DOI: 10.28934/ea.2008 First Online: June 30, 2025

ORIGINAL SCIENTIFIC PAPER

Assessing Economic Takeoff and Growth in the Arab World: An Econometric Study (1990–2023)

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ABSTRACT
Economic takeoff is a critical phase in the development of emerging economies, signifying a transition towards sustained economic growth. This study assesses the relationship between economic takeoff and economic growth in 11 Arab countries from 1990 to 2023 using econometric methods. Employing panel unit root tests, the Pedroni cointegration test, and the Fully Modified Ordinary Least Squares (FMOLS) estimation technique, the study examines the long-term equilibrium relationships between investment, capital accumulation, foreign trade, and economic growth. The findings reveal that economic takeoff is characterized by overcoming structural constraints through investment and capital formation. The study confirms that investment, capital accumulation, and trade balance positively and significantly influence economic growth, highlighting the need for policies that enhance infrastructure, financial systems, regional trade integration, and human capital development to sustain long-term economic expansion in Arab economies.

Keywords: *Economic Takeoff, Economic Growth, Arab Countries, Panel Cointegration, FMOLS Estimation*

JEL Classification: O40, O47, O53, C33, C22

INTRODUCTION

The concept of economic takeoff has been extensively studied in economic literature as a crucial phase in the transition from stagnation to sustained growth. Arab economies, despite their resource wealth, have faced structural challenges that impede their ability to achieve long-term economic resilience. Economic takeoff is not solely a matter of increased output but rather an economic transformation driven by investment, capital accumulation, technological advancements, and trade expansion.

Historically, economic takeoff has been associated with key policy reforms, industrialization, and financial system improvements that create a conducive environment for sustained growth. The Arab world presents a unique case where the interplay of natural resources, governance structures, and regional economic policies plays a significant role in determining the trajectory of economic development. While some countries have leveraged oil revenues to invest in

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infrastructure and human capital, others have struggled with political instability, economic mismanagement, and insufficient diversification strategies.

A deeper understanding of the mechanisms underlying economic takeoff is essential for policymakers seeking to formulate effective development strategies. This study investigates whether Arab economies exhibit a long-run equilibrium relationship between economic takeoff and growth determinants such as investment, capital accumulation, and trade openness. By identifying these relationships, the research aims to provide empirical evidence that can inform policy measures designed to sustain economic momentum and prevent growth stagnation.

To achieve these objectives, this study employs robust econometric techniques, including panel cointegration analysis and the Fully Modified Ordinary Least Squares (FMOLS) estimation method. These techniques allow for a comprehensive examination of economic dynamics, ensuring that the findings are not only statistically significant but also relevant for long-term policymaking. Through this approach, the study contributes to the broader discourse on economic takeoff, offering insights into how Arab countries can enhance their economic structures to achieve sustainable growth.

The primary objectives of this study are as follows:

- To analyze the determinants of economic takeoff and its long-run relationship with economic growth in Arab countries.
- To assess the role of investment, capital accumulation, and foreign trade in driving economic expansion.
- To determine whether economic growth in the Arab world is constrained by structural factors or facilitated by policy-driven interventions.
- To employ advanced econometric techniques to ensure the robustness and reliability of findings, particularly in assessing stationarity, cointegration, and long-run equilibrium relationships.
- To provide policy recommendations that support sustainable economic takeoff and growth in Arab economies.

LITERATURE REVIEW OF THE IMPACT OF ECONOMIC TAKEOFF ON ECONOMIC GROWTH

The concept of economic take-off refers to the critical phase in a country's development when it transitions from stagnation to sustained economic growth. Rooted in classical development theory, this notion was first formalized by Rostow (1960), who described take-off as the stage where investment rates, industrialization, and institutional modernization converge to launch self-sustaining growth. While economic growth denotes a continuous increase in a nation's output over time, often measured by GDP per capita, economic take-off is characterized by its catalytic nature: it marks a structural transformation rather than mere quantitative expansion (Lucas, 1988; Romer, 1990). Economic growth can persist without a genuine take-off, particularly in economies driven by extractive institutions or transient commodity booms (Acemoglu & Robinson, 2006). In contrast, take-off implies a durable shift underpinned by technological innovation, human capital accumulation, and institutional reform (Barro, 1991; Levine & Renelt, 1992). This distinction is crucial in the development literature, as it underlines the role of initial conditions and policy choices in enabling countries to escape the "poverty trap" and converge toward higher-income trajectories (Hausmann, Rodrik, & Velasco, 2005; Sachs, 2005).

Against this theoretical backdrop, the empirical literature has devoted considerable attention to understanding how various structural and policy-related factors facilitate or hinder a country's economic take-off and subsequent growth. Key areas of focus include total factor productivity (TFP), foreign direct investment (FDI), institutional quality, infrastructure development, and financial sector deepening. These elements are frequently cited as catalysts that enable economies to transition from low-growth equilibria to high-growth paths. Accordingly, this literature review draws upon influential contributions from both theoretical and empirical studies, aiming to elucidate the pathways through which these factors affect economic performance and to uncover areas where further research is needed to close persistent knowledge gaps.

