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Distributional Effects of Financial Inclusion, Trade, and Human Development on Growth: A Quantile Regression Study of Saudi Arabia

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Abstract

This study investigates the heterogenous effects of financial inclusion, energy consumption, human development, and trade openness on economic growth in Saudi Arabia over 2004–2023. The quantile regression method is employed to account for distributional features in the growth process that are otherwise lost in standard mean-based estimators. The Johansen cointegration test confirms the presence of a long-run equilibrating relationship among the variables, with an argument for the application of Fully Modified Ordinary Least Squares (FMOLS) as a robustness check. Empirical results indicate that financial inclusion significantly and positively impacts economic growth in all quantiles and underscores its impact in both lower- and higher-growth settings. Human development, as estimated by the Human Development Index (HDI), is positively related to economic growth in quantiles 0.10, 0.25, 0.5, and 0.75, but in quantile 0.90 the effect becomes statistically insignificant, indicating diminishing returns for higher incomes. Trade openness has positive and significant relations with quantiles of 0.10, 0.25, and 0.75, whereas energy consumption maintains a negative but statistically insignificant relation with all quantiles. The FMOLS estimates are broadly consistent with the results of the quantile regression. The results highlight the importance of embracing differentiated, phase-specific policy actions in an effort to develop inclusive and sustainable economic growth in line with Saudi Arabia's Vision 2030.

Keywords: *Financial Inclusion; Human Development; Trade Openness; Energy Use; Economic Growth; Quantile Regression.*

Introduction

Long-term economic growth remains a top priority for emerging nations, and particularly for those that are looking to transition out of resource dependence. To this end, the establishment of the determinants of economic growth, primarily financial inclusion, use of energy, human development, and trade openness, has increased tremendously in significance to researchers and policymakers. These are the elements widely known to determine the structural transformation and long-term prosperity of nations. Saudi Arabia, the Middle East and North Africa's (MENA) biggest economy, presents a fascinating study given its recent strategic shift under the Vision 2030 initiative that seeks to reduce reliance on oil, enhance human capital, and build an inclusive financial system.

Saudi Arabia's economic environment has experienced significant changes during the last two decades. The GDP per capita for the country was $25,635 in 2023, from around $21,546 in 2004, highlighting attempts at modernizing and diversifying the economy (World Bank, 2024). In addition, the Human Development Index (HDI) rose from 0.737 in 2000 to 0.9 in 2023, revealing significant advancement in education, health, and standard of living (UNDP, 2025). At the same

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time, financial inclusion, as reflected in domestic credit to the private sector in percentage terms of GDP, rose from 29.19% in 2004 to 50.14% in 2023 (World Bank, 2024). This improvement highlights the need to know to what extent financial development, consumption of energy, human capital formation, and trade integration have assisted in economic performance in Saudi Arabia.

With the rising body of research on macroeconomic determinants of growth, little work has explored such connections in the case of Saudi Arabia using distributional approaches such as quantile regression. The strength of the study in this paper is that it uses quantile regression to analyze the heterogeneous effects of financial inclusion, energy consumption, HDI, and trade openness on economic growth along the conditional growth distribution. This approach allows for the estimation of the extent, to which these factors influence low-growth and high-growth regimes differently, thus yielding richer policy messages than when using conventional mean-based estimations.

The rest of this paper is structured as follows. Section 2 presents a literature review. Section 3 explains the model and estimation strategy. Section 4 presents the empirical results and major conclusions. Finally, Section 5 concludes the study and makes detailed policy recommendations on the basis of the facts.

Literature Review

The connection between financial inclusion, energy consumption, human development, trade openness, and economic growth has drawn considerable empirical focus, particularly for developing and resource-rich economies. It is generally the case that most studies confirm the presence of long-run positive relationships among these variables, although the magnitude and direction of effects vary by region and econometric specification.

