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Asymmetric Effects of Oil Rent Shocks on Iran's Economic Growth: Evidence from a NARDL Approach

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ABSTRACT

This research explores how positive and negative fluctuations in oil rent impact Iran's economic performance asymmetrically over the period from 1990 to 2023, employing a Nonlinear Autoregressive Distributed Lag (NARDL) approach for analysis. Employing annual data on GDP per capita, capital stock, industrial employment, population growth, trade openness, and health expenditure, the analysis captures both long-run and short-run dynamics in this resource-dependent economy. The findings indicate a substantial long-term association between economic growth and its key drivers, where capital formation, employment in the industrial sector, and expenditures on healthcare demonstrate notable positive impacts on GDP per capita. Importantly, both increases and decreases in oil rent are found to have statistically significant and similarly sized positive long-term effects on per capita GDP, with estimated coefficients of 0.478 and 0.445 respectively. This highlights Iran's deep dependence on oil income and the dominance of a single sector within its economy. Contrastingly, in the short run, oil rent shocks of both signs exhibit negative impacts, reflecting structural inefficiencies and resource misallocations consistent with the Dutch disease phenomenon. Furthermore, the analysis shows that trade liberalization has a detrimental impact on GDP per capita in both the short and long run, with coefficients of -0.86 and -1.28 respectively, and this negative effect becomes stronger over time. The error correction term is negative and statistically significant, suggesting that the economy adjusts relatively quickly to restore long-term equilibrium after short-term disturbances. These results support the resource curse theory, implying that reliance on oil revenues undermines sustainable economic growth by distorting key sectors and economic incentives. The study recommends policy measures aimed at reducing oil dependency through institutional reforms, strengthening fiscal shock absorbers such as the National Development Fund, diversifying the tax base, and prioritizing public investments in productive sectors like agriculture and manufacturing. Implementing these strategies is essential for fostering a resilient and diversified economy capable of withstanding global oil price volatility.

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1. Introduction

Iran's economy is significantly shaped by its reliance on oil revenues, which are crucial for economic growth, fiscal policy, and long-term development strategies. As one of the top oil producers globally, possessing extensive proven reserves (OPEC, 2023), Iran's macroeconomic stability closely aligns with shifts in global oil prices and wider geopolitical factors (Farzanegan & Markwardt, 2009). According to OPEC (2023), Iran produced an average of 2.5 million barrels of oil per day in 2022, with oil exports accounting for approximately 75% of total export earnings, or around $48 billion. Moreover, oil contributes roughly 25% to Iran's GDP and nearly 55% of government budget revenues (Central Bank of Iran, 2023; World Bank, 2024). This deep dependence on oil revenues in oil-producing countries has fueled persistent macroeconomic instability, exemplified by phenomena such as Dutch disease and the resource curse (Ologunde *et al.*, 2020). Mohaddes & Pesaran (2013) report a negative correlation between oil price shocks and non-oil GDP growth, largely driven by real exchange rate appreciation that weakens the competitiveness of non-oil sectors (Alabdulwahab, 2021).

