International Journal of New Political Economy 6(2): 39-65, 2025

Estimating the Effect of Economic Growth on the Human Development Index in Iraq for the Period (1970-2022): A Quantile Regression Approach

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ARTICLE INFO

Article history:

Date of submission: 10 June 2025

Date of revise: 03 September 2025

Date of acceptance: 14 September 2025

JEL Classification:

O11, O15, C21, E23.

Keywords:

Social welfare, Economic growth, Quantile regression

ABSTRACT

This study investigates how economic growth, along with other key variables, has influenced the Human Development Index (HDI) in Iraq over the period 1970–2022, employing a quantile regression approach. Given Iraq's history of armed conflicts, political instability, and economic disruptions, understanding the determinants of human development has become increasingly vital, especially in the context of reconstruction efforts initiated in 2018. The quantile regression technique enables the assessment of differential effects of explanatory variables across various levels of the HDI distribution rather than relying solely on average effects. The analysis demonstrates that, for most quantiles, economic growth, public spending relative to GDP, exchange rate dynamics, and oil revenues have a positive and statistically significant impact on Iraq's HDI. In contrast, urbanization and trade openness show a negative and statistically significant effect in several quantiles. These findings suggest that to enhance human development, the Iraqi government should adopt flexible exchange rate policies, increase productive public spending, and focus on expanding oil production and exports to raise income levels and improve social welfare.

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DOI: https://doi.org/10.48308/jep.2025.240363.1228

1. Introduction

Macroeconomic stability, poverty reduction, and social welfare are essential for sustainable development (Shafique & Ali, 2018). Welfare is a multidimensional concept encompassing social, economic, and political aspects, aimed at enhancing individual and collective well-being (Arman Mehr & Farahmandmanesh, 2017). Recently, social welfare has become a central focus of development programs, as it reflects both progress and quality of life, particularly for disadvantaged groups (Shahabadi & Arghand, 2018). Economic growth is a key determinant of welfare, creating opportunities for income expansion, employment, and improved living standards (Jafari Samimi et al., 2017). Even modest, long-term growth can substantially raise living standards (DFID, 2004). While both developed and developing countries implement stabilization programs, differences in initial conditions and shocks produce varied outcomes (Shafique & Ali, 2018).

Since the 1970s, Iraq has faced wars, political instability, and infrastructure damage, severely affecting healthcare, food security, and general well-being (Al Hilfi et al., 2013; Farhan, , 2023). The 2014 war against ISIS caused destruction of farmland and infrastructure, and sharp increases in food prices, exacerbating poverty and hunger. With reconstruction efforts ongoing since 2018, analyzing key macroeconomic variables and the effects of conflicts on social welfare is critical. This study looks at how economic growth, along with other significant variables, affects Iraq's Human Development Index (HDI) from 1970 to 2022, using quantile regression to account for heterogeneous impacts throughout the HDI distribution. This strategy overcomes the drawbacks of classic mean-based models, such as heteroscedasticity and nonnormal residuals. Our contributions include building a long-horizon dataset, estimating a comprehensive quantile process of HDI on growth, fiscal stance, trade, currency rate, urbanization, oil revenues, and a war dummy, as well as identifying processes pertinent to an oil-based economy. The findings offer policymakers useful information,

emphasizing which economic levers are most successful at particular phases of human development.

2. Theoretical foundations

2.1. Social welfare

Social welfare reflects the overall well-being of individuals and society, encompassing both material and non-material dimensions. It goes beyond income or production, including social, psychological, and environmental factors that sustain long-term quality of life (Mendoza-Cavazos, 2019). Economically, welfare is linked to social security systems, where governments ensure minimum living standards through redistribution, public services, and infrastructure (He & Feng, 2018). Measuring welfare accurately is crucial for policy design, as it considers both tangible indicators (GDP, health, education) and intangible factors (social cohesion, equality, environmental sustainability) (Frąckiewicz & Frąckiewicz-Wronka, 2001). Traditional indicators like GDP fail to capture non-economic aspects of well-being (Alessie et al., 2013). Unlike GDP, the HDI integrates various dimensions of well-being, including health, education, and per capita income, thereby presenting a broader view on human development (UNDP, 2002). Rooted in Amartya Sen's capabilities approach, the HDI emphasizes real freedoms and achievements rather than income alone (Sen, 1999). This study adopts the HDI for its multidimensionality and suitability in analyzing welfare dynamics in developing, resource-dependent economies such as Iraq.

