

Trade Openness and Economic Growth in Saudi Arabia An ARDL Approach

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Abstract

This study examines the relationship between trade openness and economic growth in Saudi Arabia using an autoregressive distributed lag (ARDL) approach applied to annual data for 1970–2023. Real GDP per capita is modeled as a function of trade openness, physical capital, and human capital. The ARDL bounds test indicates the existence of a long-run relationship among the variables. However, the estimated long-run elasticities are not statistically significant. In contrast, short-run results show that lagged changes in trade openness and physical capital have positive and statistically significant effects on real GDP per capita, while the error-correction term confirms gradual adjustment toward equilibrium.

Keywords: Trade openness; Economic growth; ARDL model; Cointegration; Error-correction; Saudi Arabia

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1. INTRODUCTION

The relationship between trade openness and economic growth remains a central issue in applied macroeconomics and development economics. Standard growth theory suggests that openness to international trade can enhance economic performance through multiple channels, including improved resource allocation, access to larger markets, technology diffusion, and productivity gains. Empirical evidence, however, has been far from conclusive, particularly when analysis is conducted at the single-country level.

Early influential studies provide evidence of a positive causal link between trade openness and income levels (Frankel and Romer, 1999). Subsequent research, however, emphasizes that the growth effects of openness are not automatic and depend critically on domestic conditions and complementary policies. Chang, Kaltani, and Loayza (2009) show that trade openness promotes growth only in the presence of supportive macroeconomic and institutional environments, while Harrison and Rodríguez-Clare (2010) argue that trade reforms must be accompanied by policies that facilitate structural adjustment and factor reallocation.

More recent empirical work increasingly relies on time-series methods to examine the openness–growth relationship in individual countries. In this context, the autoregressive distributed lag (ARDL) framework has become a widely used empirical tool due to its flexibility with respect to integration properties and its ability to jointly model long-run relationships and short-run dynamics. A growing body of ARDL-based studies reports evidence of cointegration between trade openness and output, while often finding weak or unstable long-run elasticities alongside significant short-run adjustment effects (Ulaşan, 2015; Hye & Lau, 2015; Zahonogo, 2017).

The empirical literature on trade openness and growth has produced mixed results. Cross-country evidence often suggests a positive association between openness and long-run income, but

country-specific time-series estimates are sensitive to model specification, structural change, and sample coverage. For GCC economies, dynamic-panel approaches closely related to ARDL models—such as pooled mean group estimation—find evidence of a long-run relationship between openness and output, although estimated long-run elasticities differ across countries (Jouini, 2015; Bekhet et al., 2022).

For Saudi Arabia and the wider Arab Gulf, early evidence suggests a positive association between trade openness and growth (Al-Yousif, 1997), while more recent studies emphasize the dominant roles of investment cycles, oil revenues, and government spending in shaping growth outcomes (Alshahrani & Alsadiq, 2014). IMF assessments similarly stress that the growth benefits of openness depend on diversification efforts, investment efficiency, and complementary structural reforms (IMF, 2023).

Against this background, the present study re-examines the relationship between trade openness and real GDP per capita in Saudi Arabia using updated data from the Penn World Table (version 11.0) and an ARDL modeling framework. By explicitly distinguishing between long-run equilibrium relationships and short-run adjustment dynamics, the paper provides new evidence on how trade openness and capital accumulation influence growth in a resource-rich economy undergoing structural transformation. The focus on adjustment dynamics is particularly relevant from a policy perspective, as it sheds light on the timing and transmission of openness-related growth effects rather than solely on long-run elasticities. The remainder of the paper is organized as follows. Section 2 reviews the relevant literature. Section 3 describes the data. Section 4 outlines the econometric methodology. Section 5 presents the empirical results, and Section 6 concludes.

