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Education and Economic Growth in Algeria: An Empirical Investigation by Using ARDL Approach

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ABSTRACT: The purpose of this paper is to examine the short and long run relationship between education variables and economic growth in per capita Real GDP in the case of Algeria's economy. Following a brief outline of the theoretical discussions on the nexus between economic growth and human capital formation through education, first we present some observations for the Algeria Country. The bounds testing approach to cointegration and error correction models, developed within an autoregressive distributed lag (ARDL) framework is applied to annual data for the period 1971 to 2011 in order to investigate whether a long-run equilibrium relationship exists between the major education categories and economic growth.

The result of the bounds test indicates that there is a stable long-run relationship between primary school, university and economic growth. The estimated results show that primary school and university are positively related to the Economic Growth in the Long and short run. The paper concludes that the efforts to improve the quality of education in Algeria have significant contribution to the economic growth.

KEYWORDS: Education, Growth, ARDL, Algeria.

1 INTRODUCTION

The relationship between economic growth and education has been one of the central threads of economic analysis. Both Adam Smith in the 18th century and Alfred Marshall in the 19th century, two important figures for the economics profession, addressed the question of how individual investments in "education" influence the wealth of nations. Throughout the 20th century, as Krueger and Lindahl (2001) point out in their survey of these issues, modern professional economists have been attempting to develop empirical estimates of the relationship between education and economic growth. Some of the most famous names in late 20th century economics made their reputations studying the question of individual returns to investment in education. Jacob Mincer (1974), Gary Becker (1964) and a long list of researchers inspired by their work have produced hundreds of books and papers.

Much of this literature is highly technical in the sense that it uses formal econometric models to test hypotheses using empirical data. Some highlights of this impressive work will be sketched below, but the bottom line is that the economic evidence supports the view that both public and private returns to investment in education are positive—at both the individual and economy-wide levels.

Main purpose of the paper is to investigate the effectiveness of the various indicators of education to explain economic growth. We employed different education indicators where available in order to evaluate the Algeria country. For the ARDL analysis, on the other hand, we disaggregated the data by the education levels, such as primary, secondary, high, high-technical schools and university. The reason behind the use of disaggregated data is to grasp which type of investment in education can be effective in economic growth.

The effectiveness will reduce if the education system serves inappropriately for the skill development and other labor quality issues in a particular country through improper investments in education. Our analyses show that improvement in the quality of education in primary and secondary levels have similar contribution to the Algerian economic growth.

2 EDUCATION IN ENDOGENOUS GROWTH LITERATURE

The endogenous growth literature captures the insight that the crucial force behind growth rates is the elimination of the tendency of diminishing returns to investment in a broad class of capital goods, including human capital. Antecedents of this literature utilize theories of technological progress, innovation and imitation (Romer, 1987; Grossman and Helpman, 1991), learning by doing (Stokey, 1991), and population change, fertility and human capital investment (Becker and Barro, 1988) in order to introduce increasing or constant returns to scale to the cumulative factor of production. Recent advances in the new growth theory identify, among many others, the degree of educational attainment as a crucial determinant of the long-run rate of Economic growth (*cf*. Gallipoli *et al*., 2006; Canton, 2007).

Following the lines of Uzawa (1965) and Lucas (1988), many theories have been developed to explain the process of human capital accumulation via investment in education, both public and private. In Uzawa (1965), an individual's productivity depends on how much time she devotes to education. In Lucas (1988), human capital is the engine of growth and is produced by a technology where the only input is human capital itself. Rebelo (1991) extended this model to add physical capital in the production of human capital. Becker *et al*. (1990) presented a model where human capital is accumulated through parent's home teaching.

Romer (1989) and Barro (1991) documented the importance of human capital in the context of conditional convergence and persistent economic growth. Borjas (1992) presented empirical evidence for human capital externalities by showing that the average level of human capital of the previous generations positively affected the current generation's productivity level.

Such developments in endogenous growth theory have opened a new avenue of research to study the influence of government spending on both consumption-saving decisions and, through the education system, on human capital accumulation itself.

