	LNGCFP,LNLF,LNENROLS	7.187717	3	Co-integration
10.3	DRGDP	LNGCFP,LNLF,LNENROLT	8.956452	3	Co-integration
11.1	LNENROLP	LNGCFP,LNLF, DRGDP	3.263449	3	Inconclusive
11.2	LNENROLS	LNGCFP,LNLF, DRGDP	2.076603	3	No Co-integration
11.3	LNENROLT	LNGCFP,LNLF, DRGDP	0.472117	3	No Co-integration
12.1	DRGDP	LNGCFP,LNWH,LNENROLP	7.166110	3	Co-integration
12.2	DRGDP	LNGCFP,LNWH,LNENROLS	6.851673	3	Co-integration
12.3	DRGDP	LNGCFP,LNWH,LNENROLT	10.27400	3	Co-integration
13.1	LNENROLP	LNGCFP,LNWH, DRGDP	3.006507	3	No Co-integration
13.2	LNENROLS	LNGCFP,LNWH, DRGDP	1.350965	3	No Co-integration
13.3	LNENROLT	LNGCFP,LNWH, DRGDP	0.344792	3	No Co-integration
14.1	DGDPC	LNGCFP,LNLF,LNENROLP	5.699686	3	Co-integration
14.2	DGDPC	LNGCFP,LNLF,LNENROLS	6.328061	3	Co-integration
14.3	DGDPC	LNGCFP,LNLF,LNENROLT	8.720406	3	Co-integration
15.1	LNENROLP	LNGCFP,LNLF, DGDPC	3.250673	3	Inconclusive
15.2	LNENROLS	LNGCFP,LNLF, DGDPC	2.067230	3	No Co-integration
15.3	LNENROLT	LNGCFP,LNLF, DGDPC	0.848235	3	No Co-integration
16.1	DGDPC	LNGCFP,LNWH,LNENROLP	5.823718	3	Co-integration
16.2	DGDPC	LNGCFP,LNWH,LNENROLS	6.665674	3	Co-integration
16.3	DGDPC	LNGCFP,LNWH,LNENROLT	9.844211	3	Co-integration
17.1	LNENROLP	LNGCFP,LNWH, DGDPC	2.606026	3	No Co-integration
17.2	LNENROLS	LNGCFP,LNWH, DGDPC	1.349006	3	No Co-integration
17.3	LNENROLT	LNGCFP,LNWH, DGDPC	0.369503	3	No Co-integration

Notes:
The critical values for the lower and upper bounds for 1%, 5% and 10% significance levels are: 4.29-5.61; 3.23-4.35; 2.72-3.77. In this thesis the 5% significance level is preferred.

As a part of the sensitivity analysis, not only are the models run using proxies but also the reverse models are computed. The reverse models investigate the co-integration between enrollments and GDP.

Table 4.20 shows that for the cases where proxies are used (models 10.1, 10.2, 10.3, 12.1, 12.2 and 12.3), co-integration is found for the cases of growth of real GDP (DRGDP) for all three levels of enrollment using both labor force (LF) and worked hours (WH). In the models consisting of growth of GDP per capita (models 14.1, 14.2, 14.3, 16.1, 16.2 and 16.3) co-integration is also found for all levels of enrollment using both labor force (LF) and worked hours (WH). Regarding the reverse models it can be seen that co-integration is found for models 7.1 and 9.3. Model 7.1 is the reverse model investigating the impact of GPD per capita (GDPC) on primary enrollment (ENROLP) including data for LF and GCFP in the model. Model 9.3 is reverse model where the dependent variable is tertiary enrollment (ENROLT) and the series included in the model are GCFP, WH and GDPC.

For the models that yielded co-integration, diagnostics were computed and the results put in Table 4.21. First, it can be seen from Table 4.21 that no model has a problem of autocorrelation and heteroscedasticity, but five of the models show stability issues when looking at their respective CUSUM of squares test results. It can be concluded that there is no co-integration in models 10.2, 12.1, 12.2, 14.2, and 16.2 as these models weren't found to be stable.

