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Human Capital, Infrastructure and Economic Growth in Arab World: A Panel Granger Causality Analysis

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Abstract

This study investigates the causal-relationships between human capital and economic growth, and between infrastructure and economic growth in Arab World countries. The study covers the period from 1974 to 2013 using annual data obtained from the World Bank. Most importantly, the study uses advanced Granger causality for panel data with fixed coefficients which introduced by Venet and Hurlin. The full sample has been divided into a sub-groups according the income level, namely, rich countries and non-rich countries, to check if there any existence of the structural differences. The results indicate that the causal-relationships between variables of interest are highly heterogeneous in Arab World. However, there is a feedback relationship between human capital and economic growth and between infrastructure and economic growth in the full sample countries and rich countries group. Also, the results found a one-way causality running from economic growth to human capital and infrastructure in non-rich countries group.

Keywords: Human capital; Infrastructure; Economic growth; Arab world; Granger-causality

Introduction

The impact of human capital and infrastructure on economic growth is a well-investigated issue, for instance, human capital influence the growth positively while infrastructure contributes to the development of a country in various ways. Although the impact of human capital and infrastructure on growth is a proven-topic, but the causal-relationship between them and growth remains a much-debated issue. for example, school attainment enhances individuals' income and contributes more positively to the economic growth, also, health improvement has positive significant impact on economic growth as well as income levels of families and individuals [1-4]. Moreover, infrastructure development has had positive significant impact on economic growth in most of the studies conducted to test the relationship between them, in fact, infrastructure facilitates trade and investment by reducing the cost associated with the production of goods and services [5-9].

The importance of human capital in a country or an economy is critical in the economists' thinking; however, the proxy of human capital was a debated issue[1]. In this regard, most of the empirical studies have used education and health to proxy human capital. Most importantly, while most of developing countries achieved a noticeable improvement in term of human capital, most of Arab countries still need more development in their human capital stock to start benefit more positive impact from human capital on economic growth. However, United Nation Development Program has reported an improvement in the human development in most of Arab World[2]. In other hand, infrastructure critical enhance economic development and growth, in fact, the relationship between infrastructure and economic growth is evidently critical to promoting continues economic growth and sustainable development [5]. For instance, high cost of energy, Internet and transport is the major economic growth deflator and is partly associated with the continued marginalization of the economies in most Arab countries. Further, investment in roads reduces the transportation cost while ports, airports and other logistics infrastructure facilities, reduce the cost associated with trade. This will not only improve the competitiveness of firms in the global market, but also will enhance the development activities in the region. In fact, infrastructure development supports most of the economic activities, such as an input into production and also increases the marginal productivity of other capital that used in the production process [9]. Arab World is a resource-rich region, with great oil and natural gas reserves, the Arab economy consist of oil, tourism, telecommunication and trade. However, the economic development in the region has a significant difference between the rich Arab countries such as UAE, Qatar, Kuwait and Saudi Arabia, and the poor Arab countries like Comoros, Djibouti and Mauritania. The study covers 20 Arab countries, in this regard; the study will divide the full sample countries into two groups according to the income level, namely, rich countries and non-rich countries[3]. The rest of the paper organized as follows; section 2 is literature review, section 3 is data and empirical models, section 4 is econometrics results and discussion, section 5 is conclusion.

Literature Review

Lucas [10] extended the work of Solow [11] to include human capital in the growth model; Lucas used school attainment to check the

[1]Many economists has focused on education as a proxy of human capital, for instance, Lucas (1988) extended the work of Solow (1956) to include school attainment in the growth model. The inclusion of education in the growth model continued in the work of other economists (Barro, 1991; and others). Also, Barro argue that there are two kind of human capital, education human capital and health human capital, thus, Barro, (1996) has included health in the growth model as a proxy of human capital. Since that, economists started using health to proxy human capital, meanwhile, education still one of the human capital's proxies in the empirical studies.

[2]For more information regarding human development and human capital in Arab World, please refer to (http://hdr.undp.org/en/content/human-development-index-hdi).

[3]Rich countries' group contains countries with GDP per capita above USD 10 000 while non-rich countries group contains countries with GDP per capita below USD 10 000.

