

About Relationship between Education, Investment and Growth: Identification and Causality for 5 MENA Countries - (Algeria-Egypt-Morocco-Tunisia and Turkey)

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Abstract

This paper investigates causality direction between education, material investment and economic growth in a panel of five MENA countries (Algeria, Egypt, Morocco, Tunisia and Turkey) during 1975 to 2014. Specific results by country will be identified about the direction of causality between the three variables. In empirical estimations we used Granger causality tests, variance decomposition and impulse response functions to a panel data framework through the Arellano-Bond difference GMM estimator.

First, we identify a causal relationship between education and economic growth as well as between education and investment.

In addition, we found that the education causes economic growth after three years whereas economic growth causes the education after only one year. The results also confirm a transmission mechanism that runs from education to economic growth through material investment.

This shows that increases in human capital should boost the return on physical investment. Consequently, sustaining economic growth can be performed by investment and education.

Finally, according to the results we approve that emphasizing on physical investment instead of sufficient care on human capital investments is not the better way to achieve growth at medium and long run.

Keywords: Education; Economic growth; Investment; Causality; GMM estimator; Panel data

Introduction

Education has long been recognized as important determinant of economic development. It raises people's productivity and promotes entrepreneurship and technological advances. Over time, economists have offered a variety of theories and models for analyzing the impact of education on economic growth. Most empirical studies using cross-section, time-series and data sets that cover more countries and dynamic panel, using different theoretical approaches, identified a significant relationship and causality between education and economic growth.

Theoretical models show that education is the main way to develop human capital. Very early, Schumpeter in 1954 when distinguishing the role of innovation he pointed on education as yielding innovation process and consequently enhancing economic growth. The transmission channels to this process are: creating new products, exploring new markets and designing new production methods and organizations.

Later, by neo-classical growth theory, several growth models were developed to explain the interaction between economic growth and education. Denison [1] emphasized on investing in education because it's considered having a strong impact on economic growth. Further, developed an endogenous growth model by considering education as a mean for human capital accumulation and adopting it as an input with other production factors. In the same way, they demonstrated that economic growth has been positively influenced by the initial level of human capital measured by schooling rates. Similarly, they have found that the contribution of human capital on economic growth is significant.

These models developed by, Romer [2] dealing with effects of technology and technical progress on economic growth stimulated a new discussions wave on the role of education in enhancing the virtuous process of earnings.

Others studies have been done to investigate the causality between education and economic growth. Agiomirgianakis et al., [3] analyzed causality between human capital (analyzed by rates in primary, secondary, and higher education) and economic growth in Greece. They found that causality runs through educational variables to economic growth, with the exception of higher education where reverse causality exists.

All of these studies neglected the relationship between education and investment/capital formation. Furthermore, these studies neglected the effect of lags on the direction of causality.

The two issues impact and Granger – causality are related but not identical. Given a relationship between education and investment or economic growth, we need to know whether this relationship is excepted hold if actions controlling output are implemented when investment.

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There may be cases in which variable has predictive power for another but its impact is zero because coefficients on different lags cancel each other. This is usually the case that when the direct impact is statistically insignificant, there is also no indication of Granger causality.

The aim of this article is to fill a gap in the empirical literature and to analyze the causality between school education, investment/capital formation and economic growth for MENA regions, in between 1975 and 2014. We try to find the role of education and investment in economic growth by deriving an accounting relationship between economic growth and variables representing education and investment. The variables used are school enrolment ratio (primary and secondary) and gross domestic product per capita. According to World Bank, economic growth is higher for those countries which have higher investment ratio. Neo-classic economists have placed main emphasis on investment/capital formation as the engine of economic growth. Investment refers to all economic activity which involves the use of resources to produce goods in services. In view of the importance of the subject, many empirical studies have been conducted to assess the role of investment in economic growth [4]. It is agreed that investment generally play a positive role in the economy, although it depends on country characteristics, policy environment and sectors. This strand of literature highlights various channels through which education can affect economic growth in nonlinear fashion and investment might be considered as an important channel.

This paper is structured in the following way. A literature review is given in section 2. Section 3 gives a short overview of the data used for the empirical analysis including a discussion of the panel data properties. Section 4 describes the methodological approach of the VAR model and reports the estimation results. Finally, section 5 concludes the paper.

Relationship between Education, Investment and Economic Growth: The Literature Review

The economic literature has studied the impact of education on growth, which invites us to study first the nature of the link between these two variables.

We distinguish studies which used cross-country data when analyzing relationship between education and income like Romer [2], Nelson and Phelps [5]. The same relationship was analyzed by using time series data like de la and cross-state data within a country. Panel data were exploited.

Through the various studies different measures for economic growth and education were used. For education, Bils and Klenow [6], Agiomirgianakis et al., [3], Huang et al., [7] and Loening [8] used school enrolment rates.

Kui Liu [9] referred to school enrolment. The average years of schooling was used. Kui Liu [9], Chaudhary et al., [10] have chosen the public expenditure in education as a percent of gross domestic product. Other authors used investments in education like Podrecca and Carmeci [11], Bo-nai and Xiong-Xiang [12], Katircioglu [13].

When measuring economic growth, studies utilized different indicators like gross domestic product, gross domestic product per capita, national income or gross national income.

Unidirectional causality

Most studies report a similar finding which is a unidirectional

causality from education to economic growth or from economic growth to education. A unidirectional causality running from education to growth in the Middle East countries was proofed. However, Turkey and India have found a unidirectional causality from economic growth to education expenditures. In the case of China between 1978 and 2004 Kui Liu [9] showed that economic development enhances higher education and rise primary education results.

Chaudhary et al., [10], using the Johansen co-integration and Tod and Yamamoto causality approach in VAR framework analyzed the role of higher education in economic growth for Pakistan between 1972 and 2005. Their results proofed a unidirectional causality running from economic growth to higher education and no other causality running from higher education to economic growth.

Using error correction modeling, applied for India in 1951-2002 period, showed a unidirectional causality between education and economic growth and no reverse causality was identified.

Katircioglu [13] found, at the long-run equilibrium, a relationship between higher education increasing and economic growth for North Cyprus. Witch indicates a unidirectional causality that runs from higher education to economic growth.

Using an endogenous growth model developed, Gutema and Mekonnen [14] demonstrated that education has a significant positive influence on the economic growth of Sub-Saharan Africa.

Chaudhary et al., [10] using the Johansen co-integration and Tod and Yamamoto causality approach in VAR framework analyzed the role of higher education in economic growth for Pakistan between 1972 and 2005. The higher education had a strong causal impact on economic growth in Japan, the UK, France and Sweden; but no impact in Italy and Australia. The authors concluded that higher education is necessary for growth, but not sufficient.

Jaoul [15] used the data set in France and Germany in the period before the Second World War, and demonstrated that higher education has an influence on gross domestic product just for the case of France. However, in Germany, education does not appear a growth determinant.

Their results identified one unidirectional causality running from economic growth to higher education but not a causality running from higher education to economic growth.

Loening [8] investigated the impact of education on economic growth in Guatemala during the period 1951-2002. Using an error-correction model, the author pointed out that a better-educated labor force has a positive and significant impact on economic growth by explaining 50% of its output.

Bidirectional causalities

The bi-directional causality relationship between education and economic growth was proofed by many studies. Islam et al., [16] in Bangladesh between 1976 and 2003 picked-up bidirectional causalities. Also when including in their analysis capital and labor, the same bidirectional causality between education and growth was obtained.