King and Rebelo (1990), Lucas (1990), Rebelo (1991) and Jones *et al*. (1993) are among the studies of endogenous growth that analyze the consequences of distortionary taxation. While the studies mentioned above employ an infinite-horizon framework, Blanchard (1985) carried the argument of debt management into finite horizons and decisively influenced the stream of general-equilibrium modelling.

Ni and Wang (1994) and Glomm and Ravikumar (1997), both under the assumption of finite lifetimes, let public spending on education directly enter the production function of human capital. Ni and Wang (1994) adopted the theoretical framework of Becker and Barro (1988) and Becker *et al*. (1990), and examined the role of public expenditures on human capital formation.

Glomm and Ravikumar (1997), in turn, focused on the growth effects of productive government spending and growth maximizing level of taxation in a dynamic general equilibrium model.

Azariadis and Drazen (1990) worked in a standard overlapping-generations (OLG) framework, where they modelled identical individuals that make decisions about their schooling. Davies and Whalley (1991) explored how explicit incorporation of human capital affects dynamic general equilibrium analysis of the effects of taxes on capital formation and welfare in a life-cycle growth model.

Jones and Manuelli (1992) highlighted the role of government as an income redistributor in an OLG framework that allows for persistent growth. Likewise, Buiter and Kletzer (1991; 1995) used OLG models to present the theoretical analysis of fiscal policies.

Heckman et al. (1998; 1999) utilized a dynamic general equilibrium model with heterogeneous agents, where they introduced skill formation and considered both the choice of educational level and the investment in on-the-job training. Their framework extends the analysis of Davies and Whalley (1991), who introduced human capital into the Auerbach-Kotlikoff (1987) model, but assumed only one skill.

Bräuninger and Vidal (2000) examined interactions between education policy and growth by an OLG model with two types of individuals – skilled and unskilled. Yeldan and Voyvoda (2000) utilized an OLG model of endogenous growth and investigated the fiscal alternatives of financing public education in a debt constrained economy framework.

Creedy and Gemmell (2005) utilized an endogenous growth model to examine the growth effects of human capital investment achieved through publicly provided, compulsory education. Lee (2005) developed an OLG model of career decisions, where an individual chooses between working in a white-collar occupation, working in a blue-collar occupation, attending school or remaining at home.

Gallipoli *et al*. (2006) examined the effects of alternative policies on the distribution of education in a general equilibrium. They built a life-cycle model with endogenous labor supply and education choices, allowing for agents' heterogeneity in several dimensions, and for incomplete insurance markets.

Sequeira and Martins (2008) used an endogenous growth model with human capital and unemployment, based on Mauro and Carmeci (2003), in order to study the effects of subsidies to education on economic growth.

Table 1. Economics of education landmark theoretical contributions

Date	Concept	Exponent
1960s	Human capital theory	Schultz, Becker, Mincer
1970s	Signaling and screening	Arrow, stiglitz, .Spence
1980s	Endogenous growth	Lucas, Borner
1990s	Externalities, non-market	Venniker

3 EDUCATION AND ECONOMIC GROWTH: EMPIRICAL STUDIES

Empirical estimation of the contribution of education to economic growth dates back to 1957 when Robert Solow published his seminal paper in *The Review of Economics and Statistics*. Solow's aim was to estimate the contribution of labor, capital and technological change to economic growth in the United States over the period 1909-1949 using the aggregate production function approach. He estimated the contributions of labor and capital and attributed the unexplained part of the total growth (i.e. the residual) to technological progress.

The value of the residual, known as total factor productivity (TFP), in Solow's model was excessively large (87.5 percent) and this drew the attention of many economists (for example, Kendrick (1961), Denison (1962) and Jorgenson and Griliches (1967)) to the problem of analyzing the effect of technological change (Elias 1992: 25).

Jorgenson and Griliches estimated TFP for the US at less than ten percent (Elias 1992: 26). The interpretation and measurement of total factor productivity has not been precise. As Lipsey and Carlaw (2004) point out many interpretations are often contradictory. Some argue that TFP reflects technological change (Barro, 1998a); others that it only reflects supernormal changes in technical progress (Hulten, 2000).