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impact of education achievement on economic growth, he concluded that more education will generate more growth. In same line, the inclusion of education human capital continued in work of Barro [12] who examined the impact of school enrolment on economic growth. Further, government spending on education has also been used to proxy human capital to check its impact on economic growth, the impact was positive and statically significant [13]. Moreover, the definition of human capital has been expanded to include health as a proxy of human capital; in this regard, health human capital contribute positively on economic growth [14]. However, the impact of health on growth might be either positive or negative; this debate is a much-complicated issue due to the idea that, the nonlinear relationship[4] might be exist [15]. Gyimah-Brempong and Wilson [16] found strong and positive impact from health human capital on economic growth in Sub-Saharan Africa and in OCED countries; they suggested that increased stock oh health human capital leads to higher economic growth. Moreover, empirical results suggested that education and health economic growth contribute positively and significantly to the economic growth and development in a country [17-22]. Also, investment in infrastructure development facilitates trade and doing business in a country as well as reduces the cost associated with production of goods and services which result in enhancing the economic growth [23-26]. Further, too much investment in infrastructure may harm economic development and growth, in such case, the efficiency of the economy might be slowed down, and therefore, the economic growth may get negative impact from the infrastructure [27].

Most importantly, few studies have tested the Granger-causality between growth and human capital or infrastructure, none of these studies has conducted in Arab World countries. For example, Pradhan and Bagchi [20] found a bidirectional relationship from economic growth to transport infrastructure in India, their results suggest that economic growth is granger causing development of infrastructure in the country. Further, while there is a feedback relationship between economic growth investment in infrastructure in China, there is only one-way causal relationship running from human capital to economic growth [28]. Moreover, Glewwe et al. [29] concluded that there is a bidirectional relationship from human capital to economic growth, but they noted that the impact of human capital on growth in Africa is lower than other regions. However, Edrs found a feedback relationship between economic growth and infrastructure beside feedback relationship between human capital and economic growth in African countries. Edrs used advanced panel Granger causality analysis to test the causal nexus between human capital, infrastructure and economic growth in Africa, he argue that the feedback relationships among variables are exist.

Theoretical Base, Data and Empirical Models

Theoretical base

Testing the causality relationships between two or more variables has been introduced by Granger [30] to allow for understanding the nature of the direction of the impact. Granger suggested that, in a simple model of two variables X_t and Y_t, we say that Y_t is causing X_t if we are better able to predict X_t using all available information than if the information apart from Y_t had been used. Since-then, testing the causality has been improved by the work of Granger [31] Granger [32] Granger and Engle [33]. The needs of applying the Granger-causality in a form of panel data[5] has shown-up in the work of Venet and Hurlin [34], they extended the Granger [30] causality definition to be applied to a panel data with fixed coefficients. Hurlin [35] Hurlin [36] Dumitrescu and Hurlin [37] continued extending the Granger [38] time serious causality test to apply it to panel data with fixed coefficients.

[4]In the modern economists' thinking, the relationship between health and growth has found to be positive until certain level, and then the impact of health might be negative on growth after that level. This idea still a debated-idea supported by a few empirical studies, while others economists are believe in the positive significant impact of health on economic growth of a country.

Data

This study uses annual data obtained from the World Bank; the data covers the period from 1974 to 2013, and covers 20 Arabian countries. The study uses Real GDP to proxy the economic growth, school enrollment to proxy human capital and access to electricity to proxy infrastructure. Besides, to robustness check the results, the study uses sub-indicators of human capital and infrastructure, namely, government spending on education and health to proxy human capital, internet users and access to water to proxy infrastructure. Table 1 shows the data descriptions, such as definition, unit of measurement and sources. Table 2 reports the descriptive statistics of the variable used in the study that are GDP, human capital (school enrollment) and infrastructure (access to electricity) (Tables 1 and 2).

Empirical models

Following the contribution of Venet and Hurlin [34], Hurlin [35], Hurlin [36] and the work of Law et al. [39], the study uses the following formulas to test the Granger-causality between human capital, infrastructure and economic growth:

To test for the causality running from human capital and infrastructure to economic growth, the study uses the following Equation:

$$lnGDP_{i,t} = \alpha_i + \sum_{k=1}^{v} \lambda_i^{(k)} lnGDP_{i,t-k} + \sum_{k=0}^{v} \beta_i^{(k)} lnX_{i,t-k} + \varepsilon_{i,t} \quad (1)$$

To test for the causality running from economic growth to human capital and infrastructure, the study uses the following Equation:

$$lnX_{i,t} = \alpha_i + \sum_{k=1}^{v} \lambda_i^{(k)} lnX_{i,t-k} + \sum_{k=0}^{v} \beta_i^{(k)} lnGDP_{i,t-k} + \varepsilon_{i,t} \quad (2)$$

[5]Granger (2003) avow that the causality test needs to be extended to a panel data, then the efficiency of the test will be improved due to the large observations' number than in the time serious test. Venet and Hurlin (2001) and Hurlin (2004) developed advanced Granger-causality approach for fixed coefficients panels directly derived from the autoregressive vector representation with a fixed coefficients.

