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MEASURING AND ANALYSING THE RELATIONSHIP BETWEEN ECONOMIC GROWTH AND HUMAN CAPITAL IN IRAQ USING LUCAS MODEL FOR THE PERIOD (2003-2020)

Prof. Dr. Sami Obaid Al-Tmimi[1], Baidaa Razak Hussein[2]

[1,2] Department of Economics, Faculty of Management and Economics, University of Basra

Email: [1]Samialtmimi88@gmail.com [2]badaaalzaidi@gmail.com

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ABSTRACT

This study deals with the topic of the relationship between economic growth and human capital in the Iraqi economy for the period 2003-2020 (using the Lucas model), which revealed the possibility of generating sustainable internal growth through the accumulation of human capital. As such, the higher the human capital, the higher the rate of economic growth. Our standard analysis concluded that the relationship between the accumulation of human capital and the time devoted to education, expressed in the average years of schooling, was significant. There is also a two-way causal relationship, and in a manner consistent with the logic of economic theory. The more knowledge and skills of human capital accumulate, the better the productivity of work, which pushes economic growth towards increase.

INTRODUCTION

Despite the importance of human capital in raising economic growth rates, the development challenges facing the Iraqi economy still exist. Therefore, the problem of investment in human capital emerges in terms of the diversity of its sources and financing to meet the requirements of renewal and development for all its tracks and stages. The issue of investment in human capital is not limited to just providing the necessary resources. Rather, it involves the adoption of planning and administrative methods that ensure the efficient use of these resources and their dependence on the generally accepted standards of creativity, innovation, quality and quality that have a comparative advantage in this field.

MEASURING THE RELATIONSHIP BETWEEN ECONOMIC GROWTH AND HUMAN CAPITAL USING JOHANSSON & ENGLE-GRANGER CAUSALITY.

A Description of The Data, The Variables, The Study Model, And the Methods Used in The Estimation.

Data Description

The study relied on data from the Ministry of Planning, the Ministry of Finance, and the Ministry of Education, for the period (2003-2020). The data of the study was also obtained from the World Bank database available at https://www.worldbank.org/ar/publication/human -capital

Study Variables

The study is based on two main variables: Economic growth, symbolized by (ht) and Human capital, symbolized by (Yt).

Study Model

For the purposes of this study, we use a linear regression model to determine the nature of the relationship between economic growth and human capital. The model was formulated according to the following formula:

$$H^* = \text{ſ} (1 - u) ht$$

Estimating the parameters of the model requires carrying out a set of statistical methods and tests, using the Eviews12 program.

The Methods Used for Estimating

For the purpose of studying the relationship between economic growth and human capital and in line with recent trends in the analysis of time series, which had a prominent role in making economic relations measurable and quantitative analysis, we will use the following methods:

- The two-step Angle-Ganger method.
- The Johansson & Johansson Method.
- Bounds method developed by Pesaran.
- Using Granger's causation methodology.

The Methodology Used for Estimating

We start by studying the stability of time series of the study variables in order to be able to examine the degree of integration of the time series of the variables. Then, we test the co-integration hypothesis and then we can test the causal relationship between the study variables. Accordingly, the study methodology will be based on the following statistical tests:

- Time series stability tests
- Cointegration Tests
- Causation tests

Testing The Relationship Between Economic Growth and Human Capital in Iraq.

In this section, we try to test the relationship between economic growth and human capital within the framework of the Lucas model, which was dealt with in some detail in the theoretical part of the study, according to the following methodology:

- Estimating the accumulation of human capital in Iraq (H*) within the framework of the Lucas model.
- Testing the relationship between economic growth and human capital using the ARDL model.
- Measuring the extent to which human capital contributes to economic growth within the framework of the production function.

The Accumulation of Human Capital in Iraq Within the Framework of The Lucas Model.

Lucas' model assumes a number of workers (L) in the economy, with a skill level ranging from zero to infinity ht ∈ (0, ∞). Accordingly, the total number of workers with a skill level or the total human capital stock in the economy is (h* = ht. L), and the effective level of workers is (u. ht. L). Each worker with a skill level (ht) allocates a portion of their time (u) to work in the production sector, while the remaining time (1 - u) is devoted to the education sector to the formation of skills and knowledge (human capital formation).

Thanks to the inclusion of human capital in the model, it is possible to explain how (ht) levels affect production, and how the time allocation between (u) and (1-u) affects the accumulation of human capital.

The accumulation of human capital is a stock of knowledge and skills that accumulates over time according to the following formula: $H^* = \delta (1 - u)ht$

The terms run as follows:

H* = growth rate of human capital accumulation
δ = effectiveness or speed of human capital accumulation
U = Ratio of time devoted to production, where ($u < 1 < 0$)
(1- u) = Remaining percentage of time devoted to education (human capital formation)

Researchers usually use the average years of schooling (Yst) as a measure of the time devoted to education, or the time needed to form human capital, and this relationship can be tested by estimating the following model:

$Lnht = \beta 0 + \beta 1 LnYst + \mu t$

Ht = er.yst

The terms run as follows:

ht = human capital formation
Yst = Average years of schooling
r = income of investment in education
μt = the random variable that explains the change in the accumulation of human capital that was not explained by the independent variables (average years of study).