2.2. Determinants of Social Welfare

In the research on social welfare, several factors, including government expenditure, trade openness, inflation, and unemployment, have been found to impact results (Marza et al., 2018; Ahmed Alfaraji & Hamad, 2021; Shahraki & Ghaderi, 2021; Alizadeh et al., 2022; Purwanto & Utami, 2023; Sabermahani et al., 2023). Theoretical perspectives differ some emphasize the positive role of government intervention, while others highlight potential

inefficiencies or distortions. The following subsections review the key theoretical foundations of these determinants as they relate to this study.

2.2.1 Government Spending and Welfare

Keynesian economics considers public expenditure a key tool for stimulating aggregate demand, generating employment, and enhancing living standards. Spending on infrastructure, health, and education can raise productivity and household welfare (Keho, 2019). In contrast, the neoclassical view warns that excessive spending may crowd out private investment and reduce welfare if funded by distortionary taxes or inflation (Devereux et al., 2000). Recent perspectives highlight efficiency: limited but high-quality government intervention can be more welfare-enhancing than a large, inefficient state (Kim & Kim, 2012). Persistent fiscal imbalances may also worsen income distribution and lower long-term welfare (Nademi & Moftakhari, 2017). Overall, theory suggests a nonlinear relationship, where spending boosts welfare up to a threshold, after which inefficiency and inflationary pressures may dominate.

2.2.2 Trade Openness and Welfare

Trade openness, in the Heckscher–Ohlin framework, is expected to enhance welfare by allowing countries to specialize according to comparative advantage, increasing employment and consumption possibilities (Glick, 1997; Tsai, 2009). However, the compensation hypothesis notes that openness also exposes economies to external shocks, necessitating stronger welfare systems to mitigate risks (Williamson, 1975; Lindbeck, 2006). While openness can foster growth, competition, and foreign investment (Narayanan et al., 2016), it may also raise inequality or dependence on external markets in contexts with weak domestic institutions. Therefore, welfare effects of trade openness depend on institutional capacity and the ability to manage associated risks (Alizadeh et al., 2022).

2.2.3 Exchange Rate and Welfare

Exchange rates affect competitiveness, production, and inflation, influencing household welfare. Currency depreciation can boost export competitiveness and increase government revenues in resource-exporting economies (Asseery & Peel, 1991), but it also raises import costs, potentially causing inflation and welfare losses. Exchange rate volatility is thus double-edged: it can expand fiscal space but undermine investment, purchasing power, and long-term welfare (Asseery & Peel, 1991; Sadigh Mohammadi et al., 2021). Stable, competitive exchange rates are generally welfare-enhancing, while excessive fluctuations pose risks.

2.2.4. Urbanization and Welfare

Classical ideas have differing perspectives on urbanization and population expansion (Zhan, 2015). Malthusian theory stresses resource scarcity and welfare reduction, whereas Keynesian and neoclassical models highlight the benefits of labor concentration, innovation, and productivity growth. According to the Kuznets curve, urbanization may initially raise inequality but eventually reduce it. The Tiebout theory also emphasizes possible welfare advantages from migration to improved public services (Quigley 2009). Overall, urbanization's overall effect is context-dependent, balancing short-term stresses with long-term development advantages (Alizadeh et al., 2022).

2.2.5. Oil Revenues and Welfare

The relationship between natural resource abundance and welfare is debated. Resource wealth can fund public spending, reduce poverty, and enhance welfare (Abbasian et al., 2017). However, the “resource curse” and “Dutch disease” suggest that reliance on resources may hinder diversification, promote rent-seeking, and create macroeconomic instability (Gerelmaa & Kotani, 2016). Productive use of resource revenues in infrastructure, education, and health boosts welfare, whereas mismanagement or excessive consumption can lead to inflation and long-term vulnerability. Therefore, the

welfare effect of resource abundance depends on governance and allocation (Alizadeh et al., 2022).

2.2.6 Misery Index and Welfare

The misery index, combining inflation and unemployment, measures macroeconomic distress and its effect on welfare (Shafique & Ali, 2018). High unemployment reduces income, increases poverty and inequality, and threatens social cohesion, while persistent inflation erodes purchasing power and diverts resources from productive uses (Lucas, 2000; Sukirno, 1997; Ruprah, 2011; Nariyah Agustiani et al.., 2022). Empirically, unemployment often causes greater dissatisfaction than inflation (Di Tella et al., 2001).