Huang et al., [7] analyzed the causality between increase in higher education and economic growth in China between 1972 and 2007. In the long run, the results showed a relationship between enrolment in higher education and gross domestic product per capita.

Usually for the China case, Bo-nai and Xiong-Xiang [12]

demonstrated an evident bi-directional causality relationship between education investments and economic growth during 1952 to 2003.

According to a positive and significant relationship between education and income growth in the world can be relevant when education is measured by years of education completed compared to levels or years of all secondary education. Similarly, Cohen and Marcelo [17] find that both initial years of schooling and change in years of schooling have significant positive impact on income growth in the world.

Using panel data for 86 countries over the period 1960-1990, Podrecca and Carmeci [11] analyzed the relationship between education and economic growth using Granger causality technics. The authors found that both education investment and the educational stock had an impact on growth rates. It was relevant when adopted individually and jointly with physical capital investment.

No relationship

Finally no relationship was proofed by others studies does not indicate a significant relationship between education and income. There is no strong nexus between educational indicators and economic growth rate. They could not find a significant relationship between education expenditures and school enrolment rates and economic growth. Self and Grabowski [18], state that vocational education does not have a direct effect on economic growth. They could not find a causality relationship between higher education and the GDP in Turkey.

Point out that they could not find a long-run relationship between these variables and growth, considering the number of high school students as the level of human capital.

Human capital paradigm supports that investing in education improves a country's ability to maximize its economic growth. Empirically, some studies found a unidirectional causality relationship between economic growth and education, others identified a bidirectional relationship and few of these studies supported a unidirectional causality between education and growth.

All studies mentioned emphasize the role of human capital (education) on economic growth but they neglected the role of physical capital. Their ability to identify causal effects is limited by the small size of their dataset, the non-appropriate econometric instruments and the omission of explicative variables. In this paper, we conduct detailed

empirical analysis by including the physical capital. We use panel data on five MENA countries between 1975 and 2014 in order to study the kind of relationships and the causal directions between human capital (education), physical capital (investment) and economic growth.

Data Descriptions

We use annual data from 1975 to 2014 for 5 MENA countries namely: Algeria, Egypt, Morocco, Tunisia and Turkey. World Bank notes that there are 21 countries in MENA region. Selecting only 5 of them in this paper is due to information availability. These countries have conducted huge efforts for promoting educations in the considered period. Algeria, Egypt and Tunisia are likely to be within 5 percentage points of the target adult literacy rate in 2015. Turkey reached the latter result earlier in 201. And Morocco is likely to be more than 5 percent points below the target adult literacy in 2015:

The GDP growth per capita (annual %), is used as measurement of economic growth. The proxy of Human capital will be the enrolment ratio in two levels of education (secondary and primary education). Gross Fixed Capital Formation is used to indicate the physical capital investment and it's introduced to be a control variable and due to its bearing on both economic growth and human capital development. It also included physical capital (investment) as an important determinant in their growth models. This variable is expected to have a significant relationship with economic growth and education and vice versa.

All variables have been obtained from the World Bank's World Development Indicators. We use panel methods, because it allows for higher degree of freedom and minimize multi co linearity. Causalities will be tested on three variables. They are economic growth, education and investment. We use testing for granger causality.

Economic growth

The growth in per capita GDP indicates an improvement in standards of living for people. It's the more commonly used measure of economic growth as also it's used by Romer [2], Rebelo [19], Gupta and Chakraborty [20] and Huang et al., [7]. Economic growth is expected to relate positively and significantly with education and physical capital investment.

According to the Figure 1, GDP growth in different countries has fluctuated between -7% and 10%.

Clearly, based on long-term trends, growth rates are exceeding 5%

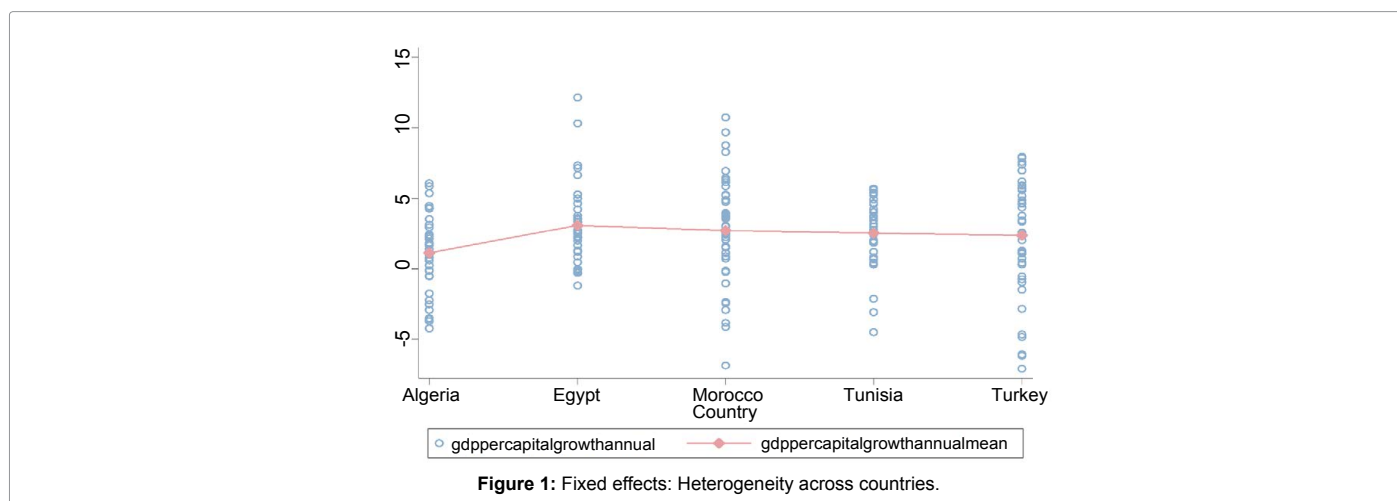


Figure 1: Fixed effects: Heterogeneity across countries.

in all countries. The GDP per capita growth rose from a minimum of 5 % to a maximum of 10 % in Egypt, Morocco and Turkey.

As a result of the Arab Spring, Egypt and Tunisia experienced a decline in the growth rate during 2011. Morocco and Algeria have experienced more limited social tensions than other countries but their economies have suffered from negative spillover effects from instability in other countries in their respective regions.

Education (HM)

In this study education is proxied by time series variable of primary and secondary education enrolments. This variable was chosen as it contributes directly to skilled human capital (Figure 2). This is a quantity measure of education which closely relates to the quality of education in the country. Secondary school enrolment used in some studies (such as by Musibau et al., [21]) is criticized because students at secondary schools will not necessarily constitute skilled human capital. In addition, primary and secondary educations contribute to economic

growth after a considerably long period as compared to tertiary education.

The variable chosen is expected to be positively and significantly related with economic growth and physical capital investment.

Although the starting points were similar, except Morocco (Figure 3), the evolution of educational attainment was not (Figure 4). The mean years of schooling went up by near 4.5 years in Tunisia and Turkey and then 4.5 years in Algeria and Egypt. In Morocco, the mean years of schooling was near 4 years.