Variable	Description	Measurement	Source
GDP	Real GDP	Current USD	WDI, World Bank
FDI	Net inflows	% GDP	WDI, World Bank
SCH	School enrollment	% Gross	WDI, World Bank
PEE	Public expenditure on education	% GDP	WDI, World Bank
PEH	Public expenditure on health	% GDP	WDI, World Bank
IU	Internet users	Each 100 person	WDI, World Bank
ATE	Access to electricity	% Population	WDI, World Bank
ATSW	Access to safe water	% population	WDI, World Bank

Table 1: Data description.

	lnGDP	lnH_{SCH}	$lnIF_{ATE}$
Mean	32,3113	35.88564	33.895321
Standard deviation	1.4453	3.65564	4.774535
Minimum	28.4483	0.334247	3.884539
Maximum	36.4432	75.55435	63.77866

Table 2: Descriptive statistics.

Where, *GDP* is economic growth, *X* is human capita o infrastructure's indicator, *i* indicates the country (i = 1,…, N), *t* indicates time (t = 1, …, T), *v* is lags and $\varepsilon_{i,t}$ refers to the white-noise error term.

All variables have been expressed in logarithms (ln). Schwarz and Akaike information criteria with a maximum number of three lags have been used to choose the number of lag length. Also, the panel is balanced and lag orders *v* are identical for all countries in the panel. $X_{i,t}$ is said to cause $GDP_{i,t}$ if past values of $X_{i,t}$ have a significant impact on $GDP_{i,t}$ in addition to the past values of $GDP_{i,t}$ and same for all variables.

Homogenous non-causality hypothesis (HNC):

$$H_0 : \beta_i^{(k)} = 0 \forall i = 1,\ldots,N, \forall k = 1,\ldots,v \quad (3)$$

$$H_1 : \beta^{(k)} \neq 0 \exists (i,k)$$

Hypothesis (3) indicates that there is no causal-relationship between the variables in all countries in the panel. Therefore, the slope coefficients associated with (lnX) in Equation (1), will be tested to equal to zero for all countries (i) and all lags (k).

To determine the existence of causal relationship, the test statistic should be calculated, to do so, the study uses the formula:

$$F_{HNC} = \frac{(\Omega_2 - \Omega_1)/Nv}{\Omega_1 / \{NT - N(1+v) - v\}} \quad (4)$$

Where, Ω_1 is the sum of squared residuals of Eq. (1), Ω_2 is the sum of squared residuals of Eq. (2), *N* is the number of cross-sectional units, *v* is the number of lags, and T is the time period.

Most importantly, if the F_{HNC} statistic is not significant; then we accept the hypothesis, which means that the variable of interest is not causing the other variable in the model in all units, then the test stop here. However, if the F_{HNC} statistic is significant, then we reject the hypothesis; which means that the variable of interest is Granger causing the other variable in the model in, at least one, and possibly all countries, then we proceed to test for the homogenous causality.

Homogenous causality hypothesis (HC):

$$H_0 : \beta_i^{(k)} = \beta^{(k)} \forall i = 1,\ldots,N \forall k = 1,\ldots,v \quad (5)$$

$$H_1 : \beta_i^{(k)} \neq \beta_j^{(k)}\ k \in (1,\ldots,v), \exists (i,j) \in (1,\ldots,N)$$

Hypothesis (5) demonstrates that there is a homogenous causality between the variables in all countries, if $\beta^{(k)}$ of all countries are identical for all lags *k* and not equal to zero; then we accept the hypothesis. That means variable of interest is Granger causing the othe variable in the model in all units/countries in a homogenous manner.

The study uses the following formula to calculate the test statistic

$$F_{HC} = \frac{(\Omega_3 - \Omega_1)/v(N-1)}{\Omega_1 / \{NT - N(1+v) - v\}} \quad (6)$$

Where Ω_3 is the sum of squared residuals of the restricted model and where one imposes the homogeneity for each lag k of the coefficients associated with the variable of interest in the test. If the test statistic value rejected the hypothesis, that doesn't implies the non-existence of the causal relationship but it implies that the process is not homogenous, and heterogeneous causality can be found. In this case, the test proceeds to examine the heterogeneous non-causality hypothesis.

