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DOES EDUCATION INVESTMENT YIELD LONG-RUN RETURNS? EVIDENCE FROM TÜRKİYE

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Abstract

Reaping the benefits of educational investments takes time. In this paper, we investigate the long-run returns of public education investment for the Turkish economy by conducting a time-series analysis for the 1970-2021 period. The Autoregressive Distributed Lag (ARDL) approach is employed for empirical analysis due to its suitability for analyses with limited observations. This approach also enables us to separate the long- and short-run results, which is important for analyses including a long-time span. Analysis results report the existence of a long-run relationship. In the short-term, there are potential negative effects, signaling certain initial disruptions. However, in the long-term, the effect turns positive. Furthermore, in the case of any divergence from the long-run equilibrium, there is an adjustment process in the next period to restore equilibrium. Our findings highlight the importance of long-term commitment to education investment despite possible short-run trade-offs. Therefore, short-run disruptions can be seen as transitional costs in achieving long-term benefits.

Keywords: Education Investment, Time Series Analysis, Türkiye, ARDL Approach

EĞİTİM YATIRIMLARI UZUN VADELİ GETİRİ SAĞLAR MI? TÜRKİYE'DEN KANITLAR

Özet

Eğitim yatırımlarının meyvelerini toplamak zaman almaktadır. Bu çalışmada, 1970-2021 dönemi için zaman serisi analizi uygulanarak kamu eğitim yatırımlarının Türkiye ekonomisine uzun vadeli getirisinin varlığı analiz edilmektedir. Ampirik yöntem olarak, sınırlı gözlem sayıları içeren analizlere uygunluğu nedeniyle Gecikmesi Dağıtılmış Otoregresif Model (ARDL) yaklaşımı tercih edilmiştir. Ayrıca, bu yöntem uzun zaman dilimini kapsayan analizlerde önemli olan kısa ve uzun dönem etkilerin ayrıştırılmasına olanak tanımaktadır. Analiz sonuçları, seriler arasında uzun dönem ilişkisi olduğunu göstermektedir. Kısa vade sonuçları, eğitim harcamalarının ekonomik performansı negatif yönde etkileme potansiyeli olduğunu ortaya koymaktadır. Ancak uzun dönemdeki etkinin pozitif olduğu bulunmuştur. Ayrıca uzun dönem dengesinden bir sapma olduğunda, bir sonraki dönemde bir uyum süreci gerçekleşmektedir. Analiz sonucu, olası kısa dönemli negatif etkiye rağmen uzun dönemde eğitim harcamalarında ısrar etmenin önemli olduğuna işaret etmektedir. Bu nedenle, kısa vadeli aksaklıklar uzun vadeli kazanımlara ulaşma sürecinde karşılaşılan geçici maliyetler olarak değerlendirilebilir.

Anahtar Kelimeler: Eğitim Yatırımları, Zaman Serisi Analizi, Türkiye, ARDL Yaklaşımı

Introduction

Human capital is an important resource for economies that aim to enhance their productivity levels. Knowledge pools of nations are crucial in increasing the overall efficiency of an economy. Given its importance, nations prioritize education and training activities to invest in their human capital. Developed nations are pioneers in providing accessible and high-quality education that is characterized by low student-teacher ratios (Glewwe and Kremer, 2006). They emphasize the importance of STEM (Science, Technology, Engineering, and Mathematics) curricula in establishing a solid foundation for knowledge creation (Li, 2014). Moreover, OECD countries share a significant amount of their resources to investments in education. From primary to tertiary education, the average education expenditure across OECD countries is 5%

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of their Gross Domestic Product (GDP) in 2015. This investment approximately equals 10400 U.S. dollars per pupil (OECD, 2019). Contrarily, as a developing nation with a significant demand for human capital, Türkiye's public education expenditure is below the OECD average. In 2020, Türkiye's total expenditure on educational institutions as a percentage of GDP was 4.7%, which is lower than the OECD average (OECD, 2023). At the tertiary level, Türkiye's expenditure was 9288 U.S. dollars per student which is significantly below the OECD average of 18105 U.S. dollars per student. Given the relatively low resource allocation for education in Türkiye, the effect of education investment on macroeconomic performance needs further investigation.