Denison (1962) adopted the conventional method of decomposing the growth of output into the growth of an array of production inputs (labor, capital, and land) together with the growth in TFP for the US for the period of 1909-57. For labor inputs, Denison took into account education, the gender and age composition of the labor force, hours of work and unemployment. He measured quality improvements in labor inputs by utilizing data on the change in the educational attainment profile of the labor force.

For capital inputs, Denison took into account, inter alia, change in the stock of capital composition by economic sector and foreign trade (Elias, 1992: 25). His evidence demonstrated that education has a significant impact on the quality of labor, thereby affecting long-run economic growth. That is, as more educated people enter the labor force, the average level of educational attainment of the workforce increases, and the more able is this workforce to implement technological advances.

Later studies by Jorgenson, Gollop and Fraumeni (1988), Jorgenson and Fraumeni (1992), Mankiw, Romer and Weil (1992) and Hall and Jones (1999) also estimated the contribution of education to economic growth by utilizing the growth accounting methodology.

The contribution of education to economic growth has also been the focus of the new growth theory, which emerged in the 1980s. Two of the architects of this theory are Romer and Lucas.

Romer (1986) argued that investing in education, training and research and other forms of human capital may help overcome the problem of diminishing returns and thus assist in achieving long-run economic growth. He further asserts that the acquisition of human knowledge, which has increasing marginal productivity, should be included as a part of factor Inputs for production. His model, based on the analysis of the role of research and development (R & D) in long run growth, placed

emphasis on incentives to generate new ideas by firms. According to Temple (2001: 4), Romer's framework "opens up the possibility that even a one-off increase in the stock of human capital will raise the growth rate indefinitely".

Lucas (1988) argued that the level of output is a function of the stock of human capital, where human capital refers to knowledge, obtained through education, rather than skills. In other words, the Lucas model is based on knowledge accumulation as in the Romer's model, but in a more direct way. His model made it possible to take into account the policy interventions and nature of institutions that influence the long run economic growth rate (Dowrick, 2003).

Temple (2001) mentioned that there are three reasons why the model of new growth theory is so important. First, it highlights education as a central determinant of economic growth. Second, it shows that even a *laissez faire* approach to the acquisition of human capital can stimulate growth. Finally, it exposes opportunities for policymakers to target growth by subsidising education and by providing tax and other incentives to private firms for their R & D expenditure. These are the arguments used by third world countries and their sponsors – the International Monetary Fund and the World Bank - to use donated and cheap loan funds to increase participation in education as the first step toward economic independence.

Whilst the literature unanimously supports the inclusion of human capital in models of economic growth, it is less clear regarding which education measures best represent its impact on growth. Chou (2003) used average years of schooling for employed workers in his estimation, using the growth accounting framework of the influences on economics growth in Australia between 1960 and 2000. Other parameters in his model were research intensity (measured by number of scientists and engineers engaged in research and development) and population growth.

Proxies for the quantity and quality of human capital include primary or secondary school enrolments as a percentage of the appropriate age population (see Barro (1989) for an example of this use.) In the main these are seen as quantity measures of human capital. However, Clements *et al.* (2003) used secondary education enrolments as a measure of the *quality* of human capital.

Other proxies for human capital are average levels of educational attainment and various characteristics of the labor force (Denison, 1962; Selowsky 1969; Griliches and Mason 1972; Hu 1976; Maglen 1991; Griliches 1997; Sianesi and Van Reenen 2000; Dowrick 2002; 2003; Ok and Tergeist, 2002; and Soto, 2002)

In Australia, some attention has been paid to the measurement of real GDP and real GDP per capita over time and the long and short run determinants of economic growth, including education. Two examples are McLean and Pincus (1983) who used educational attainment as a measure of living standards and Pope and Alston (1989) who studied the effect of human capital accumulation on growth. Recently Australia's data clearing house, the Australian Bureau of Statistics (ABS), has turned its attention to the construction of a measure of human capital within a national accounting framework (Wei, 2004).

A number of studies have previously looked at the broad contribution of schooling to growth in Australia, namely the effect on growth rates or levels from a one year increase in the average level of schooling. Benhabib and Spiegel (1994) found an extra year of schooling contributed 0.3 percentage points to long run economic growth in Australia. Estimates by Frantzen (2000) and Dowrick and Rogers (2002) are 0.8 percentage points and between 0.2 and 0.5 percentage points, respectively.

