Anggaran: Jurnal Publikasi Ekonomi dan Akuntansi
Volume. 3, Nomor. 4, Desember 2025
E-ISSN .: 3031-3384, P-ISSN .: 3031-3392; Hal. 11-33
DOI: https://doi.org/10.61132/anggaran.v3i4.1839
Tersedia: https://journal.areai.or.id/index.php/anggaran

Analysis of the Dynamic Impact of Economic Growth on Human Development Indicators in Iraq (2004-2023)

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Abstract. This paper examines the dynamic relationship between the change in economic growth and the indicators of sustainable human development in Iraq between 2004 and 2023. The paper provides an example of what can happen when there is overdependence on oil and a lack of investment in the key areas of the economy, such as education and healthcare, which lead to negative outcomes in the human development indicators in Iraq. The paper uses highly sophisticated analytical and econometric tools to examine the relationship between GDP growth, per capita income, government spending, oil exports, and inflation and their effects on human development in Iraq. The findings show that there is a positive but weak relationship between economic growth and indicators of human development in Iraq. This underscores the need that appropriate policy recommendations be made aimed at diversifying the Iraqi economy and also investing more in human capital to facilitate sustainable economic growth and improvement in the quality of life of the Iraqi people.

Keywords: Economic Analysis; Education; GDP; Health; Human Development; Iraq; Iraqi Economy; Oil Dependency; Sustainable Development

1. INTRODUCTION

The relationship between the development of human beings and the development of a country's economy determines that the correlation between these two concepts is an essential research field within the economics branch since 2003. The problems of Iraq are several. Overdependence on petroleum revenue and a lack of financial resources to support basic services such as healthcare and education. The indicators of human development have suffered a blow, and so has the quality of life of a huge number of people due to these reasons. Through the sophisticated econometric techniques, this study examines the 2004-2023 Iraqi data and the relationship between economic growth and human development. The objective of the study is to assist policymakers in identifying mechanisms for improving the well-being of society besides enhancing economic growth in the long term.

There are several critical ways through which this study contributes to the existing literature. It starts by providing a critical examination of the relationship between economic growth and human development in Iraq and then goes on to give practical recommendations to policymakers. Second, it highlights key roadblocks that have been cited to hinder human development indicators, especially in healthcare and education, from achieving their full potential. Last but not least, it provides ways of diversifying the economy and examines the disadvantages of overreliance on oil. Finally, it contributes to the discussion on the economic

Naskah Masuk: September 18, 2025; Revisi: Oktober 30, 2025; Diterima: November 19, 2025; Terbit: November 22, 2025

policy framework of Iraq by showing how significant it is to invest in human capital to achieve long-term growth.

The oil-dependent economy of Iraq is very vulnerable to oil price changes in the world market and lacks many resources to invest in human development. Poor investment in education and health has increased the rate at which the living conditions are lowered. The relationship between economic growth and human development needs to be considered in policies that are effective in addressing these issues.

The investigation is aimed at achieving the following goals: (*a*) We will also analyze the complex aspects of the relationship between economic growth and human development indices in Iraq between 2004 and 2023 through the use of rigorous econometric tools. We aim to provide comprehensive information to policymakers through the analysis of this relationship. (*b*) To determine the extent to which the economic policy of Iraq has enhanced healthcare and education, to what degree the funds provided by the government are utilized to enhance human development, and to suggest the specific amendments to the economic policy. (*c*) An overview of issues with overdependence on oil to achieve long-term economic growth and human development, as well as the degree to which we are susceptible to price fluctuations and the significance of diversifying our economy. (*d*) To recommend how to better achieve long-term economic growth that is both evidence-based and consistent; this also involves proposing to spend more on healthcare and education and promoting a focus on both economic and human developments.

Literature Review

There has been a lot of research on how economic growth and human development are related, with a focus on Iraq's unique socioeconomic situation. This study synthesizes key concepts from recent literature, concentrating on the relationship between economic growth, human development indices, and the challenges arising from Iraq's economic reliance on oil. This study seeks to address deficiencies in the literature by examining prior research employing diverse econometric methodologies across a broad range of time periods.

Majeed (2025) scrutinized the relationship between economic growth and human development in Iraq from 1990 to 2024, emphasizing wealth inequality and the allocation of public funds. Based on information about GDP growth and income distribution, 10% of Iraqis are in the richest 10%, 40% are in the middle 10%, and 16.3% are in the poorest 10%. The governorate of Muthanna has the worst economy, with a monthly income of about 170,000 Iraqi dinars (USD 110). The research indicates that these disparities stem from economic inequality, as demonstrated by the significant salary disparity between public sector employees and individuals in highly specialized professions. Majeed suggested that policies be established to guarantee social protection for marginalized populations and to utilize information and communication technology (ICT) for job creation. This would enhance outcomes in human development.

Awad, Abbas, and Obed (2024) examined the correlation between sustainable development and economic growth in Iraq from 2004 to 2020 using the Autoregressive Distributed Lag (ARDL) model. The results indicate that health expenditure exerts a more substantial positive impact of 1.4%, education expenditure yields a modest positive effect of 0.3%, and per capita GDP growth contributes a 1.7% enhancement in sustainable development indicators. The long-term equilibrium shows how the variables are related to each other. The findings indicate that for Iraq to sustain its economic advancement, it must invest in education, healthcare, and living conditions. Expenditures on education yield minimal impact, underscoring distributional inefficiencies.

Hussein (2024) utilized the ARDL model to analyze the influence of three human development indicators—income, health, and education—on Iraq's GDP growth from 2003 to 2021. The study still found a consistent co-integrating connection, even though education (-50.4), health (-9.1), and income (-161.7) all had negative coefficients. This means that, surprisingly, technological progress in many areas has slowed down economic growth. This unexpected result may indicate that public expenditure is less efficient than anticipated or that there are inherent economic limitations. The study revealed that 42% of per capita GDP fluctuations are adjusted annually, indicating a short-term corrective mechanism. This shows how important it is to have targeted interventions that connect human development with economic goals.