In developing countries, where institutional quality and labor market conditions are still developing, the economic returns to education may differ not only from those in advanced economies but also among the developing countries themselves. These differences highlight the need for country-specific analysis in developing nations. Therefore, a study on Türkiye as a developing nation, which has undergone significant economic, demographic, and institutional changes over the past five decades, gives valuable perspective in this context. Analyzing the effects of education investment in Türkiye for the period covering these changes provides broader conclusion compared to studies with shorter time-span.

In this study, we analyze the impact of investment in education on the per capita income level for Türkiye within 1970-2021 period. We employ the autoregressive distributed lag (ARDL) approach of Pesaran et al. (2001) to investigate the effect. Education expenditure reflects the resource allocation of governments and entities for the education sector, which includes spending on training, salaries, and educational materials among others. Hence, it gives a detailed outlook of the investment to improve educational quality and accessibility. Education expenditure level also demonstrates the priority given to education by policymakers. Higher expenditure indicates a strong commitment to develop human capital. While there are multiple determinants of educational outcomes, existing literature (Hanushek and Woessmann, 2011; Sylwester, 2000; Pritchett, 2001; Glewwe and Kremer, 2006) suggests a positive association between education expenditure and improved outcomes such as higher enrollment rates, reduced dropout rates, and better student performance. These factors contribute to the advancement of human capital.

The contribution of this paper is to examine a long period that is characterized by important economic transformations with the most appropriate method, considering the relatively low number of observations. As the realization of the economic outcomes of educational investment takes time, analyzing a longer period is crucial for more robust findings. Furthermore, as the main objective of this study is to investigate the long-term impact of education on income, we employ the ARDL approach to distinguish between long- and short-run dynamics. Moreover, many of the previous studies on Türkiye which addressed the education-growth nexus rely on shorter periods or use panel data methods. This study adds a time-sensitive dimension to the discussion.

The remainder of this paper goes as follows. The next section gives a review of the related literature. In the subsequent part, the data and methodology are introduced. Empirical findings are given in Section 3. Final part concludes with policy recommendations.

1. Literature Review

Educational practices have a vital role in increasing individual knowledge and skills, and investments in such practices are linked to improvements in labor productivity and overall economic output (Plant and Welch, 1984). Education holds a significant position in mainstream macroeconomic theories. In the simple neoclassical model, production function consists of labor and physical capital, and technology enters the model exogenously, affecting the outputproducing capability of labor. Model includes constant returns to scale to all inputs and diminishing returns to each input separately. However, basic model of Solow (1956) indicates certain inadequacies due to the limitations of the certain assumptions such as exogenous technology and perfect competition. According to the augmented neoclassical growth model, educational attainment increases the human capital, which leads to greater per capita income levels, and plays an important role while explaining the income differences among nations (Mankiw et al., 1992). Contrary to neoclassical theories, endogenous models of Romer (1986) and Lucas (1988) explain technology within the model, and its change was associated with human capital stock. Romer (1986) mentions technology level, which is not exogenous but rather determined by the profit-maximizing entrepreneurial activity, as the key driver of economic growth. Technology depends positively on the use of capital (learning by doing) and arises from innovative activities like R&D investment. Lucas (1988) mentions human capital as an outcome of training activities. In his model, individuals choose between training and work for increased productivity, which endogenizes the growth. Endogenous growth theories also focus on the positive externalities generated by investing in human capital, and highlights the importance of human capital for explaining income differences across countries (Pyo, 1995).

Investment in education has been proxied through various indicators in leading academic literature, including education expenditure, years of schooling, and student-teacher ratios. As one of the early contributions, Barro (1991) uses enrollment in school as an indicator of human capital, and identified a significant association between schooling and growth of national income for 98 countries within 1960-1985 period. The study of Krueger and Lindahl (2001) indicate a similar result after addressing the measurement error, showing that a significant positive link exists between changes in the number of years of schooling and the growth of income per capita in selected countries over various periods. Sianesi and Van Reenen (2000) investigate the effect of human capital in a detailed way. They highlight the significance of education on labor productivity. Increasing human capital leads to relatively higher increase in GDP per capita growth in both developing countries and OECD members in various periods. Their findings are consistent with earlier research of Gemmell (1996), which highlights the positive link between the level of education and GDP per capita growth in 1960-1985 period across a sample of developed and relatively less developed nations. Similarly, the association between tertiary education and economic growth is also confirmed by Graff (1996) in the 1990s for a selected group of countries. Furthermore, Wilson and Briscoe (2004) present a detailed review of training and growth for EU members. They conclude that the investment in training has a positive effect on growth.