3. Empirical literature review

Several studies have examined the determinants of social welfare and human development across countries. Khodaverdi Samani et al. (2023) found that financial decentralization in Iran positively influences welfare up to an optimal point, with spillover effects across provinces. Purwanto and Utami (2023) reported that government spending efficiency affects HDI in Indonesian regions, with western regions outperforming eastern ones. Aslam et al. (2023) showed that the China-Pakistan Economic Corridor improved welfare in Pakistan through connectivity, employment, and income growth.

In Iran, Sabermahani et al. (2023) used a VAR model to find that employment enhances welfare, while oil revenues and GDP per capita can reduce it. According to Alizadeh et al. (2022), several macroeconomic and structural variables influence welfare, such as the exchange rate, misery index, tax and oil revenues, urbanization, and trade openness, as well as health and ICT indicators. Suprapto et al. (2022) found that investment positively influenced economic growth and HDI in Bekasi, Indonesia, while economic growth had limited direct impact on HDI but affected overall welfare. Shahraki and Ghaderi (2021) showed that health expenditure, trade openness, GDP, and democracy positively influence HDI in developed

countries. For Iraq, Alfaraji and Hamad (2021) reported a significant positive association between GDP per capita and the Human Development Index, showing that a 1% increase in GDP per capita corresponds to a 1.77% rise in HDI. Bekheet (2021) showed that public budgets and employment significantly affect HDI. Marza et al. (2018) reported that oil price fluctuations positively affect HDI in Iraq. Menegaki et al. (2017) emphasized that while economic growth and sustainable well-being are connected, they cannot be considered perfect substitutes. Regional studies highlight the importance of economic policies and governance in shaping welfare and human development. In Iran, economic growth reduces the misery index, poor governance worsens it, and government expenditure positively affects HDI (Dadgar & Nazari, 2012). Likewise, public spending on education and health enhances socio-political stability by improving human capital, while inflation, unemployment, and income inequality undermine it (Dadgar & Eskandari, 2021). Overall, while regional studies emphasize economic performance and policy as crucial for welfare, evidence for Iraq remains limited, motivating the use of quantile regression to capture heterogeneous effects across the welfare distribution.

Iraq's Economic Structure and Stylized Facts: Iraq is a hydrocarbon-dependent economy, with oil accounting for most exports, public revenues, and a large share of GDP. This reliance exposes the economy to global oil-price volatility, affecting fiscal space and human development outcomes. The public sector dominates employment and service provision, making government spending composition and efficiency crucial for HDI progress. Trade is concentrated on crude exports and essential imports, while the exchange rate and periodic adjustments influence domestic prices and public expenditures. Post-2003 institutional reforms and the 2020 exchange-rate adjustment reshaped fiscal and monetary transmission, and repeated conflicts have damaged health and education infrastructure, interrupting HDI gains. These factors make Iraq a compelling case for examining how macroeconomic shocks and policy levers influence HDI, particularly using

distribution-sensitive methods such as quantile regression (World Bank, 2025; IMF, 2024; UNDP, 2025).

4. Methodology

4.1. Introducing the model and data

This study is practical and descriptive-analytical in nature. Data were collected through library research, document review, and databases from the World Bank, IMF, Central Bank of Iraq, and Fahd (2021). The dataset consists of annual time series from 1970 to 2022, with missing values filled by interpolation. Based on the approaches of Haile and Niño-Zarazúa (2018), Ahmadvand et al. (2020), and Alizadeh et al. (2022), the following model is employed to investigate the effect of economic growth on welfare in Iraq.

$$\ln W = f\left(\ln(GDP_t), \ln\left(\frac{G}{GDP}\right)_t . \ln(misery_t), \ln(Urban_t), \ln(Open_t), \ln(Exch_t), \ln(oil_t), War_t\right) + u_t \quad (1)$$

In equation (1), lnW serves as the dependent variable, representing the natural logarithm of the HDI. Originally developed by Mahbub ul Haq and extensively applied by the UNDP, the HDI is a composite measure encompassing life expectancy, education (both average and expected years of schooling), and per capita income, which categorizes countries into four levels of development (UNDP, 2011; Stanton, 2007). The next section outlines the conceptual and operational definitions of the explanatory and control variables included in the model.