Financial inclusion has emerged as a key driver of economic performance. It exists voluminous literature from works like Nguyen and Van Nguyen (2020), Odame et al. (2024), and Pandey et al. (2024) that there is empirical evidence that increased access to financial institutions increases the savings capital, encourages entrepreneurship, and enhances overall economic activity. Using various methods of estimation, all these papers conclude that there is a positive relationship between financial inclusion and GDP growth. Exemplarily, Khaleq and Shihab (2024), Onaolapo (2015), and Alabass Alfaki and Mohamed (2022) had established that domestic credit to the private sector plays a significant role in economic growth in emerging economies. Similarly, in the case of Saudi Arabia, it is also expressed by Bashier et al. (2022), who used an ARDL approach to establish a long-run positive association between financial inclusion and economic performance. Further, Ozili et al. (2022) and Opoku et al. (2024) emphasize the transmission channel on which financial services create human capital development while financial exclusion is reduced, hence indirectly stimulating growth.

The consumption of energy has also been recognized as one of the key production factors with long-term economic growth implications. Alshehry and Belloumi (2015) conducted Saudi Arabia's time series analysis and proved the positive link between GDP and energy consumption. Similarly, Asif et al. (2015) and Magazzino (2016) proved that energy consumption is directly liable for economic activity for GCC and Middle Eastern countries. In the general perspective, Androniceanu and Georgescu (2023) revealed that energy consumption significantly contributes to growth in a panel of economies, although the environmental price of energy consumption was also reported. The above verifies the studies by Ahmad et al. (2022) who revealed that non-renewable energy consumption contributes positively to growth, particularly in countries with high levels of CO_2 emissions. However, the energy-growth relationship is typically responsive to the income level, energy mix, and structural characteristics of the nation.

Human development, as measured by the Human Development Index (HDI), has been established to have a positive and significant effect on economic growth. Aminda et al. (2024) highlighted the contribution of education and health investment in increasing human capital and productivity that trigger economic growth. Oliveira et al. (2024) also argue that human capital not only directly supports growth but also boosts the absorptive capacity for technology and institutional quality. But Ojima and Anyanwu (2021) found that the HDI has a statistically significant negative effect on economic growth in Nigeria, indicating that a 1% increase in HDI leads to approximately a 5% decrease in GDP per capita. These are pointers that policies aimed at improving education and access to healthcare can yield long-term economic dividends.

Openness to trade has been extensively tested as a means of economic growth, but its impact varies with the country and methodology used. Tiba et al. (2016) found that openness to trade positively contributes to economic growth through an increase in environmental quality and the encouragement of the use of clean energy, particularly in high- and middle-income countries. Furthermore, the statistically significant positive contribution of trade openness to GDP per capita in high carbon-emitting economies has been established by Azam et al. (2016) and is associated with its ability to encourage market access as well as technology transfer. On the contrary, Ahmad et al. (2022), in the case of their analysis of India, held that trade openness has statistically significant negative effects on GDP per capita in both the short and long run, i.e., trade possibly exposes local sectors to competitive pressures or macroeconomic instability. In the Gulf Cooperation Council (GCC) context, Dkhili and Ben Dhiab (2018) held that economic growth is enhanced by trade openness if accompanied by more economic freedom. Collectively, these studies suggest that while openness to trade is normally associated with growth, its effect may be situation-specific and depend on institutions, the energy policy, and export structure.

Briefly stated, recent literature establishes that financial inclusion, energy use, human development, and trade openness are vital to economic growth in the long run, though their effects can be diverse by country and stage of the economy. While the majority of the previous studies utilize mean-based estimation techniques such as OLS or ARDL, increasing recognition exists that distributional effect must be explored using quantile regression. This study contributes to this emerging literature by examining these four variables simultaneously in a quantile regression setting in the Saudi Arab context, allowing more nuanced insight into how they drive economic performance at different levels.

Model and Methodology

The Model

This study aims at investigating the determinants of economic growth in Saudi Arabia, and specifically the roles played by financial inclusion, energy consumption, human development, and trade openness. In line with endogenous growth theory as well as the availability of empirical evidence, the model presumes that economic growth is stimulated by the expansion of inclusive financial systems, productive energy consumption, achievement of improved human development outcomes, and openness to foreign trade.