There is substantial body of empirical literature that highlight the positive relationship between investment in education and economic performance of nations. Baldwin and Borelli (2008), analyzing data from the U.S., find that lower student-teacher ratios caused by increased education expenditure significantly enhance economic performance for 1988-2005 period. Their findings further demonstrate that education attainment levels positively influenced U.S. economy from 1997 to 2005. Similar evidence is reported from the study of Asteriou and Agiomirgianakis (2001) for Greece, which conducted a cointegration analysis and revealed a statistically significant link between human capital and growth for the years between 1960 and 1994. In a panel data analysis, Agiomirgianakis et al. (2002) examined 93 countries for 1960-87 period, and reported consistent findings that highlight the significant role of education in stimulating economic growth. In the case of China, Changzheng and Jin (2010) applied Johansen (1988) cointegration test and Granger causality analysis over the 1978- 2004 period, demonstrating that education equity Granger causes economic performance. Similarly, Ozatac et al. (2018) investigated the impact of public education investment on growth of national income for France over the 1970–2012 period. Findings depict that there is a long-run relationship, and investment in education stimulates economic growth. Focusing on Pakistan, Aziz et al. (2008) examined the impact of education on output from 1972 to 2008. Results reveal the significant impact of higher education enrollment on GDP. Furthermore, higher level of tertiary education expenditure leads to higher education enrollment, which impacts economic output positively. The positive effect of education investment on economic performance is further confirmed by recent empirical studies for various nations (Mallick et al., 2016; Sunde, 2017; Frank, 2018; Malešević Perović et al., 2018)

ARDL approach of Pesaran (2001) is widely used approach to investigate the long- and short-run effects of investment in education and economic performance in the literature. Afzal et al. (2010), for instance, investigate the association between real GDP and schooling for Pakistan from 1970 to 2009. Their findings demonstrate a significant and long-run link between education and growth. Similarly, Ifa and Guetat (2018) apply ARDL methodology to investigate the impact of education expenditure on economic output in Tunisia and Morocco from 1980 to 2015. The bound test results report a long-term relationship in both countries. In Tunisia, the short-run effect of education expenditure on growth is negative, but the impact turns positive in the long-run. Contrarily, education expenditure leads to an increase in economic growth not only in the short-run but also in the long-run in Morocco. Moreover, Coman (Nuţă) et al. (2023) examine the association between economic growth and education investment in selected EU countries using bounds test between 1990 and 2000. Education expenditures have a negative effect on growth in the long run in Bulgaria, Croatia, and Latvia while the association is positive in Estonia, Czech Republic, and Hungary.

Several empirical studies have investigated the impact of educational investment for the Turkish case, and find a significant link between education and output (Erdem and Tugcu, 2010; Güngör, 1997; Gumus and Kayhan, 2012; Mercan, 2013). Erdem and Tugcu (2010) and Mercan (2013) employ ARDL bounds test and Granger causality to investigate the relationship. Their findings reveal that both higher education (Erdem and Tugcu, 2010) and education expenditure (Mercan, 2013) are significantly and positively related with Türkiye's economic performance. Güngör (1997), conducting a panel data analysis, investigates the effect of education for Turkish provinces. Results report that the effect is statistically significant, and an additional increase of educational attainment yields more than 70% increase in output for the periods between 1980 to 1990. Similar results are also confirmed by the study of Gumus and Kayhan (2012), using school enrollment to measure education. They test the causal relationship employing Toda-Yamamoto (1995) test. While a causal relationship is observed for primary education (bidirectional causality between GDP per capita and education) and secondary education (unidirectional causality that runs from GDP per capita to education), no causal relationship is found for tertiary education over the 1980-2008 period. Furthermore, recent empirical studies demonstrate the positive influence of education expenditure on GDP growth (İğdeli, 2019; Keçili and Esen, 2020; Demirgil and Sonkur, 2022).

2. Data and Methodology

The long-term impact of educational investment on income is examined for the 1970-2021 period using annual data. Public education expenditure, measured in U.S. dollars, is used as a proxy for educational investment, and it is converted into real terms using the U.S. CPI (2015=100). The use of the U.S. CPI may fail to reflect domestic price dynamics. Thus, inflationary pressures are further controlled in the model. Education expenditure covers the current operating expenditures in education. It includes salaries and wages and excludes capital investments in equipment and buildings.

