International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2026, 16(2), 230-241.

Oil Dependence, Economic Diversification, and Economic Growth in GCC Countries: A New Composite Index and PMG–ARDL Evidence

Nermeen Ishker[1]*, Hanadi Taher[2], Maggie Houshaimi[2]

[1]PhD Candidate in Economics, Beirut Arab University, Beirut, Lebanon, [2]Beirut Arab University, Beirut, Lebanon.
*Email: nermeeneshker@gmail.com

Received: 24 September 2025 **Accepted:** 11 January 2026 **DOI:** https://doi.org/10.32479/ijeep.22501

ABSTRACT

This paper constructs and applies a Composite Economic Diversification Index (CEDIX) to quantify the impact of economic diversification on economic growth in oil-dependent GCC economies during the period 2000-2022. In constructing CEDIX, the export, sectoral, and fiscal dimensions are combined by using principal component analysis. Estimation of the diversification-growth nexus was done through the PMG-ARDL specification. Furthermore, second-generation panel tests, the Pesaran CIPS unit-root test, and Westerlund's ECM cointegration test were implemented, and their results supported the long-run equilibrium of variables. Baseline controls are real Brent oil prices, investment, and labor. Results from the PMG estimation showed that diversification has a positive and statistically significant long-run effect on growth. The speed of adjustment to equilibrium is fast. As would be expected from reform gestation lags, the short-run effects of diversification remain modest, while investment and oil prices are the factors shaping the cyclical movements. A fixed-effects ECM estimated with Driscoll-Kraay standard errors was considered for robustness checking and also supports the sign and significance of our main findings. Therefore, policy should give priority to promoting non-oil exports, sectoral upgrading beyond hydrocarbon markets, and fiscal rebalancing in transforming oil windfalls into durable diversified growth.

Keywords: Economic Diversification, Oil Dependence, GCC, PMG-ARDL, Economic Growth, Brent Oil Price
JEL Classifications: Q43, C33, O47, O13

1. INTRODUCTION

Hydrocarbons have long been the core macroeconomic foundation supporting Gulf Cooperation Council (GCC) economies. The hydrocarbon-led model allowed for episodes of extended growth and the accumulation of large fiscal buffers, but it also left growth highly exposed to international oil price cycles and to structural frictions typical in resource-dependent economies: procyclical demand, public sector dominance, and weak tradable non-oil bases (Auty, 1997; Callen et al., 2014; Ross, 2012). Since 2000, there have been recurrent booms and busts in oil markets, which have served to sharpen a policy debate hitherto masked by trend growth: can economic diversification substantially increase trend growth in an oil economy or only reduce short-term volatility?

Diversification can lift growth through broader production and export bases that mitigate terms-of-trade shocks and stabilize investment (Hesse, 2008; Lee and Zhang, 2022). Capability accumulation and technology diffusion in non-oil tradables (Imbs and Wacziarg, 2003; Adeola and Evans, 2017; Canh and Thanh, 2022); fiscal diversification reduces spending procyclicality while expanding budget space for human capital to enhance growth (Bornhorst et al., 2009; Arezki and Ismail, 2013; Adegboyo et al., 2023). Very few studies provide evidence on GCC at the same time as being multidimensional in measurement over a panel time series; all rely either on single-dimension proxies such as export Herfindahl or cross-sectional designs, which cannot capture within-country dynamics (Hesse, 2008; Shadab, 2023). The main problem is that single indicators are able to reflect just one facet of the phenomenon under consideration.

This paper fills these gaps for the GCC by developing a Composite Economic Diversification Index (CEDIX) through principal component analysis (PCA) of export, sectoral (value added), and revenue diversification. An annual panel is compiled for six GCC economies over 2000-2022 to estimate the relationship between economic diversification and economic growth using a panel ARDL model within the pooled mean-group (PMG) framework that allows country-specific short-run dynamics while imposing long-run restrictions (controls include gross capital formation, labor, and real oil prices). Pesaran's CIPS unit root test and Westerlund ECM cointegration test under cross-section dependence provide credible time series inference on long-run relationships, also reported by an alternative fixed effects ECM estimated with Driscoll-Kraay standard errors.

Our contributions are threefold. First, we construct a multidimensional index of diversification at the level of the GCC as a composite economy. Second, by applying a PMG-ARDL model allowing for heterogeneous short-run dynamics and adjustment to the long-run equilibrium relationship between real GDP growth and diversification, we estimate elasticity in the long run. Third, while controlling for gross capital formation, employment, and real oil prices, we find statistically significant policy-relevant values applicable to hydrocarbon economies.

In summary, a positive and statistically significant relationship between diversification and long-term real GDP growth is established, while the short-term dynamics are mainly defined by oil prices and investment cycles. The rest of the paper is organized as follows: Section 2 provides a literature review, Section 3 discusses data-including index construction-and econometric methodology applied, Section 4 contains empirical results, followed by a conclusion with policy implications as well as suggestions for further research in Section 5.

2. LITERATURE REVIEW

Export diversification is a key pillar of growth and macroeconomic stability in resource-rich economies. At the same time, diversification is an inherently multidimensional concept. Scholars have identified various dimensions or margins along which it can be measured-export composition, domestic sectoral mix, and fiscal revenue base-by using concentration/entropy indices (Herfindahl-Hirschman; Theil; Gini) (Imbs and Wacziarg, 2003; Hesse, 2008; Cadot et al, 2011; Trinh and Thuy, 2021; Lee and Zhang, 2022), extensive/intensive trade margins (Canh and Thanh, 2022), capability-based measures such as the economic complexity index (Hathroubi et al., 2024), and, more recently, by composite indices that aggregate different pillars (Prasad et al., 2023; 2024). Clearly then, "diversification" is not an observed variable but rather a latent construct. This paper thus takes a multidimensional approach to diversification in oil economies.

Export concentration received much more attention. Initial cross-country findings show a channel between less export concentration and faster growth in developing economies, while high-income economies reap larger benefits from specialization (Hesse, 2008). Using broader measures: export HHI, Theil, and Gini, Lee and Zhang (2022) find that both product and partner diversification spur growth while reducing volatility with quite large effects in small states. Evidence proximate to the GCC is consistent; for the UAE, Shadab (2023) finds that reduction of export concentration fosters long- as well as short-term growth. At the same time, several studies find non-linearities in the relationship between diversification and development. Cadot et al. (2011) found at most levels a "diversify then re-specialize" hump-shaped pattern at the product level; Munir and Javed (2018) and Trinh and Thuy (2021), using HHI and Theil, respectively, found inverted-U relationships, while Aditya and Acharyya (2013) found threshold levels below which diversification increases growth but above which specialization pays off. Parteka et al. (2025) find that high-tech content is increasingly one of the main drivers of payoffs from diversification, while in capability-based approaches, diversification and complexity are mutually reinforcing, with higher levels of complexity reducing volatility in growth cycles (Canh and Thanh, 2022). In other work using relatedness based on RCA, which shows product proximity helps diversification, macro short-run conditions, oil prices, exchange rates, and investment appear to often dominate (Olvera and Spínola, 2025). Not all settings generate uniformly positive effects on growth; for Ali et al. (2023) find that concentration increased by dependence on oil contemporaneously with no strong long-run effect through complementary reforms involving either rent or non-rent-based resource diversifications.