In order to estimate the above model, it is necessary to calculate the average years of schooling first, and the income of investment in education secondly, in order to be able to estimate the accumulation of human capital (ht) and then replace the latter in the above model. With regard to the average years of schooling in Iraq, it was calculated according to the following equation, which was prepared by the researchers based on (Alwash, 2020) and as follows:

$$Yst = \frac{LKi}{TL} \times wki$$

The terms run as follows:

Lki = Number of employees for each given level of education.
TL = total number of employees.
Wki = weight for each specific educational level: primary 6 years, intermediate 9 years, preparatory 12 years, diploma 14 years, bachelor 16 years, higher diploma 17 years, masters 18 years, doctorate 21 years. The results of the assessment are shown in the following table:

Table (1): Average years of schooling in Iraq by educational level for the period 2003 – 2020.

Years	School years by educational level (%)								Average years of schooling
	Primary	Middle	Secondary	diploma	university	Higher Diploma	Master's	PhD	
2003	0.88	0.63	3.05	2.75	3.09	0.06	0.17	0.1	10.731
2004	0.8	0.58	2.44	3.28	3.76	0.07	0.23	0.13	11.286
2005	0.79	0.59	2.26	3.23	4.04	0.09	0.25	0.17	11.417
2006	0.75	0.61	2.02	3.86	3.81	0.08	0.29	0.23	11,642
2007	0.75	0.59	1.95	3.64	4.23	0.1	0.33	0.23	11,823
2008	0.73	0.6	1.97	3.74	4.11	0.11	0.32	0.23	11,808
2009	0.75	0.57	1.89	3.58	4.25	0.1	0.32	0.22	11,693
2010	0.73	0.55	1.92	3.53	4.38	0.1	0.33	0.23	11.767
2011	0.73	0.54	1.85	3.58	4.49	0.09	0.34	0.25	11.867
2012	0.7	0.52	1.81	3.51	4.65	0.08	0.36	0.26	11.877
2013	0.7	0.52	1.72	3.53	4.79	0.08	0.35	0.26	11,947
2014	0.68	0.51	1.72	3.47	4.84	0.09	0.34	0.26	11.915
2015	0.66	0.5	1.72	3.51	4.91	0.09	0.36	0.28	12.017
2016	0.63	0.51	1.74	3.71	4.98	0.09	0.38	0.32	12,352

2017	0.7	0.54	1.81	2.11	6.07	0.09	0.41	0.34	12.08
2018	0.68	0.52	1.72	2.76	5.63	0.09	0.39	0.33	12.103
2019	0.67	0.5	1.68	2.93	5.59	0.09	0.38	0.33	12.172
2020	0.68	0.52	1.74	3.21	5.18	0.09	0.37	0.31	12,096

Source: It was calculated by the researchers using the aforementioned equation.

It can be noted from the table above that the average years of schooling increased from approximately (10 years) in 2003 to approximately (11 years) during the period (2004-2014), and then to approximately (12 years) during the period (2015-2020). Therefore, it is likely that this leads to the accumulation of human capital in Iraq. As for the income of investment in education in Iraq, it was estimated according to the following equation, which was prepared by the researchers based on (Alwash, 2020) and as follows:

$$\frac{GDP/_{G}}{Yst}$$

The terms run as follows:

R = rate of income of investment in education.
G = total spending on education and health.
GDP = gross domestic product.
Yst = average years of schooling.

The result of the assessment is shown in the following table:

Table: (2): The rate of income of investment in education in Iraq for the period (2003 – 2019)

year	Spending on higher education	Spending on education	spending on health	sum	2007 GDP = 100	Output total spending	Average years of schooling	Income rate
2003	288550	1429392	1540650	3258592	101845262	31.254	10.731	2.912
2004	441780	1406643	728116	2576539	103568449	40,197	11.286	3.561
2005	604863	1564040	1128921	3297824	109368369	33.164	11.417	2.904
2006	911089	1944946	1676684	4532719	111455813	24,589	11,642	2.112
2007	1850359	3501379	2251281	7603019	120626517	15,866	11,823	1.341
2008	1969375	5613294	2938220	10520889	124702847	11,853	11,808	1.003
2009	2223481	4665392	3137096	10025969	132687028	13.234	11,693	1.131
2010	2283822	5793963	3406172	11483957	142696722	12.426	11.767	1.055
2011	2741644	6931439	3956990	13630073	162587533	11.929	11.867	1.005
2012	3017539	7770292	4767103	15554934	174990175	11.250	11.877	0.947
2013	2677222	7410095	4147176	14234493	169557865	11.912	11,947	0.997
2014	2419577	7034582	3289603	12743762	183616300	14,408	11.915	1.209
2015	2218429	7513939	3203298	12935666	199532100	15.425	12.017	1.283
2016	2238779	1788784	1143731	5171294	201059400	38,880	12,352	3.147
2017	2281918	1783996	1317937	5383851	210532887	39.105	12.08	3.237
2018	2378418	1971288	1665899	6015605	225058367	37.412	12.103	3.091
2019	2198589	1793234	1726862	5718685	189398568	33.119	12.172	2.720

2020	2198589	1793234	1726862	5718685	189398568	33.119	12,096	2.738

Source: Calculated by the researchers using the abovementioned equation.