Table 1. Introduction of research variables

Symbols	Variables	Source
W	Human Development Index as a welfare index	UNDP, Researcher's calculations
GDP	GDP (economic growth)	world bank

Symbols	Variables	Source
$\frac{G}{GDP}$	The ratio of government spending to GDP	world bank
misery	Misery index	World Bank and Fahd's research (2021) researcher's calculations
Urban	Urbanization rate	World Bank, UNDP
Open	Openness index	World Bank, Researcher's calculations
Exch	exchange rate	world bank
oil	Oil revenues	World Bank, OPEC
War	The virtual variable of war	Researcher calculations

Source: Researchers' findings

Economic growth refers to the rise in the production of goods and services within an economy, usually assessed through changes in GDP or GNI (Fegheh Majidi et al., 2018). In this study, it is represented by the natural logarithm of GDP measured at constant 2015 prices. The misery index, introduced by Okun and Barro in the 1970s, is calculated as the sum of the unemployment and inflation rates, serving as a measure of overall economic distress (Büyüksarıkulak & Suluk, 2022). This study compares unemployment + inflation. Government expenditure: Includes public consumption, investment, and transfers (Barro & Grilli, 2007). National accounts distinguish between current spending (e.g., education, health) and investment (e.g., infrastructure). In this study, the ratio of total government expenditure to GDP is used. Trade openness: Commonly reflects integration into international markets (Gräbner et al., 2021). It is measured as the ratio of exports plus imports to GDP. Exchange rate refers to the value of a domestic currency in terms of foreign currencies (Frieden et al., 2019). In this study, it is measured using the annual average official exchange rate (IQD per USD) as reported by Iraqi authorities. Urbanization refers to the proportion of the population residing in urban areas compared to the total population, according to World Bank data. Oil revenue: Refers to Iraq's annual income from crude oil and refined products, expressed in Iraqi dinars (Olayungbo & Adediran, 2017). War is a dummy variable assigned a value

of 1 for years experiencing war, terrorism, or significant internal conflict, and 0 for all other years.

4.2. Why Quantile Regression in the Iraqi Context

The utility of mean-based estimators is limited by the heavy-tailed shocks (such hostilities and changes in the price of oil) and structural breakdowns that define Iraq's HDI series. Quantile regression (QR) addresses these challenges by modeling conditional quantiles of HDI, allowing covariate effects to differ across the distribution and remain robust to non-normal errors and heteroskedasticity (Koenker & Bassett, 1978; Koenker, 2005). In our data, diagnostic tests reject both slope equality and coefficient symmetry, while quasi-LR statistics are significant, validating the QR approach. Thus, QR is particularly suited to capturing heterogeneous growth and policy effects between low- and high-HDI regimes in Iraq.

4.3. Data analysis methods

Due to the time-series nature of the variables, it is essential to test for stationarity. While the Augmented Dickey-Fuller (ADF) and Phillips–Perron tests improve upon the original Dickey–Fuller method, they may have limited power when structural breaks are present (Musa & Maijama'a, 2021). Considering that Iraq’s economy has experienced major shocks from wars and sanctions, this study applies three complementary tests: ADF, Kwiatkowski–Phillips–Schmidt–Shin (KPSS), and Zivot–Andrews (ZA). To estimate the determinants of Iraq’s HDI, quantile regression (QR) is used. Ordinary Least Squares (OLS) can be inefficient when regression errors deviate from normality or when outliers and structural heterogeneity exist. Preliminary estimates indicated that the residuals were not normally distributed, supporting the use of quantile regression (QR). Introduced by Koenker and Bassett (1978) and further discussed by Koenker (2005), QR extends traditional regression analysis by examining the conditional quantiles of the dependent variable rather than focusing solely on the mean.

Parameters are estimated by minimizing a weighted sum of absolute residuals (Least Absolute Deviations, LAD), making the method robust to outliers and skewed distributions (Buchinsky, 1998). A key advantage of QR is that it captures how the effects of explanatory variables vary across the distribution of the dependent variable, rather than only at the mean or median. Estimating models across various quantiles, QR offers a more comprehensive view of the conditional distribution of HDI, which is especially useful in settings like Iraq, where economic shocks, asymmetries, and heavy-tailed distributions are common. Quantile regression seeks to estimate the conditional quantiles of a dependent variable Y. The general expression for the cumulative distribution function (CDF) of a random variable Y is:

$$F(y) = Prob(Y \leq y) \tag{2}$$

The general quantile model of Buchinsky (1998) is defined as the following relationship:

$$Q(\tau) = inf\{y: F(y) \geq \tau\} \ \ , \tau \tag{3}$$

It should be noted that the median of the distribution of variable Y minimizes the sum of the absolute deviations as shown below:

$$Q \min_{\xi \in R} \sum_{i=1}^{n} |y_i - \xi| \tag{4}$$

Also, the quintile of the τth sample,$\xi(\tau)$ which is like Q(τ), can be presented as a solution to the following optimization problem:

$$\min_{\xi \in R} \sum_{i=1}^{n} \rho_\tau |y_i - \xi| \tag{5}$$

Where:

$$\rho_\tau(z) = z\big(\rho_\tau - I(z < 0)\big), 0 < \tau < 1 \tag{6}$$

The sample means that minimizes the following equation gives the sum of squares of the residuals:

$$\hat{\mu} = \underset{\mu \in R}{\operatorname{argmin}} \sum_{i=1}^{n} (y_i - \mu)^2 \tag{7}$$

The linear conditional mean function can be derived by solving the following equation:

$$\hat{\beta} = \underset{\beta \in R^p}{\operatorname{argmin}} \sum_{i=1}^{n} (y_i - x'\beta)^2 \tag{8}$$

The linear function of the conditional quantiles $Q(\tau|X = x) = x'\beta(\tau)$ is estimated by solving the following equation for each quantile $\tau \in (0, 1)$:

$$\hat{\beta}(\tau) = \underset{\beta \in R^p}{\operatorname{argmin}} \sum_{i=1}^{n} \rho_\tau (y_i - x_i'\beta)^2 \tag{9}$$

In this regard, the value of $\hat{\beta}(\tau)$ is called the τth quantile regression (Tian et al., 2016).

Model Quality Assessment: The performance of a quantile regression model can be evaluated using model fit criteria along with corresponding pseudo-likelihood ratio tests.

Pseudo R^2: Koenker and Machado (1999) introduced a pseudo R^2 for quantile regression, similar in concept to the R^2 used in ordinary least squares (OLS) regression. This measure ranges from 0 to 1 and indicates how well the model explains the data at a given quantile τ.

Pseudo-likelihood test: Koenker and Machado (1999) also proposed quantile ρ tests, which Koenker (2005) refers to as pseudo-likelihood ratio tests. These tests follow a chi-square distribution with q degrees of freedom and assess the restrictions imposed under the null hypothesis.

Quantile Slope Equality Test: Introduced by Koenker and Bassett (1982a), this test evaluates whether the regression slopes are consistent across different quantiles. The null hypothesis states that the slopes are equal across quantiles.

$$H_0: \beta_1(\tau_1) = \beta_1(\tau_2) = \cdots = \beta_1(\tau_k) \quad (10)$$

This test employs Wald statistics, which are distributed according to a chi-square distribution with the corresponding degrees of freedom (p-1)*(k-1), where P is the number of regressors and K is the number of quantiles.

Symmetric Quantiles Test: Developed by Newey & Powell (1987), this test evaluates the symmetry assumption of data distribution. It asserts that symmetric distributions are for symmetric distributions, where β is the coefficient estimate at the median:

$$\frac{\beta(\tau) + \beta(1-\tau)}{2} = \frac{\beta}{2} \quad (11)$$

5. Results

Table 2 provides the descriptive statistics for the variables used in this study covering the period 1970–2022. Iraq's HDI averaged 0.59 (min 0.496 in 1991, max 0.696 in 2019; SD = 0.055). Economic growth was highly volatile, averaging 7.2% (SD = 17.9%), with extreme values during sanctions and wars (–64% in 1991, 57.8% in 1990). Trade openness averaged 71.5% (SD = 37.1%), the misery index 48.6% (max 457.5% in 1994), and government expenditure 15.9% of GDP (SD = 8.6%). Urbanization steadily increased from 56.2% in 1970 to 71.4% in 2022. Oil revenues averaged 38% of GDP (SD = 15.7%), while the exchange rate averaged 1,652.8 dinars per USD (SD = 437.2). These statistics highlight two structural characteristics of Iraq's economy: strong oil dependence and high vulnerability to political and external shocks. Fluctuations in growth and the misery index coincide with wars, sanctions, and oil-price volatility, demonstrating the fragility of welfare outcomes. In contrast, steady urbanization indicates long-term demographic pressures on infrastructure and public services, providing context for interpreting the regression results.

