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Digital openness and growth beyond oil: ICT, foreign direct investment, globalization, and long-run economic performance in the GCC

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Abstract: This study examines the joint effects of digital development, foreign direct investment (FDI), globalization, and trade openness on economic growth in the Gulf Cooperation Council (GCC) countries within an augmented Cobb–Douglas production framework. Using a panel of the six GCC countries over 2000–2024, we employ group-mean fully modified OLS (FMOLS) and group-mean dynamic OLS (DOLS) panel cointegration estimators, complemented by fixed-effects and mean-group estimates. The findings are consistently robust across model specifications: ICT development, FDI, and trade openness are positively and significantly associated with real GDP per capita. The globalization coefficient is negative in the pooled and group-mean cointegration estimators but positive under the mean-group estimator, indicating that the growth payoff from global integration is conditional on country-specific absorptive capacity, institutional quality, and the composition of cross-border flows. The results imply that digital infrastructure and openness support diversification most effectively when paired with policies that convert connectivity and global linkages into domestic productive capabilities.

Keywords: *Economic growth, Foreign direct investment, Globalization, Gulf Cooperation Council, Heterogeneous panel cointegration, ICT, digital transformation, Trade openness.*

1. Introduction

The Gulf Cooperation Council (GCC) economies have used hydrocarbon wealth to build high-income states, modern infrastructure, and globally connected financial, transport, and logistics systems. This development model generated rapid improvements in income and public-service provision, but it also left the region structurally exposed to energy-price cycles and the long-term global transition away from fossil-fuel dependence. Diversification has therefore become a central policy objective across Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates [1, 2]. National strategies such as Saudi Vision 2030, Oman Vision 2040, Qatar National Vision 2030, and the UAE's industrial and digital-economy agendas share a common aim: to convert accumulated resource wealth into sustainable non-oil productive capacity [2, 3].

Digital transformation is a key part of this transition [4]. ICT infrastructure lowers information and transaction costs, supports e-government, improves financial inclusion, facilitates platform-based services, and allows firms to integrate with regional and global value chains. Digital infrastructure also interacts with the GCC's broader comparative advantages: high urbanization, strong logistics networks, large sovereign wealth funds, substantial public investment capacity, and increasingly sophisticated service sectors. Global connectivity indicators show that the region has largely closed basic access gaps, and recent policy discussions have moved beyond connectivity toward cloud infrastructure, artificial intelligence, fintech, digital public services, cybersecurity, and data governance [4-6]. These developments make ICT not only a technology variable but also a measure of institutional and productive modernization.

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At the same time, openness to foreign capital and global markets remains central to the region's diversification strategy. FDI may bring capital, managerial know-how, technology transfer, links to multinational production networks, and export upgrading [7]. Trade openness may help small domestic markets achieve scale and may pressure firms to improve quality. Globalization, measured more broadly, captures economic, social, and political integration with the rest of the world [8]. Yet openness is not automatically growth-enhancing. In resource-rich economies, global integration can reinforce dependence on hydrocarbon exports, transmit external shocks, and concentrate gains in enclaves with weak domestic spillovers. The effects of FDI and globalization therefore depend on absorptive capacity, the quality of domestic institutions, human capital, competition policy, and whether cross-border flows support non-oil sectors.

The GCC is also an econometrically distinctive setting. Member economies are exposed to common oil-price cycles, global financial conditions, geopolitical shocks, and coordinated policy changes. They are small but highly interconnected through trade, labor flows, financial linkages, and regional policy coordination. Standard pooled panel estimators that assume cross-sectional independence may therefore yield misleading standard errors and potentially biased long-run coefficients [9, 10]. At the same time, the six economies differ in hydrocarbon reserves, population size, fiscal space, labor-market structure, industrial policy, digital readiness, and FDI composition. A credible empirical design must therefore account for both cross-sectional dependence and slope heterogeneity.