Table 4.21: Diagnostic Test Results for all models with co-integration

Test	Model													
	7.1	9.3	10.1	10.2	10.3	12.1	12.2	12.3	14.1	14.2	14.3	16.1	16.2	16.3
A	1	1	1	1	2	1	1	2	1	1	2	1	1	2
B	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C	1	1	1	1	1	1	1	1	1	1	1	1	1	1
D	1	1	1	1	1	1	1	1	1	1	1	1	1	1
E	1	1	1	1	1	1	1	1	1	1	1	1	1	1
F	1	1	1	0	1	0	0	1	1	0	1	1	0	1

Notes:
A: Breusch-Godfrey Lagrange multiplier test of residual serial correlation
B: Jarque-Bera residual normality test
C: Breusch-Pagan-Godfrey test of heteroscedasticity
D: Ramsey's RESET test
E: CUSUM test
F: CUSUMSQ test
0:Problem,1:No problem, 2:Problem solved with additional lags

The long-run and short-run coefficients were computed for model 7.1 and 9.3 and shown in Tables 4.22 and 4.23, respectively. The remaining models are not included as they all yielded an error correction term, ECM(-1), that was not between 0-1 (An error correction term that is between 0-1 ensures the existence of convergence in the model which indirectly means that there is a significant long-run relation).

Table 4.22: Long-run Coefficients

Model	Dependent Variable	Independent Variables			
7.1	LNENROLP	5.67 - (11.87) [0.00]	0.02*LNGCFP - (-0.53) [0.60]	0.16*LNLF + (-2.15) [0.04]	0.07*LNGDPC (1.96) [0.06]
9.3	LNENROLT	-35.53 + (-4.18) [0.00]	0.08*LNGCFP + (0.46) [0.65]	1.88*LNWH + (1.79) [0.09]	2.79*LNGDPC (29.29) [0.00]

*****t-values are given in parenthesis and the probabilities in angular brackets.

The error correction coefficients for both models are negative and between 0-1 as required (see Table 4.23). The error coefficient for model 7.1 is -0.61 and for model 9.3 is -0.51. These coefficients are both statistically significant.

Regarding model 7.1 it can be seen that labor force has significant effect on primary enrollment in the long-run as the probability is below five percent, whereas in the short-run such a significant effect has not been found. As to model 9.3, GDP per capita has been found to have a significant effect on tertiary enrollment in the long-run. In the short-run GDP per capita (GDPC) has a significant effect on tertiary enrollment.

Table 4.23: Short-run Coefficients

	Cointegrating form							
Model 7.1	0.22*ΔLNENROLP(-1) + 0.46*ΔLNENROLP(-2) + 0.36*ΔLNENROLP(-3) – 0.01*ΔLNGCFP + 0.09*ΔLNLF + 0.18*ΔLNLF(-1) + 0.04*ΔLNGDPC – 0.61*ECM(-1)							
	ΔLNEN-ROLP(-1)	ΔLNEN-ROLP(-2)	ΔLNEN-ROLP(-3)	ΔLNGCFP	ΔLNLF	ΔLNLF(-1)	ΔLNGDPC	ECM(-1)
Coefficients	0.22	0.46	0.36	-0.01	0.09	0.18	0.04	-0.61
t-values	1.28	2.54	1.77	-0.56	0.75	1.66	1.71	-3.88
Prob.	0.21	0.02	0.09	0.58	0.46	0.11	0.10	0.00

	Cointegrating form						
Model 9.3	0.77*ΔLNENROLT(-1) – 0.16*ΔLNGCFP + 0.97*ΔLNWH +0.91*ΔLNGDPC + 0.15*ΔLNGDPC(-1) – 0.86*ΔLNGDPC(-2) – 0.51*ECM(-1)						
	ΔLNENROLT (-1)	ΔLNGCFP	ΔLNWH	ΔLNGDPC	ΔLNGDPC (-1)	ΔLNGDPC (-2)	ECM(-1)
Coefficients	0.77	-0.16	0.97	0.91	0.15	-0.86	-0.51
t-values	5.11	-1.29	1.69	2.35	0.41	-2.72	-4.50
Prob.	0.00	0.21	0.10	0.03	0.69	0.01	0.00

CHAPTER 5

CONCLUSION

In this chapter the relationship between education and GDP is summarized linking the literature and the empirical results obtained in Chapter 3. Furthermore, the limitations and implications of the study are discussed. Finally, ideas for future research are presented.

The goal of this thesis has been to investigate the effect of human capital, proxied by education, on GDP in Turkey. The relationship between education and GDP has been an interesting subject to researchers for quite a while, as human capital in terms of education is seen by many as an important part when explaining a country's overall development. In papers it has been emphasized by numerous researchers, that education has a positive effect on economic growth.

The empirical analysis for the case of Turkey yielded no results showing the existence of co-integration between education and GDP. School enrollment rates for three levels of education were used as proxies for human capital. The models were run with proxies such as real GDP, real GDP per capita, growth of real GDP, or growth of real GDP per capita as dependent variables, and labor force (or worked hours) and gross fixed capital formation as independent variables.