Physical capital investment

Physical capital refers to an increase in capital stock in the economy and is one of the traditional determinants of economic growth. Gross Fixed Capital Formation is used as a proxy for physical capital investment. This variable is used in this model as a control variable and

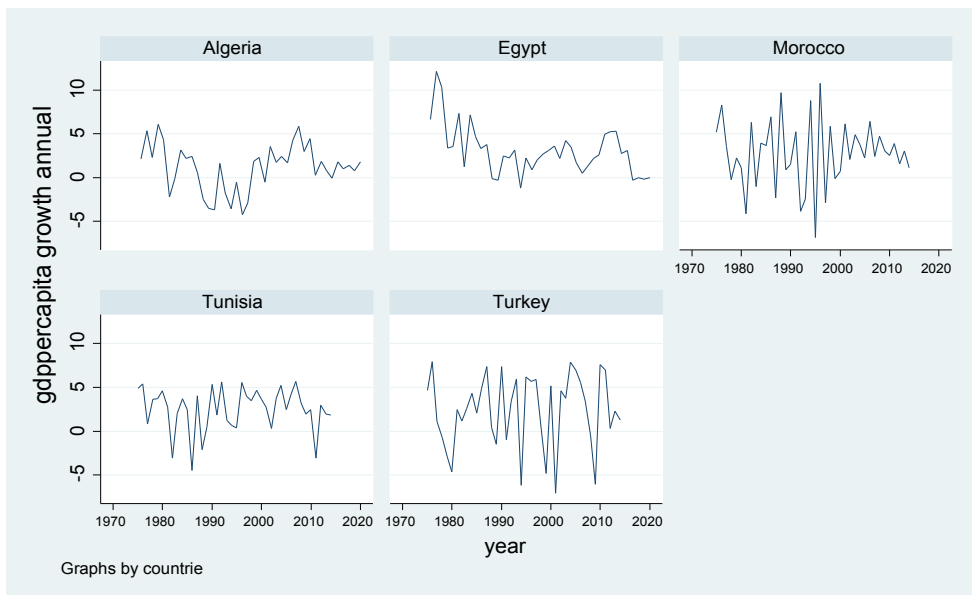


Figure 2: The evolution of GDP growth by country, per cent change.

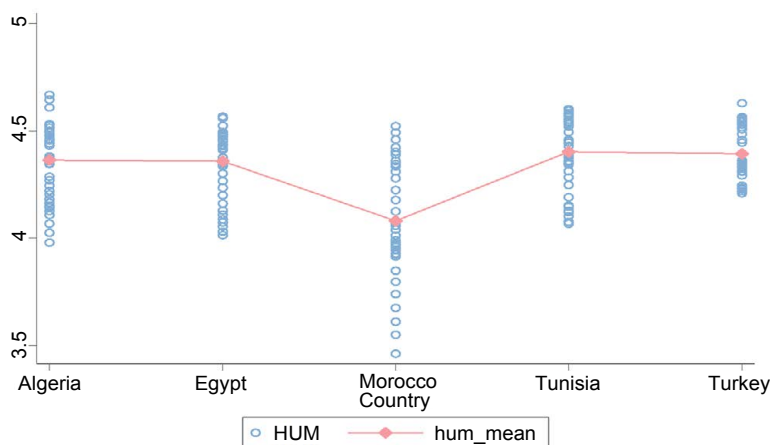


Figure 3: Fixed effects: Heterogeneity across countries.

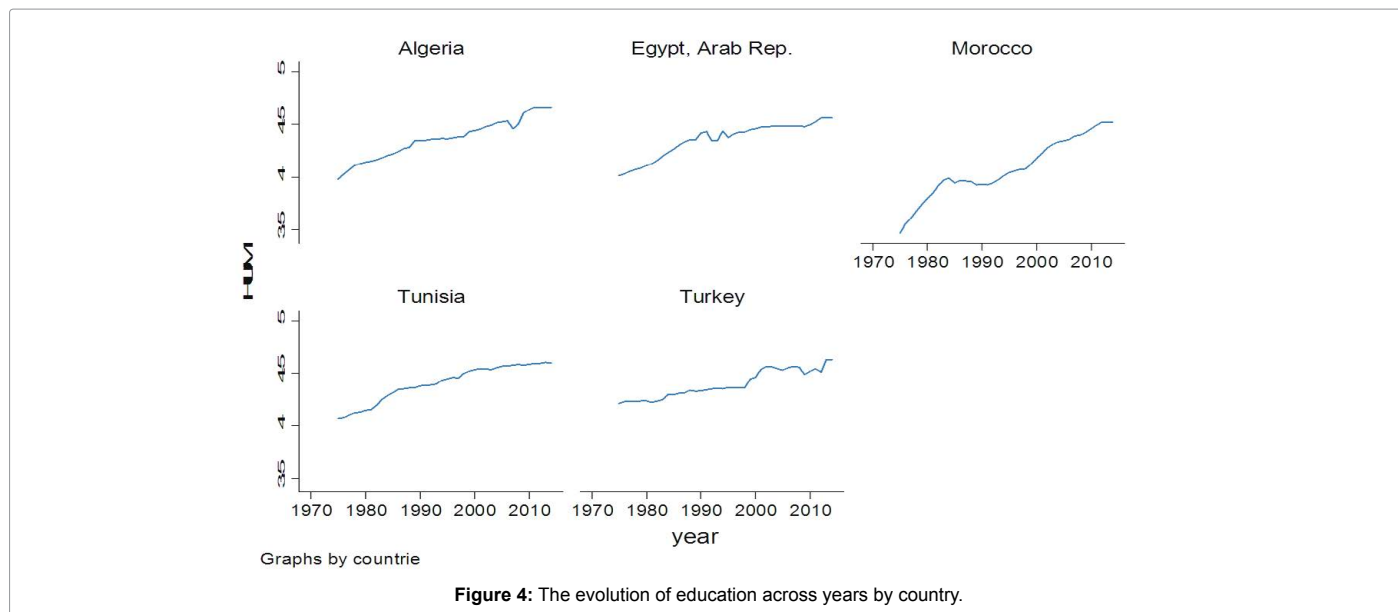


Figure 4: The evolution of education across years by country.