The connection between oil prices and gross domestic product (GDP) has been widely examined by economists, particularly since the 1970s. Findings in this area are inconsistent, with some studies reporting a substantial influence of oil prices on GDP (Ftiti *et al.*, 2016; Baek & Young, 2021), while others observe only a limited effect (Khan *et al.*, 2021). According to Moghaddam and Lloyd-Ellis (2022), one explanation for these divergent results is the failure of many analyses to distinguish between oil-exporting and oil-importing nations. This lack of differentiation may mask critical variations-particularly because increases in oil prices tend to benefit the economies of exporting countries while harming those that rely on imports (Kriskkumar & Naseem, 2019). Oil rent, defined as the surplus between the market price of oil and its extraction and distribution costs, plays a pivotal role in shaping economic growth in resource-rich nations like Iran (Chevalier, 1975). Although oil rents can potentially enhance economic prosperity, their impact on sustainable growth remains a topic of debate. Research indicates a complex dynamic in which resource wealth may either promote development or lead to negative economic effects, including the Dutch disease and rent-seeking behavior (Dekker & Missemer, 2024). For instance, Iran's industrial and agricultural sectors contributed only 14.2% and 8.7% to GDP, respectively, in 2023, reflecting the crowding-out effect of oil dependency (Statistical Center of Iran, 2024). Such structural imbalances frequently lead to an overreliance on the oil industry, hinder efforts toward economic diversification, and intensify both environmental degradation and social challenges (Adeola *et al.*, 2022). Consequently, grasping the relationship between oil rents and economic performance is essential for policymakers focused on fostering economic resilience, encouraging sectoral diversification, and mitigating the risks tied to resource dependency (Jafari & Faghihi, 2024). The paradox of sluggish economic growth in oil-rich nations, despite substantial foreign exchange revenues, presents an intriguing case in developmental economics. Some economists contend that reliance on the export of primary commodities, notably crude oil, results in an unfavorable division of labor and ultimately lower living standards when compared to industrialized sectors (Shahbaz *et al.*, 2019). Concurrently, others posit that government mismanagement of oil revenues, coupled with restrictive trade policies, exacerbates stagnation (Zheng *et al.*, 2023). Moreover, challenges such as rent-seeking behavior, inefficient resource allocation, and diminished productivity further impede economic advancement (Hou *et al.*, 2023). Economic growth is a multi-layered, intricate process that involves more than just increases in GDP; it also encompasses improvements in human capital, labor market dynamics, and productive investments. In resource-abundant nations like Iran, oil revenues play a crucial role in government funding and the overall GDP. Nonetheless, the extent to which these oil proceeds contribute to sustainable economic growth remains a debated issue (Rahim *et al.*, 2021). Recent studies suggest that revenues from natural resources can influence economic outcomes through various channels, particularly in health, employment, and investment sectors (Go *et al.*, 2016). Health metrics are directly linked to productivity and human capital accumulation, both of which are vital for long-term economic growth. Additionally, job creation not only affects income distribution but also strengthens aggregate demand and fosters social cohesion (Barro, 2013). Investment in physical and infrastructure capital is essential for enhancing production capacity and encouraging technological advancements. It is important to examine how oil revenues interact with health, employment, and investment to formulate policies that optimize resource wealth utilization, ultimately promoting inclusive and sustainable economic growth. Grasping these connections is key to developing strategies that harness oil revenues for productive purposes, rather than relying on them solely as financial resources (Karimu *et al.*, 2017). Recent empirical studies have emphasized the asymmetric impacts of oil price volatility on key macroeconomic variables, especially in economies heavily reliant on natural resources, like Iran. In contrast to symmetric models that assume consistent economic responses to both increases and decreases in oil prices, growing evidence suggests that these movements produce different effects on economic output, financial stability, investment decisions, and the overall capacity to withstand economic shocks (Kriskkumar *et al.*, 2022).

The remainder of this paper is structured as follows: Section 2 Theoretical literature, Section 3 outlines the methodology and data sources. Section 4 describes the dataset used in the analysis. Section 5 presents the empirical results, and Section 6 provides the main conclusions.