Real GDP per capita (2015=100) is used as a proxy for income. Inflation (the growth rate of the GDP deflator) and the percentage share of exports in GDP are used as control variables.

Other possible control variables which are available for the same time span, such as the percentage share of final consumption expenditures, gross fixed capital formation, foreign direct investment (net inflows) in GDP were also tested but no statistically significant effect was found. Therefore, the limited number of observations, we decide to conduct the analysis by keeping the statistically significant ones in the model.

The data source for all the variables is the World Bank. As the only available data for education expenditure covers the period from 1970 to 2021, this time series dataset is employed in the analysis.

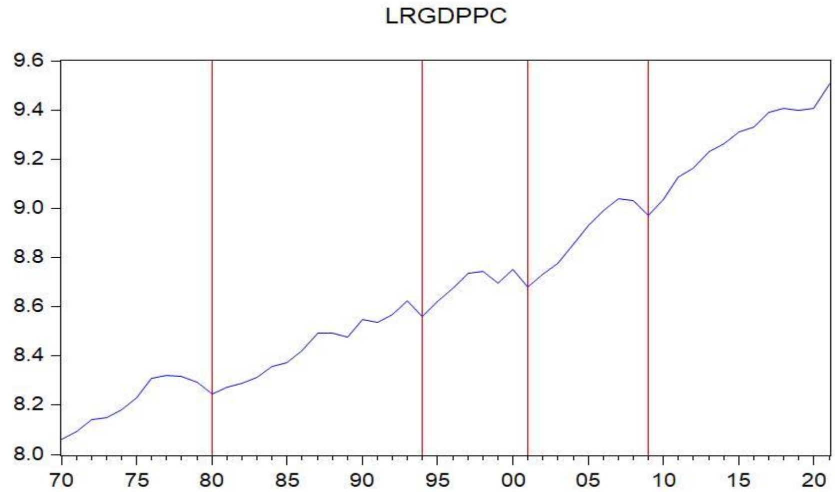
Except for the share of exports in GDP, logarithmic values of the variables are used in the analysis; LRGDPPC, LREDU, LINF, SHEXP standing for real GDP per capita, real education expenditure, inflation, and share of exports in GDP respectively. When natural logarithms are taken, the estimated coefficient can be considered as the elasticity of the relevant variable. Also, the regression analysis using natural logarithms of the variables allows for the investigation of the growth rates, which are significant for economic relationships. Although inflation is already expressed as a rate, we use its logarithmic transformation to reduce the influence of extreme values and to interpret the coefficients in elasticity form consistently with the other variables. Nevertheless, as a robustness, we also estimated the model using the non-logged inflation variable and the results remained qualitatively unchanged in terms of both the sign and statistical significance of the coefficients. Variables' summary statistics are reported in Table 1. Accordingly, all variables are approximately normally distributed.

Table 1: Summary Statistics

	LRGDPPC	LREDU	LINF	SHEXP
Mean	8.7016	22.7229	3.2331	17.6219
Median	8.6510	22.6445	3.3041	19.8864
Maximum	9.5067	24.2232	4.9673	35.7437
Minimum	8.0634	21.2061	1.6950	3.2180
Standard Deviation	0.4126	1.0105	0.9246	8.4936
Skewness	0.3594	0.0780	-0.0594	-0.1834
Kurtosis	1.9660	1.6462	1.7105	2.1545
Jarque-Bera (Prob.)	0.1794	0.1337	0.1626	0.3984
Observations	52	52	52	52

When real GDP per capita is analyzed for the time span of this study, there are several structural breakpoints in the data. Türkiye has gone through several crisis periods in this long investigation period. These crises need to be controlled for the robustness of econometric analysis. Figure 1 shows the logarithm of real GDP per capita. When Figure 1 is analyzed, the years 1980 (Military Coup and the Introduction of Structural Adjustment Policies), 1994 (Currency Crisis), 2001 (Twin Crisis: Banking and Currency Crisis), and 2009 (Global Financial Crisis spillover) need to be controlled by using dummy variables; D1980, D1994, D2001, D2009 standing for dummy variables for the years 1980, 1994, 2001 and 2009 respectively. The vertical lines in the figure mark the identified break years used in the analysis. These years show the various crisis periods that the country went through, but investigating them in depth is beyond the aim of the paper. Although multiple-break tests such as Bai–Perron (2003) and Maki (2012) provide a formal way to detect structural break, the relatively small sample size (T = 52) and the well-documented crisis periods make the use of crisis-specific dummy variables more practical.