This paper asks the following research question: How are ICT development, FDI, globalization, and trade openness associated with long-run economic performance in GCC countries once regional interdependence and country heterogeneity are considered? The analysis uses annual data for 2000–2024 and focuses on real GDP per capita as the outcome variable. ICT is measured using a composite indicator constructed from fixed telephone subscriptions, mobile cellular subscriptions, internet users, internet services, and fixed broadband subscriptions. Globalization is measured using the KOF Globalization Index [11]. FDI and trade openness are obtained from standard international macroeconomic databases and expressed relative to GDP.

The paper makes four contributions. First, it integrates digitalization, FDI, trade openness, and globalization into a single GCC-specific growth framework, rather than examining these channels separately, thereby extending multi-country evidence such as Latif, et al. [12] to a region with distinctive structural features. Second, it uses a composite ICT measure rather than a single proxy, such as mobile penetration or internet users, thereby capturing broader digital infrastructure development. Third, it explicitly begins with cross-sectional dependence diagnostics and treats the GCC countries as a region subject to common unobserved factors. Fourth, it compares fixed-effects, group-mean FMOLS, group-mean DOLS, and mean-group estimates, and explains why heterogeneous long-run estimation is more appropriate than relying on a single pooled coefficient.

The main results are clear in three dimensions. ICT, FDI, and trade openness are positively associated with real GDP per capita across the long-run estimators reported. The globalization coefficient is more fragile: it is negative under fixed effects, group-mean FMOLS, and group-mean DOLS, but positive under the mean-group estimator. This sign reversal is not a minor technical detail; it suggests that globalization's impact differs across GCC economies and depends on whether international integration is converted into domestic productivity gains. The policy implication is that digital infrastructure and openness matter most when paired with skills, competition, innovation systems, institutions, and sectoral strategies that deepen domestic value creation.

The remainder of the paper is organized as follows. Section 2 reviews the theoretical and empirical literature and develops the hypotheses. Section 3 describes the data, variable construction, and econometric strategy. Section 4 presents the empirical results. Section 5 discusses robustness, interpretation, and limitations. Section 6 develops policy implications for GCC diversification. Section 7 concludes.

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2. Literature Review and Hypotheses

2.1. ICT, Productivity, and Economic Growth

The theoretical link between ICT and growth is grounded in neoclassical and endogenous growth theory and in the literature on general-purpose technologies [13, 14]. ICT can raise output by improving the efficiency with which existing inputs are used, accelerating information diffusion, reducing search and coordination costs, supporting innovation, and enabling new business models. Unlike narrow sectoral investment, ICT generates economy-wide spillovers because it changes how firms organize production, how governments deliver services, and how households access markets, finance, and knowledge.

Early productivity studies showed that the growth contribution of ICT depends on complementary investments in skills, organizational change, and intangible capital [15-17]. This insight matters for the GCC because the region has high-quality infrastructure but often faces constraints related to private-sector productivity, labor-market segmentation, and uneven innovation ecosystems. Broadband, mobile networks, and e-government platforms can support growth, but their impact is stronger when firms possess the managerial and human-capital capabilities needed to use digital tools productively.

Recent evidence generally finds that digitalization supports growth, although the size of the effect varies across income groups and institutional settings. Cross-country and single-country studies show that ICT investment and adoption can increase productivity and output, but the effect is conditioned by development level, human capital, financial development, and policy quality [18-24]. Broadband, in particular, has been associated with measurable growth dividends in developing economies [25]. In the MENA region, ICT diffusion has been found to interact with financial development in shaping growth outcomes [26, 27], which makes digitalization central to diversification rather than a peripheral infrastructure issue.

For this paper, the relevant mechanism is not only that ICT contributes directly to productivity. ICT also increases the potential returns to FDI and globalization by allowing foreign firms, domestic suppliers, and public agencies to connect more efficiently; indeed, ICT development and FDI inflows appear to reinforce each other [28]. A digitally capable economy is better able to absorb knowledge spillovers from multinational firms, compete in service exports, and integrate into non-oil value chains. This leads to the first hypothesis.

Hypothesis 1 (H1): ICT development is positively associated with long-run real GDP per capita in GCC countries.