The ARDL modelling was supplemented by the Toda and Yamamoto approach to test for Granger causality. The Granger causality tests found that there is no Granger causality between education and GDP in any direction except for the case of secondary enrollment where reverse causality has been found between secondary school enrollment rates and real GDP.

Finally, a sensitivity analysis was done, where several alternative models have been run by using various proxies. The sensitivity analysis showed that even when using other proxies, the results were the same. Co-integration was not found in any of the models between education and GDP. However, in the reverse models, co-integration was found for two models, model 7.1 with primary school enrollment rates and model 9.3 with tertiary enrollment rates (see section 4.4). This leads to the conclusion that for the case of Turkey and by using data obtained from World Bank and OECD databases, no co-integration between education and GDP was found. Thus, it is concluded that, contrary to the findings of earlier studies, the empirical results obtained in this study show that education does not affect GDP for the case of Turkey.

Interesting findings were found in the sensitivity analysis supporting some of the results in Bils and Klenow (2000). For primary enrollment, co-integration was found in the reverse models, showing that GDP has an impact on education. And for the case of tertiary enrollment the error correction coefficients showed that the reverse model showed that GDP has a strong causal effect on tertiary enrollment. Bils and Klenow (2000), claim that an effect of education on GDP is too frail when explaining a third of the investigated relationships in the literature. Furthermore, it is argued by Bils and Klenow (2000), that the reverse channel may be explained by the anticipated growth. Bils and Klenow (2000) argue that anticipated growth increases the demand for schooling by diminishing the effective discount rate.

The empirical results showed that co-integration does not exist between education and real GDP. These results can be caused by the lack of measures of educational quality. *Numbers* of students enrolled in primary, secondary and tertiary levels of education do not account for any level of *skills* attained. With a proper measure for educational quality not only for the output, in form of test scores, but also in form of input the results may be quite different. Furthermore, the lack of data on a large number of control variables is also a problem. It is possible to use different proxies for labor force, human capital, etc., but finding data on many of these is difficult or impossible.

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APPENDIX A: LITERATURE REVIEW

Row	Year	Author(s)	Country	Methodology	Inputs	Outputs	Conclusion
1	2011	ERDEM, Ekrem TUGCU, Can Tansel	Turkey, 1970-2008	Autoregressive Distributed Lag (ARDL) approach and Dolado and Lütkepohl's style Granger causality test	Gross Fixed Capital, Total Workforce, Total Higher Education Stock, and Higher Education Graduate	GDP	Cointegration between higher education and economic growth has been found and it can be concluded that higher education affects economic growth both in the short- and long-run.
2	2008	ÖZSOY, Ceyda	Turkey, 1970-2006	VAR-model	Enrollment: Primary education, Secondary education, technical education, and tertiary education	real GNP (1987)	According to the cointegration tests there is in the long-run a stable relationship between education and economic growth
3	2013	SOLAKI, Melina	Greece, 1961-2006	Bi-variate causality analysis	Enrollment rates in Tertiary, Secondary and Primary Education, and Public Expenditures on education relative to total public expenditures	the Real Gross Domestic Product per Capita	Emperical results proves GDP per capita is affected by changes in primary, secondary, tertiary education and educational public expenditures in the long run
4	2012	HUSSIN, Mohd Yahya Mohd MUHAMMAD, Fidlizan HUSSIN, Mohd Fauzi Abu RAZAK, Azila Abdul	Malaysia, 1970-2010	VAR-model	Government Expenditure on Education, Gross Fixed Capital Formation, and Labor	GDP	By using the VAR-model a significant relationship has been found. A positive long-run relationship is shown between GDP and the three inputs
5	2011	BABALOLA, Sikiru Jimoh	Nigeria, 1977-2008	Augmented Dickey-Fuller, Phillips-Perron, Engle-Granger approach and Johansen cointegration test.	Expenditure on Education,	GDP	The Johansen cointegration test has proven the existence of a long-run relationship between education and economic growth