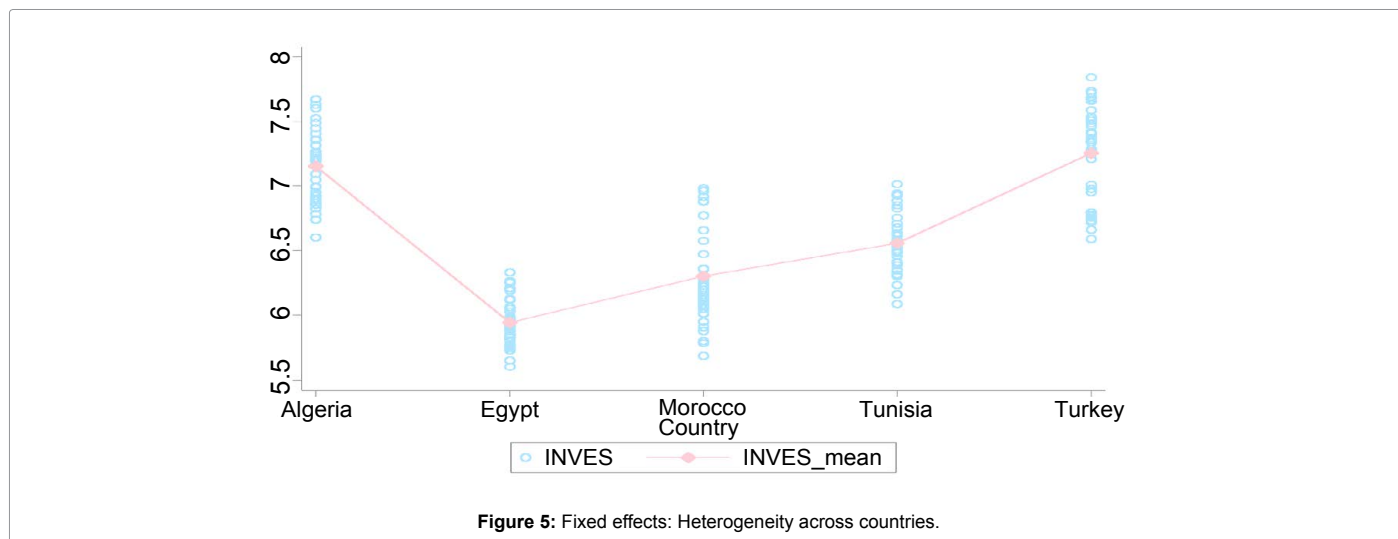


Figure 5: Fixed effects: Heterogeneity across countries.

also because investment has a bearing on both economic growth and human capital development (Figure 5).

This variable is expected to have a significant relationship with economic growth and education and vice versa.

Economic theory identifies various channels through which investment can positively impact on economic growth. Among these channels the infrastructure stimulates factor accumulation through providing facilities for human capital development.

As shown in Figure 6, throughout the period, the investment rate was high for Algeria and Turkey while Egypt had the lowest rate Tunisia and Morocco have average investment rates.

The growth in economic infrastructure investment depicts a volatile but mean reverting process with peak rises followed by peak falls. Typical years of high growth in infrastructure investment correspond to the years 1990 and 2000, while typical years of contraction correspond to 2005 and 2010.

The descriptive statistics are evidenced in Table 1 (see annex). The

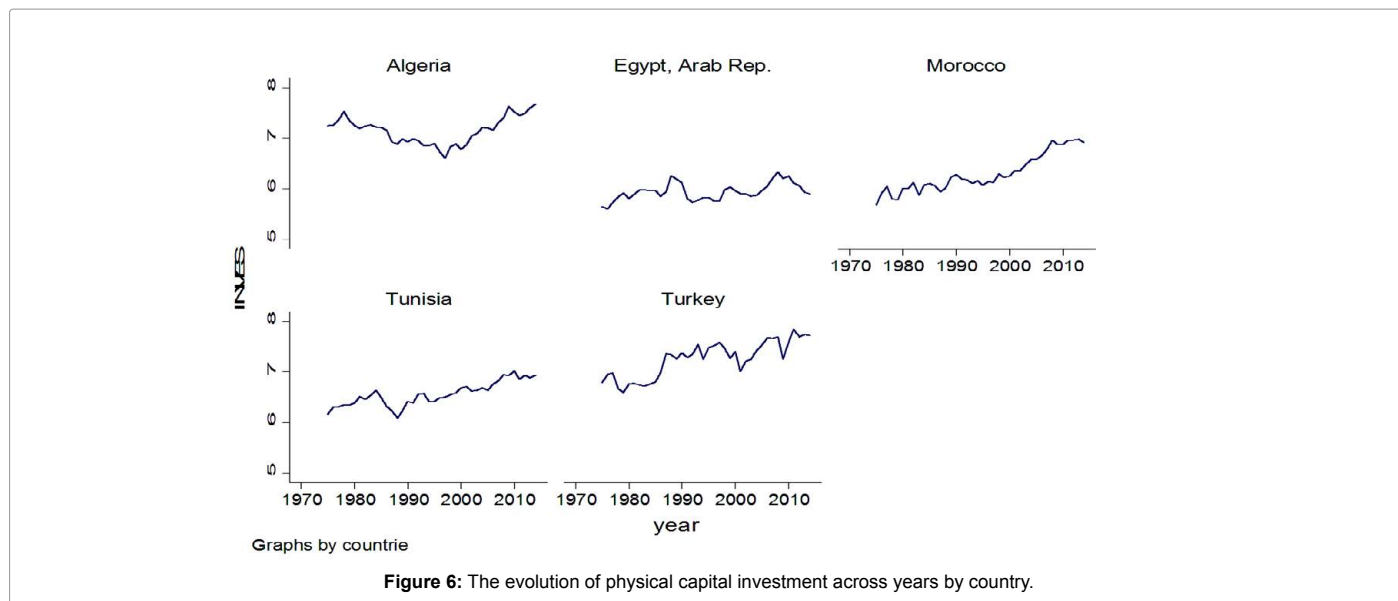
Countries	GDP/HUM	Correlation	
		GDP/INVES	INVES/HUM
Algeria	0.6871	0.7133	0.1801
Egypt	0.9473	0.5703	0.4792
Morocco	0.9583	0.9581	0.9231
Tunisia	0.9272	0.9045	0.7540
Turkey	0.9338	0.8918	0.7604

Source: Author's Calculations.

Table 1: Corrélation Coefficient.

GDP and INVES have a larger standard deviation among the three variables, which supports the general intuition that GDP and INVES are highly volatile.

The range of variation between maximum and minimum is quite logical. The Standard deviation, compared to the mean is low which indicates small coefficient of variation. We calculate the sample correlation matrix for all five countries. We find the highest correlations are between GDP and INVES except for Egypt (0.57). The lowest correlations are between INVES and HUM for Algeria and Egypt.



In general, HUM is highly correlated with GDP. The correlation coefficient is very close to +1. We find, however, that these low correlations disappear between INVES and HUM.

Therefore we can conclude that there indeed is a strong positive relationship between GDP and HUM except Algeria, between GDP and INVES except Algeria and Egypt and between INVES and HUM except Algeria and Egypt.

Empirical Analysis and Results

As indicated in the introduction, we examine the relationships among real per capita GDP (GDP), real per capita gross fixed capital formation (INVES) and education (HUM).

First, a panel data unit root test is performed to determine whether or not the observed country-specific time series for the three variables exhibit stochastic trends. Next, we examine whether these variables are cointegrated, whether there are stable long-term equilibrium relationships among them. Finally, we apply dynamic panel data methods in a VAR context to test the causality relationships among the three variables GDP, INVES and HUM.

The Granger Causality test as proposed by Sims [22] is used to test whether one variable is useful in forecasting another variable and vice-versa.

The literature generally does not provide diversified methods for causality tests in panel data models. It is possible to classify mainly two types of approaches. The first one is pioneered by Holtz-Eakin et al., [23] which considers estimation and testing vector autoregression (VAR) coefficients in panel data letting the autoregressive coefficients and regression coefficients slopes as variable.

A more or less similar procedure is applied by Hsiao [24], Holtz-Eakin et al., [23] Hsiao [25], Weinhold [26], Weinhold [27], Nair-Reichert and Weinhold [28], and Choe [29]. The second approach proposed by Hurlin and Venet [30], Hurlin [31], Hurlin [32], Hansen and Rand [33] treats the auto retrogressive coefficients and regression coefficients slopes as constant. In this study, we employ the second approach because of its suitability to our data sets, in which we have relatively short time periods whereas large number of cross-section

units. Following Hurlin and Venet [30], we consider two covariance stationary variables, denoted by x and y , observed on T periods and on N cross-section units. The use of panel data dimension has a number of advantages. First, it provides a large number of observations. Second, it increases the degrees of freedom. Finally, it reduces the co linearity among explanatory variables. In sum, it obviously improves the efficiency of Granger causality tests [30].