2.2. FDI, Technology Transfer, and Absorptive Capacity

FDI is a central channel through which emerging and resource-rich economies can acquire technology, managerial capabilities, and access to international markets [7]. The classic literature argues that multinational firms may raise host-country productivity through direct capital accumulation, worker training, supplier linkages, imitation, competition, and export upgrading, with backward linkages to domestic suppliers constituting a particularly important spillover channel [29-31]. Studies show that FDI is more likely to support growth when the host economy has sufficient human capital, financial depth, and institutional quality.

The FDI–growth channel is especially relevant for the GCC because the region seeks to attract investment into non-oil sectors such as advanced manufacturing, logistics, financial services, tourism, renewable energy, digital services, and health care. However, FDI can have a limited domestic impact if it remains concentrated in enclaves, real estate, extractive activities, or sectors with weak domestic supplier linkages. For FDI to support diversification, it must be embedded in local value chains and linked to technology transfer, training, research and development, and domestic entrepreneurship.

The recent global investment environment also underscores the importance of investment quality. The United Nations Conference on Trade and Development [32] identifies the digital economy as a major theme in international investment and reports that global FDI weakened in 2024 [32], following an earlier emphasis on investment facilitation and digital government [33]. For GCC economies, this

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makes competition for productive, technology-intensive FDI more demanding. Countries that combine transparent regulation, digital government, strong infrastructure, and skilled labor are better placed to attract and absorb high-quality foreign investment. This motivates the second hypothesis.

Hypothesis 2 (H2): FDI is positively associated with long-run real GDP per capita in GCC countries, conditional on domestic absorptive capacity and the sectoral composition of inflows.

2.3. Trade Openness, Globalization, and Resource-Dependent Growth

Trade openness can raise growth by expanding market size, facilitating specialization, exposing firms to competition, and encouraging access to imported inputs and technologies. For small, open economies such as the GCC countries, external markets are particularly important because domestic demand alone may be insufficient to support scale-intensive, non-oil industries. Trade can also support service-sector development through logistics, tourism, finance, professional services, and digital exports.

Globalization is broader than trade openness. The KOF Globalization Index combines economic, social, and political dimensions and distinguishes different forms of international integration [8, 11]. This broader measurement is useful because GCC economies are globalized not only through merchandise trade and capital flows but also through migration, aviation, tourism, diplomatic networks, sovereign investment, and global services. However, the globalization–growth relationship is theoretically ambiguous, and the empirical evidence is mixed [34, 35]. Integration may raise income through markets and knowledge flows, but it can also transmit external shocks, intensify import dependence, expose countries to global financial volatility, and reinforce existing comparative advantages in hydrocarbons.

The ambiguity is especially important in resource-rich economies. Openness may deepen commodity dependence if export structures remain concentrated, while social and political integration may not immediately translate into productivity gains. Structural transformation can also bypass traditional industrialization paths [36], and new technologies are reshaping how developing economies capture value within global value chains [37]. The growth payoff from globalization therefore depends on institutions, domestic competition, labor-market policies, innovation systems, and whether global linkages support productive diversification. As a result, this study treats globalization as a conditional and potentially heterogeneous determinant of growth rather than assuming a uniform positive effect.

Hypothesis 3 (H3): Trade openness is positively associated with long-run real GDP per capita in GCC countries.

Hypothesis 4 (H4): Globalization affects long-run real GDP per capita, but the sign and magnitude of its effects vary across GCC economies because absorptive capacity and exposure to common shocks differ.

2.4. Gaps in the GCC Literature

The GCC literature on diversification is extensive, but empirical work often examines digitalization, FDI, trade, and globalization separately. Many studies also rely on first-generation panel estimators or single-country case studies. This leaves three gaps. First, the interaction between digital openness and international openness remains underdeveloped in the GCC context, despite evidence from broader country panels that these channels operate jointly [12]. Second, empirical designs often understate the importance of common regional shocks. Third, few studies compare pooled and heterogeneous long-run estimators to test whether results are sensitive to country-specific slopes.

This paper addresses these gaps by using a unified long-run framework, a composite ICT index, and a diagnostic sequence that begins with cross-sectional dependence. This approach is consistent with the view that GCC economies are not independent observational units but rather a region exposed to shared shocks and common policy challenges. The study therefore emphasizes long-run associations and heterogeneity rather than short-run causal claims.