To formalize this relation, the functional form provided is as follows: (Equation 1):

$$LnGDPPC_t = \alpha_0 + \alpha_1 LnFI_t + \alpha_2 LnENE_t + \alpha_3 HDI_t + \alpha_4 LnTRADE_t + \varepsilon_t \quad (1)$$

LnGDPPC is the natural logarithm of GDP per capita (constant 2015 US$) as a proxy for economic growth. LnFI is the natural logarithm of financial inclusion, and domestic credit to the private sector as a percentage of GDP is used as a proxy for it. LnENE is the natural logarithm of energy consumption, which is measured in kilograms of oil equivalent per capita. HDI stands for Human Development Index and is employed as an operational proxy for human capital development. LnTRADE is the natural logarithm of trade openness, which is measured as the exports plus imports over GDP. All the variables are obtained from the World Bank's World Development Indicators (WDI) database except for HDI, which is drawn from the United Nations Development Programme (UNDP) Human Development Reports.

Estimation Method

Given the possibility of heterogeneous impacts of explanatory variables across different levels of economic growth, this study adopts quantile regression (QR) as the primary estimation technique. Unlike the traditional Ordinary Least Squares (OLS) approach, which estimates the conditional mean of the dependent variable, QR models the conditional quantiles, enabling a more detailed understanding of how financial inclusion, energy use, human development, and trade affect the entire distribution of economic growth, especially at low, middle, and high-growth regimes.

Quantile regression was first introduced by Koenker and Bassett (1978). It provides two key advantages over OLS. First, it is robust to outliers and deviations from normality, which are common in macroeconomic time series. Second, it relaxes the assumption of homoscedasticity, allowing the effects of independent variables to vary at different points of the conditional distribution of the dependent variable.

Mathematically, in the Equation (2) the quantile regression estimator minimizes the following loss function:

$$Q(\beta_\tau) = \sum_{i:y_i \geq x_i'\beta_\tau} \tau \mid y_i - x_i'\beta_\tau \mid + \sum_{i:y_i < x_i'\beta_\tau} (1-\tau) \mid y_i - x_i'\beta_\tau \mid \quad (2)$$

Where $\tau \in (0,1)$ is the quantile of interest (e.g., 0.10, 0.25, 0.50, 0.75, 0.90), x_i' is the vector of explanatory variables, and y_i is the dependent variable (economic growth). The coefficient vector β_τ captures the effect of regressors on the τ^{th}conditional quantile of the dependent variable.

In this study, the quantile regression model is specified in the Equation (3) as follows:

$$Q_{LnGDPPC_t}(\tau \mid X_t) = \alpha_\tau + \beta_{1\tau} LnFI_t + \beta_{2\tau} LNENE_t + \beta_{3\tau} HDI_t + \beta_{4\tau} LnTRADE_t + \varepsilon_{t\tau} \quad (3)$$

Here, $Q_{LnGDPPC_t}(\tau \mid X_t)$ denotes the conditional τ^{th} quantile of economic growth (proxied by the log of GDP per capita), and X_t represents the vector of explanatory variables. The coefficients $\beta_{j\tau}$ measure the marginal effect of each independent variable on economic growth at the τ^{th}quantile.

To strengthen statistical inference, the estimation is performed using bootstrapped standard errors and kernel-based sparsity functions, ensuring robustness in small samples. The estimation covers five quantiles (τ = 0.10, 0.25, 0.50, 0.75, and 0.90) to reflect distributional dynamics across different stages of economic development in Saudi Arabia. This approach unveils important policy-relevant nuances that conventional mean-based estimation methods would otherwise overlook.

Results and Discussion

Descriptive Statistics

Table 1 presents the descriptive statistics of the variables.