To begin with, Koopman and Wacker (2023) underscore the dominant role of TFP in growth accelerations, attributing 90% of growth to productivity-enhancing reforms, while capital accumulation contributes only 9%. Their findings challenge traditional neoclassical convergence models, advocating for technological adoption and structural changes over investment-driven strategies. However, they overlook sectoral heterogeneities, especially in capital-scarce economies, necessitating further exploration of how micro-level constraints influence macroeconomic productivity.

Building on the discussion of growth determinants, debt sustainability emerges as another critical factor. Agyeman et al. (2022) demonstrate that external debt and capital flight jointly suppress growth in Sub-Saharan Africa, with their interaction exacerbating negative effects. Their dynamic GMM approach effectively isolates these impacts but does not account for institutional mechanisms such as governance reforms that could mitigate fiscal leakages. This suggests that economic takeoff strategies must integrate debt sustainability with anti-corruption measures to enhance long-term growth.

Closely related to these financial constraints is the interplay between FDI, urbanization, and energy usage. Voumik et al. (2023) identify a cointegration relationship among these variables in Australia, finding that urbanization reduces long-run energy demand. However, this finding is less applicable to developing economies, where rapid urbanization often overburdens infrastructure. Similarly, Hossain et al. (2024) highlight the negative impact of geopolitical risk (GPR) on FDI in Southeast Asia, although GDP growth somewhat counterbalances this effect. These findings emphasize the need for economic launch strategies to focus on macroeconomic stability and geopolitical risk management.

A broader perspective on FDI is provided by Banday et al. (2021), who confirm bidirectional causality between FDI and growth in BRICS nations, but their ARDL model overlooks sectoral differences. Emako et al. (2022) further illustrate that manufacturing FDI has positive growth effects in developing economies, while service FDI often crowds out domestic firms. Additionally, Saidi and Ochi (2023) identify a governance threshold for FDI to positively impact growth, yet their PTR model does not consider sectoral dynamics. These insights underscore the need for sector-specific FDI incentives and governance frameworks tailored to the institutional contexts of developing economies.

Trade policies also play a significant role in economic takeoff. Naito (2022) shows that larger economies set lower tariffs due to welfare costs, yet this endogenous growth model does not apply to developing economies where protective tariffs may still be necessary for fostering infant industries. This is echoed by Sekine (2022), who highlights a 20 trillion-yen gap between Gross Domestic Income (GDI) and GDP in Japan, advocating for independent GDI estimation. However, this focus on advanced economies marginalizes developing contexts where measurement inaccuracies can distort policy targeting.

In addition to trade and investment, infrastructure development remains a cornerstone of economic takeoff. Palei (2015) links infrastructure development to competitiveness but notes that institutional weaknesses, such as corruption, limit returns. Meka'aa et al. (2024) find that energy infrastructure investment in Cameroon positively influences growth, while telecom investment can crowd out private capital. Similarly, Traoré (2022) underscores the significance of transport infrastructure in Mali's growth trajectory, while Ismail and Mahyideen (2015) demonstrate that ports and ICT infrastructure enhance Asian trade. Furthermore, Agu et al. (2022) emphasize the predictive accuracy of Principal Component Regression (PCR) for GDP forecasting in Nigeria, advocating for machine learning as a key tool in economic takeoff diagnostics. These findings call for a more strategic approach to infrastructure investment, ensuring alignment with governance reforms and technological advancements to maximize economic impact.

Turning to financial development, Qayyum et al. (2025) reveal that financial innovation dampens long-term growth in India and China due to globalization pressures. Jie and Lan (2024) show that financial development mediates the energy-growth link in China, suggesting that economic policies should align financial sector growth with broader sustainability objectives. Ullah et al. (2024) further demonstrate that regulatory quality stabilizes financial development-growth links in developed nations but stifles growth in developing ones, indicating a need for calibrated regulatory frameworks.

Beyond financial factors, demographic and social dimensions also influence economic takeoff. Temsumrit (2023) finds that an aging population increases social spending while reducing education budgets, hindering long-term growth. Similarly, Alfalih (2024) confirms that oil price thresholds affect employment levels in Saudi Arabia, advocating for economic diversification. Khana et al. (2023) highlight that natural disasters disproportionately impact low-income countries, with FDI and infrastructure investment serving as mitigating factors. Moreover, Vishandass (2022) links inclusive growth to equity, skills, and institutions, emphasizing the importance of social policies in economic takeoff. These insights suggest that economic takeoff strategies must account for demographic transitions, fiscal sustainability, and disaster resilience.

Equally important, education and human capital remain vital drivers of sustained economic growth. Hanushek (2013) argues that cognitive skills drive economic growth more than schooling duration, calling for a shift toward education quality improvements. Grant (2017) finds that secondary education yields significant growth returns in low-income countries, reinforcing the need for targeted educational investments. Similarly, Maccelli and van Leeuwen (2025) examine Italy's skill shifts from deskilling (industrialization) to polarization (ICT), urging education-technology alignment in economic takeoff strategies. Additionally, Pakrashi and Frijters (2017) define takeoffs as sustained growth exceeding the U.S., emphasizing policy-driven structural change as a core economic launch pillar.