Sectoral diversification pertains to production structures within the domestic economy. The relationship between sectoral diversification and per capita income follows a U-shaped curve: at low levels of income per capita, increasing diversification accompanies growth; beyond a certain threshold level of income per capita, typically associated with developed countries, specialization resumes (Imbs and Wacziarg, 2003). This is fully consistent with country studies on oil exporters. Using a normalized HHI within ARDL/NARDL for Saudi Arabia, Houfi (2021) finds that higher long-run growth is associated with lower concentration-higher sectoral diversification-and that decreases in concentration are more important than increases. Reduced sectoral diversification accompanies most upswings in the oil price (Sweidan and Elbargathi, 2023), this being totally consistent with the spending channel and real exchange rate channel of transmission. Studies on its determinants highlight enabling roles for education and labor force participation, finance, governance, and capital formation (Adeola and Evans, 2017; Jolo et al., 2022), suggesting close interaction between the sectoral margin, institutions and factor accumulation.

A third pillar is in revenue (fiscal) diversification, directly connecting to energy-policy levers and macro-stabilization. Approaches range from HHI over revenue categories (often oil vs. non-oil) to direct measures of non-oil revenues and their tax versus non-tax components. Non-oil revenue reforms in Saudi Arabia widen government spending but can compress private consumption and investment in the short run (Almarzoqi and

El-Mahmah, 2020), while contributions to nominal GDP from non-tax sources by Shili and Panjwani (2020) are found to be stronger than non-oil tax revenues. Over a long Saudi sample, production, export, revenue, investment, and employment-based HHI indices constructed by Alkhathlan et al. (2020) show how each facet of diversification is conditioned by macro policies on prices, exchange rates, FDI, and spending. Outside the GCC, disaggregated evidence indicates a positive association between agriculture, manufacturing, mining, and VAT revenues with growth (Adegboyo et al., 2023). The payoff in revenue diversification by a stable economic base is state-contingent on the volatility of the economic base (Yan, 2008) and mediated through local institutions (Park and Park, 2018). These results suggest an approach to the structural margin as an independent variable rather than viewing it as a passive reflection of exports.

As oil is the main driver in hydrocarbon economies, the oil–diversification–macro nexus is central. In Saudi Arabia, higher oil prices are associated with greater sectoral concentration (Sweidan and Elbargathi, 2023). Renewable-energy policies allow long-run support between diversification and renewable energy but deny any short-or medium-run support by oil revenues to diversification (Hathroubi et al., 2024). The responses appear quite asymmetric in Qatar's case: The effects of shocks to both on government revenue from petroleum as well as prices are larger when they are negative than the benefits realized when positive (Charfeddine and Barkat, 2020). These results are directly relevant for the GCC, where oil cycles are transmitted through the external account, production structure, and the budget.

Recent literature creates a composite index of diversification which combines output, trade, and income based on principal component analysis (Prasad et al 2023; 2024). Others penalize composites sensitive to resources for high hydrocarbon dependence to capture 'quality' of diversification as well as breadth; for instance, WCDI (Eskandar, 2025). These works clearly support the use of a multidimensional approach but are designed for maximum global comparability using large variable sets with either equal or arbitrary weights plus substantial imputation to address missing data rather than being constructed for within-region panel time series identification in oil economies. For GCC, most evidence still relies on single-dimensional or cross-sectional designs that severely constrain inference at the country level.

There are two implications for our study and energy policy. First, broadly in the literature, it is found that diversification supports growth and tempers volatility in resource-dependent settings. Magnitudes differ across countries and horizons as economic structure and oil cycle exposure vary. Second, sectoral and fiscal pillars matter alongside exports for investment dynamics and the stability and quality of public spending. Against this backdrop and recognizing the limitations of single proxies, we construct a GCC-tailored Composite Economic Diversification Index (CEDIX) that jointly captures export, sectoral, and fiscal structures using PCA, and evaluate its link to Economic growth. Our aim is the long-run effect on GCC economies. This design maps directly to energy-policy levers, non-oil export promotion, sectoral upgrading beyond hydrocarbons, and revenue diversification, providing a region-specific, time-series-consistent baseline for policy and subsequent extensions.

3. DATA AND METHODOLOGY

3.1. Data

The study comprises a balanced annual panel for the six GCC countries: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates for the years 2000-2022. That period covers major cycles in oil prices and recent waves toward diversification and fiscal reforms. The dependent variable is real GDP growth (GDPG) in percent constant 2015 US dollars. A composite economic diversification index (CEDIX) scaled between zero and one based on three structural pillars: export diversification (EXDIV), sectoral diversification (SECDIV), and revenue diversification (REVDIV), is used as the main regressor. Control variables include log values of real gross capital formation (LnGCF), labor force participation rate (LFPR), defined as the percentage of population aged fifteen or above, using ILO modeled estimates, plus real Brent oil price (OilPr).

All data are annual observed values with no temporal imputation. The sources include the World Bank (WDI), UNCTADstat for exports, UNData/national accounts (value added by ISIC), Arab Monetary Fund, and national Ministries of Finance (revenues), U.S. Energy Information Administration (Brent). Variable definitions, units or transformations, abbreviations, and sources are provided in summary form in Table 1.

3.2. Construction of the Composite Economic Diversification Index (CEDIX)

Economic diversification is measured by a composite indicator incorporating three complementary dimensions: (i) export diversification, (ii) sectoral diversification, and (iii) revenue diversification. Each dimension is first measured by a Herfindahl–Hirschman Index (HHI) and then aggregated using Principal Component Analysis (PCA). The higher the CEDIX, the more diversified.

3.2.1. Aspects of economic diversification

3.2.1.1. Export diversification (EXDIV)

The UNCTADstat export concentration index (a normalized HHI) is used:

$$EXDIV_j = \frac{\sum_{i=1}^{n}(\frac{x_{ij}}{X_j})^2 - 1/n}{1 - 1/n} \quad (1)$$

Where x_{ij} is the value of export of product i for country j and product i, X_j is the total exports of country j and n number of products (SITC Rev. 3 at 3-digit level). The index is bounded in [0,1], where higher values indicate greater concentration (weaker diversification).

3.2.1.2. Sectoral diversification (SECDIV)

Sectoral diversification is calculated as the HHI of GVA shares across ISIC aggregates: Agriculture (A–B), Mining and Utilities (C–E except D), Manufacturing (D), Construction (F), Trade and

Table 1: Variables, measurement, and data sources

Variable	Abbrev.	Measurement/Definition	Source
Real GDP Growth	GDPG	Annual percentage growth rate of real GDP (constant 2015 US$).	World Bank, WDI
Composite Economic Diversification Index	CEDIX	First principal component (PCA) of the three standardized pillars (EXDIV, SECDIV, REVDIV); sign-oriented, so higher=more diversified; min–max scaled to ([0,1]).	Author's calculations from sources below
Export concentration (normalized HHI)	EXDIV	UNCTAD normalized Herfindahl–Hirschman Index of merchandise export shares (SITC Rev. 3, 3-digit); bounded ([0,1]). Higher=more concentrated (less diversified).	UNCTADstat
Sectoral concentration (HHI of GVA shares)	SECDIV	HHI of Gross Value-Added shares across ISIC groups: Agriculture (A–B), Mining and Utilities (C–E excluding D), Manufacturing (D), Construction (F), Trade and Hospitality (G–H), Transport and Communication (I), Other Services (J–P). Manufacturing (D) is separated from C–E to avoid double counting. Higher=more concentrated.	UNData: national accounts
Revenue (fiscal) concentration	REVDIV	HHI across oil and non-oil revenue shares in total government revenue, with two categories, raw HHI □ ([0,1]); Higher=more concentrated (greater oil dependence).	Arab Monetary Fund; national Ministries of Finance
Gross Capital Formation (ln in model)	GCF (lnGCF)	Gross capital formation (current US$) deflated by each country's GDP deflator; natural log used in estimation.	World Bank, WDI
Labor Force Participation Rate	LFPR	Total labor force participation rate (% of population ages 15+); ILO modelled estimate.	International Labour Organization (ILO)
Real Oil Price	OilPr	Brent spot price FOB (US$/barrel) deflated by each country's GDP deflator to obtain a real oil-price series.	U.S. EIA; World Bank WDI (GDP deflator)

Source: Authors' calculations

Hospitality (G–H), Transport and Communication (I), and Other Services (J–P). Manufacturing (D) is separated from C–E to avoid double-counting.

$$SECDIV_j = \sum_{i=1}^{N} \left(\frac{VA_i}{\sum_{i=1}^{N} VA_i} \right)^2 \tag{2}$$

Where VA_i is the value added of sector i for country j, and N is the number of sectors included. Higher values of the index mean more concentration (less diversification).