Focusing on the impact of fluctuations in oil prices, Mohammed and Abbas (2018) examined the relationship between Iraq's GDP growth and human development indicators. The study utilized Ordinary Least Squares (OLS) regression to model human development indicators, including education, health, and the Human Development Index (HDI), as dependent variables in relation to poverty, unemployment, and the economic growth rate. The findings indicated that economic growth had a positive correlation (1.43), whereas poverty (-6.6) and unemployment (-1.8) exhibited a negative correlation with GDP. The findings indicated that education expenditure exerted no substantial influence, and the model accounted for merely a moderate proportion of the data ($R^2 = 58\%$), exhibiting only a tenuous statistical correlation ($F = 1.71$, $p = 0.28$). The study's findings indicate that attaining economic stability, especially by mitigating the effects of oil dependency, necessitates policies that foster human development.

Previous studies have identified regional disparities, inefficient public expenditure, and insufficient funding for healthcare and education as the primary factors contributing to Iraq's human capital dilemma. The World Bank (2021) says that adults in Iraq will only be able to reach 41% of their potential productivity, which is much lower than the regional average of 57%. Iraq is near the bottom of the Human Capital Index, just above Yemen. The problem gets worse because public services aren't evenly distributed. For instance, hospitals get 37% of the health care budget, while primary care only gets 13%. This imbalance is linked to a maternal death rate of 97 per 100,000 newborns, which is much higher than the global average. Between 2005 and 2014, Iraq's budget was very risky because 81% of government money came from oil. For every dollar drop in oil prices, the company would lose an incredible $14 billion in sales.

Additional research corroborates these findings. Darwesh and Qader (2022) used data from Iraq from 2005 to 2020 to find that GDP growth was positively linked to human development, with an estimated 0.37% rise in growth for every 1% rise in human development. Ali (2021) says that investing in education and training is important for getting the most out of economic growth, but Kamel (2024) says that specific policies are needed because the benefits of economic growth for social indicators don't always lead to environmental sustainability. The World Bank (2024) also pointed out other problems, such as a 36% unemployment rate among teenagers, a big difference in labor participation between men and women (10.6% for women compared to 68% for men), and a drop in the expected number of years of schooling from six to four. Economic shocks have created big problems for human development. For example, they have caused educational losses of 10 to 14 years and economic losses of more than $63 billion.

Iraq faces major problems that make it hard for its economy to grow and its people to thrive. These problems include its reliance on oil, political instability, and wasteful government spending. Muhammed (2022) says that between 2005 and 2019, high-income countries' GDP grew by 4.4%, while low-income countries' GDP grew by 2.7% per person. Health, education, and the environment have all gotten worse because of the problems. The UNDP (2022) says that without clear policies, economic growth could make inequality and environmental damage worse, which would not be enough to achieve sustainable human development. This research is distinguished by its extensive econometric methodology, longitudinal analysis (2004–2023), and emphasis on the rentier economy of oil-dependent Iraq. This research is distinguished by its use of credible indicators, including inflation, real GDP, GDP per capita, government expenditure, oil exports, and numerous others sourced from reputable entities such as the World Bank and the Iraqi Ministry of Planning. The study employs the ARDL model alongside extensive diagnostic tests to guarantee robust and dependable outcomes, offering comprehensive insights into the relationship between economic growth and human development in Iraq. This paper fills a gap in the literature by giving a thorough look at the link between oil dependence and investment in human capital. It also offers useful suggestions for long-term policy changes.

Hypothesis

The research indicates a positive correlation between Iraq's human development indicators (HDIs) and GDP growth, predicated on the assumption that GDP growth will enhance educational and health outcomes. There must be a fair distribution of economic and financial resources because Iraq's GDP per capita is going to rise a lot, which will greatly improve human development. The hypothesis posits that inflation adversely affects Iraq's human development indices and necessitates prompt intervention to rectify the situation.

2. METHODOLOGY

Evolution of Indicators of the Economic Situation in Iraq

The analysis of significant macroeconomic indicators in Iraq from 2004 to 2023, as outlined in Appendix (1), presents the following findings:

a) GDP at Constant Prices: The overall trend of output indicates a compound annual growth rate of 3.6% from 2004 to 2023, which points to a moderate long-term economic growth trajectory. The peak annual growth rate, noted in 2012 at 13.9%, suggests a strong recovery, possibly influenced by high global oil prices or a rise in oil production in Iraq. In contrast, a 12% decline was recorded in 2020, linked to the economic repercussions of the COVID-19 pandemic and diminished global oil demand, which affected actual productive activity in Iraq.

Furthermore, the years 2021 to 2023 have exhibited variations in output, marked by a growth rate of 7.6% in 2022, which was succeeded by a decline to 2.9% in 2023, underscoring the economic instability in Iraq. The observed instability arises from fluctuating oil prices and disruptions in local markets, which are influenced by fiscal and monetary policies, including changes to the foreign exchange rate between the dinar and the dollar.

The Iraqi economy's dependence on oil for its productive and economic metrics makes it vulnerable to external economic disturbances and variations, influenced by shifts in global oil prices as well as local, regional, and international political events.

b) Average GDP per Capita: The overall pattern of per capita growth reveals a compound annual rate of 1.1%, which is lower than the GDP growth rate in Iraq during the study period. This implies that population growth has lessened the effect of real economic growth on the lives of individual Iraqis. In 2019, the highest average per capita output reached 5392.8 thousand dinars, whereas the lowest was noted in 2005 at 3645.2 thousand dinars. A significant reduction of 14% in per capita output was observed in 2020, illustrating the impact of the COVID-19 health crisis on households in Iraq.