After calculating both the average years of schooling and the rate of income of investment in education, we can get the human capital (ht) and then the stock or accumulation of human capital (h*) as shown in the following table:

Table (3): Human capital in Iraq for the period (2003 – 2020).

Year	total workforce L	Human capital ht))	Stock or accumulation of human capitalht. L))h*=
2003	1080231	1.002976	1083446
2004	1225954	1.003982	1230835
2005	1256983	1.003258	1261078
2006	1332711	1.002424	1335942
2007	1391028	1.00159	1393240
2008	1344627	1.001198	1346238
2009	1469044	1.001316	1470978
2010	1471659	1.001233	1473473
2011	1512231	1.001192	1514034
2012	1566070	1.001119	1567823
2013	1670512	1.001195	1672509
2014	1688014	1.00143	1690427
2015	1661094	1.001502	1663589
2016	1534100	1.003984	1540212
2017	1495131	1.003911	1500978
2018	1587526	1.003727	1593443
2019	1646188	1.003338	1651683
2020	1580329	1.003355	1585631

Source: Calculated by the researchers, with the exception of the column for the total workforce.

It can be noted from the above table that the accumulation of human capital reached (1083,446) in 2003 and continued to rise until it reached (1651683) in 2020, except for the decline in 2008. This may be ascribed to the impact of the financial crisis on the Iraqi economy. This is visibly felt in the decrease in demand for oil and then the decrease in oil revenues and consequently the decrease in spending on the human development sectors (health and education). There was also the decrease in the period (2015-2017) due to the war with ISIS on the one hand and the drop in oil prices on the other.

By estimating the previous model by the method of least squares OLS, we found that the relationship between the accumulation of human capital and the time

devoted to education, expressed in the average years of schooling, is significant, as shown in the following estimation equation:

LnH = 6.048366 + 3.301575 Lnyst + tf't

Since the parameter of average years of schooling is significant and positive, it can be said that the Iraqi economy is subject to the assumptions of the theory of internal growth according to the Lucas model. Then, it can be said that human capital is an engine of economic growth.

Note that the time devoted to education, expressed as the average years of schooling, explains 0.75 of the accumulation of human capital in Iraq. This appears from the value of the modified coefficient of determination R2, and that 0.25 is due to other factors (such as experience and training) included in the random variable tf' and that the model is statistically acceptable. As shown in the probability value of the F statistic, there is no autocorrelation as demonstrated by the DW test. The results of the assessment are shown in the following table:

Table (4): Estimating the relationship between human capital and average years of schooling in Iraq.

Dependent Variable: LNHT
Method: Least Squares
Date: 01/07/22 Time: 11:26
Sample: 2003 2020
Included observations: 18

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	6.048366	1.110132	5.448330	0.0001
LNYST	3.301575	0.449679	7.342068	0.0000

R-squared	0.771121	Mean dependent var	14.19837
Adjusted R-squared	0.756816	S.D. dependent var	0.121925
S.E. of regression	0.060126	Akaike info criterion	-2.680323
Sum squared resid	0.057841	Schwarz criterion	-2.581393
Log likelihood	26.12291	Hannan-Quinn criter.	-2.666682
F-statistic	53.90596	Durbin-Watson stat	0.987964
Prob(F-statistic)	0.000002		

Source: E-Views12 outputs

Before we move on to studying the contribution of accumulated human capital to economic growth in Iraq through the production function, it is necessary to test the extent to which the long-term relationship between the two variables exists or not.

Testing The Long-Term Relationship Between Economic Growth and Human Capital Using the ARDL Model

The ARDL model combines Autoregressive Model (AR) and Distributed Lag Model (DL). Therefore, it is one of the most advanced methods for estimating econometric models for time series. It is used to study the co-integration of two non-integrated series of the same degree. To ensure a common integration relationship in the VECM model, Pesaran and Narayan offer a modern approach to verifying the balance between variables under the Unfettered Error Correction Model (UECM) through the bound testing method. The ARDL model is a dynamic model as it involves time lags, through which relationships can be measured in both the short and long term. The time series is a function of slowing down and slowing down the values of the current explanatory variables by one or more periods. ARDL has a number of advantages compared to other traditional tests such as Johansen and Engle-Granger, the most important of which are: (Ziad and Mohammed, 2019, 61) (Assaf, 2018, p. 43).

1) The ARDL can be used regardless of the degree of integration of the time series, whether it is stable at level I(0), or first-order integral I(1), or a mixture of both provided that it is not second-order integral I(2).
2) ARDL results are more accurate and have better properties in the case of short time series (small samples) in contrast to most conventional co-integration tests.
3) The ARDL model is based on the Unconstrained Error Correction Model (UECM), which has better properties in handling residuals in the short term.
4) It allows the introduction of a larger number of time delays until the optimal situation is reached.
5) The ARDL model takes into account the structural changes in the time series of variables over time.
6) It is possible to estimate the short-term and long-term compounds simultaneously at the same time, as well as separating the effects of the long-term from the short-term, where the integrative relationship of the dependent variable and the independent variable in the short and long term is determined by the same equation.
7) The parameters of the ARDL model estimated in the short and long term are more consistent compared to other methods such as Johannes and Engel-Kranger method.
8) The ARDL model helps to get rid of the problems related to variable elimination and autocorrelation problems and thus the resulting parameters are unbiased and efficient.