Entrepreneurship and innovation also play a fundamental role in economic takeoff. Acs (2006) distinguishes between opportunity entrepreneurship, which fosters innovation and growth, and necessity entrepreneurship, which often fails to drive economic takeoff. Gibson et al. (2013) advocate for community economies to support equitable growth, while Doran et al. (2018) highlight how entrepreneurial attitudes boost growth in developed economies but hinder it in developing ones due to resource constraints. Tellis et al. (2003) further show that cultural traits influence innovation adoption, suggesting that economic takeoff policies must consider cultural dimensions when designing innovation-driven strategies.

Finally, historical perspectives provide additional depth to the understanding of economic takeoff. Rostow (1956) and Smith (1960) debate the investment-sectoral-institutional trinity of economic takeoff, emphasizing the need for stage-specific policies. Ismail and Mahyideen (2015) reinforce this by linking trade infrastructure improvements to growth, while Meka'aa et al. (2024) highlight the importance of channeling investments into high-return sectors. These historical and contemporary insights continue to shape discussions on economic takeoff strategies.

In conclusion, the literature highlights the multifaceted nature of economic takeoff, with TFP, FDI, governance, infrastructure, financial development, education, and entrepreneurship all playing critical roles. While the literature provides valuable insights into the drivers of economic take-off, it often overlooks sectoral heterogeneity, institutional constraints, and the interplay between key growth factors. This paper addresses these gaps by empirically analyzing the combined effects of investment, capital accumulation, and trade balance on economic growth, offering a more integrated perspective tailored to developing economies.

METHODOLOGY

This study examines the economic takeoff process in the Arab world using a general econometric framework. It adopts a panel data approach to assess long-term trends in economic growth and identify key drivers influencing this transition. By analyzing data over multiple decades, the study seeks to capture both cyclical and structural patterns that shape economic performance in the region.

The research is based on a broad sample of Arab economies, ensuring that findings are representative of diverse economic structures. The study considers various macroeconomic indicators, including investment, capital accumulation, and trade performance, to evaluate their role in supporting economic takeoff. The data is sourced from credible international databases to ensure accuracy and consistency.

To examine the relationship between economic takeoff and growth, the study applies widely used econometric techniques. Specifically, it utilizes panel data methods, cointegration analysis, and regression techniques to explore long-run relationships between economic variables. The methodology incorporates unit root tests to assess stationarity and cointegration tests to determine whether long-term equilibrium relationships exist among the variables. The Fully Modified Ordinary Least Squares (FMOLS) method is employed to obtain reliable coefficient estimates while addressing potential endogeneity concerns. FMOLS is preferred over other panel estimators such as Dynamic Ordinary Least Squares (DOLS) or Generalized Method of Moments (GMM) because it corrects for serial correlation and endogeneity in cointegrated panels without requiring additional instrumental variables or dynamic specifications, making it especially suitable for studies focused on long-run equilibrium relationships in heterogeneous panels.

In conducting the analysis, emphasis is placed on ensuring methodological rigor. The study employs appropriate statistical techniques to validate findings and ensure robustness. Sensitivity tests and model validation techniques are used to confirm the reliability of the results. By adopting a structured and systematic approach, the research aims to contribute to policy discussions on economic development and offer insights into strategies for fostering sustainable growth in Arab economies.

While this section provides an overview of the study's methodological framework, detailed econometric modeling and statistical results are presented in the subsequent econometric study section. This ensures a focused discussion on both the theoretical foundation and empirical validation of the findings, enhancing the clarity and applicability of the research outcomes.

Methodology and Tools

This study examines the effect of key economic takeoff requirements on economic growth in Arab countries using econometric methods, particularly dynamic panel models. The analysis employs both the Pedroni residual cointegration test and the Johansen-Fisher panel cointegration rank test to identify and validate long-run equilibrium relationships among the study variables. While the Pedroni test confirms cointegration across dimensions, the Johansen-Fisher test additionally determines the number of cointegrating vectors, which supports the presence of a single long-run relationship.

Sample, Period, and Data Sources

The study utilizes a sample of 11 Arab countries from North Africa (Algeria, Egypt, Tunisia, Morocco, Mauritania) and Asia (Saudi Arabia, United Arab Emirates, Bahrain, Kuwait, Oman, Jordan, Lebanon). The analysis covers the period from 1990 to 2023, selected based on data availability for all sampled countries. All data were obtained from the World Bank.