Dowrick (2003) argued that the available evidence pointed to real GDP growth of up to 8 percent (a transition over four decades that shifts the long run trend rate of growth upwards) if the average level of educational attainment of the working-age Australian population grew by one year.

Dowrick's estimate concurs with the aforementioned annual long run growth estimates of Benhabib and Spiegel (1994), Frantzen (2000) and Dowrick and Rogers (2002), together with growth in earnings estimates by Miller, Mulvey and Martin (1995) and Preston (1997) of 4.5 to 8.3 percent and 12.8 to 63.0 percent respectively.

No studies of long run economic growth in Australia have examined the influence of schooling beyond the aggregate level. Neither have there been growth studies examining quality aspects of schooling. The time is ripe for both of these issues to be addressed.

4 EDUCATION AND ECONOMIC GROWTH: CASE STUDY: ALGERIA

In 2012, the Algerian economy grew by 2.5%, up slightly from 2.4% in 2011. Excluding hydrocarbons, growth has been estimated at 5.8% (up from 5.7% in 2011). Inflation is increasing and is estimated at 8.9% (up from 4.49% in 2011). Despite the financial authorities' good performance, which was due to modernisation reforms, the budget deficit widened to 3.3% of GDP in 2012 (as against 1.3% in 2011) due to the continuation of the expansionary fiscal policy initiated in 2011 to meet strong social demands in terms of purchasing power, jobs and housing. The oil and gas sector is the country's main source of

revenues, having generated about 70% of total budget receipts. The economy is projected to grow by 3.2% in 2013 and by 4.0 % in 2014.

The country's external position remained comfortable in 2012, with a trade surplus of about USD 27.18 billion. The current-account surplus is estimated at 8.2% of GDP and official foreign-exchange reserves have been estimated at USD 190.7 billion at end-December 2012, or the equivalent of more than three years of imports of non-factor goods and services. Oil and gas export earnings made up more than 97% of total exports.

Algeria has enormous possibilities to boost its economic growth, including huge foreign-exchange reserves derived from oil and gas. A development strategy targeting stronger, sustained growth would create more jobs, especially for young people, and alleviate the housing shortage the country is facing. The national strategic option is therefore to revitalise the process intended to diversify the economy starting with the non-oil sector while deepening the reforms needed for the structural transformation of the economy.

In contrast,, Primary education is mandatory and lasts for nine years (École fondamentale). Secondary education is compulsory and consists of a three-year cycle of study provided in secondary schools and technicums. There are three branches of secondary education: general, specialized, and technical/vocational. Students in general secondary and specialized secondary education study for three years and sit for the Baccalauréat examination. Successful students are awarded the “Baccalauréat de l’Enseignement secondaire” in one of the various streams offered.

The Baccalauréat gives access to higher education but some institutions require it to be of a certain type (science, arts, etc.). The objective of technical and vocational secondary education is to prepare students for active life and industry (technicians and qualified workers).

Studies last between one and four years, according to the type of training undertaken and can also lead to higher education. Higher education is provided by universities, specialized institutes, national institutes of higher education, and teacher training institutes, which fall under the responsibility of the Ministry of Higher Education and Scientific Research, as well as by institutes run by other ministries. The specific degrees awarded are determined by the field of study, not the institution. The Ministry of Higher Education approves the curriculum, which is standardized for each field of study. Algerian institutions also award graduate degrees (Diplômes de Postgraduation) in most fields in which a Licence or DES is awarded.

By 2015, Algeria will have met the targets of education at the primary, secondary and tertiary levels. In 2004, the total number of students at all levels of education represented 27 percent of the total population. Since 1990, the government has been investing about 5.8 percent of its GDP in education.159 As a result, the levels of education are comparable to those in developed countries. In 2003/2004, 95.3 percent of girls completed primary school160 whereas the number of girls enrolled in secondary school was slightly higher than boys161. Similarly, 61 percent of total graduates in tertiary education are women.

The investment in education resulted in a decrease in illiteracy rates for women between 1990 and 2002, declining from 59 percent to 40 percent.163 significant progress can also be seen in women’s youth literacy which increased from 68 percent in 1990 to 86 percent in 2004.