3.2.1.3. Revenue diversification (REVDIV)

Revenue diversification is measured using the HHI of government revenue composition:

$$REVDIV_j = (S_j^{oil})^2 + (S_j^{nonoil})^2 \tag{3}$$

Where S_j^{oil} and S_j^{nonoil} are the shares of oil and non-oil revenues in total government revenue for country j. A higher value reflects greater fiscal dependence on oil revenues and thus weaker diversification.

3.2.2. Estimation of the Composite Economic Diversification Index (CEDIX)

Because pillars differ in levels and dispersion, we first standardize each to z-scores over the full panel:

$$Z_{ijt} = \frac{HHI_{ijt} - \mu_i}{\sigma_i} \tag{4}$$

Where μ_i is the mean, and σ_i is the standard deviation of pillar i. Then Principal Component Analysis (PCA) is applied to the standardized variables {Z(EXDIV), Z(SECDIV), Z(REVDIV)}. The first principal component (PC1) explaining the largest proportion of variance in the three measures is selected as the composite index following both the Kaiser criterion (eigenvalue > 1) and the convention that it typically captures common variance across correlated indicators (Jolliffe and Cadima, 2016). This approach works since PC1 captures an underlying common diversification factor across export, sectoral, and fiscal dimensions. The first principal component (PC1), which explains the largest share of variance, is computed as:

$$PC1 = \alpha_1 Z(EXDIV)_{jt} + \alpha_2 Z(SECDIV)_{jt} + \alpha_3 Z(REVDIV)_{jt} \tag{5}$$

The sign of PCA components is indeterminate (Abdi and Williams, 2010), and since the HHI is a concentration measure, therefore, the composite should be oriented so that higher values reflect greater diversification. PC1 is multiplied by −1 and then rescaled to [0,1] for interpretability using Min-max normalization that preserves the distribution of values, facilitating both temporal and cross-country comparisons (Joint Research Centre, 2008).

$$CEDIX_t^{raw} = -PC1_{it} \tag{6}$$

$$PCEDIX_t = \frac{CEDIX_t^{raw} - \min(CEDIX_t^{raw})}{\max\left(CEDIX_t^{raw}\right) - \min(CEDIX_t^{raw})} \tag{7}$$

Thus, CEDIX = 1 indicates the most diversified and 0 the least diversified country-year observation in the sample.

3.3. Model Specification

The model's theoretical framework is based on the endogenous growth model approached by works such as Mahir and Azra (2017) using an augmented Cobb-Douglas production function. Let Y_{it} be real output in country i at time t:

$$Y_{it} = A_{it}\ f(L_{it}, K_{it}, OilPr_{it}, CEDIX_{it}) = A.L_{it}^{\propto}.K_{it}^{\beta}.OilPr_{it}^{\gamma}.CEDIX_{it}^{1-\propto-\beta-\gamma} \tag{8}$$

Where A_{it} captures technology/efficiency, L_{it} is labor input, K_{it} is capital, $OilPr_{it}$ is the (country-deflated) Brent oil price, and $CEDIX_{it}$ is the Composite Economic Diversification Index. Taking growth-rate/log-difference approximations yields a parsimonious growth specification with diversification and standard controls:

$$GDPG_{it} = \beta_0 + \beta_1 \, lnGCF_{it} + \beta_2 \, LFPR_{it} + \beta_3 \, OilPr_{it} + \beta_4 \, CEDIX_{it} + \in_{it} \quad (9)$$

Where β_0 is the intercept, β_i (i = 1, 2, … 4) are the elasticity parameters to be estimated and $\in_{it}$ is the independent and identically distributed error term. $\beta_4>0$ is expected: deeper diversification typically supports growth via capability expansion and risk-sharing mechanisms (export/sectoral/fiscal variety reduces exposure to idiosyncratic shocks) (Hesse, 2008; Imbs and Wacziarg, 2003; Haddad et al., 2013; Caselli et al., 2020). Investment and labor depth are expected to be growth-enhancing in standard growth empirics, although magnitudes vary across contexts (β_1, $\beta_2>0$ on average) (Barro, 1991; Mankiw et al., 1992). For oil-exporting economies, the sign of β_3 is ultimately empirical: oil prices can be expansionary or contractionary depending on whether shocks are demand- or supply-driven and on domestic transmission (Kilian, 2009; Mohaddes and Pesaran, 2017; Mohaddes and Raissi, 2019).

3.4. Estimation Procedure and Diagnostic Tests

3.4.1. Cross-sectional dependence and panel unit-root tests

Since the GCC economies are globally integrated with oil, financial shocks, and other economic activities in the world, it must be checked whether the series used is cross-sectionally dependent or not. Cross-sectional dependence has been found to produce seriously misleading results if ignored (Salahuddin et al, 2020). Therefore, in this paper, cross-sectional dependence is tested by Pesaran's (2004) CD test statistic. The null hypothesis is one of cross-sectional independence against an alternative of cross-sectional dependence; therefore, if the null is rejected, then there exists cross-sectional dependence among selected variables. We run the CD test at the level series.

Following the cross-sectional dependence test, a panel unit root test was conducted to examine the stationarity of the variable in order to explore its long-run relationship. In this study, Im–Pesaran–Shin (IPS) test (Im et al., 2003) has been applied. Moreover, as a second-generation unit root test, Pesaran's cross-sectionally augmented IPS (CIPS) test (Pesaran, 2007) is also utilized, which is better suits for controlling the cross-sectional dependencies and reducing the biases in heterogeneous panels. The null hypothesis of this test is the presence of a unit root against the alternative of a stationary series.

3.4.2. Westerlund cointegration test

Westerlund (2007) error-correction–based panel cointegration tests were applied to determine long-run relationships. These allow for cross-sectional dependence and heterogeneity. Four different possible test statistics results regarding cointegration between the variables are obtained from this test: Ga and Gt, based on the null hypothesis of no cointegration in at least one cross-sectional unit; rejection of this null hypothesis means that there is cointegration in at least one cross-section; Pt and Pa, based on the null hypothesis of no cointegration for the whole panel, rejection of which shows that there is cointegration between the variables for the whole panel. CD is calculated using bootstrap replications to get robust p-values against the null.