Heterogeneous non-causality hypothesis (HENC): As mentioned before, the non-existence of homogenous causality implies that, at least in one country or/and in one group, the variable of interest is Granger cause the other variable in the model. Therefore, the coefficients of these subgroups will be tested against the null hypothesis (equal to zero). The sum of squared residuals from this restricted model $\Omega_{2,j}$ is compared to those from unrestricted equation Ω_1. To calculate the test statistic, the study uses the following formula:

$$F_{HENC} = \frac{(\Omega_{2,j} - \Omega_1)/(n_{nc}v)}{\Omega_1 / \{NT - N(1+v) - n_c v\}} \quad (7)$$

Where n_{nc} is the subset of panel countries in which β is constrained to equals zero, n_c is the subset of panel countries in which β is not constrained to equals zero. If we reject the hypothesis for the subgroup j, that means the variable of interest is granger cause other variable in the model for this subgroup.

Econometrics Results

Table 3 reports the results of panel unit root test for the variables that used in the study; the test conducted for the full-sample countries, and for each group. Most of the t-bar statistic failed to reject the null hypothesis of the non-stationary at the level, with trend and without trend. However, all t-bar statistics are rejected at the 5% level of significance level after the first differences. Thus, the panel data used in this study is stationary at the level at the first difference (Table 3).

Table 4 reports the results of the homogenous non-causality (HNC) and homogenous causality (HC) hypothesis based on Venet and Hurlin causality test for a panel data with fixed coefficients for Equations (1) and (2) (Table 4).

In the causality between human capital and economic growth, the results reject the HNC hypothesis for the full sample and all subgroups

	Full Sample		Rich Group		Non-Rich Group	
	Trend	No trend	Trend	No trend	Trend	No trend
Level						
lnGDP	-3.76	-1.55	-2.56	-0.22	-3.88	-1.27
lnH_{SCH}	-3.86**	-.1.64**	-3.98**	-1.54**	-4.55**	-1.74**
$lnIF_{ATE}$	-4.21	-2.86	-3.39	-1.76	-3.92	-1.73
First difference						
lnGDP	-6.06**	-3.05**	-4.22**	-2.98**	-4.78**	-3.25**
lnH_{SCH}	-4.54**	-2.34**	-5.88**	-2.93**	-4.76**	-1.88**
$lnIF_{ATE}$	-6.93**	-4.28**	-5.07**	-3.74**	-4.73**	-2.32**

Notes: ** Indicate significance at the 5% level. The number of lags is determined by the Schwarz criterion with a maximum number of three lags.

Table 3: Results of panel unit root test.

	X⇒GDP		GDP ⇒ X	
	F_{HNC}	F_{HC}	F_{HNC}	F_{HC}
Human capital H_{SCH}				
Full sample countries	1.66**	2.68***	3.27**	2.73**
Rich countries	3.11***	2.54**	1.95***	1.02***
Non-Rich countries	1.77**	2.94**	3.32***	2.67**
Infrastructure IF_{ATE}				
Full sample countries	1.63**	1.82**	2.95***	1.45**
Rich countries	3.88**	3.06**	3.88**	2.43***

Note: *** and ** denote significance at the 1% and 5% levels, respectively. X refers to human capital or infrastructure.

Table 4: Results of homogeneous non-causality (HNC) and homogeneous causality (HC).

in both directions. This means, at least in one group or country, there is a causal-relationship running from human capital to growth or from growth to human capital. Further, for the causality between infrastructure and economic growth, the results reject the HNC hypothesis in the full sample and all groups, which reveals that, at least in one group or one country there is a causal-relationship between infrastructure and economic growth. Therefore, the study proceeds to test the homogenous causality hypothesis, which reported in Table 4 in Column 3 and 4. Moreover, the results reject the HC hypothesis in the full sample and all groups for the causality running between human capital and economic growth as well as between infrastructure and economic growth. This implies that the causal-relationships among the variables are not homogenous and heterogeneous causality might be exist, thus, the study proceeds to test for the heterogeneous non-causality hypothesis in the full sample and all sub-groups.