Panel unit roots and co integration tests

As a first step, we determine the order of integration of the three variables in our data. Testing for unit root is performed using the panel unit root test (2003; hereafter the IPS test), which is appropriate for balanced panels:

$$\Delta x_{it} = \alpha_i + \beta_i t + \gamma_i x_{it-1} + \sum_{j=1}^{h_i} \delta_{ij} \Delta x_{it-j} + \varepsilon_{it}$$

$i=1,2,\dots,N$ and $t=1,2,\dots,T$, where $x = GDP, INVES, HUM$, i and t denote cross-sectional unit and time, respectively, γ_i is the autoregressive root and h_i is the number of lags. The null hypothesis of this test each series in the panel are non-stationary processes.

They have proposed the following panel unit root test statistic $w(t-bar)$, which is applicable to heterogeneous cross-sectional panels:

$$w(t-bar) = \frac{\sqrt{N} \left(\bar{t} - \frac{1}{N} \sum_{i=1}^N E(t_{iT} / \gamma_i = 0) \right)}{\sqrt{Var(t_{iT} / \gamma_i = 0)}}$$

Where $E(t_{iT} / \gamma_i = 1)$ and $Var(t_{iT} / \gamma_i = 1)$ denote, respectively, the moments of mean and variance tabulated. The statistic $w(t-bar)$ approaches a standard normal distribution as N and $T \rightarrow \infty$

The panel unit root test results for GDP, INVES and HUM are summarized in Table 2. The decision of whether or not to reject the null hypothesis of unit root for the panel as whole is based on the $W[t-bar]$ statistic.

In level form, without including a trend and with a trend, the null

of non-stationary can be accepted for neither GDP nor INVES, nor for HUM (Figure 7).

When using the first differences, the null hypothesis can be rejected for delta-GDP, delta-INVES and delta-HUM without trend and with trend.

These results suggest that GDP, INVES and HUM are integrated of order one, I (1).

If series are non-stationary, then we consider the possibility of co integration and the introduction of an error-correction mechanism in the analysis.

If two series are co-integrated, then the shocks to one series will persist in the other, and the partial difference would be stable around a fixed mean. In this case the series are drifting together (“correcting”) at roughly the same rate; the error correction mechanism preserves information about both forms of covariation.

As a second step, we apply the panel cointegration tests developed. Persyn and Westerlund [34] offer the Stata code “xtwest” for the latter, which we thus incorporate below.

According to the test, the rationale is to test for the absence of cointegration by determining whether Error Correction exists for individual panel members or for the panel as a whole. Two different classes of tests can be used to evaluate the null hypothesis of no cointegration and the alternative hypothesis: group-mean tests and panel tests. Developed four panel cointegration test statistics (G_a , G_p , P_a and P_p)

These four test statistics are normally distributed. The two tests (G_p ,

P_p) are computed with the standard errors of estimated in a standard way, while the other statistics (G_a , P_a) are based on standard errors, adjusted for heteroscedasticity and autocorrelations.

By applying an Error-Correction Model in which all variables are assumed to be I(1), the tests proposed by examine whether cointegration is present or not by determining whether error-correction is present for individual panel members and for the panel as a whole.

Table 3 shows the results, in which the null hypothesis of no cointegration can be accepted for the panel statistics. The group statistics estimate whether the panel is integrated as a whole, while the panel statistics estimate whether at least one element isn’t cointegrated.

As the p-value approaches 1.000, the more likely we are able to accept the hypothesis that the series are not cointegrated.

Results obtained from the model with a constant and trend suggest that there is no cointegration for GDP, INVES and HUM.

The Pt and Pa statistics and the Gt test statistics and Ga test statistics indicate that the null hypothesis of no cointegration for GDP and HUM, for GDP and INVES and for HUM and INVES should be accepted.

The results show that GDP, INVES and HUM are non stationary in levels while the three variables are stationary first differences. They are said to be integrated of order 1 and become stationary after second differencing. This shows that the variables can be cointegrated. It would appear that the series might be not cointegrated indicating the absence of a long run relationship between GDP, INVES and HUM for some countries.

Variable	Levels		First differences	
	Constant	Constant and trend	Constant	Constant and trend
	W[t-bar] Statistic		W[t-bar] statistic	
GDP	-0.869	-2.53	-6.51***	-6.57***
INVES	-1.4	-2.28	-6.32***	-6.34***
HUM	-1.87	-2.11	-5.1***	-5.33***

Source: author’s computations.
Note: *** indicates significance at the P <0.01 level.

Table 2: Im-Pesaran-Shin Test for Unit Root in Panels for the full sample.

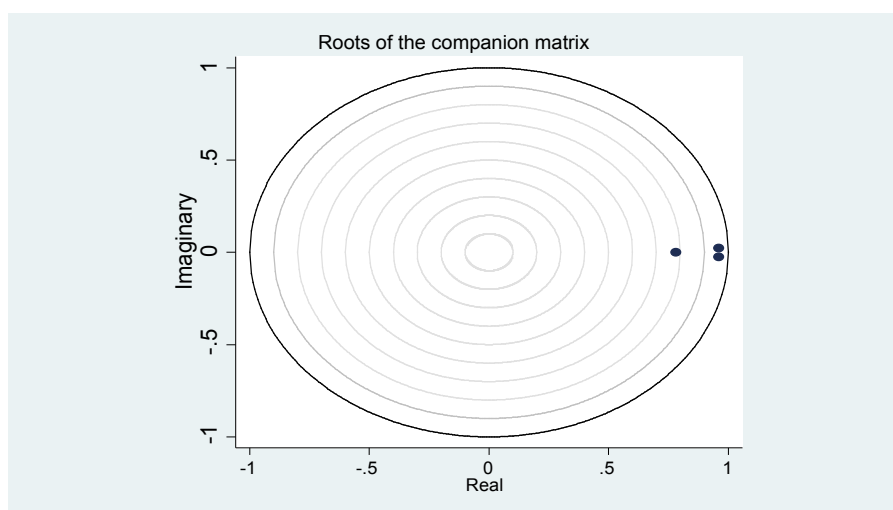


Figure 7: All the eigenvalues lie inside the unit circle, pVAR satisfies stability condition.

H₀: No Cointegration		With constant and trend			
		Statistic	Value	Z-value	P-value
H ₀ : GDP, HUM and INVES are not cointegrated	Group statistics	Gt	-1.058	2.373	0.991
		Ga	-3.788	1.903	0.979
	Panel statistics	Pt	-1.815	1.952	0.975
		Pa	-2.799	1.226	0.890
H ₀ : GDP and HUM are not cointegrated	Group statistics	Gt	-0.836	2.344	0.991
		Ga	-2.475	1.917	0.972
	Panel statistics	Pt	-1.749	1.496	0.933
		Pa	-2.272	0.986	0.838
H ₀ : GDP and INVES are not cointegrated	Group statistics	Gt	-0.570	3.005	0.999
		Ga	-1.295	2.402	0.992
	Panel statistics	Pt	-1.381	1.867	0.969
		Pa	-1.090	1.582	0.943
H ₀ : HUM and INVES are not cointegrated	Group statistics	Gt	-1.893	-0.288	0.387
		Ga	-8.493	-0.555	0.290
	Panel statistics	Pt	-3.856	-0.623	0.267
		Pa	-6.694	-1.241	0.107

Source: author's computations. The analysis was performed with the Stata 14 package.
 xtwest INVES GDP HUM, lags(1) leads(1) lrwindow(1) constant
 H₀: Excluded variable does not Granger-cause Equation variable

Table 3: Results of the Westerlund-based Panel Cointegration tests.