Overall, even with tangible economic growth in Iraq, there has been no significant enhancement in per capita income levels for the Iraqi population, indicating potential issues with wealth distribution or demographic strain on economic resources.

c) Oil Exports: The compound annual growth rate of oil exports has reached 4.2%, with an increase from 1.538 million barrels per day in 2004 to 3.470 million barrels per day in 2023. The peak annual growth rate, noted in 2015 at 19.2%, stands in stark contrast to a significant downturn of 13.6% in 2020, influenced by the economic fallout of the COVID-19 pandemic on worldwide markets and the Iraqi economy. In the years 2019 to 2023, oil production has shown notable fluctuations, with export growth rates varying between -13.6% and 9.6%. These changes can be linked to internal factors, including popular unrest and political instability during this timeframe.

Oil production continues to be the main engine of the Iraqi economy; however, this significant reliance on a single resource makes the economy vulnerable to external economic fluctuations.

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d) Government Expenditure: Government expenditure has experienced a compound annual growth rate of 8%, indicating a rising dependence on oil revenues to support public spending and an increasing reliance on public finances to invigorate the Iraqi economy. The most substantial rise in expenditure, noted in 2008 at 72.4%, can be associated with increased security threats during that period. Conversely, a notable decline of 43.8% in 2015 was attributed to the security crisis stemming from ISIS's control over certain areas of Iraqi territory, further exacerbated by a downturn in global oil prices. In recent years (2021–

2023), there has been a significant increase in expenditure, marked by a rise of 35.2% in 2021 and 21.8% in 2023, indicating fiscal policy initiatives aimed at enhancing the Iraqi economy.

In summary, government spending in Iraq exhibits significant volatility, heavily linked to oil revenues, highlighting the country's insufficient economic diversification.

e) Inflation Rate: The inflation trend in Iraq has shown considerable variations, with rates fluctuating from 26.8% in 2004 to 4.4% in 2023. The peak rate, noted in 2006 at 53.1%, emerged from heightened salaries for government sector employees and institutions, along with the government's choice to elevate the purchase prices of oil derivatives, leading to a significant rise in the overall price level during that year. In contrast, inflation saw a significant deflation of -19.2% in 2018, due to monetary policy measures implemented to stabilize foreign exchange rates and manage inflation in Iraq. Over the past few years (2019–2023), inflation has shown notable variability, with a deflationary rate of -0.2% recorded in 2019, an increase to 6.1% in 2021, followed by a decrease to 4.4% in 2023. The shifts observed were a result of fiscal policy interventions in the foreign exchange market, which led to adjustments in monetary policy in Iraq aimed at modifying the exchange rate. This reflects the disruptions occurring in the local market and the pricing of goods and services.

While the inflation rate in Iraq has shown a general decline from 2004 to 2023, it still reflects ongoing economic instability.

Trend of Human Development Indicators in Iraq

Based on the details outlined in Appendix (2) concerning the progression of the Human Development Index (HDI) and its indicators in Iraq from 2004 to 2023, an in-depth analysis of the trends linked to this index and its indicators will be presented as follows

a) Human Development Index (HDI): This is a composite measure that assesses the developmental achievements of countries in the area of human development, based on three essential dimensions (which will be explored further). This index was developed by the United Nations Development Programme (UNDP) to evaluate human well-being among different countries. The value of this indicator ranges from 0 to 1. An increased value indicates a better condition of human development.

The overall trend of this indicator in Iraq has increased from 0.588 in 2004 to 0.676 in 2023, indicating a compound growth rate of 0.7% over the study period, which points to a consistent improvement in the level of human development in Iraq. The overall average for this indicator during this period was 0.641, placing Iraq in the "medium human development" category as defined by the United Nations. The highest annual growth of this indicator was observed in 2008, achieving an annual growth rate of 2.7%. The observed increase can be attributed to improved economic and security conditions during specific years, especially after the liberation of Iraqi territory from terrorist group control (ISIS) post-2017. The indicator saw a significant drop in 2020, showing an annual change of -2.5%, which can be linked to the effects of the Covid-19 pandemic. A gradual recovery followed in 2021 and 2022, characterized by a steady growth rate of 0.9% annually. In 2023, the annual growth rate fell to 0.4%, underscoring the difficulties faced by human development in Iraq at this time.

This suggests a general improvement in health, education, and income indicators in Iraq; however, the emergence of declines highlights the fragility of this advancement in the face of crises and shocks that may affect the Iraqi economy.

b) Life Expectancy at Birth: The overall trend of this indicator has demonstrated an increase from 65 years in 2004 to 71.3 years in 2022 (data for 2023 is not available), indicating a compound growth rate of 0.5% and an average of 68 years, which implies a significant improvement in healthcare and services in Iraq. The most notable annual rise for this indicator took place in 2009, achieving 2.3%. In contrast, 2020 saw a significant decrease of 3.4%, due to the effects of the health pandemic on Iraq's healthcare sector. A decrease of 1.9% was noted in 2006, associated with the effects of security disturbances on multiple areas of human development during that period. The index exhibited a strong rebound in 2021, recording a growth of 1.8%, and continued with a growth of 1.4% in 2022, which can be linked to the initiatives undertaken by the Iraqi government to improve healthcare services. The rise in life expectancy at birth may indicate some level of progress in Iraq's healthcare sector; however, it does not necessarily reflect true advancements in the technologies employed in this domain.

c) Expected Years of Schooling: The duration of schooling increased from 9.4 years in 2004 to 12.2 years in 2022, indicating a compound growth rate of 1.5%. This signifies a significant progress in the education sector in Iraq during the study period. The average for this indicator was recorded at 11.1 years, indicating a commendable status relative to countries with moderate human development. In 2005, the peak annual growth was recorded at 2.5%, after which there was a steady decline that led to a stagnation of 0% from 2021 to 2022. Additionally, this indicator experienced notable growth during the early years (2004-2010), followed by a significant stabilization period. The increase in expected years of education indicates an expansion of educational opportunities in Iraq;

however, the recent stabilization might reflect inadequate investment in education or could be a result of the aftermath of crises.