Study Model

This study considers economic growth as the dependent variable, while the independent variables include investment, the financial system, and foreign trade:

$LY = F(LX_1, LX_2, LX_3)$

Where:
- (LY): The Logarithm of economic growth, represented by Gross Domestic Product (GDP)
- **(**LX_1**)**: The logarithm of investment, the first independent variable, is a key determinant of economic growth. Empirical evidence suggests that investment has been the primary driver of growth in emerging economies over the past decades (Mankiw & Romer, 1992). This aligns with Young's (1995) study on East Asian economies, which emphasizes capital accumulation as a fundamental mechanism in the catch-up theory of economic development.
- **(**LX_2): The financial system, represented by the logarithm of capital accumulation, serves as a fundamental driver of investment projects designed to enhance productive capacity. The effectiveness of financial policies plays a crucial role in shaping capital accumulation, either facilitating or constraining investment dynamics (Bouharb & Belkharchouche, 2021).
- (LX_3): Foreign trade, measured by the logarithm of the trade balance, plays a pivotal role in economic growth by facilitating access to technological advancements from developed countries. This occurs through the importation of capital goods and exposure to innovative products in global markets, fostering productivity and competitiveness (Berthélemy & Söderling, 1999).

Accordingly, the model can be summarized as follows:

Log(GDP)=f(Log(investment), Log (capital accumulation), Log (trade balance))

Where:
- **Log GDP**: Natural logarithm of real GDP (economic growth proxy);
- **Log investment**: Natural logarithm of gross capital formation;
- **Log capital accumulation**: Natural logarithm of capital stock (proxy for the financial system);
- **Log trade Balance**: Natural logarithm of net exports (foreign trade).

Unit Root Tests

Before estimating the dynamic panel model, it is essential to verify the stationarity properties of the variables involved. This ensures that spurious regression results are avoided and that the underlying time series are suitable for cointegration analysis. To this end, various panel unit root tests are available. In this study, the Levin, Lin & Chu (LLC, 2002) test, the Breitung test (2002), the Im, Pesaran & Shin (IPS, 2003) test, along with the Fisher-type tests based on ADF and PP statistics, are employed. These tests are among the most widely accepted methods for evaluating stationarity in panel datasets and provide robust and consistent results.

Following confirmation of the integration order, the Pedroni residual cointegration test is applied to assess the presence of a long-run equilibrium relationship among the variables. In addition, the Johansen-Fisher panel cointegration rank test is used to determine the number of cointegrating vectors, offering deeper insight into the nature and dimensionality of the long-term associations.

Finally, to capture short-run dynamics and the speed of adjustment toward long-run equilibrium, the study estimates a Vector Error Correction Model (VECM) based on the Fully Modified Ordinary Least Squares (FMOLS) method. This FMOLS-VECM framework integrates both long-run relationships and short-run fluctuations, thereby providing a comprehensive picture of the underlying economic processes.

Pedroni Residual Cointegration Test

Similar to unit root tests, panel cointegration tests offer more reliable results than individual tests. Building on the Engle-Granger (EG) individual cointegration framework, Pedroni developed a comprehensive panel cointegration test based on estimated residuals. Pedroni's methodology derives seven test statistics, categorized into two groups: the first group assumes common autoregressive parameters ("within-dimension"), while the second allows for individual autoregressive parameters ("between-dimension") (Mitić, Munitlak Ivanović, & Zdravković, 2017). This approach enhances the robustness of cointegration analysis in panel data settings.

The following equation serves as the foundation for Pedroni's panel cointegration test:

$$y_{i,t} = \beta_i' x_{i,t} + \alpha_i + \delta_{i,t} + \varepsilon_{i,t} \tag{1}$$

where:
- $y_{i,t}$: Dependent variable for country ***i*** at time ***t.***
- $\boldsymbol{\alpha_i}$: Country-specific fixed effect.
- $\boldsymbol{\delta^*_{i,t}}$: Time trend for country i.
- $\boldsymbol{\beta_i}$: Long-run elasticity coefficient.
- $\boldsymbol{x_{it}}$: Vector of explanatory variables.
- $\boldsymbol{\varepsilon_{it}}$: Cointegration residual.
- $x_{i,t}$The independent variable, or more generally, the array of independent variables, plays a crucial role in determining the model's explanatory power and robustness:
- $x_{i,t} = x_{i,t-1} + \varepsilon_{i,t}$ (Carlsson, Lyhagen, & Österholm, 2007, p. 8).

Consistent with the EG procedure, the cointegration test relies on auxiliary regressions of residuals derived from Equation (1). The test specification depends on parameter assumptions, with two distinct test types: a semi-parametric test represented by Equation (2) and a parametric test represented by Equation (3):

$$\hat{\varepsilon}_{i,t} = \rho_i \hat{\varepsilon}_{i,t-1} + \mu_{i,t} \tag{2}$$

where:
- $\boldsymbol{\hat{\varepsilon}_{i,t}}$***:*** Error term from cointegration regression.
- $\boldsymbol{\rho_i}$***:*** Autoregressive parameter for country i.
- $\boldsymbol{\hat{\varepsilon}_{i,t-1}}$: Lagged residual term.
- $\mu_{i,t}$***:*** White noise error.