2. LITERATURE REVIEW

2.1 TRADE OPENNESS AND GROWTH:

The relationship between trade openness and economic growth has long been a central issue in the empirical growth literature. Early influential

work by Frankel and Romer (1999) provides evidence of a positive causal relationship between trade and income, arguing that openness promotes growth through improved resource allocation, technology diffusion, and market expansion. Subsequent studies, however, emphasize that the growth effects of trade openness are not uniform across countries and depend critically on domestic conditions.

Chang et al. (2009) show that the impact of trade openness on growth is conditional on complementary factors such as education, institutional quality, and macroeconomic stability. Similarly, Harrison and Rodríguez-Clare (2010) argue that trade reforms alone are insufficient to generate sustained growth unless supported by appropriate domestic policies that facilitate adjustment and reallocation across sectors. These contributions suggest that the openness–growth nexus is complex and mediated by country-specific structural characteristics.

2.2 ARDL EVIDENCE ON TRADE OPENNESS AND GROWTH:

More recent empirical work increasingly employs the autoregressive distributed lag (ARDL) framework to study the trade–growth relationship in single-country and small-sample settings. The ARDL approach is particularly attractive because it accommodates variables integrated of different orders and allows for the joint estimation of long-run relationships and short-run dynamics.

Using cross-country data, Ulaşan (2015) re-examines the openness–growth relationship and finds that the long-run effects of trade openness are often weaker and less robust than suggested by earlier studies. In a time-series context, Hye and Lau (2015) apply ARDL models to developing economies and report evidence of cointegration between trade openness and output, alongside significant short-run adjustment dynamics.

Zahonogo (2017) further demonstrates that the relationship between trade openness and growth may be nonlinear, with openness contributing positively to growth only beyond certain thresholds. Related ARDL-based evidence also suggests that short-run adjustment dynamics can be statistically and economically meaningful even when

long-run openness elasticities are estimated imprecisely (Hye & Lau, 2015; Ulaşan, 2015).

2.3 EVIDENCE FROM OIL-EXPORTING AND GCC ECONOMIES:

For oil-exporting and GCC economies, the openness–growth relationship may be influenced by oil-price cycles and fiscal policy, which can dominate private-sector trade channels. Using pooled mean group estimation for GCC countries, Jouini (2015) reports evidence of cointegration between trade openness and output, but long-run effects vary across members. For Bahrain, Bekhet et al. (2022) find that trade openness supports economic growth, with meaningful short-run adjustment dynamics.

In the Saudi Arabian context and the wider Arab Gulf, early evidence such as Al-Yousif (1997) suggests a positive association between trade openness and growth. More recent work highlights the importance of investment, oil revenues, and institutional reforms. Alshahrani and Alsadiq (2014) show that government spending and oil income play a central role in Saudi growth performance, potentially diluting the direct long-run impact of trade openness.

Recent policy-oriented assessments by the International Monetary Fund (2023) emphasize that the growth benefits of openness in Saudi Arabia depend on diversification efforts, investment efficiency, and complementary structural reforms.

2.4 CONTRIBUTION OF THE PRESENT STUDY:

Against this background, the present study contributes to the literature by re-examining the trade openness–growth relationship in Saudi Arabia using updated data from the Penn World Table and a unified ARDL framework. By explicitly distinguishing between long-run equilibrium relationships and short-run adjustment dynamics, the analysis provides new evidence on the channels through which trade openness and capital accumulation influence growth in a resource-rich economy undergoing structural transformation.

3. DATA

This study uses annual data for Saudi Arabia obtained from the Penn World Table (PWT), version 11.0, which provides internationally comparable measures of output, capital stock, human capital, and trade-related variables constructed using a consistent methodology. The sample covers the period 1970–2023, corresponding to the longest span for which all variables are jointly available and internally consistent.