d) Gross National Income per Capita (GNI per Capita): The figure increased from $6,670.3 (adjusted for purchasing power parity in 2017) in 2004 to $9,901.9 in 2022, indicating a compound growth rate of 1.6%. The average for this indicator was recorded at $8,666.9, reflecting a moderate trend of economic growth in the income index linked to human development in Iraq. In 2008, the highest annual growth recorded was 13.2%, whereas in 2016, it was 11%. This rise seems to correlate with higher oil prices, which are reflected in the per capita income levels. In 2020, this indicator saw a notable decrease of 14.5%, linked to the effects of the pandemic and declining oil prices, followed by a recovery of 4.7% in 2022. Additionally, there were further declines of 3.4% in 2014 and 4.2% in 2017, which can be linked to the economic fluctuations that Iraq experienced. The Iraqi economy is primarily dependent on oil, making both national and personal income vulnerable to variations and external economic disturbances.

3. RESULTS AND DISCUSSIONS

The analysis utilizes conventional analytical techniques to investigate the correlation between economic growth and human development indicators in Iraq from 2004 to 2023. Data will be obtained from credible institutions, including the Iraqi Ministry of Planning and the World Bank, concentrating on indicators such as real GDP, GDP per capita, government expenditure, oil exports, and inflation. The ARDL model will be employed to examine the data and extract the findings. Furthermore, the investigation will include diagnostic assessments to guarantee the dependability and precision of the results.

Model Description

Following a thorough examination of the progression of key economic growth indicators and the trajectory of the Rural Development Index from 2004 to 2023, it was crucial to identify the most effective model for assessing the influence of rural development growth. This selection was grounded in the pursuit of optimal results derived from statistical, standard, and economic evaluations. The subsequent variables were employed:

a) Dependent Variable: This variable is obtained from the Human Development Index (HDI) in Iraq throughout the duration of the study.

b) Explanatory Variable: The subsequent variables were selected:

GDP Growth Rate at Constant Prices (100=2007): This acts as a crucial indicator for assessing genuine economic expansion (Real GDP Growth Rate) in Iraq. This illustrates the genuine rise in economic productivity, supplying the essential resources for enhancing education, health, and per capita income metrics, which are integral to the Human Development Index. The influence is beneficial in promoting human development in Iraq.

The growth rate of GDP per capita serves as a strong indicator of economic advancement on an individual scale (Real GDP per Capita Growth Rate) in Iraq. This indicates improvements in the economic standard of living and personal well-being, closely associated with "per capita income" in the HDI (GNI per capita). As a result, the anticipated effect is favorable, as it affects the income levels of the population in Iraq.

Growth Rate of Government Expenditure (GovExp): This variable serves as an indirect indicator of economic growth in Iraq, fostering macroeconomic activity and influencing education, health, and infrastructure, which enhance HDI. Nonetheless, dependence on oil revenues could result in variations in government spending, which may indicate inefficiencies in its distribution in Iraq.

The growth rate of oil exports serves as a clear indicator of economic growth in Iraq, considering that oil exports represent a significant portion of the GDP. An uptick in these exports enhances government revenues, potentially leading to increased spending on education and health services. Consequently, the rate of increase in oil exports serves as a vital factor in illustrating economic growth and its influence on human development in Iraq.

Inflation Rate: Although it may not serve as a direct measure of economic growth in Iraq, it plays a significant role in affecting purchasing power and overall economic stability. Low inflation can foster growth, while high inflation may hinder it by diminishing real income and adversely impacting the standard of living, which is a component of HDI.

To guarantee precise outcomes for this model, the values of the previously mentioned variables will be converted into natural logarithms to satisfy statistical, standard, and economic requirements.

Therefore, the framework for quantifying the anticipated impact can be articulated as follows:

$$Ln\,HDI = f(Ln\,GDP, Ln\,GDPp, Ln\,Gov, Ln\,OE, Ln\,Inf) \quad (1)$$

$$Ln\,HDI = \beta_0 + \beta_1\,Ln\,GDP + \beta_2\,Ln\,GDPp + \beta_3\,Ln\,Gov + \beta_4\,Ln\,OE + \beta_5\,Ln\,Inf + \varepsilon_t \quad (2)$$

It represents the following: The Human Development Index (Ln HDI), GDP growth rate (Ln GDP), GDP per capita growth rate (Ln GDPp), government expenditure growth rate (Ln Gov), oil export growth rate (Ln OE), and inflation rate (Ln Inf).

Additionally, B0 represents the intercept parameter of the target model, i.e., the y-intercept. The parameters from B1 to B5 denote the regression coefficients. εt: represents the Error Term.

The algebraic sign of the coefficients is expected to be positive, as economic growth and oil exports enhance HDI. However, B5 is expected to have a negative algebraic sign, as high inflation adversely affects HDI.

Stability Test

To prevent spurious regression when estimating the relationships between the model's variables, it is essential to ensure the stationary of the time series for these variables. For this purpose, we will employ the Augmented Dickey-Fuller (ADF) Test, based on the Akaike Information Criterion. This test evaluates two hypotheses at a 5% significance level (p-value < 0.05): the null hypothesis (H_0), which states that the variable contains a unit root (non-stationary), and the alternative hypothesis (H_1), which states that the variable is stationary. The p-value results of the ADF test for the three models are presented in Table (1).