APPENDIX A: LITERATURE REVIEW

6	2009	PRADHAN, Rudra Prakash	India, 1951-2001	Error Correction Modeling	Government Expenditure on Education	GDP	The cointegration test shows that education and economic growth are cointegrated. The Granger causality test confirms a presence of unidirectional causality from economic growth to education and no reverse causality
7	2005	BABATUNDE, Musibau Adetunji	Nigeria, 1970-2003	Johansen Cointegration technique and Vector Error Correction Methodology	Gross Fixed Capital Formation, Imports of Goods and Services, Average Years of Schooling, Primary, Secondary and Tertiary Gross Enrollments Ratios, Output per Worker, Labour Force, General Strikes, and Government Expenditure on Education	GDP per worker	The results derived indicates that a well-educated labor force have a positive and significant impact on economic growth
8	2014	CETIN, Ahmet Kibar KUTLUTURK, Murat Mustafa AKMAZ, Hakan Kasim	Turkey, 2000-2013	ARDL	Fixed Capital Formation, Illeterate, Primary, Secondary, and Tertiary Schooling.	GDP	Cointegration relationship between the illeterate, high secondary level of education and the economic growth has been found. While secondary education has a positive effect on GDP per employee the illeterate have a negative effect
9	2010	ABHIJEET, Chandra	India, 1950-2008	Linear and Non-linear Granger causality tests	Public Spending on Education	GDP	The results show that the direction of causation going from education expenditure to economic growth does not have an immediate effect. Rather, investments in education can be expected to affect the economic growth after a period, 5 or 6 years according to the study

APPENDIX A: LITERATURE REVIEW

10	2012	KHATTAK, Naeem Ur Rehman KHAN, Jangraiz	Pakistan, 1971-2008	Ordinary Least Squares and Johansen Cointegration tests	Gross Fixed Capital Formation, Elementary and Secondary Enrollments, Labor Force Participation Rate	GDP	The OLS test results show that both elemantary and secondary affect economic growth. The Johansen Cointegration test results in an existing long-run relationship between education and economic growth
11	2008	DENIZ, Zeynep DOGRUEL, A. Suut	Turkey and MENA countries, 1930-2004	VAR-model	Primary School, Secondary School, High School, High-technical School, and University	GDP	It is concluded that investments in all levels of education contribute to the economic development in the MENA region. As to Turkey the results show that the quality of education in the primary and secondary schools have long-run effects on the economic growth
12	2013	CALISKAN, Sadan KARABACAK, Mustafa MECIK, Oytun	Turkey, 1923-2011	Cointegration Analysis	Elementary School, High-School, Vocational School, Higher Education	GDP	The results show a pozitif relationship between high school, and higher education and economic growth. Furthermore, it can be said that a 0,1% increase in the number of students in high schools will results in a 0,2% increase in GDP. Whereas, an 0,1% increase in number of students taking a higher education will increase the GDP by 0,6%

APPENDIX A: LITERATURE REVIEW

13	2007	BLANKENAU, William F. SIMPSON, Nicole B. TOMLJANOVICH, Marc	Argentina, Australia, Austria, Belgium, Canada, Denmark, Finland, Francé, Greece, Iceland, Ireland, Israel, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, United Kingdom, and United States, 1960-2000	Ordinary Least Squares	Government Spending Net of Education, Federal Government Budget Surplus, Gross Enrollment Ratios for Primary Schooling	GDP	A positive relationship between public education expenditures and growth for developed countries is found. However, this relationship is sensitive to impositions of the government budget constraint
14	2009	HUANG, Feixue JIN, Ling SUN, Xiaoli	China, 1972-2007	Vector Error Correction Model	Enrollment in Higher Education	GDP	Between the variables enrollment in higher education and GDP per capita there is found a long-term cointegration relation. Indicating the existence of a long-term steady relationship between the two variables
15	2009	COORAY, Arusha V.	46 low and middle income economies as defined by the World Bank, 1999-2005	OLS and GMM techniques. GMM is used to correct for any endogeneity bias that may be present in the models	Share of Investment to GDP, Population Growth Rate, Enrollment Ratio; Primary, Secondary, Tertiary. Repetition Rate; Primary, Secondary. Education Expenditure as percentage of GDP, Public Expenditure; per Primary Student as a percentage of GDP per capita, Secondary Student as a percentage of GDP per capita. Survival Rate to Grade 5, Schooling Life Expectancy, Trained Teachers in Primary Education, Employment to Population Ratio, Test Scores	GDP	The results derived show that the impact of human capital on growth within an economy depends on the measure of human capital used. The enrollment rates for primary, secondary and tertiary levels are all positive and highly significant for economic growth. Furthermore, it can be argued that as expenditure devoted to education increases improvementes in quality is realized which therefore affects economic growth