$$\hat{\varepsilon}_{i,t} = \rho_i \hat{\varepsilon}_{i,t-1} + \sum \emptyset_{ip}\, \rho_i \Delta\hat{\varepsilon}_{i,t-p} + \mu^*_{i,t} \tag{3}$$

where:
- $\hat{\varepsilon}_{i,t}$: Residual from the cointegration regression for unit **i** at time **t**.
- ρ_i: Autoregressive coefficient indicating persistence of the residual.
- $\hat{\varepsilon}_{i,t-1}$: One-period lag of the residual term.
- $\sum \emptyset_{ip}\, \rho_i \Delta\hat{\varepsilon}_{i,t-p}$***:*** Summation over **p** lags of the first-differenced residuals, capturing short-run dynamics.
- $\emptyset_{ip}$: Coefficients associated with each lag **p**.
- $\Delta\hat{\varepsilon}_{i,t-p}$: First difference of the residual lagged by **p** periods: **(**$\hat{\varepsilon}_{i,t}, \rho\hat{\varepsilon}_{i,t-1}$**).**
- $\mu^*_{i,t}$: White noise disturbance term.
- p: Lag order of the augmentation.

The cointegration test statistics are as follows:

Panel v-Statistic $Z_{\hat{v}NT} = \left(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{\varepsilon}_{i,t-1}^{2}\right)^{-1}$

Panel rho-Statistic $Z_{\hat{\rho}NT-1} = \left(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{\varepsilon}_{i,t-1}^{2}\right)^{-1}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{\varepsilon}_{i,t-1}^{2}\Delta\hat{\varepsilon}_{i,t-1}^{2} - \hat{\lambda}_i$

Panel PP-Statistic (semi-parametric)

$$Z_{tNT-1} = \left(\tilde{\sigma}_{NT}^{2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{\varepsilon}_{i,t-1}^{2}\right)^{-1/2}\sum_{i=1}^{N}\sum_{t=1}^{T}\left(\hat{\varepsilon}_{i,t-1}^{2}\Delta\hat{\varepsilon}_{i,t-1}^{2} - \hat{\lambda}_i\right)$$

Panel ADF-Statistic (parametric)

$$Z_{tNT}^{*} = \left(\tilde{\sigma}_{NT}^{*2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{\varepsilon}_{i,t-1}^{2}\right)^{-1/2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{\varepsilon}_{i,t-1}^{2}\Delta\hat{\varepsilon}_{i,t-1}^{2}$$

Group rho-Statistic $\tilde{Z}_{\hat{\rho}NT-1} = \sum_{i=1}^{N}\left[\left(\sum_{t=1}^{T}\hat{\varepsilon}_{i,t-1}^{2}\right)\sum_{t=1}^{T}\left(\hat{\varepsilon}_{i,t-1}^{2}\Delta\hat{\varepsilon}_{i,t-1}^{2} - \hat{\lambda}_i\right)\right]$

Group PP-Statistic (semi-parametric) $\tilde{Z}_{tNT} = \sum_{i=1}^{N}\left[\left(\tilde{\sigma}_i^{2}\sum_{t=1}^{T}\hat{\varepsilon}_{i,t-1}^{2}\right)^{-1/2}\sum_{t=1}^{T}\left(\hat{\varepsilon}_{i,t-1}^{2}\Delta\hat{\varepsilon}_{i,t-1}^{2} - \hat{\lambda}_i\right)\right]$

Group ADF-Statistic (parametric) $Z_{tNT}^{*} = \sum_{i=1}^{N}\left[\left(\tilde{\sigma}_i^{*2}\sum_{t=1}^{T}\hat{\varepsilon}_{i,t-1}^{2}\right)^{-1/2}\sum_{t=1}^{T}\left(\hat{\varepsilon}_{i,t-1}^{2}\Delta\hat{\varepsilon}_{i,t-1}^{2}\right)\right]$

Ultimately, all Pedroni test statistics converge to a normal distribution, allowing the use of the following hypothesis (Mitic et al, 2017):

Common autoregressive parameter (within-dimension) $\begin{cases} H_0: \rho_i = 1 \\ H_1: \rho_i = \rho < 1 \end{cases}$

Individual autoregressive parameter (between-dimension) $\begin{cases} H_0: \rho_i = 1 \\ H_1: \rho_i = \rho_i < 1 \end{cases}$

Presenting the FMOLS Estimation Method

To estimate this model, the FMOLS (Fully Modified Ordinary Least Squares) method is employed. Originally introduced and developed by Phillips and Hansen (1990), this method is designed to estimate a first-degree cointegration relationship among variable series (I(1)). The FMOLS approach ensures more reliable estimates, particularly in small sample sizes (Bashier & Jaser Siam, 2014).

The method was later reformulated by Pedroni (2000). It relies on the asymptotic properties of adjusted-FM residuals, focusing on data integration through the within-dimension. For data integration based on the between-dimension, the Group-FM estimator is applied.

The FMOLS (Fully Modified Ordinary Least Squares) estimation method provides consistent parameter estimates that asymptotically follow a standard normal distribution, enhancing its robustness. This approach is particularly effective in addressing endogeneity in explanatory variables, serial correlation in errors, and potential heteroskedasticity in long-run parameters.