Table 2. Descriptive analysis of variables

Variables	Mean	Maximum	Minimum	Standard Deviation	Unit
HDI	0.590	0.696	0.496	0.055	-
GDP	3.204	57.818	-64.047	17.923	%
$\frac{\mathbf{G}}{\mathbf{GDP}}$	15.903	2.332	43.382	8.646	%
misery	48.559	457.538	0.019	89.618	%
Urban	67.518	71.354	56.154	3.675	%
Open	71.475	154.235	0.021	37.068	%
Exch	1650.825	2144.567	0.357	437.190	Dinar per dollar
oil	38.004	65.158	9.433	15.672	%

Source: Researchers' findings

Table 3 shows the results of the unit root tests. All variables exhibit structural breaks, with break dates reported in column eight. The Zivot–Andrews test shows that, at the 95% confidence level, all variables are stationary once structural breaks are incorporated, ensuring valid long-run estimation and reducing the risk of spurious regression. Notably, detected break dates (1991, 2003, 2008) correspond to major economic and political shocks, including the Gulf War, the U.S.-led invasion, and oil market fluctuations. This alignment supports the robustness of the econometric results by accounting for Iraq's structural instabilities.

Table 3. Results of unit root test

Variables	ADF	CR	KPS	CR	ZA	CR	Break	Result
HDI	-0.342	-2.917	0.187	0.463	-6.162	-4.444	2008	Stationarity
GDP	-3.635	-2.917	0.057	0.463	-5.422	-4.444	2004	Stationarity
$\frac{\mathrm{G}}{\mathrm{GDP}}$	-2.203	-2.917	0.144	0.463	-5.350	-4.444	1986	Stationarity
misery	-6.648	-2.917	0.102	0.463	-7.630	-4.444	1986	Stationarity
Urban	-3.439	-2.917	0.194	0.463	-9.855	-4.444	1973	Stationarity
Open	-2.346	-2.917	0.112	0.463	-9.282	-4.444	1998	Stationarity
Exch	-35.748	-2.917	0.187	0.463	-127.068	-4.444	2003	Stationarity
oil	-3.210	-2.917	0.089	0.463	-4.944	-4.444	1991	Stationarity

Source: Researchers' findings

Table 4 summarizes the quantile regression results. Economic growth positively and significantly affects HDI across all deciles, with stronger effects in lower deciles. This suggests that in Iraq's oil-dependent economy, growth boosts welfare more at earlier development stages by improving income and basic public services, while its marginal effect diminishes in higher deciles due to structural bottlenecks. Government expenditure as a share of GDP also positively impacts HDI in most deciles, especially lower ones, highlighting its key role in enhancing welfare where private sector activity and infrastructure are weak. The smaller effect in higher deciles indicates that further welfare improvements require structural reforms and greater private sector participation rather than additional public spending.

Table 4. Estimation results of quantile regression model

Variables	0. 1	0. 2	0. 3	0. 4	0. 5	0. 6	0. 7	0. 8	0. 9
C	0.165*** (2.450)	0.324*** (4.16)	0.277*** (5.51)	0.354*** (4.96)	0.129*** (2.79)	-0.495*** (-33.63)	-0.819 (-52.15)	-0.849*** (-58.53)	-0.770*** (-32.28)
GDP	0.145*** (20.19)	0.160*** (8.57)	0.182*** (15.89)	0.185*** (47.75)	0.162*** (32.63)	0.123*** (161.80)	0.097*** (104.83)	0.099*** (159.02)	0.104*** (74.36)
$\frac{G}{GDP}$	0.042*** (6.66)	0.052*** (2.95)	0.064*** (2.89)	0.050** (14.17)	0.029*** (11.27)	0.024*** (31.06)	0.014** (2.04)	0.012** (2.21)	0.001 (0.78)
misery	0.002*** (38.20)	0.001 (0.52)	0.004*** (6.57)	0.006*** (10.74)	0.003** (2.57)	-0.001*** (-2.76)	-0.001* (-1.80)	-0.001 (-1.24)	-0.000 (-0.86)
Urban	-1.126*** (-13.82)	-1.305*** (-8.17)	-1.402*** (-12.60)	-1.443*** (-24.66)	-1.209*** (-23.46)	-0.589*** (-49.11)	-0.265*** (-33.55)	-0.258*** (-30.21)	-0.311*** (-16.11)
Open	-0.013*** (-6.73)	-0.018*** (-2.82)	-0.023*** (-3.57)	-0.019** (-19.15)	-0.009** (-12.58)	-0.006*** (-79.50)	-0.001 (-0.40)	0.001 (0.74)	0.002** (2.16)
Exch	0.001 (0.93)	0.003*** (5.52)	0.003*** (35.80)	0.006*** (4.57)	0.005*** (14.07)	0.003*** (44.72)	0.002*** (20.14)	0.002*** (13.84)	0.004*** (10.22)
oil	0.032*** (17.61)	0.030*** (33.71)	0.021** (2.43)	0.004 (0.47)	0.000 (0.11)	0.002*** (7.53)	0.014*** (20.52)	0.015*** (8.09)	-0.000 (-0.15)
war	-0.004*** (-5.64)	-0.003 (-1.09)	-0.006*** (-3.12)	-0.004*** (-4.46)	0.000 (0.10)	-0.017*** (-50.41)	-0.028*** (-56.77)	-0.027*** (-36.77)	-0.030*** (-69.94)
Pseudo R-squared	0.682	0.641	0.693	0.659	0.683	0.710	0.745	0.771	0.775
Adjusted R-squared	0.625	0.571	0.573	0.598	0.625	0.657	0.699	0.730	0.734
Quasi-LR statistic	6935.3	2154.3	5013.5	1287.2	2029.0	10360.1	10419.5	10441.6	4428.52
Prob (LR)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