The dependent variable is real GDP per capita, denoted by $y_t = \ln(\text{RGDP_pc}_t)$, where real GDP per capita is measured as real output at constant prices divided by total population. Trade openness is denoted by $\text{open}_t = \ln(\text{Open}_t)$, where trade openness is defined as the ratio of exports plus imports to gross domestic product. Physical capital is proxied by the per capita capital stock series from the PWT and denoted by $k_t = \ln(\text{K_pc}_t)$. Human capital is captured by the PWT human capital index and denoted by $hc_t = \ln(\text{HC}_t)$. All variables are expressed in natural logarithms prior to estimation, allowing estimated coefficients to be interpreted as elasticities and helping to stabilize variance over time.

Table 1 reports descriptive statistics for y_t , open_t , k_t , and hc_t over the period 1970–2023. The statistics indicate that real GDP per capita, physical capital, and human capital evolve gradually over time, reflecting the long-run nature of growth and accumulation processes, while trade openness exhibits relatively greater variability. This time-series behavior supports the application of a dynamic econometric framework to examine both short-run adjustment and long-run relationships among the variables.

Table 1. Descriptive Statistics

Statistic	y (ln RGDP_pc)	open (ln Open)	k (ln K_pc)	hc (ln HC)
Mean	11.195	-1.551	11.859	0.754
Standard deviation	0.362	0.61	0.324	0.203
Minimum	10.833	-3.118	11.109	0.427
Maximum	11.929	-0.374	12.463	1.095

Note: Variables are expressed in natural logarithms. y is log real GDP per capita, open is log trade openness, k is log physical capital per capita, and hc is log human capital index. Data source: Penn World Table 11.0.

4. METHODOLOGY

4.1 MODEL SPECIFICATION:

The baseline long-run relationship is specified as:

$$\ln(RGDP_pc_t) = \alpha + \beta_1 \ln(Open_t) + \beta_2 \ln(K_t) + \beta_3 \ln(HC_t) + \varepsilon_t$$

To estimate both long-run and short-run dynamics, this relationship is embedded within an ARDL framework.

4.2 ARDL BOUNDS TESTING APPROACH:

The ARDL bounds testing approach developed by Pesaran et al. (2001) allows for testing the existence of a long-run relationship regardless of whether regressors are integrated of order zero or one, provided none are integrated of order two. This flexibility is particularly useful for macroeconomic time series.

The unrestricted error correction representation of the ARDL model is estimated, and the joint significance of lagged level variables is tested using the bounds F-statistic. Evidence of cointegration is established if the F-statistic exceeds the upper critical bound.

4.3 ERROR CORRECTION MODEL:

Once cointegration is confirmed, short-run dynamics are estimated through an error correction model (ECM), which captures the speed at which deviations from the long-run equilibrium are corrected following short-run shocks. Rolling-window implementation.

4.4 DIAGNOSTIC TESTS:

Standard diagnostic tests are conducted to assess serial correlation, heteroskedasticity, normality of residuals, and model stability. These tests ensure the robustness of the estimated ARDL model.

Endogeneity concerns are acknowledged as a common limitation in single-country time-series studies. The ARDL framework mitigates some endogeneity through lag structure, but results are interpreted with appropriate caution.

5. EMPIRICAL RESULTS

This section presents the empirical findings from the ARDL framework, examining the existence of a long-run relationship and the

associated short-run dynamics between real GDP per capita, trade openness, physical capital, and human capital in Saudi Arabia.

The ARDL model is estimated using annual data over the period 1970–2023. Lag lengths are selected based on the Akaike Information Criterion, allowing for a maximum of two lags given the annual frequency and sample size. The preferred specification is an ARDL(1,2,2,0) model, indicating persistence in real GDP per capita and delayed responses to changes in trade openness and physical capital accumulation.

As a first step, the existence of a long-run relationship among the variables is examined using the ARDL bounds testing approach to cointegration. The bounds test is conducted under Case 3 of the Pesaran et al. (2001) framework, which allows for an intercept but excludes a deterministic time trend. The null hypothesis of no cointegration is tested against the alternative of a level relationship among the variables. The results, reported in Table 2, show that the computed F-statistic is 5.52, exceeding the upper bound critical value at conventional significance levels. Accordingly, the null hypothesis of no cointegration is rejected, providing evidence of a stable long-run relationship between real GDP per capita, trade openness, physical capital, and human capital in Saudi Arabia over the sample period.