2. Theoretical literature

Positive oil shocks often precipitate income booms; however, these windfalls may not be directed towards productive investment due to structural inefficiencies. Conversely, negative oil price shocks typically result in austerity measures, currency devaluation, and a contraction in public investment. This divergence underscores the critical need for implementing countercyclical fiscal policies, enhancing institutional frameworks, and fostering economic diversification to alleviate the adverse effects associated with oil price volatility (Aimer & Lusta, 2021). For policymakers in oil-exporting nations, grasping these nonlinear dynamics is indispensable for constructing sustainable and resilient economic systems. The disproportionate impact of oil price swings, whether upward or downward, on macroeconomic performance further intensifies the urgency for strategic interventions in response to these asymmetries (Fakhreddine *et al.*, 2024). Numerous studies have explored the link between oil rents and economic growth, revealing complex and context-dependent effects shaped by institutional quality, governance, and economic structure (Difiglio, 2014; Osintseva *et al.*, 2022). Oil revenues can either promote or hinder growth depending on factors such as policy frameworks and trade openness. For example, in Indonesia, oil rents do not directly reduce growth but negatively affect it indirectly by weakening institutions, highlighting the mediating role of governance in the resource curse phenomenon (Saraswati, 2013). In contrast, research focusing on sub-Saharan Africa indicates that both oil and natural gas rents exert a negative influence on economic growth, whereas forest rents contribute positively to economic outcomes (Ofori & Grechyna, 2021). In Saudi Arabia, fluctuations in domestic oil demand and changes in oil prices significantly affect inflation, unemployment, and ultimately economic growth, forcing the government to adopt austerity responses to maintain economic stability (Al-Sasi *et al.*, 2017). In sub-Saharan oil-exporting countries, oil price volatility significantly boosts economic growth, while non-oil exporters see a positive but statistically insignificant effect (Akinlo & Apanisile, 2015). Oil rents negatively impact economic development in the Congo, largely due to over-reliance on oil revenues, weak governance, and corruption, suggesting that resource wealth can be a source of vulnerability rather than growth (Edwig, 2020; Mbingui *et al.*, 2021). In contrast, in Algeria, a positive long-term relationship was observed between oil and gas rents and economic growth, driven by strategic allocation and monitoring of resource revenues alongside economic diversification efforts (Siham and Esmahi, 2014). Adabor and Buabeng (2021) found that a 1% rise in oil resource rent boosts Ghana's long-term economic growth by 0.84%. However, their study showed only a marginal, statistically insignificant short-term effect during the examined period. In a recent study, Belloumi and Almashyakhi (2025) investigated how natural resource rents and institutional quality influence economic growth in twelve oil-rich MENA countries over the period 2002–2021. Their findings suggest that natural resource revenues contribute positively to long-run economic expansion, particularly when accompanied by strong governance structures. Additionally, government effectiveness, control of corruption, and financial development enhance long-term growth. Additionally, Qian and Chen (2025) explore the influence of different types of resource rents on sustainable development in G7 nations by applying a panel ARDL methodology. Their results indicate that rents from coal, natural gas, and overall natural resources tend to hinder long-term environmental progress, whereas oil-related rents appear to promote it; in contrast, mineral rents do not show a statistically significant effect. While oil rents have historically played a dominant role in shaping fiscal policy and macroeconomic stability, empirical evidence increasingly suggests that long-term sustainable growth depends on complementary drivers such as human capital development (Adelakun, 2011), labor market performance (Soava *et al.*, 2020), and productive investment (Kanval *et al.*, 2024). For example, indicators of health, productivity, and overall labor force efficiency reflect these factors, and thus affect economic output. Employment creation not only determines income levels and poverty reduction, but also affects social cohesion and aggregate demand. In addition, investment, both public and private, serves as a major engine for expanding productive capacity, advancing technology, and developing infrastructure. Hence, a comprehensive understanding of how oil revenues influence economic growth requires careful consideration of their interplay with key non-resource determinants. This research adds a unique perspective to the existing literature by exploring the asymmetric effects of oil rent fluctuations on GDP per capita in Iran. It sheds new light on the ways resource dependency affects economic outcomes, both directly and through mediating factors. In contrast to earlier studies that typically focus on the overall or symmetric impact of natural resource revenues on growth, this paper specifically examines how GDP per capita responds differently to positive versus negative changes in oil rents. This approach offers a more detailed and nuanced view of economic dynamics in a resource-dependent country facing international sanctions and ongoing structural reform challenges. Furthermore, the analysis extends beyond traditional frameworks by incorporating key non-resource mediating factors, such as health expenditures, industrial employment, and trade openness, to reveal how oil revenues indirectly shape long-term growth trajectories. By integrating these dimensions, the study not only enriches the ongoing debate on the resource curse but also offers policy-relevant insights for leveraging oil rents to support sustainable development, reduce economic vulnerability, and promote diversification in resource-rich economies like Iran.