Figure 1: Logarithm of real GDP per capita



First, stationarity of the variables is tested with two different unit root tests: the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. These tests are employed together because they emphasize different statistical properties. After the integration order of the variables is defined, the ARDL model by Pesaran et al. (2001) is employed to investigate the long-run and short-run effects of education expenditure on income. There are several reasons behind the selection of ARDL as an empirical technique of this study. Firstly, it helps to alleviate potential endogeneity concerns arising from possible reverse causality by allowing separate optimal lag selection for each variable. Secondly, it is more applicable in the case of having low observations. Lastly, it provides long-run and short-run estimates separately. The ARDL approach proceeds in the following steps: first, a cointegration test is conducted using the bound testing procedure. Second, if a cointegration relation is found, long-run coefficients can be interpreted by using the estimated long-run model. Lastly, short-run dynamics are analyzed by the error correction representation of the ARDL model.

The reason for preferring the conventional ARDL model over the NARDL (Nonlinear Autoregressive Distributed Lag) in this study is that long-term asymmetric effects are not expected, because while real education expenditures decline in certain years, these decreases are not substantial enough to generate a clearly distinguishable cumulative negative component compared to the positive one for the long-run. Our primary interest is to investigate the long-term effect of education expenditure on income. Moreover, Figure 2 below shows that although there are minor divergences in the short term, education expenditure and income move in a consistent relationship in the long term. Furthermore, in order to confirm this empirically, a NARDL model was estimated and Wald tests were conducted. The results show that while short-run asymmetries are statistically significant (F-statistics = 3.0503, p-value = 0.0373; Chi-square = 12.2013, p-value = 0.0159), long-run asymmetry is not (F-statistic = 4.39×10^{-5}, p-value =0.9948; Chi-square = 4.39×10^{-5}, p-value = 0.9947). Therefore, conventional ARDL framework is appropriate for our long-run analysis. For illustrative purposes, the cumulative dynamic multiplier graph based on the NARDL specification is presented in the Appendix.

Figure 2: LREDU and LRGDPPC

Considering the low number of observations, and following Liew (2004) optimal model is determined using the AIC (Akaike Information Criterion). Taking into account the characteristics of the dataset, the maximum lag is determined to be 4.

3. Results

Firstly, ADF and PP unit root tests are employed to examine the stationarity of the variables and to determine their integration order. The results are given in Table 2 below. Results show that the variables are first-difference stationary.

Table 2: Unit Root Tests Results

Variables	ADF			PP		
	Constant	Trend and Constant	No Constant No Trend	Constant	Trend and Constant	No Constant No Trend
LRGDPPC	0.9912	0.7368	1.0000	0.9953	0.7104	1.0000
D(LRGDPPC)	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
LREDU	0.7425	0.5261	0.9602	0.7416	0.4368	0.9602
D(LREDU)	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
LINF	0.3501	0.3923	0.6397	0.3534	0.4132	0.6572
D(LINF)	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
SHEXP	0.8626	0.1275	0.9454	0.9201	0.1361	0.9835
D(SHEXP)	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***

Notes: (1) Values represent probabilities of indicated unit root tests. (2) D() is used to indicate the first difference. (3) *** indicates the significance of stationarity at 1%.

As an initial procedure, the ARDL bounds test is employed whether a cointegration relationship exists, as demonstrated in Equation (1) below, where u_t denotes the error term and Δ demonstrates the first difference of the variables.

The ARDL bounds test equation, specified as ARDL (1,2,0,3), is presented as follows:

$$\Delta LRGDPPC_t = \sum_{i=1}^{1}\beta_{1i}\Delta LRGDPPC_{t-i} + \sum_{i=0}^{2}\beta_{2i}\Delta LREDU_{t-i} + \sum_{i=0}^{0}\beta_{3i}\Delta LINF_{t-i} + \sum_{i=0}^{3}\beta_{4i}\Delta SHEXP_{t-i} + \gamma_1 D1980 + \gamma_2 D1994 + \gamma_3 D2001 + \gamma_4 D2009 + \delta_1 LRGDPPC_{t-1} + \delta_2 LREDU_{t-1} + \delta_3 LINF_{t-1} + \delta_4 SHEXP_{t-1} + constant + u_t \quad (1)$$