Since 2000, specific measures have been adopted to integrate students who are facing educational difficulties including those who have not attended schools or not completed their education. The programs (job placement and practical training) implemented by the Ministries of Professional Training and National Education target young adults aged 16 and older, focusing specifically on disadvantaged groups.

In 2011, The national education service has 7.38 million children in primary (44%), middle (42.8%) and secondary (13%) schools. The number of girls is put at 3.64 million, or 49.3% of pupils, for a ratio of 97 girls for every 100 boys. Almost 208 000 pupils are educated through correspondence courses and 18 000 are privately schooled. There are more than 22 000 schools nationwide. Some 1.25 million students were enrolled in higher education in 2011-12. The literacy rate is 80%. As part of its national literacy strategy, the country aims to cut by 22% the rate of illiteracy among those aged 10 and above by 2012.

The challenge faced by the Government as stated in the national report is to **improve the quality and content of the education system** and professional training programs with the purpose of promoting gender equality.

5 METHODOLOGY AND DATA

The variable in this study, the Gross domestic product (GDP) per capita (annual Growth), is measured as the major education categories, which are primary school (PRY), Middle school (MIE) secondary school (SEC), and university (TER). All variables are expressed in natural logarithms in order to estimate their elasticities.

The traditional approach to determining long run and short run relationships among variables has been to use the standard Johanson Cointegration and VECM framework, but this approach suffers from serious flaws as discussed by Pesaran et al. (2001). We adopt the autoregressive distributed lag (ARDL) framework popularized by Pesaran and Shin (1995, 1999), Pesaran, et al. (1996), and Pesaran (1997) to establish the direction of causation between variables. The ARDL method yields consistent and robust results both for the long run and short-run relationship education and economic growth variables. This approach does not involve pretesting variables, which means that the test for the existence of relationships between variables is applicable irrespective of whether the underlying regressors are purely I(0), purely I(1), or a mixture of both. In order to obtain robust results, we utilize the ARDL approach to establish the existence of long-run and short-run relationships. ARDL is extremely useful because it allows us to describe the existence of an equilibrium/relationship in terms of long-run and short-run dynamics without losing long-run information. The ARDL approach consists of estimating the following equation.

$$\Delta LnGDP = c + \delta_1 LnPRY_{t-1} + \delta_2 LnMIE_{t-1} + \delta_3 LnSEC_{t-1} + \delta_4 LnTER_{t-1} + \delta_5 LnGDP_{t-1} + \sum_{j=0}^{p} \alpha_j \Delta LnGDP_{t-j} + \sum_{j=0}^{p} \omega_j \Delta LnPRY_{t-j}$$

$$+ \sum_{j=0}^{p} \varphi_j \Delta LnMEI_{t-j} + \sum_{j=0}^{p} \theta_j \Delta LnSEC_{t-j} + \sum_{j=0}^{p} \gamma_j \Delta LnTER_{t-j} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The second part of the equation with $\alpha_j, \omega_j, \varphi_j, \theta_j,$ and γ_j represents the short-run dynamics of the model whereas the parameters $\delta_1, \delta_2, \delta_3, \delta_4$ and δ_5 represents the long-run relationship. The null hypothesis of the model is:

$H_0 : \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_4 = 0$ (There is no long-run relationship)

$H_1 : \delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq \delta_4 \neq 0$

We start by conducting a bounds test for the null hypothesis of no cointegration. The calculated F-statistic is compared with the critical value tabulated by Pesaran (1997) and Pesaran et al. (2001). If the test statistics exceeds the upper critical value, the null hypothesis of a no long-run relationship can be rejected regardless of whether the under lying order of integration of the variables is 0 or1. Similarly, if the test statistic falls below a lower critical value, the null hypothesis is not rejected. However, if the test statistic falls between these two bounds, the result is inconclusive. When the order of integration of the variables is known and all the variables are *I(1)*, the decision is made based on the upper bound. Similarly, if all the variables are *I(0)*, then the decision is made based on the lower bound.