Table 1: ADF Test Results

Type of Variable	Levels Variables	at level			1st Difference		
		Intercept	Trend & Intercept	None	Intercept	Trend & Intercept	None
Dependent	Ln HDI	0.0200	0.0146	0.3976	–	–	–
Independent	Ln GDP	0.6454	0.0681	0.6160	0.0001	0.0005	0.0000
	Ln GDPp	0.0036	0.0114	0.5606	–	–	–
	Ln Gov	0.0005	0.0027	0.6356	–	–	–
	Ln OE	0.5880	0.3228	0.5926	0.0000	0.0001	0.0000
	Ln Inf	0.1186	0.0960	0.3910	0.0000	0.0157	0.0000

At the 5% level of significance, the variables (Ln HDI, Ln GDPp, and Ln Gov) show stationarity in the Trend & Intercept and Intercept models, but non-stationarity in the None model, according to the p-values given in Table (1) from the ADF test. Because these variables are stable at the level I(0), calculating the first difference I(1) is thus superfluous.

Contrarily, non-stationarity is shown at the level of all three variables (Ln GDP, Ln OE, and Ln Inf), suggesting that the Iraqi economy is very sensitive to changes in oil prices and security situations. Therefore, finding the initial difference, I(1), for these variables is crucial. Table (1) shows that all three models had p-values for these variables that were less than 5%, indicating that they were stable at the first difference.

Model Specification

The results above indicate a mix of variables that are stable at the level I(0) and others that are stable at the first difference I(1). Accordingly, the most suitable model is the

Autoregressive Distributed Lag (ARDL) model. This model is appropriate for variables that are stationary at the level, at the first difference, or a combination of both. It enables the estimation of long-run and short-run relationships without requiring all variables to be integrated of the same order. Thus, the formulation of Equation (2) can be revised as follows:

$$Ln\,HDI_t = \beta_0 + \beta_1\,t + \alpha_i\,Ln\,HDI_{(t-i)} + \beta_{2j}\,Ln\,GDP_{(t-j)} + \beta_{3k}\,Ln\,GDPp_{(t-k)} + \beta_{4m}\,Ln\,Gov_{(t-m)} + \beta_{5n}\,Ln\,OE_{(t-n)} + \beta_{6p}\,Ln\,Inf_{(t-q)} + \varepsilon_t \quad (3)$$

Where $Ln\,HDI_t$is the dependent variable at time t, β_0 is the intercept, β_1 is time trend coefficient and α_i, β_{2j}, β_{3k}, β_{4m}, β_{5n}, β_{6p} are lag coefficient, for the variables i, j, k, m, n, p are Number of lags per variable so $\varepsilon_t$is error term.

ARDL Model Estimation

Lag Selection: Prior to estimating the ARDL model, it is necessary to determine the optimal lag length. This will be achieved using the Akaike Information Criterion (AIC), with the results presented in Figure (1).

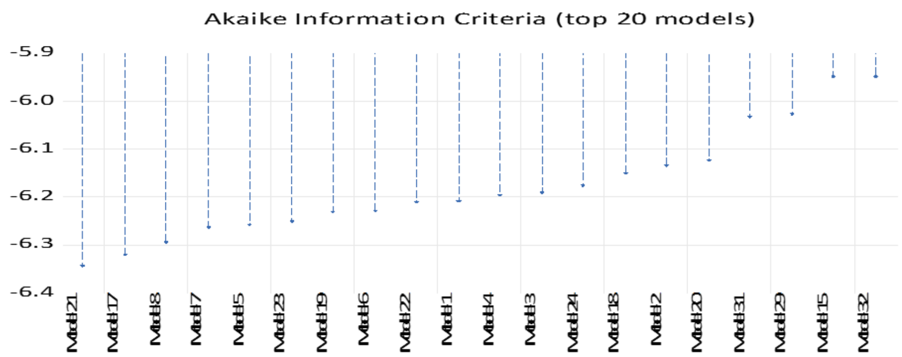

Figure 1. Optimal Lag Length Results Based on the AIC Criteria

The findings from the leading 20 models, illustrated in Figure (1), emphasize the ARDL model (1, 0, 1, 0, 1, 1, 1). The selection of this model was based on the AIC criterion results, which indicated a minimum optimal lag length of 5.9. This suggests that the model achieves a balance between fit quality and simplicity, thus reducing the risk of overfitting.

Bounds Test

This test assesses the suitability of the studied variables for estimating the model over the long run, incorporating the error correction parameter CointEq (-1). Accordingly, we will derive the calculated values for the Bounds Critical Values test (at 10%, 5%, and 1% significance levels), as presented in Table (2) below:

Table 2: Bounds Test Results

Null hypothesis: No levels relationship						
Number of cointegrating variables: 5						
Trend type: Rest. constant (Case 2)						
^sample size						
Test Statistic						Value
F-Statistic						3.899466
	10%		5%		1%	
^sample size	I 0	I (1).	I 0	I (1).	I 0	I (1).
30	407	517	910	4.193	4.134	5.761
Asymptotic	2.080	3,000	2.390	3.380	3.060	4.150
* I (0) and I (1) are respectively the stationary and non-stationary bounds.						

Table (2) shows the estimated F-statistic value, which is 3.899466. After comparing this value to the critical values outlined in Table (2) for the asymptotic scenario (given the sample size of 17), it is clear that the calculated value exceeds both the upper limit I(1) and lower limit I(0) of the F-statistic critical values at the 10% and 5% significance thresholds, implying the presence of co-integration. At the 1% significance level, the data on co-integration remain inconclusive.

At both 10% and 5% significance levels, the null hypothesis (H_0) is rejected in favor of the alternative hypothesis (H_1), providing support for co-integration. This shows a long-term equilibrium relationship between the variables under investigation. As a result, it is possible to proceed with estimating the Error Correction Model (ECM) to investigate both long- and short-term relationships.