The economic implication of the absence of cointegration is that there is an instable equilibrium long run relationship among the variables GDP, INVES and HUM.

Panel vector auto regression: GMM estimation

At this level we consider the generalized method of moments (GMM) estimators for panel vector autoregression models (PVAR) with fixed individual effects. The first difference GMM estimator is implemented. In addition to the GMM-estimators we contribute to the literature by providing specification tests (Hansen over identification test, lag selection criterion and stability test of the PVAR polynomial) and classical structural analysis for PVAR models such as orthogonal and generalized impulse response functions and forecast error variance decompositions.

In testing causality with panel data sets, we should consider the different sources of heterogeneity of the data generating process (heterogeneity between cross-section units).

The empirical results presented in this paper are based on a bivariate causality test between the four variables stated earlier. There are three sets of bidirectional hypotheses to be tested:

1. Education Granger causes economic growth and vice versa;
2. Education Granger causes investment and vice versa;
3. Investment Granger causes economic growth and vice versa.

In order to examine the three hypotheses, suitable econometric models are required. The Granger-causality test is based on the appropriate models like vector autoregression (VAR). We consider three multivariate systems in our analysis, namely, growth investment and Education (1), Investment growth and Education (2) and Education growth and Investment (3)

The following VAR equations can be specified:

$$GDP_{it} = \sum_{j=1}^p \alpha_{1j} GDP_{i,t-j} + \sum_{j=0}^p \beta_{1j} INVES_{i,t-j} + \sum_{j=0}^p \gamma_{1j} HUM_{i,t-j} + \varepsilon_{1it} \quad (1)$$

$$INVES_{it} = \sum_{j=1}^p \alpha_{2j} INVES_{i,t-j} + \sum_{j=0}^p \beta_{2j} GDP_{i,t-j} + \sum_{j=0}^p \gamma_{2j} HUM_{i,t-j} + \varepsilon_{2it} \quad (2)$$

$$HUM_{it} = \sum_{j=1}^p \alpha_{3j} HUM_{i,t-j} + \sum_{j=0}^p \beta_{3j} GDP_{i,t-j} + \sum_{j=0}^p \gamma_{3j} INVES_{i,t-j} + \varepsilon_{3it} \quad (3)$$

$$\varepsilon_{kit} = \theta_{ki} + u_{ki,t} \quad k = 1,2,3 \quad i = 1,2,3$$

Following Andrews and Lu (2001), one period lag is taken, since this has the smallest MBIC, MAIC and MQIC.

While we also want to minimize Hansen's J statistic, it does not correct for the degrees of freedom in the model like the model and moment selection criteria by Andrews and Lu. Based on the selection criteria, we fit a first-order panel VAR model with the same specification of instruments as above using GMM estimation implemented by pvar. Although Granger causality for a first-order panel VAR may be inferred from the pvar output above, we still perform the test using pvargranger as an illustration.

The estimation results for the PVAR model based on the efficient two-step system SYS-GMM approach are reported in Table 4 which presents the results of the panel VAR estimation for the full sample of countries and for each country. We present the effect of changes in a given variable on another.

The direct effect of one variable (X) on another (Y), given the past history of the variable (Y). Our analysis attempts to determine whether changes in a given variable have a lasting impact on other variables and whether the behavior of a variable may help predict the future path of other variables.

The results related to equation (1) are presented in the first four lines of Table 5. When we focus on growth as the dependant variable, we find that it is highly persistent with an auto regression coefficient of 0.9 for the full sample of countries and surprisingly, it is not highly affected by past investment. Firms will increase their investment in the present is less costly when growth is high. Investment is less costly when growth is high, firms will increase this investment in the present if they expect growth rates to decline in the future.

According to equation (2), when investment is dependent variable, we find that it has a high degree of inertia 0.805 for the full sample of countries.

lag	CD	J	P value	MBIC	MAIC	MQIC
1	.9999913	30.1994	.3052692	-109.2498	-23.8006	-58.46124
2	.9999905	22.86059	.1960044	-70.10556	-13.13941	-36.2465
3	.999988	7.013784	.6356842	-39.46929	-10.98622	-22.53976

Selection order criteria : Sample: 1979-2013
No. of obs=17, No. of panels=5, Ave. no. of T=35.000

Table 4: Panel VAR lag order selection on estimation sample.

	All	Algeria	Egypt	Morocco	Tunisia	Turkey
To GDP						
Equation 1: Growth investment and education						
GDP (-1)	0.910*** (51.29)	0.957*** (20.91)	0.920*** (87.42)	0.711*** (17.97)	0.877*** (28.18)	0.545*** (9.73)
INVES (-1)	0.0396** (3.09)	0.0196 (1.00)	0.0499*** (5.80)	-0.000435 (-0.02)	0.0330* (2.52)	0.127*** (6.55)
HUM (-1)	0.0620* (2.53)	0.0526** (3.11)	0.0834*** (5.29)	0.340*** (6.43)	0.207*** (3.84)	0.709*** (7.06)
To INVES						
Equation 2: Investment growth and education						
GDP (-1)	-0.0305 (-0.32)	3.132*** (6.18)	0.460*** (13.67)	-0.586*** (-4.85)	-0.054 (-0.35)	-1.193*** (-5.23)
INVES (-1)	0.805*** (11.35)	-0.0102 (-0.05)	0.474*** (17.22)	0.908*** (17.48)	0.96*** (7.81)	1.223*** 15.99)
HUM (-1)	0.291** (3.18)	-0.577*** (-4.96)	-0.921*** (-13.38)	0.780*** (9.54)	0.144 (0.93)	1.999*** (5.27)
To HUM						
Equation 3: Education growth and investment						
GDP (-1)	-0.0324 (-1.48)	0.164*** (4.98)	-0.00206 (-0.12)	-0.213** (-3.25)	-0.044** (-3.17)	0.210*** (9.64)
INVES (-1)	0.0361** (3.12)	0.0630*** (5.39)	0.0220*** (5.70)	0.107*** (4.27)	0.041*** (5.15)	0.0560*** (-6.32)
HUM (-1)	0.965*** (38.12)	1.038*** (82.38)	0.941*** (26.56)	1.050*** (22.39)	0.964*** (43.57)	0.698*** (17.50)
N	175	35	35	35	35	35

t S
statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001
L(0.5).(gdp, invest, hum)
eststo: pvar gdp inves hum if id=5, instl (0/4)

Table 5: Panel vector autoregression: GMM Estimation.

For the full sample and each country, estimate of the equation (2) indicates education variables were all statistically significant with expected signs but except Algeria an Egypt.

Contrary to our expectation, the coefficient estimate for the growth variable was negative and statistically significant for Morocco and Turkey.

But it is negatively preceded by economic growth. Growth encourage new investment is observed only in Egypt and Algeria.