*, ** & *** are significant, respectively, at the significance levels of 10, 5, and 1%. Source: Researchers' findings

The quantile regression findings provide useful information on the elements impacting human development in Iraq. Government spending as a proportion of GDP has a positive and statistically significant influence on HDI in virtually all deciles, with the exception of the ninth. The biggest impacts are shown in the bottom deciles, emphasizing the significance of fiscal policy in enhancing welfare where infrastructure is scarce and private investment is constrained. During the early phases of development, public investment supported by oil income served as the primary avenue for improving education, health, and basic amenities. However, as the economy grows, the marginal impact of government spending decreases, indicating the need for Iraq to gradually transition away from state-driven expenditures and toward structural reforms and more private sector engagement. The misery index demonstrates a dual effect on HDI. In the first through fifth deciles, its relationship with HDI is positive, likely reflecting the buffering role of oil revenues, which allowed the state to sustain social spending even amid high unemployment and inflation. In the higher deciles (sixth through ninth), however, the effect turns negative, as persistent inflationary pressures, structural joblessness, and weak diversification erode welfare gains. This transition highlights that oil rents can offset shocks temporarily, but long-run stability requires inflation control and labor market reforms to reduce vulnerability. The impact of urbanization is statistically significant and consistently negative across the distribution, with the effect being stronger in the lower deciles. Iraq's fast urbanization throughout the research period outpaced spending on public services, infrastructure, and housing, resulting in overpopulation and declining living conditions. Lack of good water, power, and healthcare in cities undermined the possible welfare gains from urbanization. According to the findings, growing urbanization will continue to put pressure on welfare outcomes, particularly for disadvantaged populations, in the absence of decentralization and smart urban planning. Different consequences are produced by trade openness. HDI is adversely affected in the lower and middle deciles (first through sixth), but it has a

favorable and significant effect in the ninth decile. The findings show little statistical significance at intermediate levels. With few connections to domestic output, these findings reflect the trade structure of Iraq, with imports mostly consisting of consumer and capital items and exports primarily consisting of crude oil. Thus, increased transparency did not immediately result in benefits. Access to technology, foreign finance, and new markets was only made possible by trade openness at higher stages of development, when integration into international markets improved. This suggests that domestic capacity-building and diversification tactics are necessary for trade gains.

The exchange rate also has a notable impact. Depreciation of the dinar is associated with positive effects on HDI in nearly all deciles except the first. Given that Iraq's oil exports are denominated in U.S. dollars, a weaker dinar boosted government revenues in local currency, expanding fiscal space for health, education, and social programs. In many developing economies, depreciation reduces welfare through higher import costs, but in Iraq's case the opposite occurred due to heavy oil dependence. Nevertheless, this channel exposes the economy to external price volatility, underscoring the need for cautious management of exchange rate policy. Oil revenues exert a positive and statistically significant influence on HDI, particularly in the lower declines. For example, the average effect of oil revenues on HDI in the lowest three deciles is around 0.028, compared to about 0.010 in higher deciles. This demonstrates that welfare gains from oil were most powerful when the economy was at earlier stages of development. However, the results also reveal diminishing returns at higher levels of welfare, as oil income was often allocated to current expenditures rather than long-term investment. This pattern reinforces Iraq's dependence on global oil cycles and the vulnerability of its welfare outcomes to price shocks, highlighting the need to channel oil rents into sustainable, diversified development. Finally, war has a continuous and considerable negative influence on HDI, with the most severe consequences appearing in the greater drops. Conflict