Estimating the Model in the Long and Short Run

The results of the limits test (refer to Table 2) confirm the existence of an equilibrium relationship among the variables investigated in this study. This makes it easier to estimate the target model, focusing on short-run dynamics and including the Error Correction Model (ECM). The ECM provides a complete analysis of the long-term equilibrium connection. The model's estimation additionally determines the speed of adjustment using the error correction parameter CointEq(-1) following the initial difference of the relevant variables. The error correction parameter is set with a one-period lag, and the variable differences indicate the model's short-run parameters. The model results were produced using the Conditional Error Correction approach, as shown in Table 3.

A. Conditional Error Correction

Dependent Variable: D(LNHDI)
Method: ARDL
Date: 03/28/25 Time: 22:10
Sample: 2007 2023
Included observations: 17
Dependent lags: 1 (Automatic)
Automatic-lag linear regressors (1 max. lags): LNGDP LNGDPP LNGOV LNOE LNINF
Deterministics: Resyricted constant and no trend (Case 2)
Model selection method: Akaike info criterion (AIC)
Number of models evauated: 32
Selected model: ARDL (1.0.1.0.1.1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNHDI (-1) *	-1.296660	0.275531	-4.706031	0.0022
LNGDP **	0.325597	0.193971	1.678582	0.1371
LNGDPP (-1)	0.160814	0.064583	2.490035	0.0416
LNGOV **	-0.001597	0.007508	-0.212690	0.8376
LNOE (-1)	0.004765	0.024621	0.193516	0.8521
LNINF (-1)	-0.049519	0.032560	-1.520859	0.1721
C	4.842738	1.035548	4.676498	0.0023
D (LNGDPP)	-0.2403603	0.194495	-1.235820	0.2564
D (LNOE)	0.025076	0.017609	1.424036	0.1974
D (LNINF)	-0.024201	0.017055	-1.418984	0.1989

R-squared	0.807720	Mean dependent var	0.000373
Adjusted R-squared	0.769074	S.D. dependent var	0.019104
S.E. of regression	0.008774	Akaike info criterion	-6.344904
Sum squared resid	0.000539	Schwarz criterion	-5.854778
Log likelihood	63.93168	Hannan-Quinn criter	-6.296184
F-statistic	7.650669	Durbin-Watson stat	1.774083
Prob (F-statistic)	0.006861		

* p-values are incompatible with 1-bounds distribution.

** Zero-lag variable

B. Error Correction

Dependent Variable: D(LNHDI)
Method: ARDL
Date: 03/28/25 Time: 22:10
Sample: 2007 2023
Included observations: 17
Dependent lags: 1 (Automatic)
Automatic-lag linear regressors (1 max. lags): LNGDP LNGDPP LNGOV LNOE LNINF
Deterministics: Resyricted constant and no trend (Case 2)
Model selection method: Akaike info criterion (AIC)
Number of models evauated: 32
Selected model: ARDL (1.0.1.0.1.1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
COINTEQ *	-1.296650	0.182118	-7.119905	0.0000
D(LNGDPP)	-0.240360	0.047517	-5.058367	0.0002
D(LNOE)	0.025076	0.007617	3.291961	0.0058
D(LNINF)	-0.024201	0.006002	-4.032324	0.0014

R-squared	0.807720	Mean dependent var	0.000373
Adjusted R-squared	0.756425	S.D. dependent var	0.019104
S.E. of regression	0.006438	Akaike info criterion	-7.050786
Sum squared resid	0.000539	Schwarz criterion	-6.854736
Log likelihood	63.93168	Hannan-Quinn criter	-7.031298
F-statistic	42.62516	Durbin-Watson stat	1.774083
Prob (F-statistic)	0.000001		

* p-values are incompatible with t-Bounds distribution

Important information about the short- and long-term relationships between the Human Development Index (HDI) and its determinants in Iraq can be found in Table 3: A, B, which displays the findings of the Conditional Error Correction Model (ECM) that was developed from the ARDL framework.

The lagged dependent variable Ln HDI (-), which has a coefficient of -1.296659 (p-value = 0.0022), represents the negative and statistically significant error correction term (COINTEQ), which in the long run confirms the existence of co-integration. The bounds test confirms that this meets the essential requirement for co-integration (F-statistic = 3.899466). Approximately 129.67% of deviations from the long-run equilibrium are corrected annually, according to the coefficient's magnitude. The adjustment path involves over-correction because the value is greater than unity, which causes oscillations before the system stabilizes.

Mixed results are highlighted by the estimated long-run coefficients, which are calculated by dividing the coefficient of each variable by the absolute value of the COINTEQ. The coefficient for real GDP is 0.3, indicating that a 1% increase in GDP eventually results in a 0.3% increase in the HDI. Nevertheless, this effect is not statistically significant (p-value = 0.1371), indicating that Iraq's overall economic growth has not always resulted in improvements in human development. This probably reflects structural problems like corruption, unequal resource distribution, and the concentration of growth in oil-related activities. On the other hand, over time, HDI is statistically significantly impacted by GDP per capita. According to economic theory, a 1% increase in per capita income results in a 0.12% increase in HDI (p-value = 0.0416), as income growth raises purchasing power, living standards, and the ability to invest in health and education. The lagged impact of per capita income also implies that socioeconomic investments in human development take time to manifest.

On the other hand, government spending has a negligible but adverse impact on HDI. The HDI decreases by 0.001% (p-value = 0.8376) for every 1% increase in government spending, which is contrary to theory. This result might indicate fiscal policy inefficiencies, specifically resource misallocation and institutional corruption. In a similar vein, oil exports have a very small and inconsequential positive impact on HDI; a 1% increase in HDI only results in a 0.004% increase (p-value = 0.8521). Iraq is heavily dependent on oil, so this result highlights the weak correlation between resource revenues and advancements in human development. This is probably because of inadequate revenue management and fluctuations in oil prices around the world. A 1% increase in inflation lowers HDI by 0.04% (p-value = 0.1721), a negative but statistically insignificant effect. Although it supports the theoretical idea that inflation lowers living standards and purchasing power, its lack of statistical significance indicates that inflation did not significantly influence human development outcomes between 2004 and 2023. Last but not least, the model's intercept shows a significant positive value (3.7, p-value = 0.0023), indicating baseline improvements in HDI that are unrelated to the variables under study.