We now turn to equation (3). When we consider education as the dependent variable, we find a significant and positive impact of the lagged investment on education with the expected signs. The variable GDP was insignificant. The contributions of the lagged variable education are almost higher large times than the investment.

For each country except Turkey, the lagged variable investment has a significantly positive direct effect on the education.

For the full sample, lagged growth does not have a robust relationship with education

For each country, the lagged growth has a positive and significant relationship with education for Turkey. For the others countries like Algeria, Morocco and Tunisia, this relationship are significantly negative.

In sum, our empirical results also indicate the existence of a direct effect to the education on growth and investment. The growth has a negative coefficient sign with investment and education.

The estimation results for economic growth equation show that the lagged variables investment and education are statistically significant and of expected signs. Only investment is statistically insignificant for Algeria and Morocco.

We see that investment and education cause increase in growth 0.04% and 0.05%. We find that the impact of lagged growth on the investment and education does no change significantly for each country. An increase of investment will have a positive and significant impact on economic growth one year later.

In order to assess the two-way effects among growth, investment and education variables, we compute impulse–response functions of the PVAR. Additionally, we report variance decompositions derived from the orthogonalized impulse–response coefficient matrices.

First, we first check the stability condition of the estimated panel VAR. The resulting Table 6 and graph of eigenvalues confirms that the estimate is stable.

Second, Figure 8 plots impulse–response functions with 5 per cent errors bands generated through Monte Carlo simulations with 500 repetitions.

We recognize that impulse–response functions describes the reaction of one variable to innovations in another variable of the system, while holding all other shocks equal to zero.

An impulse to the education and investment variables increases the GDP per capita. Similarly, an impulse to the investment variables increases education.

In summary, it is clear to show that education induces economic growth and increases investment. The response to a shock in the education has the expected positive dynamics. The economic growth responses to education and investment shocks turn out to be positive and show a higher degree of persistence.

Third, Table 7 reports variance decompositions derived from the orthogonalized impulse–response coefficient matrices. The variance decompositions display the proportion of movements in the dependent variables that are due to their own shocks versus shocks to the other variables, which is done by determining how much of an s-step ahead MSE forecast error variance for each variable is explained by innovations to each explanatory variable (we report until 10).

The variation of economic growth

At period 10, 13.5% of the variation of economic growth is explained by past investment level and 7.60% by past education level, while 78.9% by past economic growth rate. The variation of economic growth rate can be explained by past investment level in the long-run while a slight part of these variations are related to education.

The variation of investment

At period 10, 27.7% of the variation of investment is explained by past economic growth, 9.5% by past education level and 27.7% by past investment. That means education shocks are important for explaining investment level in the long-run, although growth shocks account for about more than one-third.

The variation of education level:

At period 10, 81.7% of past education levels explain the variation of education and 1% of past education levels explain the same variation, while 17.21% of past investment explain the variation of education.

Real	Eigenvalue	
	Imaginary	Modulus
.9636338	.0296732	.9640905
.9636338	-.0296732	.9640905
.7527629	0	.7527629

Table 6: Eigenvalue stability condition.

In the long-run horizon, investment account for more part in the explanation of education level.

The link from education to enhanced economic growth is especially expected to work through the investment channel of human capital, which has been tested highly significant in the PVAR (1) estimation results.

If we look, for example, at the response of economic growth to a shock in education, we see the following reaction. In both cases, the impulse–response functions show a significantly negative adjustment process, which only fades out gradually.

The empirical results presented in this paper are calculated within a simple Granger-causality test in order to test whether education and investment “Granger cause” economic growth and vice versa.

Granger causality tests

After fitting a VAR, we may want to know whether one variable “Granger-causes” another (Granger 1969). A common method for testing Granger causality is to regress y on its own lagged values and on lagged values of x and tests the null hypothesis that the estimated coefficients on the lagged values of x are jointly zero.

There are three different types of situation in which a Granger-causality test can be applied: In a simple Granger-causality test there are two variables and their lags. In a multivariate Granger-causality test more than two variables are included, because it is supposed that more than one variable can influence the results. Finally Granger-causality can also be tested in a VAR framework; in this case the multivariate model is extended in order to test for the simultaneity of all included variables.

For each equation and each endogenous variable that is not the dependent variable in that equation. For each equation in a VAR (each endogenous variable that is not the dependent variable in that equation), vargranger tests the hypotheses that each of the other endogenous variables does not Granger-cause the dependent variable in that equation.

Table 8 reports the three Wald tests for each equation. The coefficients on all the lags of an endogenous variable are jointly zero.

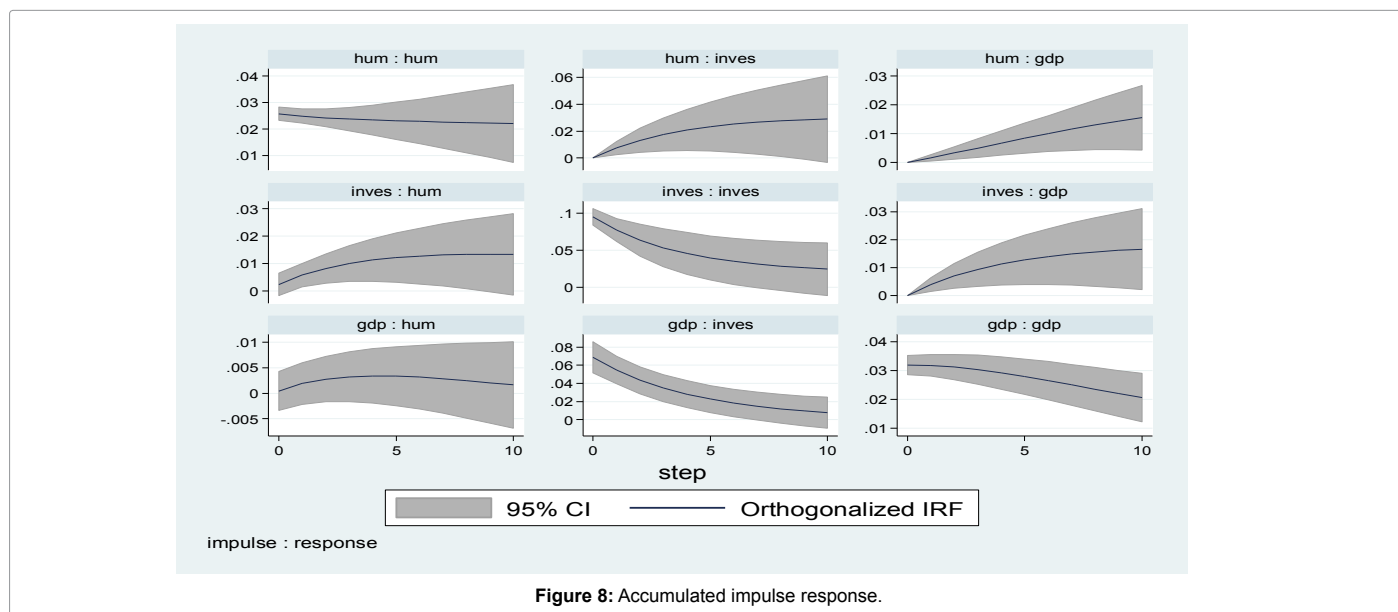


Figure 8: Accumulated impulse response.