3. Methodology

3.1. Model specification

The neoclassical growth model serves as a foundational theoretical framework for analyzing the key determinants of economic growth, building on seminal contributions such as the Cobb-Douglas production function (Cobb & Douglas, 1928) and the Solow growth model (Solow, 1956). In this framework, economic output is largely determined by two key productive inputs: labor and capital. The model assumes that technological progress remains unchanged in the short term, which allows for a more focused analysis of how changes in labor and capital affect overall production levels. A widely used specification for capturing this relationship is the Cobb–

Douglas production function, which models output as a function of these two inputs. This functional form is known for exhibiting constant returns to scale and a unitary elasticity of substitution between labor and capital. The mathematical expression of this function is commonly written as:

$$Y_t = AK_t{}^{\alpha} L_t{}^{\beta} e_t{}^{\mu} \quad (1)$$

Where Y denotes total output, K represents capital input, L signifies labor input, A captures the level of technology (assumed constant for this representation), e is the error factor that captures unobserved variables, and α and β are output elasticities of capital and labor respectively, reflecting their relative contributions to production. This functional form provides a powerful tool to understand the mechanics of growth by linking factor accumulation directly to output expansion. Extending this framework, the neoclassical growth model incorporates technological progress as an exogenous factor to explain sustained long-run economic growth beyond mere accumulation of capital and labor. Solow (1956) introduced the concept that continual improvements in technology drive increases in productivity, enabling economies to overcome diminishing returns to capital and labor inputs alone. This insight underscores that while capital and labor are essential, technological innovation is a pivotal component for achieving balanced, long-term economic expansion, influencing policy focus towards fostering innovation and efficient resource allocation.

This growth model has been extended by introducing additional factors that may shape economic development. The effect of oil revenues on economic expansion remains a subject of considerable discussion. On one hand, they can stimulate growth by financing critical investments in infrastructure and innovation; on the other, they carry potential downsides such as the Dutch disease phenomenon and the broader risks associated with resource dependence (Shahbaz *et al.*, 2019). Dutch disease can lead to currency overvaluation, harming other export sectors, while the resource curse highlights issues like rent-seeking and poor governance. However, with effective management, oil rents can drive sustained growth through productive investments and diversification (Hou *et al.*, 2023). Besides, population issues are crucial for a nation's development, as unchecked growth can hinder economic progress (Wardani & Arif, 2021). Amirat and Zaidi (2020) found evidence of a positive relationship between population size and GDP per capita, underscoring the influence that demographic trends can have on key economic outcomes. However, Hossain (2019) found that in India, population growth did not significantly affect per capita income growth. Economic theories suggest that higher export activity indicates greater openness to international trade, which is linked to economic benefits (Upreti, 2015). Trade openness allows countries to focus on goods where they have a comparative advantage, leading to efficient resource allocation and increased competition. This, in turn, can enhance productivity and economic growth. Empirical studies typically find a positive correlation between exports and economic performance. Additionally, trade openness can foster innovation and attract foreign direct investment, but the extent of its impact varies based on factors like institutional quality, export diversification, and economic structure, highlighting the complexity of the relationship.

$$GDP_t = f(OR_t.EMP_t.EX_t.CAP_t.POP_t.Health_t) \quad (2)$$

$$LGDP_t = \alpha_0 + \alpha_1 LOR_t + \alpha_2\, LEMP_t + \ \alpha_3\, LEX_t + \alpha_4\, LCAP_t + \alpha_5\, Pop_t + \ \alpha_6 LHealth_t + u_t \quad (3)$$

LGDP= Logarithm of gross domestic product per capita,
LOR=Logarithm of oil rent
LEMP=Logarithm of industrial employment
LTR=Logarithm of trade openness
LCAP=Logarithm of gross fixed capital formation
LPop=Logarithm population growth
LHealth=Logarithm of current health expenditure
U_t= Error term.