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3. Data and Methods

3.1. Data

The analysis examines how ICT development, FDI, globalization, and trade openness are associated with long-run economic performance in the six GCC economies from 2000 to 2024. As reported in Table 1, the data were obtained from the World Bank [38]; the International Telecommunication Union [5]; the International Telecommunication Union [6]; Gygli, et al. [11]; and KOF Swiss Economic Institute [39].

The dependent variable is the natural logarithm of real GDP per capita in constant 2015 U.S. dollars. This transformation reduces scale differences across countries and allows the estimates to be interpreted as long-run associations with income per person. FDI is measured as net inflows as a percentage of GDP. Trade openness (TRADE) is the sum of exports and imports of goods and services as a percentage of GDP. Globalization (GI) is measured by the overall KOF Globalization Index, which summarizes economic, social, and political integration. ICT is a standardized composite index constructed from fixed telephone subscriptions, mobile cellular subscriptions, internet users, internet services, and fixed broadband subscriptions. Combining several ICT indicators reduces the risk that the results reflect one narrow technology rather than the broader digital infrastructure environment.

Table 1.
Variable definitions, sources, and expected signs.

Variable	Definition	Source	Expected sign
Y	Natural log of real GDP per capita, constant 2015 U.S. dollars	World Bank [38]	Dependent variable
ICT	Composite standardized ICT index based on fixed telephone, mobile cellular, internet-user, internet-service, and fixed broadband indicators	International Telecommunication Union [5]; International Telecommunication Union [6] and World Bank [38]	+
FDI	Foreign direct investment, net inflows as a percentage of GDP	World Bank [38]	+
GI	KOF Globalization Index, overall index of economic, social, and political globalization	Gygli, et al. [11] and KOF Swiss Economic Institute [39]	Conditional
TRADE	Exports plus imports of goods and services as a percentage of GDP	World Bank [38]	+

Note: The expected signs summarize the main hypotheses. The globalization effect is treated as conditional because globalization can transmit either productivity-enhancing flows or external vulnerability, depending on domestic absorptive capacity.

3.2. Empirical Strategy

To capture how digital development and openness relate to long-run income, we adopt a baseline specification relating real income per person to ICT, FDI, globalization, and trade openness. Because these variables are persistent and the economic question concerns structural diversification rather than year-to-year fluctuations, the empirical focus is on their long-run relationship. The baseline panel specification is:

$$y_{it} = \alpha_i + \beta_1 \mathrm{ICT}_{it} + \beta_2 \mathrm{FDI}_{it} + \beta_3 \mathrm{GI}_{it} + \beta_4 \mathrm{TRADE}_{it} + \varepsilon_{it} \qquad (1)$$

Where y_{it} is the log of real GDP per capita in country i and year t, α_i captures time-invariant country characteristics, ε_{it} is the error term, and β_1–β_4 are the long-run coefficients associated with the explanatory variables. Country effects absorb fixed factors such as geography, historical institutions, and long-run resource endowments. Time effects or cross-sectional augmentations are important because GCC economies share common shocks, especially oil-market and global financial shocks.

The appropriate estimator must address four features of the data: a small regional panel, persistent variables, potential endogeneity between growth and openness, and cross-country heterogeneity. Ordinary least squares with country fixed effects is useful as a benchmark because it controls for time-

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invariant heterogeneity [9, 10], but it is not sufficient for the main inference if the variables are nonstationary, cointegrated, and affected by common shocks.

The group-mean fully modified OLS (FMOLS) estimator corrects for serial correlation and endogeneity in cointegrated panels using a semiparametric adjustment [40, 41]. The group-mean dynamic OLS (DOLS) estimator augments the cointegrating regression with leads and lags of the first differences of the regressors, thereby correcting for feedback effects and serial correlation [42, 43]. The group-mean DOLS specification is

$$y_{it} = \alpha_i + \beta_i^{\prime x_{it}} + \sum_{q=-Q}^{Q} \pi_{iq}^{\prime} \Delta x_{i,t-q} + \lambda_t + e_{it} \qquad (2)$$

Where x_{it} the model contains ICT, FDI, GI, and TRADE, while the leads and lags of the first differences absorb short-run dynamics. The mean-group estimator estimates country-specific coefficients and then averages them, allowing the long-run slopes to differ across GCC economies. These estimators therefore provide a better basis for inference than a single pooled coefficient.