Given the evidence of cointegration, the estimated ARDL model is re-parameterized in a restricted error-correction form (RECM), which captures short-run dynamics while enforcing the long-run equilibrium relationship among the variables.

Table 2. ARDL Bounds Test for Cointegration

Statistic	p_value
5.5173	0.0104

Source: Prepared by the author

In the Saudi context, income dynamics are influenced by oil revenues, fiscal policy, and state-led investment cycles, which may weaken the stability and precision of long-run elasticities commonly identified in cross-country growth regressions. Accordingly, the estimated long-run relationship should

be interpreted as an equilibrium condition constraining the joint evolution of the variables, rather than as a set of fixed structural parameters.

Short-run dynamics are examined through the restricted error-correction representation of the ARDL model. The results reveal statistically significant short-run effects. Changes in trade openness exert a positive and significant impact on real GDP per capita with a one-year lag, while the contemporaneous effect is insignificant, indicating that the growth effects of trade integration materialize gradually. Similarly, lagged changes in physical capital have a positive and statistically significant effect on growth, consistent with investment gestation lags and gradual capital deepening.

The estimated error-correction term is positive and highly significant. Given the normalization adopted in the ARDL framework, this indicates convergence toward the long-run equilibrium. The magnitude of the coefficient implies that approximately 4 percent of deviations from the long-run equilibrium are corrected each year, pointing to a slow but stable adjustment process. Overall, the results suggest that growth responses in Saudi Arabia are driven primarily by short- to medium-run dynamics rather than by tightly estimated long-run elasticities.

Conditional on the existence of a long-run relationship, Table 3 reports the estimated long-run coefficients derived from the ARDL model. The estimated elasticities of real GDP per capita with respect to trade openness and physical capital are positive, while the coefficient on human capital is negative. However, none of the long-run coefficients are statistically significant at conventional levels.

This pattern is consistent with parts of the broader openness–growth literature showing that long-run openness elasticities are often weak or unstable once country-specific dynamics are accounted for (Ulaşan, 2015). In ARDL-type applications, cointegration between openness and output is frequently observed alongside imprecisely estimated long-run coefficients, reflecting sensitivity to sample length, structural change, and the dominance of other macroeconomic drivers (Hye & Lau, 2015; Jouini, 2015). Evidence for GCC economies similarly suggests that long-run openness effects may be difficult to identify precisely, while adjustment dynamics remain economically meaningful (Jouini, 2015; Bekhet et al., 2022).

Table 3. Long-Run Multipliers from the ARDL Model

Term	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	-54.6871	113.9886	-0.4798	0.6338
open	1.4638	2.5711	0.5693	0.5721
k	6.3757	10.8976	0.5851	0.5616
hc	-8.8618	12.9523	-0.6842	0.4975

Note: Long-run multipliers implied by the selected ARDL model. Standard errors and p-values are reported.

Source: Prepared by the author

The lack of statistical significance of the long-run coefficients does not contradict the evidence of cointegration. Rather, it indicates that while real GDP per capita, trade openness, physical capital, and human capital share a common long-run equilibrium path, the individual long-run elasticities are not precisely estimated in a single-country time-series setting. In the Saudi context, long-run income dynamics are strongly influenced by oil revenues, fiscal policy, and state-led investment cycles, which may weaken the stability and identifiability of long-run proportional effects typically observed in cross-country growth regressions. Accordingly, the estimated long-run relationship should be interpreted as an equilibrium condition constraining the joint evolution of the variables over time, rather than as a set of fixed structural parameters.