Additionally, FMOLS delivers unbiased estimators with minimal variance (Laacab, 2015).

The estimator can be expressed as follows:

$$\hat{\beta}_{NT} = \left(\sum_{i=1}^{N}\sum_{t=1}^{T}(x_{i,t} - \bar{x}_i)^2\right)^{-1}\sum_{i=1}^{N}(x_{i,t} - \bar{x}_i)(y_{i,t} - \bar{y}_i)$$

The FMOLS estimator is presented as a modified version of the OLS estimator as follows:

$$\hat{\beta}_{FM} = \left(\sum_{i=1}^{N}\hat{L}_{22i}^{-1}\sum_{t=1}^{T}(x_{i,t} - \bar{x}_i)^2\right)^{-1}\sum_{i=1}^{N}\hat{L}_{11i}^{-1}\hat{L}_{22i}^{-1}\sum_{t=1}^{T}(x_{i,t} - \bar{x}_i)y_{i,t}^{*} - T\hat{\delta}_i$$

Where: $y_{i,t}^{*} = (y_{i,t} - \bar{y}_i) - \left(\frac{\hat{L}_{21i}}{\hat{L}_{22i}}\right)\Delta x_{i,t} + \left(\frac{\hat{L}_{21i} - \hat{L}_{22i}}{\hat{L}_{22i}}\right)\beta(x_{i,t} - \bar{x}_i)$

$\hat{\delta}_i \equiv \hat{\Gamma}_{21i} + \hat{\Omega}_{21i}^{0} - \left(\frac{\hat{L}_{21i}}{\hat{L}_{22i}}\right)(\hat{\Gamma}_{21i} + \hat{\Omega}_{21i}^{0})$

Where:
- $\boldsymbol{\hat{\beta}_{FM}}$: Fully Modified OLS estimator of the long-run coefficient vector.
- $\boldsymbol{x_{it}^{*}}$: Transformed regressor for unit i at time t, corrected for serial correlation and endogeneity.
- $\boldsymbol{x_{it}^{*}}'$: Transpose of the transformed regressor.
- $\boldsymbol{y_{it}^{*}}$: Transformed dependent variable (e.g., GDP), also corrected for serial correlation.
- $\sum_{\boldsymbol{i}}\sum_{\boldsymbol{t}}$: Double summation over countries (i = 1 to N) and time (t = 1 to T).
- $[\ ]^{-1}$: Matrix inverse.

The FMOLS estimator for panel data is obtained by estimating the following regression (Mitić, Munitlak Ivanović, & Zdravković, 2017):

$$y_{i,t} = \beta_i' x_{i,t} + \sum_{j=-q}^{q}\varepsilon_{ij}\Delta x_{i,t+j} + \gamma_{li}' D_{li} + \varepsilon_{i,t}$$

Where:
- $\boldsymbol{y_{it}}$: Dependent variable for unit i at time t (e.g., log of GDP).
- $\boldsymbol{x_{it}}$: Independent variable(s) (e.g., investment, capital accumulation, trade balance).
- $\boldsymbol{\beta}$: Long-run slope coefficient.
- $\sum_{\boldsymbol{j=-q}}^{\boldsymbol{q}}\boldsymbol{\varepsilon_{ij}\Delta x_{i,t+j}}$: This summation includes the leads and lags of the first differences of the independent variables x.
- $\Delta x_{i,t+j}$: denotes the first difference of x at time t+j.
- $\boldsymbol{\varepsilon_{it}}$: Residual term (cointegration error).
- $\boldsymbol{\gamma_{li}'}$: Coefficients corresponding to the deterministic terms D_{li}
- D_{li} : Vector of deterministic terms or time dummy variables for unit i.

RESULTS AND DISCUSSION

This section presents the empirical results. It begins with unit root tests to verify stationarity, followed by cointegration analysis using Pedroni and Johansen-Fisher tests. The long-run relationships are estimated using FMOLS, and short-run dynamics are captured through an FMOLS-based VECM model.

Panel Unit Root Tests

This part presents the results of five-panel unit root tests (LLC, Breitung, IPS, Fisher-ADF, and Fisher-PP), as shown in Table 2. The results indicate that all variables become stationary after first differencing, confirming they are integrated of order one, I(1).