The ARDL methods estimates $(p+1)^k$ number of regressions in order to obtain the optimal lag length for each variable, where p is the maximum number of lags to be used and k is the number of variables in the equation.

In the second step, if there is evidence of a long-run relationship (cointegration) among the variables, the following long-run model (Equation 2) is estimated,

$$LnGDP = c + \sum_{j=0}^{p_1} \alpha_j LnGDP_{t-j} + \sum_{j=0}^{p_2} \omega_j LnPRY_{t-j} + \sum_{j=0}^{p_3} \varphi_j LnMIE_{t-j} + \sum_{j=0}^{p_4} \theta_j LnSEC_{t-j} + \sum_{j=0}^{p_5} \gamma_j LnTER_{t-j} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

If we find evidence of a long-run relationship, we then estimate the error correction model (ECM), which indicates the speed of adjustment back to long-run equilibrium after a short-run disturbance. The standard ECM involves estimating the following equation.

$$\Delta LnGDP = c + v(ECM)_{t-1} + \sum_{j=0}^{p_1} \alpha_j \Delta LnGDP_{t-j} + \sum_{j=0}^{p_2} \omega_j \Delta LnPRY_{t-j} + \sum_{j=0}^{p_3} \varphi_j \Delta LnMIE_{t-j} + \sum_{j=0}^{p_4} \theta_j \Delta LnSEC_{t-j} + \sum_{j=0}^{p_5} \gamma_j \Delta LnTER_{t-j} + \varepsilon_t \ldots\ldots (3)$$

The Third equation with $\alpha_j, \omega_j, \varphi_j, \theta_j,$ and γ_j represents the short-run dynamics of the model whereas the parameter v represent error correction Coefficient. The model (ECM) is:

$$ECM_t = LnGDP_t - C_0 - \hat{\beta}_1 LnPRY_t + \hat{\beta}_2 LnMIE_t + \hat{\beta}_3 LnSEC_{t-1} + \hat{\beta}_4 LnTER_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

To ascertain the goodness of fit of the ARDL model, diagnostic and stability tests are conducted. The diagnostic test examines the serial correlation, functional form, normality, and hetroscedasticity associated with the model. The structural stability test is conducted by employing the cumulative residuals (CUSUM) and the cumulative sum of squares of recursive residuals (CUSUMSQ).

Furthermore, we simulate VDCs and IRFs for further inferences. VDCs and IRFs serve as tools for evaluating the dynamic interactions and strength of causal relations among variables in the system. The VDC indicates the percentages of a variable's forecast error variance attributable to its own innovations and innovations in other variables. Thus, from the VDC, we can measure the relative importance of the RER, income, and money fluctuations in accounting for fluctuations in the trade balance variable. Moreover, the IRF traces the directional responses of a variable to a one-standard deviation shock to another variable. This means that we can observe the direction, magnitude, and persistence of Gross domestic product (GDP) per capita to variations in the RER, education.

We are using time series annual data that cover the period of 1971 – 2011 and it is provided by the Algerian Statistical office, the World Bank World Development Indicators (WDI, 2013), UNICSO, BARRO AND LEE.

- **Empirical Analysis:**

Before testing the cointegration relationship, a test of order of integration for each variable using the Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) tests are conducted. Even though the ARDL framework does not require the pre-testing of variables, the unit root test could help in determining whether or not the ARDL model should be used. The results in Table-1 and 2 are the unit root test results of the Augmented Dickey-Fuller and Phillip Perron tests, respectively, showing that there is a mixture of I(1) and I(0) of underlying regressors and that, therefore, we can proceed with ARDL testing.

The Gross domestic product (LnGDP) per capita, primary school (LnPRY), and university (LnTER) are integrated to the order of one I (1), while the Middle school (LnMIE), secondary school (LnSEC), are integrated to the order of zero I (0).