Weaker and mostly negligible relationships are highlighted by the model's short-run dynamics. Because of instability, delayed distributional effects, or unequal access to resources, short-term increases in income per capita may temporarily lower HDI, according to the coefficient of the first difference of GDP per capita (ΔLn GDPp), which is -0.24036 (p-value = 0.2564). With a coefficient of 0.025076 (p-value = 0.1974), the short-run impact of oil exports (ΔLn OE) is likewise positive but statistically insignificant. Iraq's susceptibility to fluctuations in the price of oil is reflected in this limited short-term impact. The differenced form of inflation, ΔLn Inf, also exhibits a short-term negative but negligible effect (-0.024201, p-value = 0.1989). Even though higher inflation lowers living standards, the coefficient's insignificance indicates that during the studied period, monetary and fiscal interventions lessened its immediate effects.

Overall, the ECM results show that although Iraq shows a strong long-term equilibrium relationship between economic variables and HDI, structural inefficiencies and weak statistical significance limit the explanatory power of the majority of variables. The most dependable long-term predictor of HDI is per capita income, whereas government spending and oil exports fall short of their anticipated developmental role, primarily because of institutional flaws and resource mismanagement. The results highlight how crucial it is to diversify the economy, enhance governance, and guarantee growth is distributed fairly in order to achieve sustainable human development.

The estimated model's diagnostic statistics show a robust and good overall fit. According to the R-squared value of 0.8077, the model explains about 80.8% of the variation in the dependent variable, D(Ln HDI), with only 19.2% coming from factors not specified in the specification. Likewise, the adjusted R-squared, which accounts for the quantity of explanatory variables, is 0.7691. This demonstrates the model's explanatory power and dependability in a multivariate setting by confirming that it captures 76.9% of the variation in D(Ln HDI).

The F-statistic value of 7.6507, which is statistically significant at the 5% level (p-value = 0.0069), further supports the model's overall significance. This suggests that when considered collectively, the explanatory variables play a significant role in explaining the variation in Iraq's human development. The model's effectiveness and fit for the dataset at hand are confirmed by the low Akaike Information Criterion (AIC) value of -6.3449.

The model's robustness is further supported by additional diagnostic measures. The reliability of the results is increased by the Durbin-Watson statistic of 1.7741, which is near the benchmark value of 2 and shows that there is no significant serial correlation among the residuals. Additionally, the model's high predictive accuracy is demonstrated by the regression's noticeably low standard error, which stands at 0.00877. Lastly, the model's overall quality and ability to produce accurate and meaningful estimates are further highlighted by the fact that the sum of squared residuals is only 0.000539.

Testing for Diagnosis

Diagnostic tests are a collection of statistical analyses that are used to evaluate the estimated model's overall quality, identify any possible econometric problems, and confirm the model's validity. These tests are essential for making sure the model produces accurate results and captures the fundamental connections between economic variables. Diagnostic checks improve the credibility of the estimated model for both policy-oriented decision-making and predictive analysis by verifying its robustness.

Test of Normalcy

As a basic prerequisite for the validity of many inferential statistical procedures, the normality test is used to confirm whether the residuals of the estimated model have a normal distribution. The Jarque–Bera test is used to achieve this. Reliability of the model's parameter estimates and hypothesis testing is supported by the test results, which are shown in Figure (2) and offer a formal statistical evaluation of residual normality.

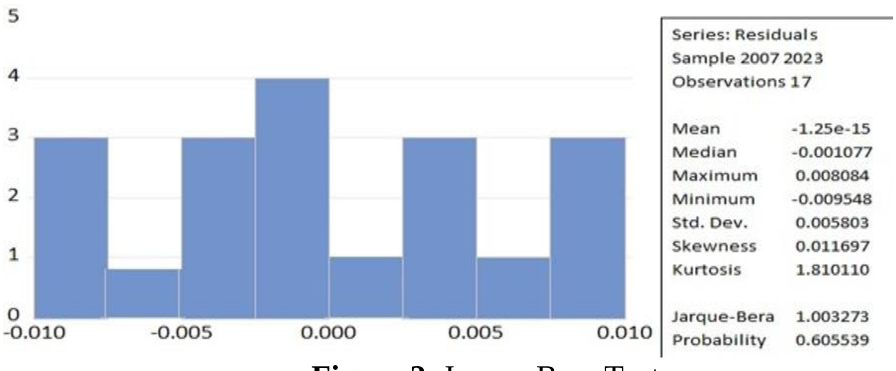

Figure 2. Jarque-Bera Test

The skewness and kurtosis measures in Figure (2) demonstrate that the residuals of the estimated model follow a normal distribution. This conclusion is further supported by the Jarque–Bera test, which produces a probability value of 0.605539 that is higher than the 5% significance level. As a result, it is not possible to reject the null hypothesis (H_0), which asserts that the residuals are normally distributed. This result confirms one of the fundamental tenets of the used econometric methodology, which strengthens the validity of the statistical conclusions drawn from the model estimation. In summary, the findings support the robustness and reliability of the model by confirming that it accurately depicts the key interactions between the dependent variable (Ln HDI) and the chosen explanatory variables.

Test of Serial Correlation

The effectiveness and dependability of parameter estimates may be compromised if the residuals of the estimated model exhibit cross-temporal correlation, which is examined using the serial correlation test. When serial correlation is present, it suggests that the error terms are not independent, which could skew standard errors and produce false statistical conclusions. The Breusch–Godfrey test is used to evaluate this problem because it offers a reliable framework for identifying higher-order autocorrelation in the residuals. Table (4) reports the test's results.