has frequently destroyed infrastructure, delayed service delivery, and reduced institutional capacity, wiping out previous welfare gains. These findings demonstrate that political stability and peace are not only necessary for human growth but also improve the efficacy of economic policy. Without stability, benefits from fiscal policy, oil income, and foreign trade are likely to be short-lived. Overall, the quantile regression results reveal that Iraq's welfare dynamics are highly sensitive to fiscal policy, oil income, and external shocks. Government spending and oil revenues support welfare most strongly in lower declines, while structural weaknesses in urbanization, trade dependence, and inflation undermine progress. The analysis highlights the importance of combining short-term fiscal instruments with long-term reforms in diversification, governance, and urban planning to ensure sustained improvements in human development.

Model Diagnostics: The model's general validity is supported by the Likelihood Ratio (LR) statistics, which are significant at the 5% level for all quantiles. With pseudo R-squared values between 0.641 and 0.775, substantial explanatory power is shown. Furthermore, at the 95% confidence level, the Symmetry Test rejects coefficient symmetry, and the Slope Equality Test rejects the null hypothesis of equal slopes across quantiles. These results validate the suitability of the quantile regression technique and highlight the diversity of interactions throughout the HDI distribution (see Table 5).

Table 5. Results of the coefficient equality test and coefficient symmetry test

Test	Test statistic	DF	Prob
Symmetry test	262150.0	64	0.000
Slope equality test	25076.6	36	0.000

Source: Researchers' findings

6. Conclusion

This study applied a quantile regression approach to investigate the factors influencing Iraq's HDI from 1970 to 2022. The results indicate that the

impacts of economic and social variables vary considerably across different levels of development, highlighting the importance of designing policies that address heterogeneous welfare outcomes. Economic growth emerges as a consistently positive and significant driver of HDI across most quantiles, with stronger effects at lower levels of development. These findings are consistent with Alfaraji and Hamad (2021), who reported that a 1% increase in GDP per capita leads to a 1.77% rise in Iraq's HDI. It implies that growth not only accelerates development but also has a stronger welfare impact when the economy is in earlier stages. Similarly, government spending as a share of GDP exerts a positive and significant effect on HDI, especially in the lower quantiles. This result supports Bekheet (2021) and highlights the vital role of fiscal policy in funding education, healthcare, and social programs within Iraq's oil-dependent economy. Yet, the declining marginal impact at higher quantiles suggests that beyond a threshold, structural reforms and private sector expansion are required to sustain progress. By contrast, the misery index exerts a negative and significant influence, especially in higher quantiles, consistent with Khodaverdi Samani et al. (2023). Persistent inflation, unemployment, and inequality erode welfare gains, pointing to the importance of macroeconomic stabilization. Urbanization also shows a negative effect across most quantiles, reflecting the mismatch between population growth in urban centers and insufficient infrastructure or service provision. This shows that the trend of urbanization in Iraq has not resulted in increased well-being. The currency rate and trade openness have different functions. Across the lower six quantiles, trade openness has a negative effect on HDI, but at higher levels of development, this effect becomes positive and substantial, indicating that openness only benefits welfare when institutional and structural capacity are sufficiently created. Conversely, the exchange rate has a favorable and noteworthy impact on practically every quantile, with the exception of the first. Currency depreciation expanded government revenues from oil exports and strengthened fiscal capacity for human development investments. This finding suggests that maintaining a flexible exchange rate, rather than a rigid

peg, can enhance welfare outcomes. War remains a major constraint, significantly reducing HDI across most quantiles. Beyond economic shocks, conflict undermines health, education, and infrastructure, reversing welfare gains. Hence, peacebuilding and conflict mitigation are fundamental prerequisites for sustained human development in Iraq. While the study provides important insights, several limitations remain. The reliance on annual data may obscure short-term dynamics, highlighting the need for future studies with higher-frequency data. Moreover, the focus on macroeconomic variables overlooks institutional, political, and environmental dimensions that are equally critical to development. Incorporating these factors would provide a more comprehensive picture of welfare dynamics in Iraq and comparable fragile economies. In conclusion, Iraq's pathway to sustainable human development requires a dual strategy: leveraging oil revenues and fiscal policy to meet immediate welfare needs while pursuing structural reforms, economic diversification, and conflict resolution to secure long-term, inclusive growth.

Funding

This study received no financial support from any organization.

Authors' contributions

All authors had contribution in preparing this paper.

Conflicts of interest

The authors declare no conflict of interest

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