In view of the above considerations, the ARDL model was adopted in this study to estimate the long-term relationship between economic growth and human capital in Iraq. The ARDL model includes two main steps:

a) To test the existence of the long-term relationship, that is, the co-integration between the study variables.
b) In the case of co-integration between the variables, the analysis can be completed to measure the short-term and long-term relationship between the variables.

The ARDL model is based on three types of tests:

1) Tests before estimating the model:

Before estimating the model, it is necessary to ensure the stability of the time series through unit root tests, and to choose the optimal deceleration period for the model, as well as to carry out diagnostic tests for the model and as follows:

Time Series Stability Test

There is a difference between stationary and non-stationary time series. In the time series, their levels change with time, while the medium in them remains constant over a long period of time, as it does not contain a general trend or seasonal fluctuations. Shocks are temporary in stable time chains and their impact fades over time as well as due to long-term mid-term values (Assaf, 2018, p. 32). Accordingly, the time series is stable if it varies around a fixed arithmetic mean with a common variance and variance that has nothing to do with time, i.e.: (Sagheer, 2019, p. 39).

$E(Yt) = E(Yt+k) = u$
$VAR(Yt) = VAR(Yt+k) = y$
$Cov(Yt, Yt+k) = cov(Yt+k, Yt+k+s)$

Unstable time series contain permanent elements, therefore the medium or variation depends on time for the unstable time series and constantly changes towards increase or decrease. This makes the time series unstable and has no long-term medium so that the chain mechanism returns.

Since most macroeconomic time chains are vector-oriented and therefore unstable such as economic growth, physical and possibly human capital as well, the use of oil with unstable time chains leads to a spurious Regression and thus obtain incorrect and misleading results in terms of standard analysis. For example, the R2 identification coefficient may produce a higher t test value than its real value, and the DW test may be less than they are, while the variables used in the analysis are not linked by any relationship.

Based on this, the stability of time series is an important, fundamental and necessary condition when studying and analysing time series. There are many statistical methods used to detect the stability of economic time series, including drawing method and unit Roots Tests, the most important of which are:

- Dickey and Fuller (DF).
- The Augmented Dickey and Fuller (ADF).
- Phillips Perron (PP) test.
- Kwiatkowski - Phillips - Schmidt - Shin (KPSS) test

In view of the criticism directed at the first three tests that produce incorrect decisions as regards short time series (sample size is small) (Batal, 2020, p. 10), we will rely on the KPSS test. This choice is based on the latter test's appropriateness to the time series of this study, and it also tests the hypotheses differently from the previous tests in that:

- The null hypothesis: the stability of the time series H0 : Yt ~I(0)
- Alternative Hypothesis: Time Series Instability.

We accept the null hypothesis (stability) if the LM value is less than the critical values suggested by Kwiatkowski *et al*. (Sagheer, 2019, p. 52).

After applying the KPSS test to determine the stability of the time series used in the model represented by economic growth and human capital, whether at their original level or after taking the first difference in two models (fixed, fixed and general trend) and using the E-Views12 program, the following results were reached:

Table (5) KPSS Test

Source: Prepared by the researcher based on the results of E-Views12

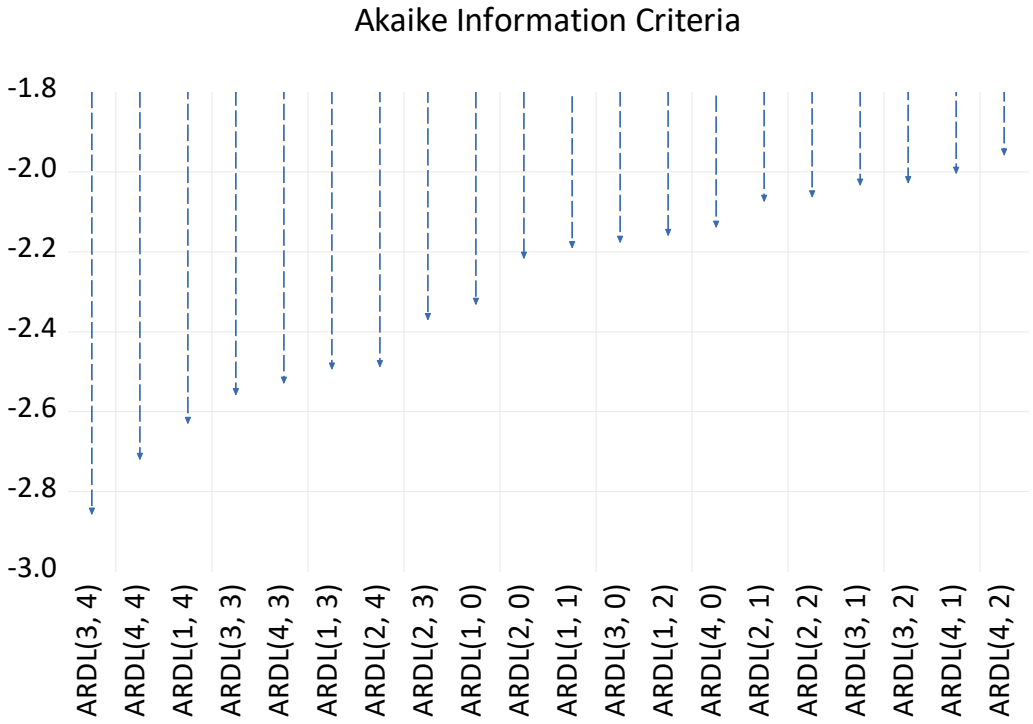
The following can be noted from table:

- The stability of the time series of economic growth LnG at the level, whether using the model of constant or constant and trend. This is because the calculated LM statistic value is less than the tabular value of Kwiatkowski et al. At a significant level of 1%. That is, the series is integrated of degree I(0).
- The stability of the LnH human capital time series at the level, whether using a constant or a constant and trend model. This is because the calculated LM value is less than the tabular value of Kwiatkowski et al. At the level of significance (1%). That is, the series is integrated of degree I(0).

Determining the optimal slowdown period for the ARDL model

The optimal slowdown period is defined as the time period that ensures that there is no autocorrelation between the residuals (Assaf, 2018, pp. 37-38). The distributed slowdown autoregressive model has a dynamic mechanism to determine the number of slowdown periods or the optimal number of time delays for building the model using the statistical program Eviews12. The model (ARDL, 3,4) was obtained, which means that the model identified three slow-down periods for the economic growth variable and four slow-down periods for human capital. Figure (1) shows the relative superiority of the chosen model compared to other models.

Figure (1): The relative superiority of the ARDL model according to the AIC standard.



Diagnostic Tests

Before adopting the ARDL model, 3,4) chosen by the Akaike information criterion (AIC) to be used in estimating the long-term model, the quality of the performance of this model should be ascertained. This can be obtained by conducting the following diagnostic tests:

i. The Jarque – Bera Test . Normal Distribution Random Error Test.

The JB test is used to ensure that the random errors of the model are normally distributed. This is obtained by testing the following hypotheses:

- The null hypothesis: Errors are normally distributed.
- Alternative Hypothesis: Errors are abnormally distributed.

We accept the null hypothesis in the event that the probability of Prob. (Jarque – Bera) is greater than the level of significance (5%).

The practical application showed that the probability of Prob. (JB = 0.87), which means that the null hypothesis is accepted and the alternative hypothesis is rejected, that is, the errors are distributed with a normal distribution.

ii.LM Test

The LM test is used to ensure that there is no self-correlation between errors. This is obtained by testing the following hypotheses:

- The null hypothesis: There is no sequential autocorrelation between errors.
- Alternative hypothesis: There is a sequential autocorrelation between errors.

We accept the null hypothesis in the event that the probability of Prob.(F-Statistic) is greater than the significance level 5% and the practical application showed that the probability of Prob.(F-Statistic = 0.54). This means accepting the null hypothesis and rejecting the alternative hypothesis that is, there is no sequential autocorrelation between mistakes.

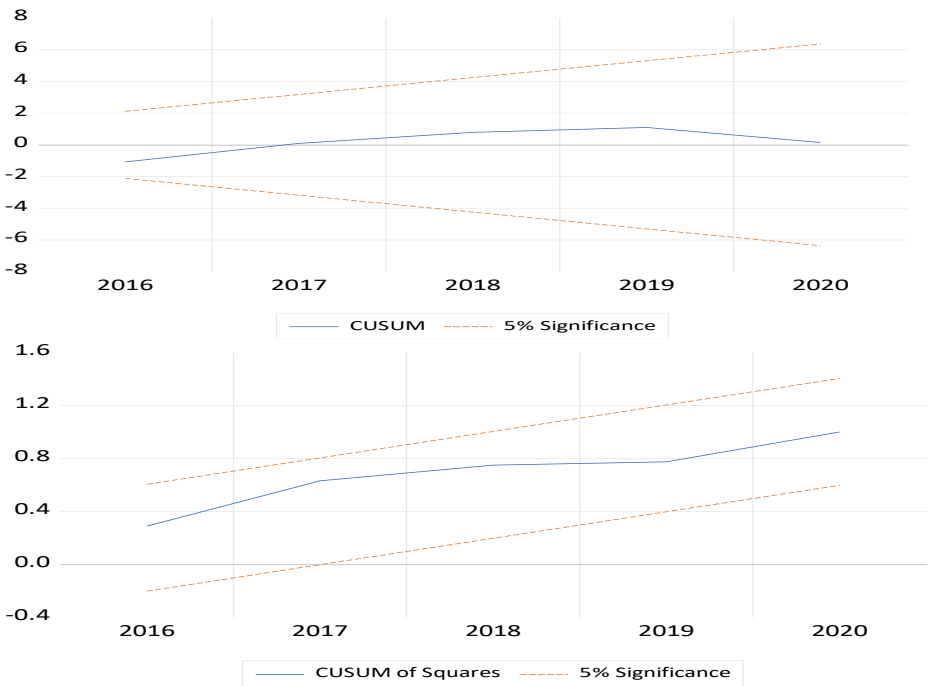
iii.Heteroscedasticity Test

This test is used to ensure the homogeneity of the variance of errors by applying the Brusch – Pagan – Godfrey test and testing the following hypotheses:

- The null hypothesis: the homogeneity of the variance of errors.
- Alternative hypothesis: heterogeneity of error variance

We accept the null hypothesis in the event that the probability of Prob. (F – Statistic) is greater than the level of significance (5%) and the practical application showed that the probability of Prob. (F – Statistic = 0.91). This means accepting the null hypothesis and rejecting the alternative hypothesis i.e. homogeneity of errors. The following table summarizes the results of the aforementioned diagnostic tests.

Table (6) Diagnostic Test Results



Source: Prepared by the researchers based on the results of E-Views12

After confirming the integrity of the model from the structural problems of serial autocorrelation and error variance, and that the errors are subject to a normal distribution, we can test the long-term equation relationship between the model variables using the co-integration methodology as well as testing the short-term relationship using the error correction limit methodology.

Estimation of the Autoregressive Distributed Lag (ARDL) Model

After ensuring the stability of the model's time series represented by economic growth and human capital and its stability in the level according to the KPSS test, and then determining the optimal lag period according to the AIC standard, as well as the diagnostic tests of the model, we directly used the E-Views12 program to estimate the model (ARDL, 3,4). However, before adopting the model in estimating the long-term relationship between the study variables, it is necessary to test the structural stability of the model

Tests After Estimating the ARDL Model

Stability Model

To ensure that the data used in the study is free from the presence of any structural changes, one of the appropriate tests must be used, namely: cumulative sum control chart (CUSUM) or the cumulative sum of squares of residuals test (CUSUM of Squares). These two tests are considered among the most important tests in this regard for two important considerations: the first is to show the existence of any structural change in the data, and the second is the extent of its stability and the consistency of long-term parameters with short-term parameters.

The structural stability of the estimated parameters of the error correction formula of the ARDL model is achieved if the graph of the tests of (CUSUM), (CUSUM of Squares) falls within the critical limits at a level of significance of (5%).

After the practical application of the abovementioned tests, it becomes clear that the model is structurally stable, as shown in the following two figures:

Form (2) CUSUM Tests, (CUSUM of Squares).

Coenitagration

To find out whether there is a long-term equilibrium relationship between the model variables, we apply the ARDL Bound Test to ensure the existence of co-integration between economic growth and human capital. This is obtained by testing the following hypotheses:

- The null hypothesis: There is no co-integration between the model variables.

- Alternative Hypothesis: There is a co-integration between the model variables

The null hypothesis is rejected and the alternative hypothesis accepted if the value of F is greater than the upper limit of the critical values suggested by (Pesaran et. al. 1999) at a significant level (1%, 2.5%, 5%, 10%).

The table shows the results of the Bound Test. It becomes clear from this table that the F-Statistic is greater than the upper limits of Pesaran. Therefore, it can be said that there is a co-integration between the variables of the model, that is, the existence of a long-term equilibrium relationship from the independent variable (human capital), towards the dependent variable (Economic growth).

Table (7): Bound Test

ARDL Bound Test **Null Hypothesis : No Long Run Relationships exist**		
Test Statistic	Value	**K**
F – Statistic – Model 1	6.78	**1**
Critical Value Bounds		
Significance	l0 Bound	**l1Bound**
%10	3.02	**3.51**
%5	3.62	**4.16**
%2.5	4.18	**4.79**
%1	4.94	**5.58**

Source: Prepared by the researchers based on the results of E-Views12

Error Correction Model

Proving the co-integration between the model variables in the previous step enables us to test the error correction model (ECM). This is to measure the short-term relationship on the one hand, and to measure the speed of adjustment (adaptation) to rebalance the dynamic model, which takes the following formula:

$$\Delta LGt=\propto 0+ECTt-1+i=12\oint i\Delta LGt-1+\delta\Delta Lht$$

The coefficient of the error correction limit should be significant and with a negative sign, the value of which lies between (ECM (-1)>-1>0). Note that the negative sign of the error correction coefficient means that there is an imbalance in the long-term, which means that there is a need for some mechanism for the occurrence of short-term adjustments. While the significance of the error correction coefficient indicates the existence of a co-integration relationship of the explanatory variable (independent) towards the dependent variable. (Assaf, 2010, p. 63).