The test involves comparing F-statistics. The null hypothesis (H_0) indicates no long-run association between the level variables ($H_0 = \delta_1 = \delta_2 = \delta_3 = \delta_4 = 0$). Table 3 below presents the asymptotic critical values of the F-test. To capture the validity of a long-term relationship, F-statistics must be evaluated against the critical values (thresholds) of lower and upper bound. If the F value exceeds the upper-bound value, the null hypothesis of no cointegration is rejected, and there is a long-run relationship between variables. If it falls between the critical values, it is regarded to be inconclusive. Lastly, if F value is below the lower-bound critical value, we fail to reject the null hypothesis. Referring to Table 3, the F-statistic is bigger than the upper critical value at the 5% significance level, confirming the validity of a long-run relationship.

Table 3: ARDL Bounds Test Results

		Thresholds	
F-statistics	k	Lower-Bound	Upper-Bound
5.0159	3	3.23	4.35

The long-run model that is constructed to examine the effect of education on income is given in Equation (2) (ARDL level equation) below.

$$LRGDPPC_t = \sum_{i=1}^{1} \beta_{1i} LRGDPPC_{t-i} + \sum_{i=0}^{2} \beta_{2i} LREDU_{t-i} + \sum_{i=0}^{0} \beta_{3i} LINF_{t-i} + \sum_{i=0}^{3} \beta_{4i} SHEXP_{t-i} + \gamma_1 D1980 + \gamma_2 D1994 + \gamma_3 D2001 + \gamma_4 D2009 + constant + u_t \qquad (2)$$

Diagnostic tests are employed to determine whether the model suffers from heteroskedasticity (the H_0 of Breusch-Pagan-Godfrey test is no heteroskedasticity) , serial correlation (the H_0 of the Breusch-Godfrey LM Test states that there is no serial correlation), non-normal distribution of residuals (the H_0 of the Jarque-Bera test is that the residuals are normally distributed), model misspecification (the H_0 of Ramsey RESET test is no functional form misspecification), and parameter instability (the CUSUM and CUSUM of squares tests demonstrate that the model's parameters remain stable over time, as long as the plots remain within the critical bounds at the 5% significance level). Level equation results and diagnostic tests are presented in Table 4. All diagnostic tests are successfully passed, indicating the robustness of the model. Furthermore, the coefficient of the lagged dependent variable is less than unity which indicates the dynamic stability of the model. Dummy variables have a negative effect on income as expected, and all of them is statistically significant except for D1980.

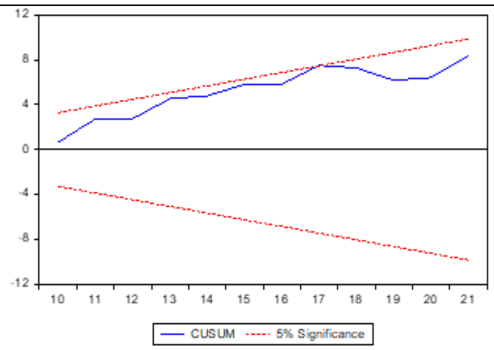
Table 4: Level Equation Results

Dependent Variable: LRGDPPC		
Variables	**Coefficients**	**Standard Errors**
LRGDPPC(-1)	0.8387***	0.0492
LREDU	0.0329*	0.0197
LREDU(-1)	-0.0488**	0.0242
LREDU(-2)	0.0380**	0.0186
LINF	-0.0164***	0.0064
SHEXP	0.0049**	0.0022
SHEXP(-1)	-0.0045*	0.0023
SHEXP(-2)	0.0027	0.0023
SHEXP(-3)	0.0024	0.0018
D1980	-0.0380	0.0350
D1994	-0.0894***	0.0323
D2001	-0.1327***	0.0304
D2009	-0.1136***	0.0283
constant	0.8934***	0.2511
$R^2 = 0.9967$ $\bar{R}^2 = 0.9955$		