Table 4. Breusch-Godfrey test

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	0.019222	Prob. F(2,5)	0.9810
Obs*R-squared	0.129711	Prob. Chi-Square(2)	0.9372

There is no indication of serial correlation between the residuals of the estimated model, according to the Breusch–Godfrey test results shown in Table (4). The null hypothesis (H_0), which postulates the absence of serial correlation, is accepted since the Chi-Square probability value of 0.9372 significantly surpasses the 5% significance threshold. This result guarantees that the predictions are not skewed by correlated errors and supports the accuracy and dependability of the model's estimations. As a result, the model exhibits a high ability to capture the crucial dynamic interactions between the chosen explanatory variables and human development (Ln HDI).

Test of Heteroskedasticity

To find out if the variance of the residuals stays the same across observations, the heteroskedasticity test is used. When the variance of the residuals systematically varies with the values of the independent variables, this assumption is broken, a phenomenon called heteroskedasticity. Although the estimated coefficients are not skewed by such an issue, biased standard errors may result in ineffective estimates and untrustworthy statistical conclusions. The Breusch–Pagan–Godfrey test is used to assess this problem because it offers a reliable framework for identifying heteroskedasticity in regression models. Table (5) reports the test's results.

Table 5. Breusch-Pagan-Godfrey Test

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
Null hypothesis: Homoskedasticity			
F-statistic	6.432397	Prob. F(9,7)	0.0113
Obs*R-squared	15.16617	Prob. Chi-Square(9)	0.0865
Scaled explained SS	1.041569	Prob. Chi-Square(9)	0.9993

It is evident from the test results in Table (5) that the probability value of Chi-Square is 0.9993, exceeding the 5% threshold (0.05 < 0.9993). The null hypothesis (H_0), which states that the variance is homogeneous and that the variance of the errors stays constant, is thus accepted. This implies that the estimated model has effectively taken into account changes in oil prices, which is crucial given how heavily the Iraqi economy depends on oil earnings.

Test of Structural Stability

To check if the estimated model's coefficients hold steady over the course of the study, the structural stability test is used. Maintaining stability is essential because large variations in the estimated parameters would suggest that the fundamental connections between economic variables are not stable over time, which would compromise the model's dependability. Two complementary tests are used to evaluate this.

The first is the Cumulative Sum of Residuals (CUSUM) Test, which assesses whether the residuals build up in a way that would suggest possible changes to the model's structure. The second is the Cumulative Sum of Squared Residuals (CUSUMSQ) Test, which emphasizes residual variability more in order to identify subtler structural changes. When combined, these tests offer a thorough analysis of parameter stability over the course of the sample. Figure (3) provides a graphic representation of the outcomes of both tests.

B. CUSUMSO Test **A.** CUSUM Test

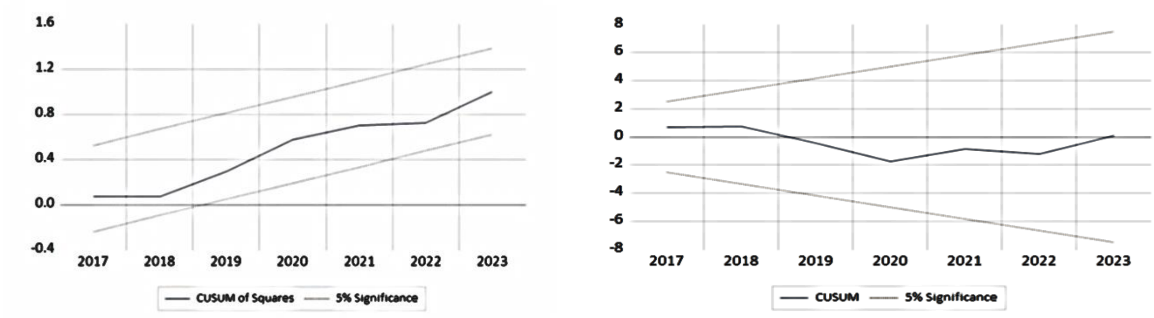

Figure 3. CUSUM and CUSUMSQ Tests

The results of the CUSUM and CUSUMSQ tests both oscillate around zero and stay within the critical bounds at the 5% significance level, as shown in Figure (5). Consequently, the alternative hypothesis (H_1), which raises the possibility of instability, is rejected, while the null hypothesis (H_0), which maintains that the parameters of the estimated model are structurally stable, is accepted. The estimated coefficients' stability over the short and long terms is confirmed by these findings. Thus, there is no indication of structural breaks in the model over the course of the study, which removes the need for parameter adjustments and strengthens the model's ability to produce reliable conclusions and aid in economic decision-making.

4. CONCLUSIONS

A long-term equilibrium relationship between human development (Ln HDI) and important economic variables, particularly GDP and GDP per capita, is confirmed by the ARDL model. The need for steady, long-term economic strategies to guarantee equitable growth is highlighted by the error correction coefficient (COINTEQ = -1.296659), which shows a quick adjustment to equilibrium, albeit with overcorrection.

While GDP per capita exhibits a positive and significant long-term effect, a 1% increase in GDP results in a 0.3% increase in HDI. Nonetheless, the effects of government expenditure and oil exports on HDI are minimal and statistically insignificant, reflecting corruption, resource misallocation, and structural inefficiencies. Although the short- and long-term effects of inflation are negligible, it has a negative impact on human development.

Diagnostic tests verify the robustness of the model: there is no serial correlation, the residuals are homoscedastic (Breusch–Pagan–Godfrey p-value = 0.9993), and they are normally distributed (Jarque–Bera p-value = 0.605539). The CUSUM and CUSUMSQ tests show that the coefficients are structurally stable over time.

Overall, Iraq's human development could be enhanced by economic growth, but these benefits are limited by the country's structural flaws and reliance on oil. The model offers a trustworthy empirical framework to support well-informed decision-making and direct successful development policies.

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