The results of the practical application of the ARDL model,3,4), using the statistical program E-Views12, showed that the error correction factor is statistically acceptable (0.69 >-1- > 0). This reveals the speed of return of the economic growth variable towards equilibrium in the long run equal to (0.69). In other words, deviations from long-term economic growth have been corrected by a rate of (69%). On the other hand, the significance of the error correction coefficient (Prob. Coint.Eq(-1) = 0.003) indicates the existence of a joint integration relationship of human capital towards economic growth, and that the error correction mechanism is present in the model. As shown in the following table:

Table: (8)

ARDL Error Correction Regression
Dependent Variable: D(LNG)
Selected Model: ARDL(3, 4)
Case 2: Restricted Constant and No Trend
Date: 01/07/22 Time: 15:07
Sample: 2003 2020
Included observations: 14

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNG(-1))	-0.141594	0.247391	-0.572348	0.5919
D(LNG(-2))	-0.701772	0.286296	-2.451211	0.0579
D(LNHT)	0.533602	0.273844	1.948566	0.1089
D(LNHT(-1))	-0.932097	0.323403	-2.882157	0.0345
D(LNHT(-2))	-1.358117	0.356445	-3.810175	0.0125
D(LNHT(-3))	-0.625916	0.300253	-2.084628	0.0915
CointEq(-1)*	-0.690081	0.129240	-5.339524	0.0031

R-squared	0.805519	Mean dependent var	0.039224
Adjusted R-squared	0.638821	S.D. dependent var	0.072529
S.E. of regression	0.043589	Akaike info criterion	-3.121187
Sum squared resid	0.013300	Schwarz criterion	-2.801659
Log likelihood	28.84831	Hannan-Quinn criter.	-3.150765
Durbin-Watson stat	1.896053		

* p-value incompatible with t-Bounds distribution.

Error correction model (economic growth is a dependent variable and human capital is an independent variable)

Causality Test Under the ARDL Model

The long-term causal relationship can be tested by the error correction coefficient (ECM (-1))). If the value of the coefficient is significant and negative, this indicates the existence of a long-term causal relationship from the independent variable towards the dependent variable (Al-hayd, 2018, p. 150). This requires us to estimate two models to correct the error, one of which is economic growth as a dependent variable and human capital as an independent variable, and the second makes human capital as a dependent variable and economic growth as an independent variable.

The first model was estimated and it became clear to us that the error correction coefficient Coint.Eq(-1) =- 0.69 is negative and significant. This means that changes in human capital cause changes in economic growth. It remains for us to estimate the second model, and the results of the estimation are shown in the following table:

Table (9)

ARDL Error Correction Regression
Dependent Variable: D(LNHT)
Selected Model: ARDL(1, 0)
Case 2: Restricted Constant and No Trend
Date: 01/07/22 Time: 20:28
Sample: 2003 2020
Included observations: 17

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CointEq(-1)*	-0.446547	0.096339	-4.635170	0.0004

R-squared	0.486628	Mean dependent var	0.022402
Adjusted R-squared	0.486628	S.D. dependent var	0.051286
S.E. of regression	0.036746	Akaike info criterion	-3.712541
Sum squared resid	0.021605	Schwarz criterion	-3.663528
Log likelihood	32.55660	Hannan-Quinn criter.	-3.707669
Durbin-Watson stat	1.759372		

* p-value incompatible with t-Bounds distribution.

Error Correction Model (Human capital is a dependent variable and economic growth is an independent variable).

It can be noted from the table above that the error correction coefficient Coint.Eq(-1)=- 0.44 also came negative and significant. This indicates the existence of a causal relationship of economic growth towards human capital, or in other words that changes in economic growth cause changes in human capital.

In light of the foregoing, it can be concluded that there is a two-way causal relationship, and in a manner consistent with the logic of economic theory. On the other hand, the increase in economic growth represented by the real GDP provides a greater possibility of spending on important sectors such as health and education. This enhances the possibility of accumulating human capital.

Measuring The Extent to Which Human Capital Contributes to Economic Growth Within the Framework of The Production Function

The last step is to measure the extent to which human capital contributes to Iraqi economic growth within the framework of the Cube-Douglas production function, which takes the following form:

$Y = A\ K\ h^{1-}$

By adding the natural logarithm, we get the following linear equation:

$$Ln\ Y\ =\ LnA\ +\ \beta LnK\ +\ (1-\beta)Lnh$$

For the purposes of quantitative measurement, the economic model can be rewritten as follows:

$$LnYt = \beta 0 + \beta 1 LnKt + \beta 2 Lnht + \xi t$$

The terms run as follows:

Yt = economic growth expressed in gross domestic product.
Kt = physical capital expressed as total fixed capital formation.
ht = human capital expressed as labour augmented by human capital (u. h. L).
β0 = constant coefficient.
β1 = coefficient that measures the contribution of physical capital to GDP.
β2 = coefficient that measures the contribution of human capital to the gross domestic product.

When applying the model in the Iraqi economy for the period (2003 - 2020) and using the E-Views12 program, we got the following estimated equation:

$$LnYt = 3.556980 + 0.481120\ Kt + 0.689244\ ht$$

It is clear from the estimation equation that both physical capital and human capital have a positive role in economic growth (GDP). However, the contribution of human capital (β2 = 0.69) is greater than the contribution of physical capital (β1 = 0.48). This can be explained in that GDP and then economic growth in Iraq depends largely on the oil sector, which is a capital-intensive sector that depends on oil technology and techniques in production processes. This requires a high level of human skills and knowledge, and perhaps that was the main motive for resorting to oil licensing rounds attracting international oil companies with human expertise and knowledge. In other words, the increase in human capital (domestic and foreign) contributed to an

increase in oil production, which is one of the most important components of Iraq's GDP.