3.2. Model and Estimation

3.2.1. Stationarity test

The application of ARDL and NARDL frameworks necessitates specific integration properties in the data series - all variables must demonstrate either level stationarity (I(0)) or first-difference stationarity (I(1)). Crucially, second-order integrated series (I(2)) must be excluded to prevent econometrically invalid outcomes. For rigorous stationarity assessment, we employ the Augmented Dickey-Fuller procedure, which extends the conventional Dickey-Fuller test by incorporating lagged difference terms to address potential serial correlation in the error structure. This diagnostic examination serves two critical purposes: first, it evaluates the presence of unit roots that would indicate non-stationary behavior; second, it verifies the fundamental time-series assumption of stable statistical properties over the observation period. The test's implementation follows the standard specification:

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \cdots + \delta_{p-1} \Delta y_{t-p+1} + \varepsilon_t \quad (4)$$

Where α is constant, β is the time trend coefficient, p is the lag order in the autoregressive process, and ε is a stationary error. The test statistic is derived from the estimated coefficient γ. If the estimated value of γ is significantly less than zero, this suggests rejecting the null hypothesis (i.e., the process is non-stationary). The Augmented Dickey-Fuller procedure evaluates stationarity through competing statistical hypotheses:

H_0: The data generating process contains a unit root (non-stationary)

H_1: The time series is stationary (unit root absent)

For hypothesis testing, we apply a conventional significance threshold of α=0.05, whereby we reject the null hypothesis of non-stationarity when the computed probability value falls below this critical level.

3.2.2. Nonlinear Autoregressive Distributed Lag (NARDL)

The Nonlinear Autoregressive Distributed Lag (NARDL) model is an advanced econometric approach designed to elucidate asymmetric dynamic interactions between variables across both short- and long-term horizons (Shin *et al.*, 2014). By building upon the conventional Autoregressive Distributed Lag (ARDL) framework, NARDL innovatively decomposes the explanatory variables into their positive and negative partial sums. This decomposition enables distinct estimation of the impacts that increases and decreases in the regressors exert on the dependent variable, thus allowing for a more nuanced understanding of the relationships at play. The nonlinear ARDL framework initiates with a bounds examination to detect cointegrating relationships between variables, accommodating mixed integration orders of I(0) and I(1) without requiring pretesting for unit roots. Following the establishment of equilibrium relationships, the estimation phase separately computes dynamic multipliers for increasing and decreasing movements in predictors, enabling detection of directional asymmetries in economic responses. The cointegration test specification under this framework takes the following mathematical form:

$$\Delta lnGDP_t = \alpha + \beta_0 lnGDP_{t-1} + \beta_1 lnOR_{t-1} + \beta_2 lnCAP_{t-1} + \beta_3 lnEMP_{t-1} + \beta_4 lnPOP_{t-1} + \beta_5 lnTR_{t-1} + \beta_6 lnHealth_{t-1} + \sum_{i=1}^{n} \varphi_1 \Delta lnGDP_{t-i} + \sum_{i=0}^{m} \varphi_2 \Delta lnOR_{t-i} + \sum_{i=0}^{m} \varphi_3 \Delta lnCAP_{t-i} + \sum_{i=0}^{m} \varphi_4 \Delta lnEMP_{t-i} + \sum_{i=0}^{m} \varphi_5 \Delta lnPOP_{t-i} + \sum_{i=0}^{m} \varphi_6 \Delta lnTR_{t-i} + \sum_{i=0}^{m} \varphi_7 \Delta lnHealth_{t-i} + \varepsilon_t \quad (5)$$

The model specification incorporates optimal lag structures (n, m) selected through AIC minimization criteria. Stochastic disturbances are represented by tε, a serially uncorrelated error process. Long-term equilibrium relationships are parameterized through β coefficients (β_0-β_6), with transient adjustment mechanisms quantified by φ parameters (φ_2-φ_7). Cointegration detection employs an F-distribution based bound testing approach, where the joint null hypothesis of β-coefficient insignificance (H0: $\beta_0=\beta_1=...=\beta_6=0$) undergoes Wald-type evaluation. Diagnostic inference compares computed F-values against established critical thresholds to determine equilibrium relationships.Following cointegration verification, the estimation proceeds in two phases: equilibrium-level relationships and transitional dynamics. The error correction mechanism (Equation 6) features δ_i as the convergence rate parameter, measuring how rapidly deviations from steady-state conditions are corrected following exogenous disturbances.