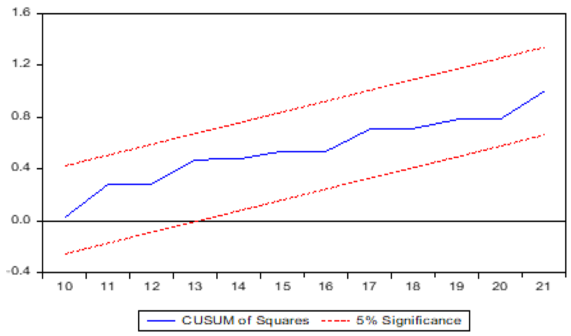
Diagnostic Tests

Breusch-Pagan-Godfrey Prob: 0.8878; **Breusch-Godfrey LM Test Prob:** 0.9212; **Jarque-Bera Prob:** 0.4803; **Ramsey RESET Prob:** 0.2409

CUSUM Test



CUSUM of Squares Test



Note: (1) D() stands for the first difference. (2) *** indicates significance at 1%, ** at 5%, * at 10%.

Using the long-run model estimation results, the long-run coefficients are determined by summing the coefficients of the independent variable and dividing that by one minus the sum of the coefficients of the dependent variable (Gujarati, 1999, p. 58). The results are presented in Table 5. According to the findings, all coefficients of the variables listed in Table 5 are statistically significant. While education and exports have a positive effect, the effect of inflation on income is negative in the long-run.

Table 5: Long-run Coefficients

Dependent variable: LRGDPPC		
Variable	**Coefficient**	**Standard Error**
LREDU	0.1370**	0.0566
LINF	-0.1019**	0.0473
SHEXP	0.0346***	0.0063

Note: *** indicates significance at 1%, ** at 5%.

Equation (3) below presents the short-run error correction model derived from the ARDL specification.

$$\Delta LRGDPPC_t = \sum_{i=1}^{1} \beta_{1i} \Delta RGDPPC_{t-i} + \sum_{i=0}^{2} \beta_{2i} \Delta LREDU_{t-i} + \sum_{i=0}^{0} \beta_{3i} \Delta LINF_{t-i} + \sum_{i=0}^{3} \beta_{4i} \Delta SHEXP_{t-i} + \gamma_1 D1980 + \gamma_2 D1994 + \gamma_3 D2001 + \gamma_4 D2009 + \sigma ECT_{t-1} + constant + u_t \quad (3)$$

Table 6 presents the short-run estimation results. There is no inflation variable included in the short-term results because the optimal lag length for inflation is zero, and this variable drops out after differencing. Moreover, the short-run impact of exports appears to be ambiguous: while the contemporaneous (non-lagged) effect is positive, the one-period lagged effect is negative. As in the long-run model, except for the 1980 dummy variable, other crisis dummies have a statistically significant and negative impact on income. The key variable of interest - education expenditure- has a negative and statistically significant impact on income with a one-period lag. Although the contemporaneous effect is positive, it does not appear to be statistically significant according to the 5 percent significance level. Hence, the short-term effect of education expenditures on income appears to be negative. Furthermore, the error correction term (ECT) is negative and statistically significant, indicating that there is short-run adjustment to long-run equilibrium. In other words, following any deviation from the long-run equilibrium, the adjustment process begins, and approximately 16% of the deviation is adjusted in the following period. It takes approximately 6-7 years for a full adjustment.