APPENDIX A: LITERATURE REVIEW

16	2013	AGELI, Mohammed Moosa	Saudi Arabia, 1970-2012	OLS, Unit Root tests, cointegration tests, ECM,	Education Expenditure	real Oil GDP, Non Oil GDP	The overall findings suggests that cointegration exists between the share of education expenditure in national output and per capita income. The importance of Keynesian relation for a late developing country such as Saudi Arabia is significantly verified by the study. Where fiscal policy in form of education expenditures has been the engine of economic growth and development
17	2011	RIASAT, Saima ATIF, Rao Muhammad ZAMAN, Khalid	Pakistan, 1972-2010	Bounds testing approach	Gross Fixed Capital Formation, Total Employment and Government Education Expenditures per Worker	GDP	Using the bounds testing approach the empirical results show a positive and significant impact between education expenditures and economic growth in the long run
18	2012	AK, Rengin BINGÜL, Berna Ak	Turkey, 1968-2010	Co-integration method	Education Expenditure	GNP	A long-term relationship between economic growth and education expenditures in Turkey are found
19	2013	KIRAN, Burcu	18 Latin American Countries, 1970-2009	Co-integration	Educational Expenditures per Capita	Gross National Income per Capita.	The results indicate cointegration between education expenditures and economic growth for chosen countries except Chile, Guyana, Jamaica, Nicaragua, Paraguay, Peru and Uruguay.

APPENDIX A: LITERATURE REVIEW

20	2010	AFZAL, Muhammad FAROOQ, Muhammad Shahid AHMAD, Hafiz Khalil BEGUM, Ishrat QUDDUS, M. Abdul	Pakistan, 1970-2008	ARDL	Fixed Capital Formation, School Enrollment Ratio, Inflation Rate, Head Count Index (measure of absolute poverty)	Real GDP	The results obtained by the bounds testing approach confirm the relationship between school education and economic growth.
21	2010	BESKAYA, Ahmet SAVAS, Bilal SAMILOGLU, Famil	Turkey, 1923-2007	ARDL	per capita enrolments in primary school, in secondary school, in high school, in technical schools and in higher education.	the rate of growth per capita real GDP	Evidence of a long-run cointegrating relationship between real income and school enrolment was found. Furthermore, a bidirectional long-run Granger causality was found. However, a uni-directional short-run Granger causality going from enrolments in secondary, high and technical high schools to real income was found. Concluding, all results underline education as a means of long-run economic growth in Turkey.

APPENDIX A: LITERATURE REVIEW

22	2011	TAMANG, Pravesh	India, 1980-2008	Time series; co-integration, unit roots, error correction	gross fixed capital formation per labour, government education expenditure per labour	GDP per labour	Results indicate the existence of a long-run relationship between education expenditure and economic growth. The results of the error-correction estimates are that education expenditure per labour have less impact on economic growth when compared to gross fixed capital formation per labour. A 1% increase in government education expenditure per labour leads to a 0.11% increase in GDP per labour as to a 1% increase in gross fixed capital formation per labour leads to a 0.28% increase in GDP per labour.
23	2011	SHAIHANI, Ahmad Lutfy Mohammed HARIS, Asmaddy ISMAIL, Normaz Wana SAID; RUSMAWATI	Malaysia, 1978-2007	ARDL	Enrollment rates in primary, secondary and tertiary education Control varables: trade openness (percentage export plus import in current price per GDP) and foreign direct investment (net inflows from foreign investors divided by GDP)	real GDP per capita	The results derived using ARDL show primary and tertiary education to be negatively significant in the short run as to explain developments in economic growth. Whereas, secondary education on the short run was shown to be positively significant . However, in the long-run tertiary education is the only variable impacting economic growth positively and significantly. The control variables were found to be significant in both short and long-run.

24	2014	HAMMEKEN, Elaina	Scandinavia, 1950-2010	two-stage least squares instrumental variables regression	percentage of females aged 25 and over in total tertiary education	PPP converted GDP constant 2005 prices	Estimation results show a negative and significant effect on economic growth. Which, explained by the author, can be a reflection of the underutilization of females in the workforce. A 0.72 percentage points decrease in GDP is followed five years after a one percent increase in the percentage of females in tertiary education.
25	2014	JOHANSEN, Anette Løndal	123 countries, 1960-2010	two-least square estimation	average years of total; primary; secondary; tertiary schooling, % completed primary; secondary; tertiary school, life expectancy, population growth (annual %), PPP converted GDP per capita 2005 constant prices, opennes at 2005 constant prices (%), government consumption share of PPP converted GDP per capita at 2005 constant prices.	Gini coefficient of net disposable household income	Using educational attainment as a proxy for human capital showed a positive effect of improved educational attainment if aiming for a decrease in income inequality.