Among the reported estimators, group-mean DOLS is treated as the preferred long-run estimator because the research question concerns a cointegrated long-run relationship and because DOLS directly addresses serial correlation and regressor endogeneity through dynamic leads and lags. The mean-group estimator is interpreted as the key heterogeneity check, especially for the globalization coefficient. Fixed effects and group-mean FMOLS are retained as robustness checks.

For additional robustness, the strongest specification would add common correlated effects mean-group (CCE-MG) estimates [44], dynamic common correlated effects (DCCE) estimates [45], or cross-sectionally augmented ARDL/CS-DL estimates [46]. These estimators augment the country-specific equations with cross-sectional averages of the dependent variable and the regressors to proxy for unobserved common factors:

$$y_{it} = \alpha_i + \beta_i^{\prime x_{it}} + \delta_i^{\prime \bar{z}_t} + \sum_{l=0}^{L} \theta_{il}^{\prime \bar{z}_{t-l}} + e_{it} \quad (3)$$

where $\bar{z}_t$ denotes the cross-sectional averages of the dependent and explanatory variables. This cross-sectional augmentation is the main mechanism through which CCE-type estimators control for unobserved common factors. Such estimators are especially attractive in the GCC setting because they explicitly model cross-sectional dependence while allowing for heterogeneous slopes. The reported estimates should therefore be understood as a cointegration-based baseline, with CCE-MG or CS-ARDL serving as the natural complementary robustness exercise.

The descriptive statistics in Table 2 show a high-income and highly open regional panel. The dependent variable ranges from 9.784 to 11.310, indicating a relatively narrow but meaningful spread in log real GDP per capita. The ICT index has a mean of zero by construction and a standard deviation of 1.521, reflecting substantial digital catch-up over time and cross-country variation. The globalization index averages 68.410, while trade openness averages 107.808 percent of GDP. FDI is the most volatile variable, ranging from -10.360 to 13.378 percent of GDP, consistent with the episodic nature of investment inflows in small, open economies.

Table 2.
Descriptive statistics.

Variable	Obs.	Mean	Std. dev.	Min.	Max.
Y	138	10.361	0.436	9.784	11.310
ICT	138	0.000	1.521	-2.830	2.980
GI	137	68.410	5.155	55.780	77.520
TRADE	138	107.808	33.765	47.533	202.333
FDI	138	2.251	3.149	-10.360	13.378

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3.3. Cross-Sectional Dependence and Integration Properties

The first diagnostic step is the Pesaran cross-sectional dependence (CD) test [47]. The null hypothesis is cross-sectional independence. Rejection of the null indicates that residuals or variables are correlated across countries, which is likely when units share common shocks. For the GCC, cross-sectional dependence is expected because oil-price cycles, geopolitical shocks, global liquidity conditions, and regional policies affect multiple countries simultaneously.

The second step is to evaluate the time-series properties of the variables. Macroeconomic panels containing income, trade, FDI, and digital infrastructure often exhibit unit roots or near-unit-root behavior. When cross-sectional dependence is present, first-generation panel unit-root tests that assume independence [48] can be misleading, and second-generation tests, such as the cross-sectionally augmented IPS (CIPS) approach [49], are preferred. If the variables are integrated but cointegrated, long-run estimation should use estimators designed for cointegrated panels rather than a static regression in levels.

The third step is panel cointegration testing. Residual-based panel cointegration tests [50] and Westerlund-type error-correction tests [51, 52] are appropriate because they evaluate whether deviations from a long-run equilibrium are corrected over time and allow for heterogeneity in adjustment. Evidence of cointegration justifies estimating the long-run parameters in (1). The estimation sequence indicates a stable long-run relationship among the core variables, motivating the FMOLS, DOLS, and mean-group estimators reported below.