Horizon	Impulse response to GDP			Impulse response to INVES			Impulse response to HUM		
	GDP	INVES	HUM	GDP	INVES	HUM	GDP	INVES	HUM
1	1	0	0	0,344	0,656	0,000	0,000	0,008	0,991
2	0,991	0,007	0,001	0,339	0,658	0,002	0,003	0,029	0,968
3	0,975	0,021	0,004	0,333	0,659	0,008	0,006	0,053	0,941
4	0,954	0,037	0,009	0,326	0,658	0,016	0,008	0,077	0,915
5	0,929	0,054	0,016	0,318	0,656	0,027	0,010	0,099	0,891
6	0,903	0,072	0,025	0,310	0,652	0,039	0,011	0,119	0,870
7	0,875	0,089	0,036	0,301	0,646	0,052	0,012	0,136	0,853
8	0,847	0,106	0,048	0,293	0,641	0,066	0,012	0,150	0,839
9	0,818	0,121	0,061	0,285	0,634	0,081	0,011	0,162	0,827
10	0,789	0,136	0,076	0,277	0,627	0,095	0,011	0,172	0,817

Table 7: Variance decomposition for economic growth, investment and education.

Equation\Excluded		chi2	df	Prob> chi2
GDP	INVES	9.563	1	0.002
GDP	HUM	6.419	1	0.011
GDP	ALL	19.880	2	0.000
INVES	GDP	0.101	1	0.751
INVES	HUM	10.112	1	0.001
INVES	ALL	17.534	2	0.000
HUM	GDP	2.181	1	0.140
HUM	INVES	9.747	1	0.002
HUM	ALL	11.428	2	0.003

Table 8: Panel VAR-Granger causality Wald test.

For the first equation (GDP), the null hypothesis that investment does not Granger-cause economic growth can be rejected. Similarly, we accept an alternative hypothesis of causality between education and economic growth. The third Wald test indicates that we can reject the null hypothesis that investment and education, jointly, do not Granger-cause economic growth.

For the second equation (INVES), we accept the null hypothesis that economic growth does not Granger-cause investment. We can reject the null hypothesis that education does not Granger-cause investment. We can reject the null hypothesis that economic growth and education, jointly, do not Granger-cause investment.

For the third equation (HUM), the null hypothesis of investment does not cause education was rejected. We can accept the null hypothesis that economic growth does not Granger-cause education. Similarly, we reject the third test is with respect to the null hypothesis that the coefficients on the two lags of all the other endogenous variables (investment and economic growth) are jointly zero.

We conclude that granger causality can either be uni-directional between economic growth and investment and between education and economic growth or bidirectional between education and investment.

Ho: Excluded variable does not Granger-cause Equation variable

Ha: Excluded variable Granger-causes Equation variable

pvar gdp inves hum , instl(0/4)

We then use xtgcause to test for the causality from education to economic growth and from education to investment, which correspond to the tests reported in Table 9. The idea to determine the existence of causality is to test for significant effect of past values of x on the present value of y which implements a procedure recently developed by Dumitrescu and Hurlin [35] (hereafter DH) in order to test for Granger causality in panel datasets. Using Monte Carlo simulations, DH have shown that the test exhibits very good finite sample properties, even with both T and N small.

		Causality from			
		INVES to HUM	HUM to INVES	HUM to GDP	GDP to HUM
ALL	Zbar	2.67**	2.25**	8.62***	1.87*
	Lag order	2	1	3	1
Algeria	Zbar	2.32**	3.15***	3.31***	2.49**
	Lag order	7	3	4	7
Egypt	Zbar	22.18***	-2.82***	-1.804*	2.35**
	Lag order	7	3	4	2
Morocco	Zbar	6.53***	2.07**	2.15**	2.71***
	Lag order	2	2	2	2
Tunisia	Zbar	-2.75***	8.97***	-2.37**	-1.85*
	Lag order	4	4	3	2
Turkey	Zbar	-1.97*	1.705*	1.74*	2.809**
	Lag order	5	2	2	3

Null hypothesis : Y does not Granger-cause X
*, ** and ***: Reject H0 at 10%, at 5% and at 1% level of significance. xtgcause

Table 9: Results of causality test.

Lags specify the lag structure to use for the regressions performed in computing the test statistic.

The results of the causality tests are presented in Table 4 [36-38]. For all countries, we can conclude that the education is Granger cause of investment after one year but investment is Granger cause of education after two years.

The education is Granger cause of economic growth after three years but economic growth is Granger cause of education after one year.

It is very important to perform the Granger test for different countries and the results should not be sensitive to the different countries. As can be noticed from Table 5, for Morocco and Turkey, education is Granger cause of economic growth and of investment with a 10% significant level. Investment is Granger cause of education in Morocco and in Algeria.

Education Granger – causes economic growth after two years in

Turkey and Morocco three years in Tunisia and four years in Algeria and Egypt whereas economic growth Granger – causes education after two years in Egypt, Morocco and Tunisia, three years in Turkey and seven years in Algeria.

We observe that in the couple economic growth-education, education affects growth first in Algeria and Turkey whereas growth affects education first in Egypt, Morocco and Tunisia. We could conclude that in the case of Egypt, Morocco and Tunisia, education follows economic growth.

According to this test, the education Granger-causes investment after two years in Morocco and Turkey three years in Algeria and Egypt and four years in Tunisia but investment Granger-causes education after one year.

We can conclude that the relationship between education and economic growth exhibits bidirectional causality. A change in education will affect economic growth and a change in education will similarly affect economic growth.

There is also a bi-directional relationship between education and investment, implying that a change in education will affect investment and vice versa.

Conclusion

Our objective in this paper is to examine the relationship direction between economic growth, education and investment. We used an econometric panel data approach for five MENA countries over the period of 1975-2014, where the three variables are considering simultaneously. Material capital formation (investment) is also included in the model along with these two variables, education and economic growth. We consider that education is an investment in human capital, similar to investment in better equipment.

First, the main finding is provided by the estimation of panel vector autoregression (VAR). It shows that education has a greater impact in determining physical capital investment than economic growth. A 1% increase in education across the 5 countries constitutes an increase of approximately 0.29% on investment and 0.06% on economic growth.

In addition, a 1% increase in investment across the 5 countries brings an increase on economic growth of approximately 0.04%. Finally, a 1% increase in investment across the 5 countries leads an increase of approximately 0.04% on education.

Second, utilizing Granger Causality within the framework of a panel model, the results suggest that there is strong causality running from education and investment to economic growth with no feedback effects from economic growth to education and investment.

The results show a presence of short-run bi-directional causality between investment and education. This implies that education and investment are interconnected in short-run, which also supports the feedback hypothesis indicating that the investment drives the education in mentioned countries, and vice versa. In addition, the investment has contributed to education and economic growth during the sample period.

Third, according to Granger Causality test, we observe that causality between education and economic growth runs in both directions with an optimal lag of 3 from education to economic growth and with an optimal lag of 1 from economic growth to education. Similarly, our findings suggest that the causality between education and investment runs both ways, but after 2 years from investment to education and

after 1 year from education to investment. It implies that feedback effects are significant for growth, for investment and for education. The investment affects the education after 2 years, but education affect investment after only one year.

Dynamic analysis shows that changes in investment and education help predict future changes in growth. Furthermore, changes in investment help to predict future changes in investment.

The main conclusion from dynamics analysis at annual frequencies is that education helps predict growth and investment exerting a positive influence on future outcomes of these variables. Increases in growth are led by surges in investment and in education.

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