Variable	Mean	Std. Dev.	Min	Max	Skew.	Kurt.	J.B.	Prob.
LnGDPPC	10.046	0.068	9.932	10.193	0.391	2.490	0.726	0.696
LnFI	3.576	0.232	3.188	3.996	0.247	2.188	0.753	0.686
LnENE	8.897	0.075	8.760	8.985	-0.545	1.925	1.952	0.377
HDI	0.835	0.042	0.773	0.900	0.022	1.508	1.856	0.395
LnTRADE	4.254	0.222	3.861	4.565	-0.247	1.650	1.723	0.423

Table1. Descriptive Statistics.

Table 1 reveals descriptive statistics of variables employed in the research between the years 2004–2023. The natural logarithm of GDP per capita (LnGDPPC) is defined by an average of 10.05 with a standard deviation of 0.068, representing relatively low variation of economic output per person in Saudi Arabia over the years. The value of the Jarque-Bera test statistic of 0.726 and its associated probability of 0.696 confirms that the variable is normally distributed. Financial inclusion (LnFI) as a proxy by domestic credit to the private sector as a percentage of GDP has a mean of 3.58 and moderate variability (std. dev. = 0.232). It is slightly positively skewed (0.25) and nearly mesokurtic, with no sign of extreme non-normality. Energy consumption (LnENE) is 8.90 with low variance (std. dev. = 0.075) and mildly left-skewed (-0.54) but suggests more high observations of energy consumption. The variable is normally distributed as Jarque-Bera p-value is 0.377. The Human Development Index (HDI) has a relatively high mean value (0.8345), consistent with Saudi Arabia being classified as a high-HDI country. Its very low standard deviation (0.042) indicates little variation in human development over the years. The distribution is nearly symmetric and platykurtic. Openness of trade (LnTRADE) has a mean of 4.25 and range of 3.86 to 4.57. Moderate variation (std. dev. = 0.213) and trivial left skew (-0.25) would be expected from fluctuations in trade, particularly when there are global economic occurrences. The distribution is nearly normal as well.

Briefly, the descriptive statistics portray a well-behaved dataset to work with in regression analysis. The variables are not very skewed and are not kurtotic, and all are reasonably normally distributed, hence favoring the use of parametric and semi-parametric estimation methods.

Unit Root Test

Prior to the conduct of the regression analysis, it is important to test the stationarity characteristics of the variables to avoid spurious results. The Augmented Dickey-Fuller (ADF) test was conducted for all the series using two specifications: with only an intercept and with an intercept and a deterministic trend. All the variables were tested at level and first difference. The findings are summarized in Table 2.

Variable	Level		1st Diff.		**Remark**
	Intercept	Trend & Intercept	Intercept	Trend & Intercept	
	Prob.	**Prob.**	**Prob.**	**Prob.**	
LnGDPPC	0.6474	0.0294**	0.0005***	0.0026***	I(1)
LnFI	0.8372	0.1124	0.0098***	0.0540*	I(1)
LnENE	0.2997	0.9340	0.0127**	0.0254**	I(1)
HDI	0.9589	0.2457	0.0688*	0.2039	I(1)
LnTRADE	0.8931	0.0834*	0.0089***	0.0424**	I(1)

Note: *, **, and *** indicate rejection of the null hypothesis of a unit root at the 10%, 5% and 1% significance levels, respectively.

Table 2. The Results of the ADF Unit Root Test.

As presented Table 2, the Augmented Dickey-Fuller test statistics indicate that none of the variables are stationary in levels when tested using an intercept alone or an intercept and trend. But after taking first differences, all variables are found to be stationary based on statistically significant ADF test statistics at the 1%, 5%, or 10% levels. This confirms that all series (LnGDPPC, LnFI, LnENE, HDI, and LnTRADE) are of order one integrated, I(1). They are thus usable for estimation methods involving I(1) variables, such as cointegration analysis, FMOLS, and quantile regression on cointegrated data.

Cointegration Test

To ensure whether there exists a long-run equilibrium relationship among the variables (LNGDPPC, LNFI3, LNENE, HDI, and LNTRADE), Johansen cointegration test was employed on the basis of both trace and maximum eigenvalue statistics. The results are shown in Table 3.