4. Empirical Results

4.1. Cross-Sectional Dependence

Table 3 reports the Pesaran CD tests [47]. The null hypothesis of cross-sectional independence is rejected for real GDP per capita, globalization, ICT, and trade openness. ICT displays an especially high test statistic, which is plausible because digital diffusion across the GCC has been driven by common technological trends, regional competition, and similar policy agendas. Globalization and income also show strong comovement. FDI is the only variable for which the null is not rejected, consistent with the episodic and country-specific nature of investment inflows.

The diagnostic evidence confirms that the GCC panel should not be treated as a collection of independent economies. The results support the use of time effects, heterogeneous long-run estimators, and, as a complementary exercise, cross-sectional augmentation through CCE-MG or CS-ARDL [44-46]. The CD tests also help interpret the coefficient on globalization: common global shocks may be an important channel through which globalization affects domestic outcomes.

Table 3.
Cross-sectional dependence tests.

	Y	GI	ICT	TRADE	FDI
CD statistic	8.030 (0.000)	12.260 (0.000)	17.500 (0.000)	6.500 (0.000)	0.820 (0.414)

Note: The CD test of Pesaran [47] is applied; the null hypothesis is cross-sectional independence. p-values are reported in parentheses.

4.2. Long-Run Estimates

Table 4 presents the long-run estimates. Across the four reported estimators, ICT, FDI, and trade openness have positive coefficients. This consistency is the most important empirical finding of the paper. It indicates that digital development, investment openness, and trade integration complement the GCC's long-run income performance. The fact that the coefficients remain positive across the fixed-effects, FMOLS, DOLS, and mean-group estimators increases confidence that the result is not an artifact of any particular specification.

The ICT coefficient is positive in every model and statistically strongest under the group-mean FMOLS and group-mean DOLS estimators. In the preferred DOLS specification, the coefficient is 0.986 and statistically significant at conventional levels. Because the ICT variable is a standardized composite index, the coefficient should be interpreted as a long-run association between stronger digital

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development and log real GDP per capita, rather than as the effect of a single ICT indicator. This result supports H1 and aligns with broader evidence that digital infrastructure helps economies raise productivity and diversify [18-23, 52-55].

The FDI coefficient is positive and statistically significant across all estimators. In the group-mean DOLS specification, the coefficient is 0.958, while the mean-group estimator produces a larger coefficient of 1.465. The larger mean-group coefficient suggests that FDI–growth associations vary across countries and that some GCC economies may extract greater growth benefits from foreign investment than others. This supports H2, but the interpretation should remain conditional: FDI is most likely to raise growth when it is linked to technology transfer, non-oil productive capacity, domestic suppliers, and human-capital development [29-31, 56-61].

Trade openness is also positive in all specifications. The group-mean DOLS coefficient is 0.924 and statistically significant. This result supports H3 and reflects the reality that GCC economies rely on external markets, imported inputs, logistics networks, and global services. However, trade openness should not be interpreted as a sufficient condition for diversification. Trade can support long-run growth when it facilitates export sophistication and non-oil value creation; it may be less beneficial if it merely reflects import dependence or hydrocarbon export concentration.

The globalization coefficient is the most nuanced result. It is negative and statistically significant under fixed effects, group-mean FMOLS, and group-mean DOLS, but positive under the mean-group estimator. This sign reversal supports H4. It implies that globalization has heterogeneous effects across GCC economies and that pooled estimates may mask differences in institutions, absorptive capacity, sectoral structure, and exposure to external shocks [34, 35]. The negative DOLS coefficient does not necessarily imply that globalization is harmful in a general sense. Rather, it suggests that broad integration does not automatically translate into higher real income per person unless it supports domestic productive capabilities.

Table 4.
Long-run estimates.

Regressor	OLS with fixed effects	Group-mean FMOLS	Group-mean DOLS	Mean-group estimator
FDI	0.916 (0.000)	0.670 (0.000)	0.958 (0.000)	1.465 (0.000)
Globalization	-4.544 (0.001)	-3.661 (0.000)	-4.931 (0.000)	5.011 (0.000)
ICT	0.237 (0.065)	0.250 (0.000)	0.986 (0.000)	0.348 (0.092)
Trade openness	0.520 (0.000)	0.878 (0.000)	0.924 (0.000)	0.411 (0.059)

Note: Coefficients are reported with p-values in parentheses. The dependent variable is the natural logarithm of real GDP per capita. The preferred long-run estimator is group-mean DOLS; the other estimators are used for robustness and heterogeneity checks.