Short-run dynamics are examined through the restricted error-correction representation of the selected ARDL model. The results in Table 4 indicate that the short-run effect of trade openness is not statistically significant contemporaneously, but becomes positive and statistically significant with a one-year lag. Specifically, the coefficient on Δopen_{t-1} is positive but insignificant, whereas Δopen_t is positive and significant, suggesting that the growth effects of trade integration materialize with delay rather than instantaneously. For physical capital,

contemporaneous changes are not statistically significant, while the one-year lag of capital changes is positive and statistically significant, consistent with investment gestation and gradual capital deepening. The estimated error-correction term is positive and highly significant; under the normalization adopted in the ARDL restricted ECM, this indicates convergence toward the long-run equilibrium. The magnitude implies that approximately 4 percent of deviations from the long-run equilibrium are corrected each year, indicating a slow adjustment process.

The finding that openness effects emerge with a lag is consistent with the view that trade influences growth through gradual adjustment channels—such as reallocation across sectors, learning-by-doing, and adoption of imported inputs—rather than immediate level shifts (Harrison & Rodríguez-Clare, 2010). Recent ARDL-type evidence for developing economies and resource-rich settings also reports stronger short-run effects and meaningful error-correction behavior even when long-run elasticities are not tightly estimated (Hye & Lau, 2015; Jouini, 2015; Bekhet et al., 2022). For Saudi Arabia, this interpretation aligns with evidence that macroeconomic performance is heavily shaped by oil and fiscal cycles, which can obscure stable long-run proportional effects while leaving short-run adjustments detectable (Alshahrani & Alsadiq, 2014; IMF, 2023).

Table 4. Short-Run Dynamics and Error-Correction Representation (RECM)

Variable	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	2.2863	0.4751	4.8117	0
d(open)	0.0245	0.0163	1.5017	0.14
d(L(open, 1))	0.0517	0.0148	3.502	0.001
d(k)	-0.145	0.3298	-0.4396	0.6623
d(L(k, 1))	0.8705	0.3518	2.4748	0.0171
ect	0.0418	0.0086	4.8589	0

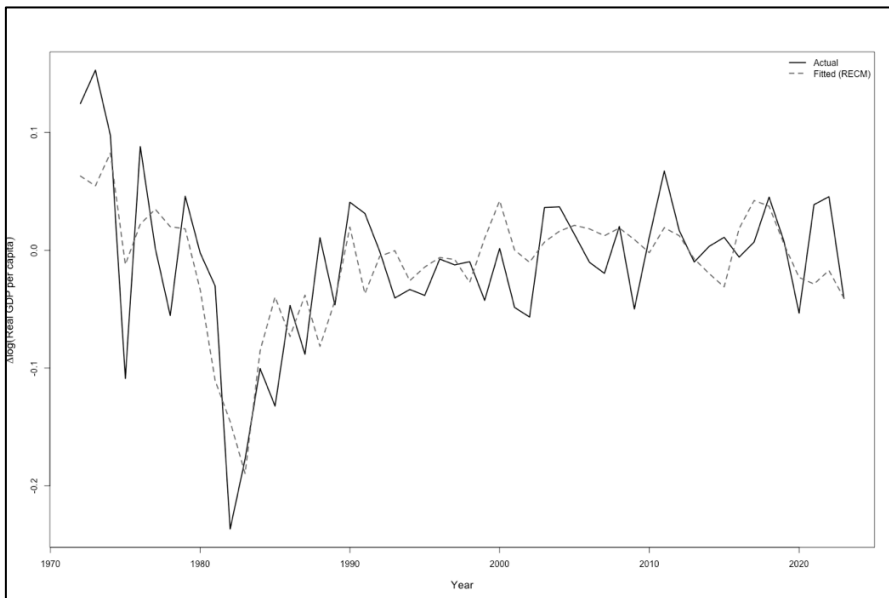
Note: The table reports short-run coefficients from the restricted error-correction model. The error-correction term (ect) captures adjustment toward long-run equilibrium.