Table 2. Unit-Root Estimation

Variables	Augmented Dickey-Fuller test statistic		Philips Perron Test statistic	
	Intercept	**Intercept & trend**	**Intercept**	**Intercept & trend**
LnGDP	-1.203033 (0.668)	-2.220413 (0.4655)	-1.203033 (0.6638)	-1.971392 (0.5987)
DLnGDP	-5.208586 (0.0001) ***	-5.237312 (0.0006) ***	-5.197759 (0.0001) ***	-5.223757 (0.0007) ***
LnPRY	0003444 (0.9529)	3.075627 (1.00)	-3.185621 (0.0283) **	0.021838 (0.9952)
DLnPRY	-.334454 (0.0539) **	-1.430743 (0.8349)	-3.561048 (0.0113) **	-5.763330 (0.0001) ***
LnMIE	-5.195827 (00001) ***	-3.979480 (0.0183) **	-4.942709 (0.0002) ***	-2.946748 (0.1595)
LnSEC	-7.529001 (0.00) ***	-1.944679 (0.6123)	-7.529001 (0.00) ***	-1.845531 (0.6636)
LNTER	-2.256500 (0.1906)	-2.906662 (0.1713)	-2.316852 (0.1718)	-2.895541 (0.1747)
DLnTER	-4.927760 (0.0003) ***	-5.045568 (0.0011) ***	-5.015243 (0.0002) ***	-5.462535 (0.0003) ***

Note:*,** ,*** represents significant at 1%, 5% and 10%.

Now we turn to the ARDL approach to determining long-run relationships as mentioned in Table-4. The main assumption of ARDL is that the variables in model are counteracted to the order of *I(0)* or *I(1)* or both. This lends support to the implementation of bounds testing, which is a three step procedure. In the first step, we select a lag order on the basis of the Schwarz Bayesian criteria (SBC) because the computation of F-statistics for cointegration is very sensitive to lag length. The lag length that minimizes SBC is one. The calculated *F*-statistic (*F*-statistic = 6.30) is higher than (4.47) at a 5% level of significance (Table 3):

Table 3. Testing for existence of a level relationship (Pesaran et al. (2001))

Dépendent Variable : LnGDP		
***F*-statistic=6.30**		
Upper value	**higher value**	**critical value**
3.19	4.47	5%
2.65	3.79	10%

Using a restricted intercept and no trend as reported by Pesaran et al. (2001). This implies that the null hypothesis of no cointegration is rejected at 5% and that, therefore, there is a cointegrating relationship among the variables.

The empirical results of the long-run model obtained by normalizing the trade balance are presented in Table-4 (ARDL (1,0,1,1,1) selected based on the Akaike information criterion [AIC]).

Table 4. Estimated Long Run Coefficients using the ARDL Approach

ARDL (1,0,1,1,1) based on Schwarz Bayesian Criterion			
Dépendent Variable : (LnGDP)			
Variables	**Coefficient**	**t-Values**	**Prob-Values**
Constant	2.068	0.51	0.61
LnGDP(-1)	0.90	12.93	0.000***
LnPRY	0.024	0.088	0.93
LnMIE	-1.13	-3.58	0.001***
LnMIE(-1)	0.93	2.32	0.027**
LnSEC	-0.73	-1.96	0.058*
LnSEC(-1)	0.72	2.63	0.013**
LnTER	-0.51	-2.14	0.040**
LnTER(-1)	0.65	2.77	0.009***
R^2=0.998		**F-Statistics(8,31)=2039.6 [0.000]**	
Adjusted-R^2= 0.997		**Durbin-Watson Stat =2.52**	

Note:*,** ,*** represents significant at 1%, 5% and 10%.

The results indicate that the Gross domestic product per capita for the previous period is an important determinant of Gross domestic product per capita (LnGDP). Every 1% increase in GDP previous period yields an average 0.90% improvement in the Gross domestic product per capita (Akaike selection criterion results). Similarly, the sign of the Gross domestic product per capita for the previous period variable is consistent with the endogenous growth approach. The impact of education in the previous period on the Gross domestic product per capita is positive and statistically significant. Every 1% increase in (LnMIE(-1), LnSEC(-1), LnTER(-1)) yields an average Respectively (0.93%, 0.72%, 0.65%) improvement in the Gross domestic product per capita in the long run as suggested by AIC selection criterion. It indicates that the sum of elasticities of exports and imports exceeds unity in the long run and that devaluation/depreciation improves the trade balance.