4.3. Hypothesis Assessment

Table 5 summarizes the empirical assessment of the four hypotheses developed in Section 2.

Table 5.
Summary of hypothesis tests.

Hypothesis	Empirical evidence	Assessment
H1: ICT is positively associated with long-run income.	ICT is positive in all four estimators and strongly significant in FMOLS and DOLS.	Supported
H2: FDI is positively associated with long-run income.	FDI is positive and statistically significant in all estimators.	Supported
H3: Trade openness is positively associated with long-run income.	Trade openness is positive in all estimators and statistically significant in pooled and group-mean estimators.	Supported
H4: Globalization has heterogeneous or conditional effects.	Globalization is negative in FE/FMOLS/DOLS but positive in the mean-group estimator.	Conditionally supported

5. Discussion, Robustness, and Limitations

The results provide a coherent message about growth beyond oil. Digital development, FDI, and trade openness are positively associated with long-run income in GCC countries. This does not mean

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that each variable mechanically causes growth in every setting. Rather, it suggests that these channels form a mutually reinforcing development package when supported by domestic capabilities. ICT raises the ability of firms and governments to use information efficiently; FDI can provide technology and managerial knowledge; trade openness provides market access and competitive pressure. Together, these channels can support diversification if they shift resources toward productive, non-oil sectors. This reading is consistent with panel evidence that ICT, FDI, and globalization operate jointly rather than in isolation [53, 55, 57, 59, 60, 62-65].

The globalization result is more complex and arguably more interesting. Broad globalization is not the same as productive integration. The negative coefficient in the preferred DOLS estimate may reflect the costs of exposure to external shocks, the persistence of import dependence, or the possibility that global integration has not always generated domestic value added. The positive mean-group coefficient suggests that some countries have converted globalization into higher income more effectively than others. This interpretation is consistent with the idea that institutional quality, logistics capability, human capital, regulatory predictability, and sectoral strategy shape whether globalization becomes a source of resilience or vulnerability.

The comparison across estimators is important for assessing robustness. Pooled fixed effects provide a baseline but impose common slopes. FMOLS and DOLS are more appropriate for cointegrated panels because they correct for endogeneity and serial correlation [40-43]. The mean-group estimator reveals heterogeneity across countries. The main robust finding is therefore not the exact magnitude of any single coefficient; it is the consistently positive sign of ICT, FDI, and trade openness, and the instability of the globalization coefficient across estimators.

The study also has limitations. First, the GCC panel includes only six countries, so inference is necessarily based on a small cross-section and a moderate time dimension. Second, country-level annual data cannot identify firm-level productivity spillovers or sectoral mechanisms. Third, reverse causality is plausible: richer economies may invest more in ICT and attract more FDI. Fourth, the composite ICT index captures infrastructure and access more directly than digital skills, cybersecurity, cloud adoption, or artificial-intelligence capability. Fifth, because the CD tests reveal strong common shocks, the reported results should be complemented by cross-sectionally augmented estimators, such as CCE-MG, DCCE, or CS-ARDL [44-46].

Several extensions would further strengthen the analysis. The first is to re-estimate the long-run model using CCE-MG or CS-ARDL and compare the coefficients with the DOLS results [44, 46]. The second is to decompose the KOF Globalization Index into its economic, social, and political dimensions [11]. The third is to use alternative ICT measures, including principal-component scores and separate broadband, internet, and mobile indicators. The fourth is to include controls for oil rents, human capital, financial development, and institutional quality, while recognizing the limited degrees of freedom. The fifth is to test interaction terms such as ICT × FDI and ICT × globalization to examine whether digital readiness increases the payoff from openness [28].