Table 1. Results of Breitung, IPS, ADF-Fisher, PP-Fisher, and LLC tests for variables' stationarity

	LLC	Breitung	IPS	ADF-fisher	PP- fisher
LY	LEVEL				
	-5. 3820	1.9597	-2.8778	79.6548	15.6474
	(0.000)***	(0.9685)	(0.0057)***	(0.000)***	(0.8633)
	1st Difference				
	-0.9784	-3.5065	-3.3387	52.2820	95.8912
	(0.1639)	(0.000)***	(0.0004)***	(0.000)***	(0.000)***
LX_1	LEVEL				
	2.3141	0.8948	1.0173	17.7080	40.2928
	(0.9897)	(0.8146)	(0.8455)	(0.8169)	(0.0199)**
	1st Difference				
	-0.48072	-2.1042	-3.9766	58.0598	378.171
	(0.3154)	(0.0177)**	(0.0000)***	(0.000)***	(0.000)***
LX_2	LEVEL				
	1.2271	1.4412	-0.0789	28.0775	279.696
	(0.8901)	(0.9253)	(0.4686)	(0.2568)	(0.000)***
	1st Difference				
	-3.7666	-2.1800	-5.2082	70.2178	366.538
	(0.00)***	(0.0146)**	(0.000)***	(0.000)***	(0.00)***
LX_3	LEVEL				
	1.8994	1.2602	-0.07807	27.0806	27.4451
	(0.9712)	(0.8962)	(0.4689)	(0.3007)	(0.2841)
	1st Difference				
	-3.1305	0.3840	-4.1304	62.0237	207.797
	(0.000)***	(0.6495)	(0.0000)***	(0.000)***	(0.00)***

Values in parentheses (***) (**) are statistically significant at the 1% and 5% levels, respectively.

Source: Computed by the authors using EViews 12 software outputs.

The table above presents the results of various panel unit root tests (Breitung, LLC, IPS, ADF-Fisher, PP-Fisher) applied at the level and first difference. At level, the p-values for most tests across all variables (LY, LX1, LX2, LX3) exceed the 0.05 threshold, indicating failure to reject the null hypothesis of a unit root. Therefore, the variables appear to be non-stationary in level. However, when the tests are applied to the first differences, the p-values are consistently below 0.05 for nearly all test statistics, except for a few cases, such as the Breitung test for LY and LX3. These results provide strong evidence against the null hypothesis, confirming that the series become stationary after first differencing. Hence, the variables are integrated of order one, (1).

Cointegration Rank Determination: Johansen-Fisher Panel Test

Table 2. Generalized Results of Johansen-Fisher Panel Cointegration Rank Test

Hypothesized No. of CE(s)	Fisher Stat (Trace)	Prob.	Fisher Stat (Max-Eigen)	Prob.
None	61.85	0.000	39.21	0.000
At most 1	46.17	0.024	25.80	0.043
At most 2	13.02	0.326	9.83	0.447
At most 3	5.77	0.680	5.77	0.680

Source: Computed by the authors using EViews 12 software outputs.

The Johansen-Fisher panel cointegration test results reveal statistically significant evidence of cointegration. Specifically, the null hypothesis of no cointegrating relationship (rank = 0) is rejected at the 1% significance level, while the null of at most one cointegrating vector (rank ≤ 1) is rejected at the 5% level, but not at the 1% level. Although the hypotheses of at most two cointegrating relationships cannot be rejected, given the theoretical findings from the previous literature, we opt for a single normalized cointegrating vector between growth, investment, capital accumulation, and trade balance.

Panel Cointegration Analysis

The Pedroni and Johansen-Fisher tests confirm the presence of a stable long-run relationship among the variables.

Table 3. Results of Pedroni Residual Cointegration Test

Prob	**Statistic**	
Cointegrating regression parameter (within-dimension)		
(0.0000)***	Panel v-Statistic	11.0317
(0.7817)	Panel rho-Statistic	0.7778
(0.0070)***	Panel PP-Statistic	-2.4553
(0.0007)***	Panel ADF-Statistic	-3.1876
Individual autoregressive parameter (between-dimension)		
(0.9730)	up rho-Statistic	9262
(0.0387)**	up PP-Statistic	.7662
(0.0008)***	up ADF-Statistic	.1740

Values in parentheses (**) (*) are statistically significant at the 1% and 5% levels, respectively.

Source: Computed by the authors using EViews 12 software outputs.

After confirming that the variables are stationary at first difference and thus integrated of order one, the next step is to investigate the presence of a long-run equilibrium relationship among them using the Pedroni cointegration test. As shown in Table 3, most of the reported p-values are less than 0.05, particularly for the Panel PP-Statistic, Panel ADF-Statistic, Group PP-Statistic, and Group ADF-Statistic, indicating statistical significance at conventional levels. These results lead to the rejection of the null hypothesis of no cointegration for several dimensions of the test. Although the Panel v-Statistic and Group rho-Statistic yield p-values above 0.05, the overall evidence from the majority of tests supports the existence of a long-run cointegrating relationship among the study variables. Accordingly, these findings justify the use of a Vector Error Correction Model (VECM) in the subsequent analysis.

Following the confirmation of cointegration between economic growth and its key determinants, investment (LX1), capital accumulation (LX2), and trade balance (LX3), the final step involves estimating the long-run equation of the model. The results reveal a high coefficient of determination (R^2=0.97R 2 =0.97), indicating that the independent variables jointly explain 97% of the variation in economic growth (LY). This high level of goodness-of-fit reflects the strong explanatory capacity of the model.

Long-Run Estimation Using FMOLS

The normalized long-run coefficients, estimated using the FMOLS method and presented in Table 4, show that investment, capital accumulation, and trade balance have significant and positive impacts on economic growth.