APPENDIX B: TODA & YAMAMOTO USING EVIEWS 9

1. Primary Enrollment. (Source Eviews 9)

Lag Length Criteria:

Lag	LogL	LR	FPE	AIC	SC	HQ
0	144.4938	NA	7.22e-09	-7.394413	-7.222035	-7.333082
1	301.9066	273.4012*	4.26e-12*	-14.83719*	-13.97530*	-14.53054*
2	311.7205	14.97902	6.08e-12	-14.51160	-12.96021	-13.95963
3	322.8153	14.59840	8.51e-12	-14.25344	-12.01253	-13.45614

Notes:
* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
VAR Lag Order Selection Criteria
Endogenous variables: LNENROLP LNRGDP LNGCFP
LNLF
Exogenous variables: C
Sample: 1971 2011
Included observations: 38
HQ: Hannan-Quinn information criterion,

From above it can be seen that one lag is given as optimal, but before proceeding one must check for stability conditions as follows

Stability Conditions:

Root	Modulus
1.001933	1.001933
0.773876	0.773876
0.689368	0.689368
0.600075	0.600075

Notes:
Warning: At least one root outside the unit circle.
VAR does not satisfy the stability condition.
Roots of Characteristic Polynomial
Endogenous variables: LNENROLP LNRGDP LNGCFP LNLF
Exogenous variables: C
Lag specification: 1 1

As it can be seen from the stability conditions a probiem with the roots ocur, as one root is outside the unit circle, why it is checked again with the next avaliable lag being two.

Stability Conditions Two:

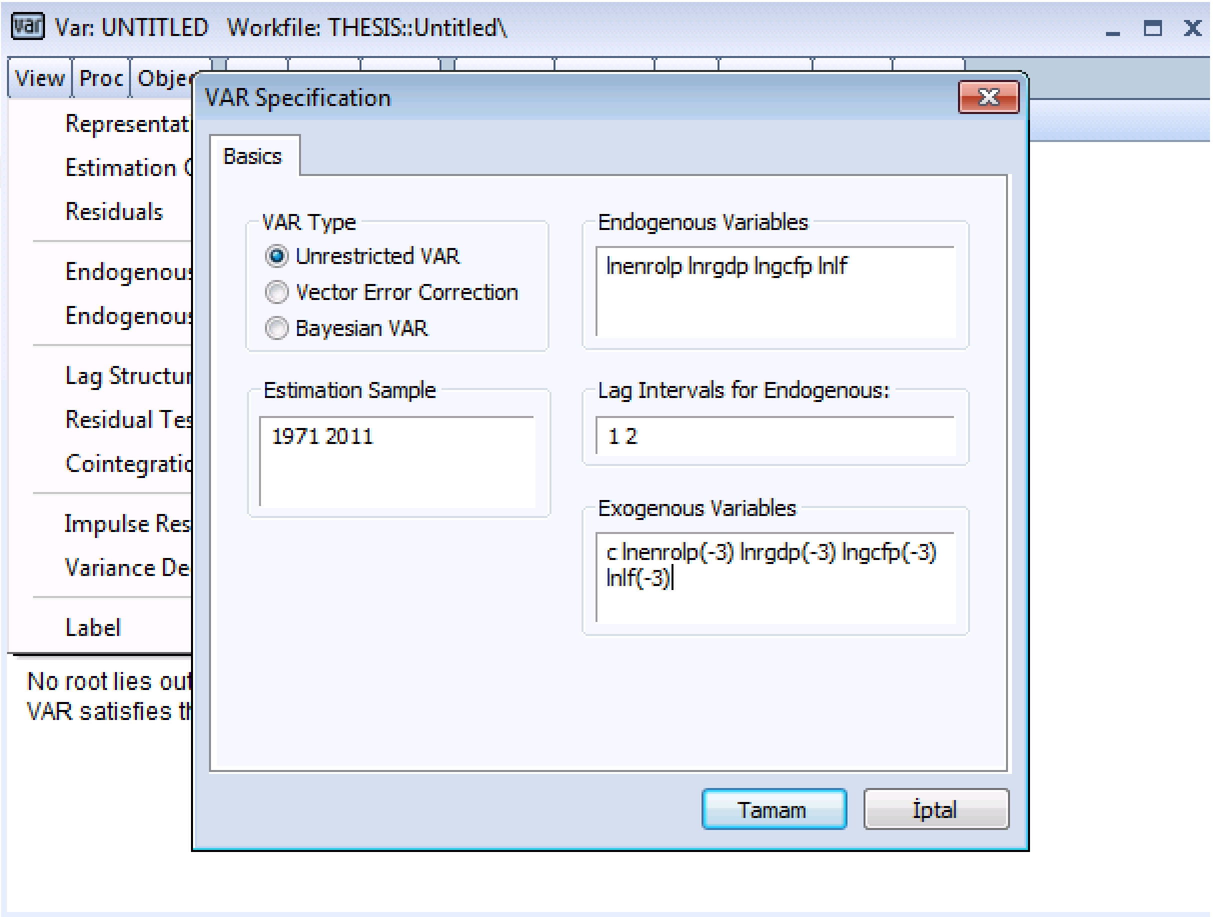
Root	Modulus
0.999551	0.999551
0.815894	0.815894
0.663453	0.663453
0.509119	0.509119
-0.476276	0.476276
0.239618 - 0.250648i	0.346758
0.239618 + 0.250648i	0.346758
-0.135104	0.135104