3.4.3. Linear panel ARDL model

To estimate the effect of economic diversification on economic growth, we use a panel ARDL model with the pooled mean group (PMG) estimator of Pesaran et al. (1999). PMG is particularly appropriate in the GCC context: it pools long-run coefficients (interpreted as a common structural relationship) while allowing country-specific short-run dynamics, intercepts, and speeds of adjustment. It is suitable when heterogeneity exists among the panel and allows for the specific lag structure of the variables. One very appealing feature about this model is that it can be applied irrespective of whether some regressors are I(0) and others are I(1)-but not I(2). The PMG-ARDL model for this study may therefore be written thus,

$$\begin{aligned}\Delta GDPG_{it} = {} & \phi_i (GDPG_{i,t-1} - c_i - \theta_1 CEDIX_{i,t-1} - \theta_2 \mathrm{lnGCF}_{i,t-1} \\ & - \theta_3 \mathrm{LFPR}_{i,t-1} - \theta_4 OilPr_{i,t-1}) + \sum_{k=1}^{p-1} \alpha_{1,i,k} \; \Delta GDPG_{i,t-k} \\ & + \sum_{k=0}^{q_1-1} \psi_{1,i,k} \Delta CEDIX_{i,t-k} + \sum_{k=0}^{q_2-1} \psi_{2,i,k} \Delta ln\mathrm{GCF}_{i,t-k} \\ & + \sum_{k=0}^{q_3-1} \psi_{3,i,k} \Delta \mathrm{LFPR}_{i,t-k} + \sum_{k=0}^{q_4-1} \psi_{4,i,k} \Delta OilPr_{i,t-k} + \varepsilon_{it} \quad (10)\end{aligned}$$

Where, $\phi_i < 0$ is the error-correction speed measuring how quickly country i converges to the long-run equilibrium; c_i is the country long-run intercept; θ_m are pooled long-run coefficients under PMG; $\alpha_{i,k}$, $\psi_{i,k}$ are short-run coefficients (heterogeneous).

As a comparator for the restriction on pooling, we also estimate the Mean Group (MG) estimator by Pesaran and Smith (1995), which permits heterogeneity in both long- as well as short-run slopes across countries. To select between PMG and MG estimators, we implement Hausman's (1978) specification test where the null hypothesis is that differences in coefficients are not systematic, thus favoring the more efficient PMG estimator if the null cannot be rejected.

Lag selection is a very important aspect of ARDL estimation. As noted by Loayza and Ranciere (2006), while lag selection at the country level may be appropriate for long run analysis, a common lag structure should be imposed when short run dynamics are also considered. Kim et al. (2016) estimates country specific lag orders and adopts the most frequent specification for the panel. In line with this practice, alternative lags were tested for variables in each GCC country with diagnostic checks determining feasible orders of choice. The most frequent specification was then imposed uniformly for the panel estimation.

As a check on robustness, we re-estimate the fixed effects error-correction specification by applying the heteroskedasticity and autocorrelation consistent standard errors of Driscoll–Kraay (DKSE) (Driscoll and Kraay, 1998), which remain valid under general cross-sectional dependence. This is therefore fully

Table 2: Descriptive statistics (2000-2022)

Variable	Obs.	Mean	Standard deviation	Min.	Max.	Unit/Notes
GDPG	138	4.409	4.999	−7.076	26.170	Annual real GDP growth, %
CEDIX	138	0.558	0.247	0.000	1.000	[0–1] Higher=more diversified
lnGCF	138	24.237	1.096	21.664	26.333	Log real GCF (constant US$)
LFPR	138	69.892	10.631	47.891	87.575	% of population 15+
OilPr	138	71.469	17.280	39.917	111.888	Real Brent, US$/bbl

Source: Authors' calculations

complementary to our PMG-ARDL baseline since it maintains the ECM structure but safeguards inference against cross-sectional dependence in line with very recent panel time series applications (Bangura and Saibu, 2024; Ggoobi et al., 2025; Paul et al., 2025).

3.4.4. Model diagnostic tests

A set of diagnostic tests was conducted to validate the models and check their robustness after estimation. The Wooldridge (Drukker, 2003) test for autocorrelation in panel data was applied, where the null hypothesis is no first-order serial correlation. Groupwise heteroskedasticity using the Modified Wald test (Greene, 2012), with a null hypothesis of homoscedastic disturbances across panels, was also applied. Normality of residuals using the Shapiro and Wilk (1965) test, where the null hypothesis is that residuals are normally distributed, was checked. Passing all these diagnostics proves most likely reliable both short-run and long-run estimates.

4. RESULTS AND DISCUSSION

4.1. Descriptive Statistics and Visualization

Table 2 displays summary statistics for the balanced panel of GCC countries covering the period 2000-2022. GDP growth has a mean value of 4.41% with quite high variability (SD ≈ 5.00), reflecting both oil and global cycles. The composite diversification index CEDIX, on a scale from 0 to 1, where higher is more diversified, has an average mean value of 0.558 (SD = 0.247), showing large cross-country as well as over time variation. Labor force participation averaged at 69.9%. The sample average country-deflated real Brent price is about $71/bbl.

Figure 1 shows pillar-level concentration (HHI) by country, normalized on a common scale from 0 to 1. Three clear patterns emerge: (i) revenue concentration (REVDIV) is highest and also most volatile, emphasizing the channel of fiscal exposure to hydrocarbons; (ii) export concentration (EXDIV) generally trends downward after the mid-2000s and again post-2015, consistent with gradual market broadening, and, (iii) sectoral concentration (SECDIV) is lowest and relatively stable reflecting slow-moving production structures. Heterogeneity at the country level is visible in the panels. Revenue HHI often declines after the 2014–2016 oil slump and the 2020 shock, whereas export HHI reductions are more gradual. These stylized facts motivate separating long-run structure (captured by CEDIX and the pooled PMG slope) from short-run adjustments (country-specific responses to investment and oil cycles) in the subsequent ARDL analysis.

4.2. Principal Component Analysis (PCA) Results

There is a very strong first principal component that emerges when PCA is run on the three standardized pillars. The eigenvalue associated with this PC1 is 1.929, accounting for 64.3 percent of the total variance (Table 3), comfortably exceeding the Kaiser criterion. All loadings are positive and approximately equal in magnitude: EXDIV = 0.543, SECDIV = 0.604, REVDIV = 0.583 (Table 4). Evidently, this is a common diversification factor shared equally at all three levels: export, sectoral, and fiscal. Sampling adequacy is decent (KMO overall = 0.664) and Bartlett's test rejects the null hypothesis that the correlation matrix equals an identity matrix ($\chi^2(3) = 83.89$, $P < 0.001$) (Table 5).

Table 3: Principal component analysis (PCA): Eigenvalues and explained variance

Component	Eigenvalue	Proportion	Cumulative
PC1	1.929	0.643	0.643
PC2	0.619	0.206	0.849
PC3	0.452	0.151	1

Source: Authors' calculations

Table 4: PCA loadings (standardized variables)

Variable	PC1	PC2	PC3
Export Diversification (EXDIV)	0.543	0.821	0.177
Sectoral Diversification (SECDIV)	0.604	−0.235	−0.762
Revenue Diversification (REVDIV)	0.583	−0.521	0.623

Source: Authors' calculations

Table 5: Sampling adequacy and sphericity (KMO and Bartlett tests)

Statistic	EXDIV	SECDIV	REVDIV	Overall/Value
KMO sampling adequacy	0.727	0.6317	0.6558	0.6641
Bartlett's test of sphericity	$\chi^2(3)=83.89$, prob>Chi-square=0.0000			

Source: Authors' calculations

Since the inputs are HHI-type concentration measures, we orient PC1 so that a lower value means more diversification. Then apply min-max scaling to [0,1] to form CEDIX. The almost perfectly balanced loadings of PC1 between the three pillars imply that CEDIX reflects all three, with slightly stronger weights coming from sectoral and revenue structures relative to exports. This is consistent with what should be considered structural features of an economy's diversification as a multidimensional concept rather than changes along one margin only. It is this composite index that we use in the PMG-ARDL analysis thereafter on the relationship between diversification and growth.