Table 4. Normalized Co-integrating Vector Estimates from FMOLS Regression

Variable	Coefficient	Std. Error	t-Statistic	Significance Level
Log(Investment)	0.02199	0.00421	5.22	*** (1%)
Log(Capital Accumulation)	0.0963	0.01075	8.96	*** (1%)
Log(Trade Balance)	0.6234	0.0921	6.77	*** (1%)
Constant	0.378	0.1103	3.43	** (5%)

Source: Computed by the authors using EViews 12 software outputs.

All coefficients are statistically significant and exhibit the expected positive signs, confirming a stable long-run equilibrium relationship.

The normalized coefficients further validate the theoretical expectations, emphasizing the significant contribution of investment, capital accumulation, and trade balance to economic growth in the long run.

Short-Run Dynamics and Error Correction: FMOLS-VECM Estimation

To complement the long-run results, Table 05 presents the FMOLS-VECM estimates, capturing short-run effects and the adjustment speed toward equilibrium. The error correction term (ECT_{t-1}) reflects how quickly deviations from the long-run path are corrected.

Table 5. FMOLS-VECM Estimates: Short-Run Dynamics and Error Correction Term (1990–2023)

Variable	Coefficient	Std. Error	t-Statistic	Significance
Δ Log (Investment)	0.0087	0.0029	3.00	** (5%)
Δ Log (Capital Accumulation)	0.0154	0.0053	2.91	** (5%)
Δ Log (Trade Balance)	0.1126	0.0398	2.83	** (5%)
Error Correction Term (ECT_{t-1})	-0.3672	0.0881	-4.17	*** (1%)

Source: Computed by the authors using EViews 12 software outputs.

The results presented in Table 5 provide insights into the short-run dynamics of the model and the adjustment process toward the long-run equilibrium. All differenced explanatory variables (investment, capital accumulation, and trade balance) exhibit positive and statistically significant effects on short-run economic growth.

Notably, the coefficient of the error correction term (ECT_{t-1}) is negative (−0.3672) and significant at the 1% level. This confirms the presence of a stable long-run relationship and indicates that approximately 36.7% of any disequilibrium from the previous period is corrected in the current period.

These results reinforce the findings from the Pedroni and Johansen tests and justify the use of a cointegration framework. They also highlight that, in addition to long-run determinants, short-run adjustments play an important role in the dynamic behavior of GDP in Arab economies.

Overall, the results confirm that investment, capital accumulation, and trade balance play a significant and consistent role in explaining economic growth in the Arab region. The long-run estimates align with theoretical expectations, while the short-run dynamics further validate the stability of the model through a significant error correction mechanism. These findings highlight the importance of both sustained capital formation and external trade performance in fostering macroeconomic resilience.

CONCLUSIONS

Economic takeoff remains a crucial focus for researchers and policymakers, particularly in the context of Arab countries striving for sustainable development and long-term economic resilience. This transition is not merely an economic shift but a multidimensional process requiring coordinated efforts across governments, the private sector, and civil society. Sustained economic growth in the Arab world depends on an enabling environment that supports investment, innovation, infrastructure development, and human capital formation.

This study examined the economic takeoff in 11 Arab countries using the Fully Modified Ordinary Least Squares (FMOLS) methodology over the period 1990–2023. Panel unit root tests confirmed that the variables were non-stationary at level but became stationary after first differencing, and the Pedroni cointegration test established the existence of long-run equilibrium relationships. The results revealed statistically significant positive effects of investment, capital accumulation, and trade balance on economic growth, validating their role as key drivers of structural transformation in the region.

By integrating these core variables within a unified empirical framework and applying them to the underexplored context of Arab economies, this study offers a novel contribution to the literature on economic takeoff. Unlike prior research that tends to isolate growth determinants or focus on global samples, this paper provides region-specific insights grounded in long-run dynamics. Future research may enhance this model by incorporating variables related to governance, institutional quality, and environmental sustainability, or by exploring country-level heterogeneities and threshold effects that shape the trajectory of economic development.

Based on these findings, the following policy recommendations are proposed to support economic takeoff and long-term stability in Arab economies:

- Strengthen Infrastructure Development & Investment in Key Sectors: Focus on large-scale projects in renewable energy, transportation, and digital infrastructure to enhance productivity and attract investment.
- Diversify Economic Activity & Encourage Private Sector Growth: Broaden the economic base beyond oil by promoting investment in agriculture, industry, and services to build resilience and generate employment.
- Develop Financial Systems & Improve Financial Literacy: Expand access to finance and implement financial literacy programs to empower households and SMEs, enabling capital formation and innovation.
- Enhance Regional Trade Integration: Promote intra-Arab trade by reducing barriers, harmonizing policies, and investing in trade facilitation.
- Invest in Human Capital & Education: Align educational systems and vocational training with labor market demands to boost productivity and innovation-driven growth.

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Article history:	Received: 5.4.2025.
	Revised: 4.6.2025.
	Accepted: 18.6.2025.