Source: Prepared by the author

The lag structure in the short-run coefficients is economically plausible in a setting where trade exposure and investment translate into output changes through gradual adjustment mechanisms, including sectoral reallocation, learning effects, and implementation lags in capital formation. The slow speed of adjustment is also consistent with the idea that medium-run dynamics in Saudi Arabia are influenced by broader macroeconomic cycles, which may delay the reversion of income toward its long-run equilibrium path.

Figure 1 provides a visual check on the dynamic fit of the restricted error-correction model by comparing fitted and actual changes in log real GDP per capita over the estimation sample.

Fig.1. Actual and Fitted Changes in Log Real GDP per Capita



Source: Prepared by the author

Standard diagnostic tests are conducted to assess the adequacy of the estimated error-correction model. The results, reported in Table 5, indicate no evidence of residual serial correlation and approximate normality of residuals. The Breusch–Pagan test suggests the presence of heteroskedasticity; however, this does not invalidate inference given the use of heteroskedasticity-robust standard errors. Overall, these diagnostics

suggest that the estimated ARDL-ECM specification is statistically well behaved for inference purposes.

Table 5. Diagnostic Test Results

Test	Statistic	p_value
Breusch-Godfrey (serial correlation)	0.0948	0.7581
Breusch-Pagan (heteroskedasticity)	15.9945	0.0069
Jarque-Bera (normality)	0.297	0.862

Note: Reported p-values correspond to Breusch–Godfrey (serial correlation), Breusch–Pagan (heteroskedasticity), and Jarque–Bera (normality) tests.

Source: Prepared by the author

While the analysis focuses on trade openness, physical capital, and human capital, the results should be interpreted as conditional relationships, recognizing that other factors—such as oil-market developments and fiscal policy—also influence income dynamics in Saudi Arabia.

6. CONCLUSION

This study examined the relationship between trade openness and economic growth in Saudi Arabia using an ARDL framework applied to annual data over the period 1970–2023. The analysis focused on real GDP per capita, trade openness, physical capital, and human capital, allowing for both long-run equilibrium relationships and short-run adjustment dynamics to be assessed within a unified time-series setting.

The results provide evidence of a long-run relationship among the variables, as indicated by the ARDL bounds test for cointegration. However, the estimated long-run elasticities of real GDP per capita with respect to trade openness, physical capital, and human capital are not statistically significant, suggesting that long-run proportional effects are difficult to identify precisely in a single-country context. This finding is consistent with the view that long-run income dynamics in Saudi Arabia are shaped by a range of structural and institutional factors beyond the variables included in the model.

In contrast, the short-run dynamics reveal economically meaningful adjustment patterns. Trade openness and physical capital exert positive and

statistically significant effects on real GDP per capita with a one-year lag, while contemporaneous effects are weak. The estimated error-correction term indicates convergence toward the long-run equilibrium, albeit at a slow pace, highlighting the gradual nature of adjustment in the Saudi economy. These findings suggest that the growth effects of trade integration and capital accumulation materialize over time rather than instantaneously.

From a policy perspective, the results imply that the benefits of trade openness are more likely to be realized through medium-run adjustment channels rather than through immediate or stable long-run effects. Policies aimed at enhancing the efficiency of capital formation, reducing adjustment costs, and facilitating the transmission of trade-related gains across sectors may therefore play a critical role in supporting growth. More broadly, the findings underscore the importance of interpreting openness–growth relationships in Saudi Arabia within a broader macroeconomic context characterized by oil-driven cycles and an active fiscal role of the state.

Future research could extend the analysis by incorporating additional macroeconomic factors—such as oil prices, fiscal policy indicators, or measures of external competitiveness—or by exploring potential nonlinearities and structural changes in the trade–growth relationship. Such extensions may help further clarify the channels through which trade openness interacts with growth dynamics in resource-rich economies.

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