Figure 2 shows CEDIX [0-1] for each GCC economy over the years 2000-2022. Three facts stand out. First, a persistent upward trend is seen for the UAE and Oman, in excess of 0.85 by the late 2010s. Second, Saudi Arabia registers a dip during the early 2000s

Figure 1: Concentration by pillar (HHI), GCC countries, 2000-2022. Pillar HHIs (export, sectoral, revenue) in their raw form, where higher values indicate more concentration (less diversification)

Source: Authors' calculations

but then picks up significantly after 2015-2016, perfectly consistent with the reforms undertaken post oil slump. Qatar is trending upwards with a mid-2010s dip; Bahrain is moderately high and relatively stable. Third, Kuwait remains low and fairly flat (~0.1-0.3). This itself underlines heterogeneity in the pace of reforms and fiscal/external conditions across countries, thus justifying an estimate that pools only the long-run slope while allowing for country-specific short-run adjustments in PMG-ARDL.

4.3. Cross-Sectional Dependence and Panel Unit-Root Tests Results

Tables 6 and 7 present the dependence and stationarity diagnostics. Pesaran's CD test strongly rejects cross-sectional independence for all series ($P < 0.001$), with large average pairwise correlations, highest for oil prices and investment, consistent with common oil-cycle shocks in the GCC. Thus, we use second-generation unit-root tests. By Pesaran's CIPS with a constant and trend in levels (except GDPG) and a constant in first differences (lags: two in levels, one in Δ), GDPG is I(0) while CEDIX, lnGCF, LFPR, and OilPr are I(1). Since the variables are of mixed order (I(0)/I(1)) and none is I(2), the ARDL framework with a PMG-ECM specification is suitable. IPS results are reported for completeness, but inference on integration relies on CIPS given the detected cross-sectional dependence.

Table 6: Cross-sectional dependence (Pesaran CD) in levels, GCC (2000-2022)

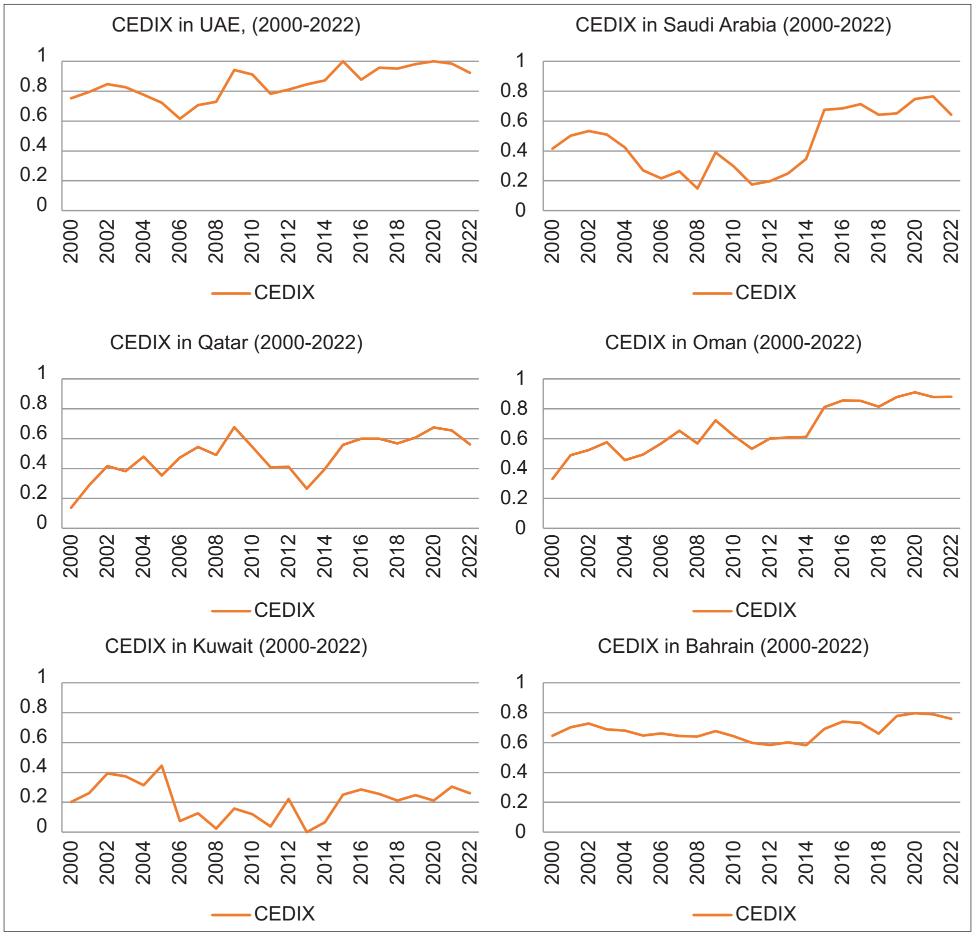
Variable	CD statistic	P-value	Avg. corr (ρ)	|ρ|
GDPG	8.15	(0.000)	0.443	0.443
CEDIX	10.07	(0.000)	0.546	0.546
lnGCF	16.44	(0.000)	0.891	0.891
LFPR	14.94	(0.000)	0.81	0.81
OilPr	17.87	(0.000)	0.969	0.969

H_0: cross-section independence; under H_0, CD~N (0,1). Source: Authors' calculations

4.4. Westerlund Cointegration Test Results

Table 8 shows the results of Westerlund (2007) ECM-based panel cointegration tests, with 400 bootstrap replications to accommodate cross-sectional dependence. We focus on the bootstrap P-values. The group-mean Gt rejects the null of no cointegration at the 5% level ($P = 0.013$), which means that at least one GCC country exhibits a valid long-run error-correcting

Figure 2: CEDIX by country, GCC (2000-2022). CEDIX is sign-oriented and min–max scaled to [0,1]; higher = more diversified



Source: Authors' calculations

Table 7: Panel unit-root tests (IPS vs. CIPS), GCC (2000-2022)

Variable	Im, Pesaran and Shin (IPS)				Cross-sectional Im, Pesaran, and Shin (CIPS)				
	IPS t-bar (level)	P-value	IPS t-bar (Δ)	P-value	CIPS Z[t̄] (level)	P-value	CIPS Z[t̄] (Δ)	P-value	Order
GDPG	−3.7256	0.0001	—	—	−2.474	0.007	−4.196	0.000	I (0)
CEDIX	−1.4145	0.0786	−6.3005	0.000	2.112	0.983	−3.966	0.000	I (1)
GCF	0.1432	0.5569	−4.8420	0.000	−0.495	0.31	−3.271	0.001	I (1)
LFPR	1.4181	0.9219	−2.9928	0.0014	0.809	0.791	−2.327	0.01	I (1)
OilPr	−1.1038	0.1348	−4.8405	0.000	0.139	0.555	−3.224	0.001	I (1)

Source: Authors' calculations

Table 8: Westerlund ECM panel cointegration test (400 bootstrap replications)

Statistic	Value	Z-value	P-value	Bootstrap P value
Gt	−3.447	−2.568	(0.005)	(0.013)
Ga	−6.612	2.028	(0.979)	(0.08)
Pt	−7.047	−1.647	(0.05)	(0.037)
Pa	−6.179	1.01	(0.844)	(0.085)

Null hypothesis: no cointegration. Reported bootstrap P values are robust to cross-sectional dependence. Source: Authors' calculations

relationship among GDPG, CEDIX, lnGCF, LFPR, and OilPr. For the panel as a whole, Pt statistic also rejects at 5% (P = 0.037), hence evidence of panel cointegration. The Ga and Pa statistics are marginal (≈0.08-0.09), but taken together, the results support the presence of a long-run equilibrium relation, an inference which is corroborated below by a negative and significant error-correction term in PMG-ARDL estimates.

4.5. Panel ARDL Model Estimation Results (PMG vs. MG) Results

Table 9 shows the country-level lag trials that helped in guiding specification; the most recurrent combination is imposed uniformly, yielding a final ARDL (1,2,1,2,2) for (GDPG, CEDIX, lnGCF, LFPR, OilPr). The Hausman test fails to reject the pooling restriction (χ^2 (4) = 0.89, P = 0.926), hence PMG is taken as the preferred estimator (Table 10).