6. Policy Implications

The findings have direct implications for GCC diversification strategies. First, digital infrastructure should be treated as a productivity platform rather than an end in itself [4]. High broadband coverage, mobile connectivity, and digital public services are necessary but not sufficient. Governments should invest in advanced digital skills, data governance, cybersecurity, digital competition policy, cloud regulation, and the interoperability of public digital systems. The key policy metric should shift from infrastructure coverage to productivity outcomes, such as firms' digital adoption, non-oil exports, innovation, domestic supplier upgrading, and high-skilled employment.

Second, the positive FDI coefficient supports policies that attract foreign investment, but the quality of FDI matters more than its quantity [32]. Incentives should be linked to technology transfer, local supplier development, research and development, training, domestic employment quality, and export capability. Special economic zones and investment licenses can help, but they should be evaluated

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against measurable spillovers rather than headline inflow values. The GCC's digital transformation can make investment facilitation more transparent and efficient, but investment policy should avoid creating enclaves disconnected from domestic firms.

Third, trade openness should be aligned with export sophistication. The GCC already has high trade-to-GDP ratios, so the policy challenge is not simply to increase trade volume. The challenge is to increase non-oil domestic value added in traded sectors. This requires high-quality logistics, standards infrastructure, intellectual-property protection, competition policy, customs modernization, regional value-chain integration, and support for small and medium-sized exporters. Trade agreements and regional integration should be judged by whether they expand productive capacity rather than merely increase import and export flows.

Fourth, globalization should be managed strategically. The mixed globalization estimates show that global integration can be beneficial or costly, depending on domestic capabilities. GCC policymakers should therefore treat openness as a complement to domestic reform. Institutions, skills, competition, and innovation systems determine whether global flows become a source of resilience. Policies that strengthen macroprudential frameworks, fiscal buffers, supply-chain resilience, and labor-market upgrading can reduce vulnerability associated with global shocks.

Fifth, digitalization and sustainability should be considered together. Data centers, cloud computing, and artificial intelligence require energy and water resources. For GCC economies, this creates both an opportunity and a constraint. Digital development can support diversification, but it must be aligned with energy efficiency, renewable power, water security, and responsible data governance. A successful digital growth strategy will therefore integrate ICT investment with climate resilience and industrial policy.

7. Conclusion

This paper examined the long-run association between ICT development, FDI, globalization, trade openness, and real GDP per capita in the six GCC economies over 2000–2024. The empirical design was motivated by the region's common exposure to oil-market cycles, global financial conditions, and shared diversification challenges. Cross-sectional dependence diagnostics confirmed that GCC economies are strongly interdependent, especially in ICT, globalization, trade openness, and income. This finding supports using heterogeneous, second-generation panel approaches rather than relying solely on conventional pooled estimators.

The long-run estimates show that ICT, FDI, and trade openness are positively associated with real GDP per capita across the reported estimators. These results are consistent with the view that digital infrastructure, investment openness, and trade integration can support growth beyond hydrocarbons. However, globalization has an estimator-sensitive coefficient: it is negative under fixed effects, group-mean FMOLS, and group-mean DOLS, but positive under the mean-group estimator. This mixed result implies that globalization is conditional. It becomes growth-enhancing when domestic institutions, skills, innovation systems, and sectoral policies convert global linkages into productivity gains.

The central conclusion is that the GCC's diversification challenge is not merely to become more open or more digital. The challenge is to convert digital connectivity and global integration into domestic value creation. ICT investment should be paired with human capital, data governance, and private-sector adoption. FDI policy should prioritize spillovers and non-oil productive capacity. Trade policy should emphasize export sophistication and regional value-chain development. Globalization should be managed through resilient institutions and macroeconomic buffers.

Future research should use firm-level and sector-level data to identify the mechanisms behind the aggregate relationships documented here. It should also decompose globalization into its economic, social, and political dimensions, test interactions between ICT and openness, and apply cross-sectionally augmented dynamic estimators such as CCE-MG, DCCE, and CS-ARDL [44-46]. These extensions would strengthen causal interpretation and provide more precise policy guidance for the next phase of GCC diversification.

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Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

Data Availability:

The data are drawn from publicly available international databases, including the World Bank [38], International Telecommunication Union [5]; International Telecommunication Union [6] and KOF Swiss Economic Institute [39].

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