It is worth noting that the human capital coefficient (β2 = 0.69) is exactly equal to the error correction factor that was estimated earlier Coint.Eq(-1) =- 0.69 (see Table 9). This means that deviations in economic growth can be corrected at a speed of 69% in the long run through human capital.

Note that the estimated model has high quality and is statistically acceptable, as evidenced by (Prob. (F-Statistic) and that the independent variables (physical capital and human capital) explain 94% of the changes that occur in economic growth as evidenced by the adjusted coefficient of determination (R2 = 0.94). The DW test confirms that there is no autocorrelation problem, and the results of the estimation are shown in the following table:

Table (10) Cobb-Douglas production function test in Iraq for the period 2003-2019

Dependent Variable: LNY
Method: Least Squares
Date: 01/08/22 Time: 14:13
Sample (adjusted): 2003 2019
Included observations: 17 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.556980	3.934558	0.904035	0.3813
LNK	0.481120	0.078843	6.102285	0.0000
LNH	0.689244	0.334058	2.063246	0.0581

R-squared	0.950182	Mean dependent var	18.77443
Adjusted R-squared	0.943065	S.D. dependent var	0.328580
S.E. of regression	0.078403	Akaike info criterion	-2.095134
Sum squared resid	0.086058	Schwarz criterion	-1.948096
Log likelihood	20.80864	Hannan-Quinn criter.	-2.080518
F-statistic	133.5113	Durbin-Watson stat	1.838685
Prob(F-statistic)	0.000000		

Source: E-Views12 outputs

CONCLUSIONS AND RECOMMENDATIONS

Conclusions: -

1) There is a two-way causal relationship, and in a manner consistent with the logic of economic theory, the more knowledge and skills of human capital are accumulated, the more labour productivity will improve, which pushes economic growth towards increase.
2) The increase in economic growth represented by the real GDP provides a greater possibility of spending on important sectors such as health and education, which enhances the possibility of accumulating human capital.

3) Both physical capital and human capital have a positive role in economic growth (GDP), but the contribution of human capital ($\beta 2 = 0.69$) is greater than the contribution of physical capital ($\beta 1 = 0.48$). This can be explained by the fact that economic growth in Iraq depends largely on the oil sector, which is a capital-intensive sector that depends on technology and oil techniques in production processes. This requires a high level of human skills and knowledge, and perhaps that was the main motive for resorting to oil licensing rounds and attracting international oil companies with human experience and knowledge. In other words, the increase in human capital (domestic and foreign) contributed to an increase in oil production, which is one of the most important components of Iraq's GDP.

4) Significant error correction coefficient (Prob. Coint.Eq(-1) = 0.003) indicates the existence of a co-integration relationship of human capital towards economic growth.

5) The Iraqi economy is subject to the assumptions of the theory of internal growth according to the Lucas model, and then it can be said that human capital is an engine of economic growth. Note that the time devoted to education, expressed as the average years of schooling, explains 0.75 of the accumulation of human capital in Iraq. This appears from the value of the modified coefficient of determination R2, and that 0.25 is due to other factors (such as experience and training) included in the random variable $t\vartheta$. The model is statistically acceptable as shown from the probability value of the F statistic, and no autocorrelation.

Recommendations:

1- Improving the adequacy of public spending in education and increasing the share of education in the government budget by enhancing investment spending and expanding the share of non-wage and salary expenditures. This enables improving the quality of education services and targeting the regions and groups most in need. A specific program should be adopted to address learning losses due to school closures and preparation for a safe return to it.

1- Addressing institutional and financial management challenges in education by clarifying roles and responsibilities among public sector bodies and levels of government charged with financing education in Iraq, assessing the needs of the Ministry of Education and provincial education directorates, and building their capacity to implement various policies in a coherent manner. This is particularly needed in the area of Capital investment in addition to the adoption of new policies to allocate resources from school infrastructure and teachers to achieve greater transparency, equity and efficiency.

2- Paying attention to the educational staff and working to develop it by including it in development courses annually during the summer vacation, as in some countries. The aim of these courses is learning about the experiences of others and benefiting from them as much as possible, and initiating the process of reforming the curricula to develop relevant skills and achieve competitive education at the national and global levels.

3- Improving the efficiency of public spending in the health sector through better allocation of available resources and prioritizing effective primary health care. It is necessary to implement a referral system through which those seeking primary health care can pay additional fees in order to relieve bottlenecks in

hospitals and enable them to focus on improving Secondary or tertiary level care. The efficiency of drug and medical supplies procurement as well as other major inputs should be improved.

4- Improving the efficiency of public spending in education through a better allocation of available resources within the education sector, increasing public spending per student in pre-university education compared to university education, and moving from the current ratio of (3.6%-2.5%) to be in line with international standards. This can be achieved by diversifying the sources of funding for universities in order to reduce their dependence on the government budget.

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