In the long run, diversification is growth-enhancing (coefficient on CEDIX of 13.819, P = 0.039): broader export base, sectoral base, and fiscal base are associated with faster trend growth; an association also found in resource-dependent economies by Hesse (2008) and Lee and Zhang (2022). The investment variable enters negative and significant (−5.817, P = 0.001). We do not interpret this as "investment reduces growth" but rather an efficiency/composition effect typical to hydrocarbon booms: in upswings, spending turns toward non-tradables as well as import-intensive megaprojects with weak spillovers so that higher GCF today does not translate into sustained productivity or tradable capacity tomorrow (Devarajan et al., 1996; Tanzi and Davoodi, 1997; Pritchett, 2000; Ghosh and Gregoriou, 2008; IMF, 2015; Nili and Rastad, 2007). Labor force participation (LFPR) does not have any significant effect on the long run. This result is quite reflective of a GCC labor market where higher participation, mostly through expatriate employment, would not automatically translate into productivity without complementary reforms (Callen et al., 2014; Behar, 2015). Real oil prices are positive and significant, hence confirming the pro-cyclical role that oil income plays in exporters (Esfahani et al. 2014).

This can also be explained by short-run dynamics. There is little and no statistically significant change in CEDIX, implying that the structural payoffs are slowly realized and may include transition costs as explained by Houfi (2021). On the other hand, investment increases output immediately (ΔlnGCF = 13.851; P < 0.001), consistent with demand side multipliers (Abiad et al., 2016), LFPR is temporarily expansionary (ΔLFPR = 1.644; P = 0.011) but shows no persistence, and oil prices are short-run marginally expansionary (ΔOilPr = 0.115; P = 0.079).

Table 9: Country-specific lag trials by variable

Optimal lags for Country	GDPG	CEDIX	lnGCF	LFPR	OilPr
Bahrain	2	2	2	2	2
Kuwait	2	2	2	2	1
Oman	2	0	0	1	1
Qatar	1	1	1	2	0
Saudi Arabia	2	0	1	0	2
UAE	1	1	0	0	0

Numbers denote lag lengths explored in country-level trials. Source: Authors' calculations

Table 10: Panel ARDL estimates (DV: GDPG) — PMG versus MG, ARDL (1,2,1,2,2)

Variable	PMG		MG	
	Coefficient	P-value	Coefficient	P-value
Long-run coefficients				
CEDIX	13.8189**	(0.039)	−3.0476	(0.883)
lnGCF	−5.8166***	(0.001)	0.8037	(0.887)
LFPR	−0.0087	(0.971)	−0.3207	(0.446)
OilPr	0.0866**	(0.021)	−0.0309	(0.879)
ECM coefficient (ϕ)	−0.7155***	(0.000)	−1.0387***	(0.000)
Short-run coefficients				
Δ CEDIX	−8.8795	(0.166)	2.1875	(0.891)
Δ $CEDIX_{t-1}$	−7.4642	(0.278)	5.9963	(0.601)
Δ lnGCF	13.851***	(0.000)	11.9757***	(0.005)
Δ LFPR	1.6439**	(0.011)	1.8041**	(0.014)
Δ $LFPR_{t-1}$	0.1287	(0.912)	0.0192	(0.989)
Δ OilPr	0.1152*	(0.079)	0.1543	(0.297)
Δ $OilPr_{t-1}$	−0.0072	(0.886)	0.0742	(0.516)
Constant	94.6091***	(0.000)	45.8954	(0.689)
Hausman (PMG vs. MG) test	χ^2 (4) 0.89		P=0.9255	PMG preferred

***, **, * denote P<0.01, P<0.05, P<0.10. ECM coefficient (ϕ) is the error-correction speed (per year). Δ indicates first difference. Source: Authors' calculations

The error-correction term is negative and highly significant (ϕ = −0.716; P < 0.001), suggesting that about 70% of any deviation from the long-run equilibrium is corrected within one year, in agreement with Westerlund's cointegration evidence. Under MG, the long-run slopes are poorly determined and mostly insignificant, while the adjustment term stays negative and significant; together with the Hausman result, this supports PMG specification as both economically sensible for closely integrated GCC oil exporters and statistically more efficient.

Overall, in the long run, diversification becomes a driver of sustainable growth. Investment is a short-term driver of growth and does not change the trend levels of growth when allocation and governance are weak. Oil prices matter for both horizons; therefore, structural policies should deepen non-oil tradable and non-oil revenue bases as well as improve the productivity of public and private investment.

4.6. Model Diagnostic Test Results

Table 11 shows the results of post-estimation diagnostics on the ARDL–PMG specification. The Wooldridge test fails to reject within-panel AR(1) serial correlation (F(1,5) = 2.308, P = 0.189). The Modified Wald test is also insignificant ($\chi^2(6)$ = 0.61, P = 0.434). There is no evidence of groupwise heteroskedasticity. Residual normality is not a requirement for PMG consistency, but as a matter of completeness, both tests are not rejected at conventional levels: Skewness/Kurtosis $\chi^2(2)$ = 5.02 (P = 0.081) and Shapiro–Wilk W = 0.982 (P = 0.085). Therefore, there is no serial correlation or heteroskedasticity and thus strong departures from normality to cast doubt on the reliability of reported short- and long-run estimates.

4.7. Robustness: FE-ECM with Driscoll–Kraay SEs

To protect inference from heteroskedasticity, autocorrelation, and potential cross-sectional dependence, we re-estimate a fixed effects ECM with Driscoll-Kraay standard errors (ARDL (1,2,1,2,2); DV: ΔGDPG).

Table 12 mimics very closely the PMG results: in the long run, CEDIX is positive and significant (24.53, P = 0.002), lnGCF is negative and significant (−6.68, P < 0.001), and LFPR is insignificant and OilPr positive and significant (0.156, P < 0.001). The error correction term remains large and negative (−0.718, P < 0.001), confirming rapid convergence.

Point estimates differ from PMG because the FE-ECM imposes fully homogeneous slopes and constructs long-run effects as ratios of level coefficients, whereas PMG pools only the long

Table 11: Diagnostic tests (Wooldridge, Modified Wald, Skew/Kurt, Shapiro–Wilk)

Test	Statistic	P-value
Wooldridge test for autocorrelation in panel data	F (1,5) = 2.308	(0.1892)
Modified Wald test for groupwise heteroskedasticity	$\chi^2(6)$ =0.61	(0.4338)
Skewness/Kurtosis test for normality	$\chi^2(2)$ =5.02	(0.0814)
Shapiro–Wilk W test for normality	W=0.98236	(0.0848)

Source: Authors' calculations

Table 12: Robustness: FE-ECM with Driscoll–Kraay SEs (DV: ΔGDPG), ARDL (1,2,1,2,2)

Variables	Coefficient	P-value
Long-run coefficients		
CEDIX	24.532 **	(0.002)
lnGCF	−6.679 ***	(0.000)
LFPR	−0.1981	(0.231)
OilPr	0.1555 ***	(0.000)
ECM coefficient (ϕ)	−0.7177 ***	(0.000)
Short-run coefficients		
Δ CEDIX	**10.268****	(0.022)
Δ $CEDIX_{t-1}$	−4.396	(0.298)
Δ lnGCF	3.621	(0.055)
Δ LFPR	**0.849****	(0.021)
Δ $LFPR_{t-1}$	0.439	(0.406)
Δ OilPr	**0.1775*****	(0.002)
Δ $OilPr_{t-1}$	**−0.0678*****	0.007)
Constant	**110.791*****	(0.001)

*P<0.10, **P<0.05, ***P<0.01. Within $R^2 \approx 0.5813$. Source: Authors' calculations

run while allowing heterogeneous short-run dynamics (Pesaran et al., 1999). Despite these differences in specifications, signs and statistical significance are preserved; the DK-robust estimates again support the PMG conclusion that diversification is a long-run growth driver.