Hypothesized No. of CE(s)	**Trace Statistic**	**Critical Value (5%)**	**Prob.**	**Max-Eigen Statistic**	**Critical Value (5%)**	**Prob.**
None	146.9178	69.8189	0.0000*	65.8645	33.8769	0.0000*
At most 1	81.0533	47.8561	0.0000*	43.0453	27.5843	0.0003*
At most 2	38.0079	29.7971	0.0045*	22.8643	21.1316	0.0282*
At most 3	15.1437	15.4947	0.0564	12.7674	14.2646	0.0850
At most 4	2.3763	3.8415	0.1232	2.3763	3.8415	0.1232

Note: * indicates significant at 5% level.

Table 3. Johansen Cointegration Test Results.

Trace test involves rejection of null hypothesis of no cointegration at "at most 2", i.e., three cointegrating vectors at 5% level. The same result is obtained with the maximum eigenvalue test, where null hypotheses are rejected at the same level. These findings indicate the existence of a statistically significant long-run equilibrium relationship among economic growth

(LnGDPPC), financial inclusion (LnFI3), energy consumption (LnENE), human development (HDI), and trade openness (LnTRADE) in Saudi Arabia during 2004-2023.

Hence, it is understandable to approximate the long-run connection using cointegration-based estimation techniques such as FMOLS, which corrects for serial correlation and endogeneity, and is a good robustness check to quantile regression.

Quantile Regression Estimation

In order to quantify the heterogeneous effects of financial inclusion, energy use, human development, and trade openness on economic growth in Saudi Arabia, the study employs the quantile regression approach. Unlike ordinary least squares (OLS), which provides the mean effect, quantile regression accounts for the effect of explanatory variables at different points of the conditional distribution of GDP per capita. This is particularly appropriate when variable relationships may differ in low-growth and high-growth regimes. The quantile regression was estimated at five key quantiles: 0.1, 0.25, 0.5 (median), 0.75, and 0.9. Table 4 presents the coefficient estimates for each quantile.

	Quantile	0.10	0.25	0.50	0.75	0.90
LnFI	Coefficient	0.0906**	0.1112*	0.0459*	0.1664***	0.1426**
	Std. Error	0.0324	0.0573	0.0222	0.0133	0.0543
LnENE	Coefficient	-0.1020	-0.1010	-0.0424	-0.0731	-0.0350
	Std. Error	0.1084	0.0616	0.0384	0.0561	0.2070
HDI	Coefficient	2.5084***	2.2883***	1.1753***	1.3004***	1.4507
	Std. Error	0.3937	0.4033	0.0992	0.1734	0.9315
LnTRADE	Coefficient	0.0.2346***	0.2506***	-0.0045	0.1174**	0.1516
	Std. Error	0.0545	0.0321	0.0290	0.0453	0.1601
C	Coefficient	7.5010***	7.5426***	9.3058***	8.5445***	8.0270***
	Std. Error	1.3189	0.6284	0.2574	0.25337	0.7134

Note: ***,** and* means 1 %, 5 % and 10 % significance level.

Table 4. Quantile Regression Results.

The quantile regression estimates exhibit considerable heterogeneity in how the explanatory variables affect economic growth across points of the income distribution. Financial inclusion (LnFI) positively affects GDP per capita across all quantiles, and its magnitude increases at higher quantiles. This suggests that as the economy grows larger, the enhancements in access to credit and financial services are increasingly beneficial to propping up higher income levels. Energy consumption (LnENE) is, on the other hand, negatively related to economic growth throughout the distribution, albeit its impact is statistically insignificant. This may indicate inefficiency or environmental damage resulting from energy consumption. The human development index (HDI) exerts a statistically significant and positive influence on economic growth at the 0.10, 0.25, 0.50, and 0.75 quantiles, but loses statistical significance at the 0.90 quantile. Notably, the impact of HDI is strongest at the lowest quantile and declines progressively across higher quantiles, highlighting the greater role of human capital in fostering growth at earlier stages of development rather than in high-growth contexts. Trade openness (LnTRADE) has a more mixed pattern. It is positive and strongly significant at lower quantiles, indicating that external trade is one of the key drivers of growth at earlier stages, but its impact weakens at the median and returns only imperfectly at higher quantiles.