Notes:
No root lies outside the unit circle.
VAR satisfies the stability condition.
Roots of Characteristic Polynomial
Endogenous variables: LNENROLP LNRGDP LNGCFP LNLF
Exogenous variables: C
Lag specification: 1 2

And the model with 2 lags meets the stability conditions.

To run the Granger Causality test Toda & Yamamoto require to add an extra lag for the variables:

Var Specifications:



Thus the following results appear:

Estimation Output:

Dependent variable: LNENROLP			
Excluded	Chi-sq	df	Prob.
LNRGDP	4.105911	2	0.1284
LNGCFP	6.115823	2	0.0470
LNLF	4.127573	2	0.1270
All	10.00624	6	0.1244

Dependent variable: LNRGDP			
Excluded	Chi-sq	df	Prob.
LNENROLP	0.087094	2	0.9574
LNGCFP	0.132736	2	0.9358
LNLF	0.688542	2	0.7087
All	0.954572	6	0.9873

Dependent variable: LNGCFP			
Excluded	Chi-sq	df	Prob.
LNENROLP	0.767049	2	0.6815
LNRGDP	0.163469	2	0.9215
LNLF	0.035835	2	0.9822
All	0.929923	6	0.9881

Dependent variable: LNLF			
Excluded	Chi-sq	df	Prob.
LNENROLP	4.117352	2	0.1276
LNRGDP	1.840948	2	0.3983
LNGCFP	1.655550	2	0.4370
All	13.88785	6	0.0309

Notes:

VAR Granger Causality/Block Exogeneity Wald Tests
Sample: 1971 2011
Included observations: 38

Secondary Enrollment. (Source Eviews9)

Lag length criteria:

Lag	LogL	LR	FPE	AIC	SC
0	110.3980	NA	4.35e-08	-5.599893	-5.427515
1	275.1179	286.0925*	1.74e-11*	-13.42726*	-12.56537*
2	282.9409	11.94036	2.76e-11	-12.99689	-11.44549
3	290.0115	9.303422	4.78e-11	-12.52692	-10.28601

Notes:
* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

VAR Lag Order Selection Criteria
Endogenous variables: LNENROLS LNRGDP LNGCFP LNLF
Exogenous variables: C
Sample: 1971 2011
Included observations: 38

One lag is found optimal given AIC and the roots table is as follows:

Stability Conditions:

Root	Modulus
0.992819	0.992819
0.787890 - 0.156758i	0.803333
0.787890 + 0.156758i	0.803333
0.381467	0.381467

Notes:
No root lies outside the unit circle.
VAR satisfies the stability condition.
Roots of Characteristic Polynomial
Endogenous variables: LNENROLS LNRGDP LNGCFP LNLF
Exogenous variables: C
Lag specification: 1 1

No roots lie outside the unit circle and the model can be run with one lag

As for the case of primary enrollment an extra lag is added to the variables and the granger causality test is run:

Estimation Output:

Dependent variable: LNENROLS			
Excluded	Chi-sq	df	Prob.
LNRGDP	4.356357	1	0.0369
LNGCFP	3.904604	1	0.0482
LNLF	0.845208	1	0.3579
All	5.359439	3	0.1473

Dependent variable: LNRGDP			
Excluded	Chi-sq	df	Prob.
LNENROLS	0.000223	1	0.9881
LNGCFP	0.038779	1	0.8439
LNLF	0.121546	1	0.7274
All	0.239759	3	0.9709

Dependent variable: LNGCFP			
Excluded	Chi-sq	df	Prob.
LNENROLS	0.185974	1	0.6663
LNRGDP	0.011311	1	0.9153
LNLF	0.010340	1	0.9190
All	0.287223	3	0.9624