5. CONCLUSION

This paper builds a composite economic diversification index (CEDIX) for the six GCC economies over 2000-2022 by combining export, sectoral, and fiscal concentration into one single PCA-based measure; then estimates its growth effects in a PMG-ARDL framework with heterogeneous short-run dynamics. Three results stand out clearly. First is that diversification is a long-run driver of growth: higher CEDIX goes hand-in-hand with faster trend GDP growth, confirmed by all diagnostics (CIPS, Westerlund cointegration) and robustness re-estimation using fixed-effects ECM with Driscoll-Kraay standard errors. Second, the long-run coefficient on investment (lnGCF) is negative, while the short-run effect of ΔlnGCF happens to be strongly positive. We understand this as a signal of efficiency/composition rather than an effect of quantity: in hydrocarbon booms, spending swings toward non-tradables and imports, which are highly intensive but have low productivity linkages; hence, investment today does not translate into sustained capacity tomorrow, yet output is achieved on impact. Third, oil prices remain recovery-positive across both horizons with a large negative short-run deviation from the long run, indicating quick adjustment to equilibrium.

Policy implications for energy-rich economies are direct. Diversification beyond hydrocarbons is not only a hedge against volatility; it raises long-run growth. In simple words, there must be continuous structural transformation in these countries towards non-hydrocarbon tradable sectors because the current boom may arguably have worsened the already weak structure and added more to hydrocarbon concentration. For the GCC, this implies (i) deepening non-oil tradables (manufacturing and tradable services, including logistics and renewables) through export-promotion and competition policies; (ii) mobilizing non-oil revenues (broad-based VAT/excises, broadened CIT bases) to reduce fiscal procyclicality and finance human-capital and innovation outlays; (iii) public investment management reform that shifts the composition of capital spending toward high-return projects; (iv) medium-term fiscal frameworks targeting a non-oil primary balance with coordination between SWFs as an institutional mechanism for managing oil cycles, (v) labor market/skills policy aimed at raising productivity per participant rather than just levels of participation itself. These levers map directly onto the pillars embedded within CEDIX: export sectoral structure revenue, and also with growth channels identified by econometric evidence.

Promising future extensions of this study can be summarized as: (i) testing for asymmetric adjustments (NARDL); (ii) linking CEDIX to growth volatility and to sector- or firm-level productivity so that micro channels are illuminated, and (iii) expanding the index to a broader set of oil exporters in benchmarking GCC progress over time steps that would strengthen external validity and policy relevance. Testing for asymmetric adjustments will confirm how valid, robust, and stable the estimated parameters reported under symmetric adjustment are across alternative specifications. In linking CEDIX with growth volatility at the country level as well as at disaggregated levels by sectors or firms, new light could be shed on transmission mechanisms between diversification, volatility, and growth.

REFERENCES

Abdi, H., Williams, L.J. (2010), Principal component analysis. Wiley Interdisciplinary Reviews: Computational Statistics, 2(4), 433-459.

Abiad, A., Furceri, D., Topalova, P. (2016), The macroeconomic effects of public investment: Evidence from advanced economies. Journal of Macroeconomics, 50, 224-240.

Adegboyo, O.S., Ajoje, O., Agu, O. (2023), The impact of non-oil revenue on economic growth: Empirical evidence from Nigeria. EuroEconomica, 42(2), 158-168.

Adeola, O., Evans, O. (2017), Financial inclusion, financial development, and economic diversification in Nigeria. The Journal of Developing Areas, 51(3), 1-15.

Aditya, A., Acharyya, R. (2013), Export diversification, composition, and economic growth: Evidence from cross-country analysis. The Journal of International Trade and Economic Development, 22(7), 959-992.

Ali, S., Murshed, S.M., Papyrakis, E. (2023), Oil, export diversification and economic growth in Sudan: Evidence from a VAR model. Mineral Economics, 36(1), 77-96.

Alkhathlan, K.A., Alkahteeb, T.T., Mahmood, H., Bindabel, W.A. (2020), Determinants of diversification from oil sector in Saudi Arabia. International Journal of Energy Economics and Policy, 10(5), 384-391.

Almarzoqi, R., & El Mahmah, A. (2020). Non-oil revenue and economic growth on major net oil exporters? Evidence from Saudi Arabia (Research Square preprint). https://doi.org/10.21203/rs.3.rs-132808/v1

Arezki, R., Ismail, K. (2013), Boom-bust cycle, asymmetrical fiscal response and the Dutch disease. Journal of Development Economics, 101, 256-267.

Auty, R.M. (1997), Natural resource endowment, the state and development strategy. Journal of International Development: The Journal of the Development Studies Association, 9(4), 651-663.

Bangura, M., Saibu, O. (2024), Modeling electricity demand in the Ecowas Region: New insights using fixed effect with Driscoll and