Quantile Process Plot

To further assess stability and heterogeneity of the coefficients for other quantiles, quantile process plot was presented for every explanatory variable as seen in Figure 1. The traces represent the trajectories of the coefficients (blue line) over the quantile range between 0.1 and 0.9, while the red lines represent 95% confidence intervals.

As can be observed, the impact of financial inclusion (LnFI) increases with increasing quantiles, especially beyond the median, which means its impact becomes stronger in more affluent segments. This nonlinearity supports the hypothesis that financial development may be more growth-enhancing at later levels of economic development.

For energy consumption (LnENE), the coefficient is largely stable and negative across quantiles, indicating a consistent but negative relationship with economic growth. The close bands for the confidence intervals indicate that this effect is statistically insignificant throughout the distribution, while the size does not vary significantly.

The impact of the Human Development Index (HDI) on economic growth is strongly and statistically significant at lower and intermediate quantiles but falls increasingly at higher quantiles. This pattern indicates that human development is a significant growth driver at early and intermediate stages, but its marginal contribution will fall in more advanced growth environments, possibly due to diminishing returns or saturation effects.

Finally, trade openness (LnTRADE) is U-shaped. Its coefficient is positive and relatively large at low quantiles, declines towards the middle (even turning negative), and rises again at higher quantiles. This implies a non-linear relationship between trade and growth and that openness contributes more to growth in both low-income and high-income states.

Overall, the differential patterns in coefficients over quantiles provide strong graphical evidence in favor of the use of quantile regression compared to standard mean-oriented techniques such as OLS. These findings reinforce the need to recognize heterogeneity between the macroeconomic variables and their effects on growth.

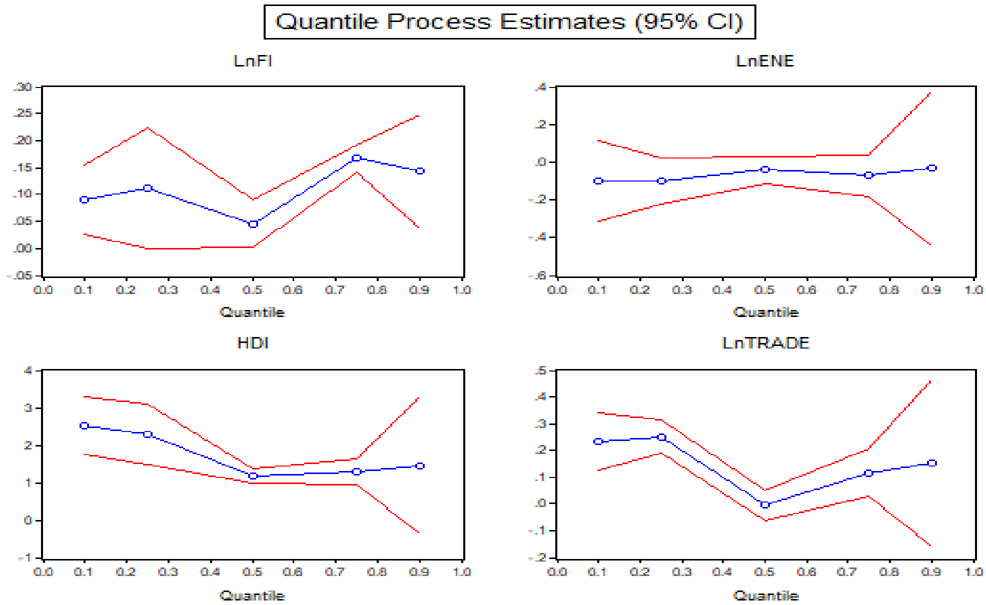

Figure1. Quantile Process Plot With 95% Confidence Intervals.