Dependent variable: LNLF			
Excluded	Chi-sq	df	Prob.
LNENROLS	1.861085	1	0.1725
LNRGDP	4.144359	1	0.0418
LNGCFP	0.005469	1	0.9410
All	9.735426	3	0.0210

Notes:

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 06/24/16 Time: 19:49
Included observations: 39

2. Tertiary Enrollment. (Source Eviews9)

Lag Length Criteria:

Lag	LogL	LR	FPE	AIC	SC	HQ
0	75.48697	NA	2.73e-07	-3.762472	-3.590095	-3.701142
1	235.3961	277.7370*	1.41e-10*	-11.33664*	-10.47475*	-11.02999*
2	251.1408	24.03130	1.47e-10	-11.32320	-9.771802	-10.77122
3	259.9603	11.60463	2.33e-10	-10.94528	-8.704372	-10.14798

Notes:
* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
VAR Lag Order Selection Criteria
Endogenous variables: LNENROLT LNRGDP LNGCFP LNLF
Exogenous variables: C
Included observations: 38

The model is estimated with one lag given the AIC lag length criteria above and the stability conditions are not met as follows:

Stability Conditions:

Root	Modulus
1.003727	1.003727
0.817412 - 0.074757i	0.820824
0.817412 + 0.074757i	0.820824
0.498020	0.498020

Notes:
Warning: At least one root outside the unit circle.
VAR does not satisfy the stability condition.
Roots of Characteristic Polynomial
Endogenous variables: LNENROLT LNRGDP LNGCFP LNLF
Exogenous variables: C
Lag specification: 1 1

Thus the model is run again this time with 2 lags and the stability conditions are as follows:

Stability Conditions Two:

Root	Modulus
0.987995	0.987995
0.889494	0.889494
0.721974 - 0.368251i	0.810466
0.721974 + 0.368251i	0.810466
0.509799	0.509799
-0.335221	0.335221
-0.066455 - 0.232820i	0.242119
-0.066455 + 0.232820i	0.242119

Notes:
No root lies outside the unit circle.
VAR satisfies the stability condition.
Roots of Characteristic Polynomial
Endogenous variables: LNENROLT LNRGDP LNGCFP LNLF
Exogenous variables: C
Lag specification: 1 2

As no roots lie outside the unit circle the Granger Causality test can be computed (again adding an extra lag for all variables in the exogeneous variables box):

Estimation Output:

Dependent variable: LNENROLT

Excluded	Chi-sq	df	Prob.
LNRGDP	1.272265	2	0.5293
LNGCFP	0.135847	2	0.9343
LNLF	0.627828	2	0.7306
All	3.139765	6	0.7911

Dependent variable: LNRGDP

Excluded	Chi-sq	df	Prob.
LNENROLT	4.278304	2	0.1178
LNGCFP	0.084939	2	0.9584
LNLF	0.377188	2	0.8281
All	5.914272	6	0.4329

Dependent variable: LNGCFP			
Excluded	Chi-sq	df	Prob.
LNENROLT	1.823500	2	0.4018
LNRGDP	0.876468	2	0.6452
LNLF	0.227400	2	0.8925
All	2.689281	6	0.8467

Dependent variable: LNLF			
Excluded	Chi-sq	df	Prob.
LNENROLT	0.245981	2	0.8843
LNRGDP	1.875180	2	0.3916
LNGCFP	1.167455	2	0.5578
All	8.565597	6	0.1995

Notes:

VAR Granger Causality/Block Exogeneity Wald Tests
Sample: 1971 2011
Included observations: 38

APPENDIX C: Öz Geçmiş / CV

Kişisel Bilgiler

Soyisim, isim : Çelik, Kübra Yeşim

Uyruğu : T.C.

Doğum Tarihi ve Yeri : 16.05.1989 Danimarka

Medeni Hali : Evli

Telefon Numarası : 0 535 026 78 18

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EĞİTİM

Derece	**Kurum**	**Mezuniyet Yılı**
Lisans	Copenhagen Business School (Danimarka)	2011
Lise	Kongholm Gymnasium & HF (Danimarka)	2008

İş Deneyimi

Yıl	**Yer**	**Pozisyon**
2007-2008	Foetex Aps (Danimarka)	Kasiyer
2010-2011	Hoeje Taastrup Erhvervsraad (Danimarka)	İşveren Temsilcisi

Yabancı Dil

Danca : Anadil Seviyesinde.

İngilizce : Birinci Dil; çok iyi seviyede.

Almanca : İkinci Dil; orta seviyede.

Hobiler

Seyahat etmek, arkeoloji, tarih, film, tennis, futbol, moda.