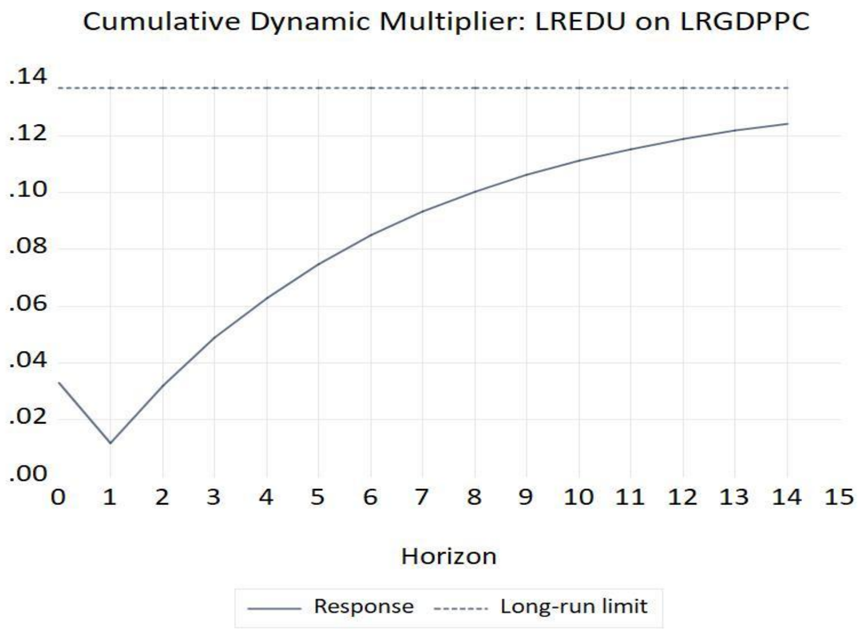
Table 6: Short-run Results

Dependent Variable: D(LRGDPPC)		
Variables	**Coefficients**	**Standard Errors**
D(LREDU)	0.0329*	0.0186
D(LREDU)(-1)	-0.0380**	0.0173
D(SHEXP)	0.0049**	0.0021
D(SHEXP)(-1)	-0.0051***	0.0018
D(SHEXP)(-2)	-0.0024	0.0016
D1980	-0.0380	0.0312
D1994	-0.0894***	0.0297
D2001	-0.1327***	0.0286
D2009	-0.1136***	0.0268
constant	0.8934***	0.1833
ECT(-1)	-0.1613***	0.0345
$R^2 = 0.6995 \quad \overline{R}^2 = 0.6204$		

Note: (1) D() stands for the first difference of the variable. (2) *** indicates significance at 1%, ** at 5%, * at 10%.

For the robustness of the finding that the negative effect of education investment on income may only be a temporary process, the cumulative dynamic multiplier derived from the ARDL model is given below in Figure 3. This figure shows the dynamic effect of a permanent one-unit change in LREDU on LRGDPPC. The figure is consistent with the ARDL short- and long-run results as the cumulative dynamic multiplier decreases in the first period, meaning that the marginal effect is negative in the first period (short-run), but then it increases consistently. Therefore, Figure 3 proves the positive impact of education investment on income in the long-run, although a temporary negative effect is possible in the short-run. These results are also consistent with the findings of short-run asymmetry, but the main aim of this paper is to investigate the effects of education investment on income in the long-run.

Figure 3: Cumulative Dynamic Multiplier



Conclusion

In this study, we examine the long-run returns of public education investment on economic performance of Türkiye. Empirically, we employ the ARDL approach for the 1970-2021 period. Results report the existence of cointegration. Furthermore, although the short-run relationship appears to be negative, the association is positive in the long-run. This signals an initial period of potential trade-offs. These findings are aligned with prior research on various developing countries and Türkiye, which reveals the positive effect of education on economic output across varying periods.

Our findings indicate that education investment policies must be designed with an intertemporal perspective. Although governments may face short-term constraints, educational investment is crucial for long-run economic advancement. A stable allocation of budget to investment in education can improve the long-run productivity of the labor force. Hence, investments in education need to be recognized as a foundational component to achieve long-run economic gains.

Future research may focus on regional differences in educational investment for a more detailed understanding of its effect on the Turkish economy, and to give region-specific policy recommendations based on different conditions and characteristics. Moreover, investigating the spillover effects of educational investments on other sectors of the economy may yield further insights. However, education investment data for Türkiye is quite limited, which is also a limitation of this study.

Among all types of investments, few offer the lasting benefits without depreciation as does investment in human capital. Educational investments are crucial for improving the country's overall productivity and income as supported by various studies. Developed countries put great importance on education as a vital part of their planning strategies. As a developing nation, Türkiye strongly needs educated and qualified individuals. In achieving needed human capital formation, educational investments play a significant role. The short-run trade-offs can be viewed as transitional costs on the way of sustained growth by policymakers. Complementary policies might be implemented to mitigate short-run disruptions. Therefore, education policies should be assessed with respect to their long-term benefits. Thus, optimizing resource allocation towards education may serve as an essential strategic tool to achieve positive long-run outcomes for Türkiye.

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Appendix

Figure 4 below indicates the convergence of the positive and negative responses in the long-run. This evidence supports the statistical finding of long-run symmetry. Moreover, the positive long-run limit (blue dashed line) and the negative long-run limit (yellow dashed line) overlap and the asymmetry (red line) flattens in the long-run, and the 95% confidence interval (gray area) includes zero. This evidence indicates that there is no statistically significant difference in the long-run.

Figure 4: Cumulative Dynamic Multiplier based on NARDL specification