Robustness Checks

As a robustness test for the consistency and precision of the quantile regression estimates, a Fully Modified Ordinary Least Squares (FMOLS) regression is employed. FMOLS fits best with time series data with potential endogeneity and serial correlation among regressors and is similarly most frequently applied in cases where variables are integrated of order one, I(1), and cointegrated. The method corrects for serial correlation and endogeneity in the long-run relationship through a semi-parametric adjustment mechanism to offer efficient and unbiased coefficient estimates.

The above table presents long-run elasticities of per capita GDP in relation to financial inclusion (LnFI), energy consumption (LnENE), human development (HDI), and trade openness (LnTRADE).

Dependent variable: LnGDPPC			
Variable	**Coeff.**	**t-stat.**	**Prob.**
Long –run coefficients			
LnFI	0.1287^{**}	2.4112	0.0302
LnENE	-0.0136	-0.1407	0.8901
HDI	1.2815^{**}	2.4761	0.0267
LnTRADE	0.1047	1.3871	0.1871
C	8.1909^{***}	9.0612	0.0000
R-Square	0.8032		
AdjustedR^2	0.7470		

Note: * and ** indicate 10% and 5% significance levels, respectively.

Table 6. Regression Estimates (FMOLS).

The FMOLS estimates confirm the relevance of financial inclusion and human development in the Saudi Arabian economic growth process during the 2005-2023 period. Specifically, a 1% increase in domestic credit to the private sector (LnFI) is associated with a 0.13% increase in GDP per capita, which is statistically significant at the 5% level. Similarly, HDI has a powerful and positive significant effect, suggesting that improvements in human capital are strongly related to economic performance in the long term. However, both energy consumption (LnENE) and openness to trade (LnTRADE) are not statistically significant with FMOLS estimation, which may be due to structural determinants or threshold effects being more accurately described at some quantiles than at the conditional mean.

These findings provide evidence to the robustness of the quantile regression estimates and establish that the effect of the most important development variables for economic growth is persistent across different econometric specifications.

Discussion

The positive, statistically significant influence of financial inclusion on economic growth in most of the quantiles, especially the higher quantiles, indicates the significance of access to credit in enabling investment and private sector development in Saudi Arabia. This result is consistent with previous work by Bashier et al. (2022) and Nguyen and Van Nguyen (2020), who established that private sector domestic credit plays a considerable role in promoting the rate at which growth takes place among Gulf and developing countries. Increasing influence of financial inclusion with higher quantiles suggests that in more developed segments of the Saudi economy, financial services are increasingly central to facilitating growth. This follows the Vision 2030 financial sector development strategy of the Kingdom, which aims to enhance financial inclusion, particularly for the SME and underprivileged segments (Ministry of Finance, 2020).

On the other hand, energy consumption had a statistically insignificant but negative correlation with GDP per capita across all quantiles during the quantile regression. Also, the FMOLS estimation revealed a negative long-run impact. This trend is the opposite of previous studies such as Alshehry and Belloumi (2015), who had established a direct link between energy consumption and economic growth in Saudi Arabia, but are in agreement with the study of Azam et al. (2016), who established that energy consumption decreases economic growth at a considerable rate in high CO_2-emitting economies. In Saudi Arabia, this can be attributed to energy allocation inefficiencies, the prevalence of fossil fuels in the energy composition, and ongoing energy subsidies that induce production distortions. With the country making its way through its price reforms and promoting renewable energy under Vision 2030, the role of energy in supporting growth can be maximized and the energy-growth nexus transformed from a cost to a factor of production.