Kraay standard errors. Modern Economy, 15(1), 67-85.
Barro, R.J. (1991), Economic growth in a cross section of countries. The Quarterly Journal of Economics, 106(2), 407-443.
Behar, M.A. (2015), Comparing the Employment-Output Elasticities of Expatriates and Nationals in the Gulf Cooperation Council. United States: International Monetary Fund.
Bornhorst, F., Gupta, S., Thornton, J. (2009), Natural resource endowments and the domestic revenue effort. European Journal of Political Economy, 25(4), 439-446.
Cadot, O., Carrère, C., Strauss-Kahn, V. (2011), Export diversification: What's behind the hump? Review of Economics and Statistics, 93(2), 590-605.
Callen, M.T., Cherif, R., Hasanov, F., Hegazy, M.A., Khandelwal, P. (2014), Economic Diversification in the GCC: Past, Present, and Future. United States: International Monetary Fund.
Canh, N.P., Thanh, S.D. (2022), The dynamics of export diversification, economic complexity and economic growth cycles: Global evidence. Foreign Trade Review, 57(3), 234-260.
Caselli, F., Koren, M., Lisicky, M., Tenreyro, S. (2020), Diversification through trade. The Quarterly Journal of Economics, 135(1), 449-502.
Charfeddine, L., Barkat, K. (2020), Short-and long-run asymmetric effect of oil prices and oil and gas revenues on the real GDP and economic diversification in oil-dependent economy. Energy Economics, 86, 104680.
Devarajan, S., Swaroop, V., Zou, H.F. (1996), The composition of public expenditure and economic growth. Journal of Monetary Economics, 37(2), 313-344.
Driscoll, J.C., Kraay, A.C. (1998), Consistent covariance matrix estimation with spatially dependent panel data. Review of Economics and Statistics, 80(4), 549-560.
Drukker, D.M. (2003), Testing for serial correlation in linear panel-data models. The Stata Journal, 3(2), 168-177.
Esfahani, H.S., Mohaddes, K., Pesaran, M.H. (2014), An empirical growth model for major oil exporters. Journal of Applied Econometrics, 29(1), 1-21.
Eskandar, G. (2025), Weighted Composite Diversification Index: A New Measure of Economic Diversification in Resource-Dependent Economies. Working Paper.
Ggoobi, R., Jeke, L., Musiita, B. (2025), Input-growth linkages in Uganda's industrial development: Insights from sectoral panel data. American Journal of Industrial and Business Management, 15(10), 1561-1593.
Ghosh, S., Gregoriou, A. (2008), The composition of government spending and growth: Is current or capital spending better? Oxford Economic Papers, 60(3), 484-516.
Greene, W.H. (2012), Econometric Analysis. 7th ed. Boston, MA: Pearson Education.
Haddad, M., Lim, J.J., Pancaro, C., Saborowski, C. (2013), Trade openness reduces growth volatility when countries are well diversified. Canadian Journal of Economics/Revue Canadienne D'économique, 46(2), 765-790.
Hathroubi, S., Aloui, C., Ben Hamida, H. (2024), Economic diversification, oil revenue and energy transition in oil dependent countries: A wavelet decomposition and panel data approach. International Journal of Energy Economics and Policy, 14(5), 447-456.
Hausman, J.A. (1978), Specification tests in econometrics. Econometrica: Journal of the Econometric Society, 46, 1251-1271.
Hesse, H. (2008), Export Diversification and Economic Growth. Vol. 21. Washington, DC: Commission on Growth and Development. p1-23.
Houfi, M.A. (2021), Is the impact of the economic diversification on economic growth symmetric or asymmetric? Evidence from Saudi Arabia. International Journal of Economics and Finance, 13(10), 1-11.
Im, K.S., Pesaran, M.H., Shin, Y. (2003), Testing for unit roots in heterogeneous panels. Journal of Econometrics, 115(1), 53-74.
Imbs, J., Wacziarg, R. (2003), Stages of diversification. American Economic Review, 93(1), 63-86.
IMF. (2015), Making Public Investment More Efficient. IMF Policy Paper.
Joint Research Centre. (2008), Handbook on Constructing Composite Indicators: Methodology and User Guide. Paris: OECD Publishing.
Jolliffe, I.T., Cadima, J. (2016), Principal component analysis: A review and recent developments. Philosophical transactions of the royal society A: Mathematical, Physical and Engineering Sciences, 374(2065), 20150202.
Jolo, A.M., Ari, I., Koç, M. (2022), Driving factors of economic diversification in resource-rich countries via panel data evidence. Sustainability, 14(5), 2797.
Kilian, L. (2009), Not all oil price shocks are alike: Disentangling demand and supply shocks in the crude oil market. American Economic Review, 99(3), 1053-1069.
Kim, D.H., Lin, S.C., Suen, Y.B. (2016), Trade, growth and growth volatility: New panel evidence. International Review of Economics and Finance, 45, 384-399.
Lee, D., Zhang, H. (2022), Export diversification in low-income countries and small states: Do country size and income level matter? Structural Change and Economic Dynamics, 60, 250-265.
Loayza, N.V., Ranciere, R. (2006), Financial development, financial fragility, and growth. Journal of Money, Credit and Banking, 38, 1051-1076.
Mahir, H., Azra, B. (2017), Endogenous growth model: Evidence from east European countries. Economic Review - Journal of Economics and Business, XV(1), 33-46.
Mankiw, N.G., Romer, D., Weil, D.N. (1992), A contribution to the empirics of economic growth. The Quarterly Journal of Economics, 107(2), 407-437.
Mohaddes, K., Pesaran, M.H. (2017), Oil prices and the global economy: Is it different this time around? Energy Economics, 65, 315-325.
Mohaddes, K., Raissi, M. (2019), The US oil supply revolution and the global economy. Empirical Economics, 57(5), 1515-1546.
Munir, K., Javed, Z. (2018), Export composition and economic growth: Evidence from South Asian countries. South Asian Journal of Business Studies, 7(2), 225-240.
Nili, M., Rastad, M. (2007), Addressing the growth failure of the oil economies: The role of financial development. The Quarterly Review of Economics and Finance, 46(5), 726-740.
Olvera, B.C., Spinola, D. (2025), Determinants of export diversification in resource-dependent economies: The role of product relatedness and macroeconomic conditions. Structural Change and Economic Dynamics, 74, 578-590.
Park, J.H., Park, S. (2018), The effect of revenue diversification and form of government on public spending. Journal of Public Budgeting, Accounting and Financial Management, 30(2), 211-229.
Parteka, A., Zarach, Z.H., Kordalska, A. (2025), Technological content of export diversification-evolution along the economic growth process. Structural Change and Economic Dynamics, 74, 14-27.
Paul, A., Sahoo, D., Mohapatra, S., & Behera, M. K. (2025). How does the energy transition shape inclusive green growth in the European Union? Jahrbücher für Nationalökonomie und Statistik / Journal of Economics and Statistics. https://doi.org/10.1515/jbnst-2024-0046
Pesaran, M.H. (2004), General diagnostic tests for cross section dependence in panels. Cambridge Working Papers. Economics, 1240(1), 1.
Pesaran, M.H. (2007), A simple panel unit root test in the presence of cross-section dependence. Journal of Applied Econometrics, 22(2), 265-312.
Pesaran, M.H., Shin, Y., Smith, R.P. (1999), Pooled mean group estimation of dynamic heterogeneous panels. Journal of the American Statistical Association, 94(446), 621-634.

Pesaran, M.H., Smith, R. (1995), Estimating long-run relationships from dynamic heterogeneous panels. Journal of Econometrics, 68(1), 79-113.

Prasad, A., Refass, S., Saidi, N., Salem, F., Shepherd, B. (2023), Global Economic Diversification Index 2023. Global Economic Diversification Index Series. United Arab Emirates: MBR School of Government.

Prasad, A., Subramani, K., Refass, S., Saidi, N., Salem, F., & Shepherd, B. (2024). Global Economic Diversification Index 2024: Exploring the Impact of Digital Trade on Economic Diversification. World Government Summit Series. Mohammed bin Rashid School of Government (MBRSG). https://economicdiversification.com/wp-content/uploads/2024/02/Global-Economic-Diversification-Index-2024_Full-report.pdf

Pritchett, L. (2000), The tyranny of concepts: CUDIE (cumulated, depreciated, investment effort) is not capital. Journal of Economic Growth, 5(4), 361-384.

Ross, M.L. (2012), The Oil Curse: How Petroleum Wealth Shapes the Development of Nations. United States: Princeton University Press.

Salahuddin, M., Gow, J., Vink, N. (2020), Effects of environmental quality on agricultural productivity in sub-Saharan African countries: A second generation panel based empirical assessment. Science of The Total Environment, 741, 140520.

Shadab, S. (2023), The new Arab gulf: Evaluating the success of economic diversification in the UAE. In: Social Change in the Gulf Region: Multidisciplinary Perspectives. Singapore: Springer Nature Singapore. p415-430.

Shapiro, S.S., Wilk, M.B. (1965), An analysis of variance test for normality (complete samples). Biometrika, 52(3-4), 591-611.

Shili, N., Panjwani, K. (2020), Non-oil revenue impact on economic growth: Empirical study of Saudi Arabia's economy. Business and Economic Research, 10(4), 13-25.

Sweidan, O.D., Elbargathi, K. (2023), Economic diversification in Saudi Arabia: Comparing the impact of oil prices, geopolitical risk, and government expenditures. International Economics, 175, 13-24.

Tanzi, V., Davoodi, H. (1998), Corruption, public investment, and growth. In: The Welfare State, Public Investment, and Growth: Selected Papers from the 53rd Congress of the International Institute of Public Finance. Tokyo: Springer Japan. p41-60.

Trinh, P.T.T., Thuy, H.T.T. (2021), Export diversification and economic growth: A threshold regression approach for emerging markets and developing countries. Economic Journal of Emerging Markets, 13(2), 188–199.

Westerlund, J. (2007), Testing for error correction in panel data. Oxford Bulletin of Economics and Statistics, 69(6), 709-748.

Yan, W. (2008), The impact of Revenue Diversification and Economic Based on Revenue Stability: An Empirical Analysis of County and State Governments." Ph.D. dissertion. Martin School of Public Policy and Administration, University of Kentucky, Lexington.