Table 5 reports the results of heterogeneous non-causality hypothesis for the causal relationships between human capital, infrastructure and economic growth. First, in the causality between human capital and economic growth, the results indicate that there is a feedback relationship between growth and human capital, in both, full sample countries and rich countries' group. However, the results show that there is a one-directional causal relationship running from economic growth to human capital in the non-rich group. This reveals that, in non-rich group, more economic growth cause more human capital accumulation. The study's results are in line with Barro [1], Zhang and Zhuang [19], Park [40], Hanushek [41], who concluded that human capital is one of the economic growth determinants. However, the results suggested that, human capital doesn't cause economic growth in non-rich countries in Arab World countries, this is not implies that human capital is not important factor in the performance of the economies in that group, but it implies that human capital stock didn't yet reached that level to start enhancing the economic growth in this group (Table 5).

Second, in the causality between infrastructure and growth, the results rejected the null hypothesis in the full sample and rich group, which implies the existence of the bi-directional causal-relationships between growth and infrastructure. Nevertheless, the results indicated that there is a one-way causal relationship running from economic growth to infrastructure in non-rich group. The study's results are in line with Pradhan et al. [20], Herranz-Loncan [26] who found that infrastructure has positive significant impact on economic growth. However, infrastructure seems to not have a causal impact on economic growth in the non-rich Arab countries as supported by the results of the heterogeneous non-causality hypothesis.

To robustness check the results; the study uses sub-indicators to proxy human capital and infrastructure, namely, government spending on education and health, access to water and Internet users. Table 6 reports the robustness check' results (Table 6).

	X ⇒GDP	**GDP ⇒X**
Equations (3) and (4)	F_{HENC}	F_{HENC}
Human Capital: $H_{\_SCH}$		
Full sample	2.55***	1.59**
Rich Countries	2.38***	1.55**
Non-Rich Countries	3.77	2.43*
Infrastructure: IF_{ATE}		
Full sample	1.53***	2.94***
Rich Countries	2.65**	1.67**
Non-Rich Countries	3.55	2.78***

Note: ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively, X refers to human capital or infrastructure.

Table 5: Results of heterogeneous non-causality HENC.

Sample	**Indicator**		**GDP**
Full Sample Countries	Public expenditure on education	↔	GDP
	Public expenditure on health	↔	
Rich Countries Group	Public expenditure on education	↔	GDP
	Public expenditure on health	↔	
Non-Rich Group	Public expenditure on education	←	GDP
	Public expenditure on health	←	
Sub-infrastructure			
Full Sample Countries	Internet users	↔	GDP
	Access to safe water	↔	GDP
Rich Countries Group	Internet users	↔	GDP
	Access to safe water	↔	GDP
Non-Rich Group	Internet users	←	GDP
	Access to safe water	←	GDP

Notes: ↔ indicates a feedback relationship, → and ← indicate the causation direction.

Table 6: Robustness check.

Most importantly, the robustness check results confirm the main results of the study. For instance, there is a feedback causal relationships between human capital and economic growth in the full sample and the rich countries group, also, there is a one-way causal relationship running from economic growth to human capital in the non-rich group. Moreover, there is a bi-directional causal-relationship between economic growth and infrastructure in the full sample and in the rich countries group. Also, there is a one-direction causal relationship running from economic growth to infrastructure in the non-rich group, which reveals that the study's results are robust.

Conclusion

This study investigated the causal-relationships between human capital and economic growth, and between infrastructure and economic growth in Arab World countries. The study covered the period from 1974 to 2013 using annual data obtained from the World Bank. Most importantly, the study used advanced Granger causality for panel data with fixed coefficients which introduced by Venet and Hurlin [34]. The full sample has been divided into a sub-groups according the income level, namely, rich countries and non-rich countries, to check if there any existence of the structural differences. The results indicate that the causal-relationships between variables of interest are highly heterogeneous in Arab World. However, there is a feedback relationship between human capital and economic growth and between infrastructure and economic growth in the full sample countries and rich countries group.

Moreover, the results indicate that, these causal-relationships are not uniform at the different level of income. For instance, economic growth is Granger cause human capital in all groups, while human capital is Granger cause economic growth in full sample countries and in rich countries group. Likewise, economic growth is Granger cause infrastructure accumulation in all groups, while infrastructure doesn't cause economic growth in non-rich countries group. Most importantly, the study's findings need more explanation to get clear that through which channels these causal-relationships are working. For example, how human capital causes economic growth? How infrastructure' accumulation causes economic growth? Why

infrastructure causes economic growth in all groups and it's not in non-rich group? However, these questions could be answered by more deep investigation, and many studies can be conducted here, but we leave this for other researchers and our future research.

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