Human development, as measured by the HDI, exerts a high positive influence on economic growth at all quantiles, except the 0.90 quantile, when the influence becomes statistically weak. This pattern reinstates the impact of human capital on economic performance, particularly during low to moderately high growth phases. The findings are also consistent with the endogenous growth theory expectations that improvements in education, health, and knowledge accumulation contribute to long-run economic growth via productivity improvement and innovation (Lucas, 1988; Romer, 1990). The absence of an impact at the upper quantile may imply diminishing marginal returns to human development in high-growth settings or reflect inefficiencies in the translation of high quantities of human capital into economic product in the higher end of the distribution. Compared to Ojima and Anyanwu (2021), who discovered an inverse relation between HDI and economic growth in Nigeria, the results in the Saudi case suggest more effective translation of human development gains into economic performance, likely influenced by nationwide efforts under Vision 2030 to increase education, health, and labor market participation.

By measures of trade openness, the results were mixed across quantiles but uniformly positive and statistically significant at the lower and upper-middle of the GDP distribution. This pattern indicates that trade openness significantly boosts economic growth during low- and mid-growth phases, but its effect weakens and becomes statistically insignificant at both the median and upper ends of the growth distribution. This partly aligns with Tiba et al. (2016) and Azam et al. (2016), who found a positive effect of trade openness on economic growth in high-emitting and resource-dependent countries. However, the quantile variation is also aligned with Ahmad et al. (2022), which found that trade openness lowered growth in India, an observation indicating that country-specific trade structures and the structure of exports matter. In the Saudi instance, where business is still predominantly focused on oil exportation, the heterogeneous impact by income group can be a reflection of unevenly dispersed gains from trade openness. This goes to highlight the importance of Saudi economic diversification policy and efforts at boosting non-oil exports.

Conclusion and Policy Implications

This research investigated the heterogeneous impacts of financial inclusion, energy consumption, human development, and trade openness on the economic growth of Saudi Arabia between 2004 and 2023, employing the quantile regression methodology. This helped us examine how these connections differ at different levels of the distribution of economic growth. The findings verified cointegration of the variables, which supports long-run analysis. The quantile regression estimates revealed that the impact of every independent variable on economic growth is not homogeneous but rather heterogeneous but does vary significantly by quantile.

Specifically, economic growth is positively influenced by financial inclusion and is also significant at all quantiles, suggesting its importance is most powerful at lower and upper ends of the growth distribution. The consumption of energy, although always negative across all quantiles, is not statistically significant, which means it has no significant effect on economic growth during the study period. Human development index significantly contributes to economic growth in all quantiles with the exception of the highest (0.90), highlighting its robust contribution, particularly in lower and middle growth regimes. Openness to trade is positively and statistically significant at the lower (0.10 and 0.25) and upper-middle (0.75) quantiles but not at the median or highest quantile, indicating its conditional nature in growth stimulation.

5.1. Policy Implications

The findings of this study have several important policy implications for Saudi Arabia. To begin with, the positive and statistically significant effect of financial inclusion on economic growth at all but the median quantiles suggests that expanding financial service coverage can induce growth, particularly in low- and high-growth regimes. The policymakers need to put emphasis on inclusive financial policies, such as facilitating more digital banking, support for SME lending, and financial education, in a way that people in larger numbers become engaged in economic activity. Second, although energy consumption is negatively related to economic growth at all quantiles, the absence of significance shows that energy consumption in its current form does not significantly contribute to economic progress. This calls for the need for reforms to raise the energy efficiency, promote clean and renewable energy investment, and align the energy plans with Vision 2030's sustainability objectives. Third, the strong and stable positive contribution of human development to growth across all quantiles, except at the top, highlights the need to continue investing in social welfare, health, and education. The government can thus support its agenda for human capital construction with initiatives such as growing vocational education, developing health systems, and bridging development gaps across regions. Lastly, the favorable and significant impact of trade openness in the lower and mid-upper quantiles emphasizes its role in driving economic growth, especially in developing and evolving industries. The trade policy should therefore be targeted at export diversification, regional and international integration, and reducing structural constraints to competitiveness. Overall, these findings establish that growth drivers of the economy are heterogenous in stages of development, and that accordingly differentiated policy instruments are needed responsive to the evolving economic dynamics of the nation.

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