Table 4 displays the long-term coefficients under ARDL Approach. Results reveal that, except for Middle school (LnMIE) and secondary school (LnSEC). the primary school (LnPRY), and university (LnTER) are statistically insignificant at 10% and 5% Respectively. So there is a long run relationship betwin primary school (LnPRY), university (LnTER) and the gross domestic product (GDP) in Algeria.

Table 4. Estimated Long Run Coefficients for Selected ARDL Model

Variables	Coefficient	Prob-Values
LnPRY	1.38	0.09*
LnMIE	-1.20	0.268
LnSEC	0.72	0.335
LnTER	0.65	0.000***
F-Statistics=10.15 [0.000]		**[2.50:3.80]**

Note:*,** ,*** represents significant at 1%, 5% and 10%.

Error Correction Representation of above long run relationship is reported in Table 5, which captures the short-run dynamics of relationship among education variables and gross domestic product (GDP). The error correction model based upon ARDL approach establishes that changes in educations variables, are statistically insignificant while changes in GDP.

Table 5. Error Correction Representation for the selected ARDL-Model

ARDL (1,0,1,1,1) based on Schwarz Bayesian Criterion		
Dépendent Variable : (ΔLnGDP)		
Variables	**Coefficient**	**Prob-Values**
Constant	2.068	0.61
$\Delta LnGDP_{t-1}$	0.15	0.001***
ΔLnPRY	0.024	0.93
$\Delta LnMIE_{t-1}$	0.93	0.027**
$\Delta LnSEC_{t-1}$	0.72	0.013**
$\Delta LnTER_{t-1}$	0.65	0.009***
ECM_{t-1}	-0.11	0.034**
R^2=0.55		**F-Statistics=10.15 [0.000]**
Adjusted-R^2= 0.55		**Durbin-Watson Stat =2.64**

Note:*,** ,*** represents significant at 1%, 5% and 10%.

The results of the ECM for trade balance are presented in Table-5. Most of the coefficients in the short run are significant, but, It is worth mentioning that these elasticities are not much lower than long run elasticities. It is also observed that primary school (LnPRY) is significant in long term but it is not statistically significant in short term.

We apply a number of diagnostic tests to the ECM, finding no evidence of serial correlation, heteroskedasticity and ARCH (Autoregressive Conditional Heteroskedasticity) effect in the disturbances. The model also passes the Jarque-Bera normality test, which suggests that the errors are normally distributed.

ECM (–1) is one period lag value of error terms that are obtained from the long-run relationship. The coefficient of ECM (–1) indicates how much of the disequilibrium in the short-run will be fixed (eliminated) in the long run. As expected, the error correction variable ECM (–1) has been found negative and statistically significant. The Coefficient of the ECM term suggests that adjustment process is quite fast and 39 percent of the previous year's disequilibrium in equity prices from its equilibrium path will be corrected in the current year.

6 CONCLUSION

This study examine the relationship among the Gross domestic product (GDP), education for the period 1971 to 2011 in Algeria by using ARDL approach based on bounds testing procedure proposed by Pesaran and Shin (2001). The ARDL approach has been applied as it more powerful procedure to explore the long run relationship as well short term dynamics of relationship and yields consistent estimates of the long-run coefficients that are asymptotically normal, irrespective of whether the underlying regressors are I(0) or I(1).

Data has been tested to examine econometric problems like serial correlation, functional form, normality, heteroscdasticity and unit root by using LM test, Ramsey Reset test, skewness and kurtosis test, white test and ADF Test and Phillip Parren Test respectively. Results indicate that, there is not econometric problems like autocorrelation.

Conflict to normal distribution has not been observed. Similarly, no model specification error exists with reference to Functional form. Unit root test clearly indicate that the index series are not stationary at level but the first differences of the logarithmic transformations of the series are stationary.

The error correction variable ECM (–1) has been found negative and statistically significant. The Coefficient of the ECM term suggests that adjustment process is quite fast and 11 percent of the previous year's disequilibrium in Gross domestic product from its equilibrium path will be corrected in the current year.

Results of ARDL long run coefficients reveal that primary school **LnPRY**, and university (Ln TER) are statistically insignificant in determining income per capita. The error correction model based upon ARDL approach captures the short-term dynamics of education variables, except primary school, it is not statistically significant in short run.

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