$$\Delta lnGDP_t = \alpha + \delta_i ECM_{t-1} + \sum_{i=1}^{n} \varphi_1 \Delta lnGDP_{t-i} + \sum_{i=0}^{m} \varphi_2 \Delta lnOR_{t-i} + \sum_{i=0}^{m} \varphi_3 \Delta lnCAP_{t-i} + \sum_{i=0}^{m} \varphi_4 \Delta lnEMP_{t-i} + \sum_{i=0}^{m} \varphi_5 \Delta lnPOP_{t-i} + \sum_{i=0}^{m} \varphi_6 \Delta lnTR_{t-i} + \sum_{i=0}^{m} \varphi_7 \Delta lnHealth_{t-i} + \varepsilon_t \quad (6)$$

4. The asymmetric analysis

The current study utilizes the NARDL technique (Shin et al., 2014) to examine the nonlinear and asymmetric relationships among GDP per capita, oil rent, capital, employment, health expenditure, trade openness and population growth in Iran. This approach allows for the detection of both negative and positive shocks in the short and long run, moving beyond the linear assumptions of ARDL models. The NARDL framework simultaneously tests these relationships, illustrated by the long-run asymmetric relationship in the following equation:

$$Y_t = \beta^+ X_t^+ + \beta^- X_t^- + \varepsilon_t \quad (7)$$

Where Y_t is the dependent variable (GDP per capita) at the time (t); β^+ and β^- are the long-run asymmetric parameters; X_t denotes the exogenous variables which can be expressed in the following equation:

$$X_t = X_0 + X_t^+ + X_t^- \quad (8)$$

In this context, X_0 is the initial value, while X_t^+ and X_t^- represent the positive and negative partial sums of the independent variables, respectively. X_t is defined by certain equations.

$$X_t^+ = \sum_{i=1}^{t} \Delta X_i^+ = \sum_{i=1}^{t} \max(\Delta X_i . 0) \tag{9}$$

$$X_t^- = \sum_{i=1}^{t} \Delta X_i^- = \sum_{i=1}^{t} \min(\Delta X_i . 0) \tag{10}$$

In the NARDL model, the relationship between variables is expressed through changes in independent variables (ΔX_i), with '+' and '−' indicating positive and negative shocks. The short-run and long-run relationships are shown in the following equation:

$$\Delta Y_t = \alpha_0 + \rho Y_{t-1} + \theta^+ X_{t-1}^+ + \theta^- X_{t-1}^- + \sum_{i=0}^{p} \varphi_i \Delta Y_{t-i} + \sum_{i=0}^{q} (\pi_i^+ \Delta X_{t-i}^+ + \pi_+^- \Delta X_{t-i}^-) + e_t \tag{11}$$

Where $\theta^+ = -\rho\beta^+$and$\theta^- = -\rho\beta^-$.

The symmetry hypotheses (H_0: $\theta^+ = \theta^-$ for the long-run; H_0: $\pi^+ = \pi^-$ for the short-run) are rigorously tested using the Wald statistical framework, following the methodological approach developed by Shin et al. (2014). These null hypotheses, which assert symmetric responses to positive and negative shocks, are systematically examined across both the long-run and short-run dynamics of the economic system. The following Shin et al. (2014), equation 5 can be restated in the following form:

$$\Delta lnGDP_t = \alpha + \beta_0 lnGDP_{t-1} + \beta^-{}_1 lnOR^-{}_{t-1} + \beta_2^+ lnOR_{t-1}^+ + \beta_3 lnCAP_{t-1} + \beta_4 lnEMP_{t-1} + \beta_5 lnPOP_{t-1} + \beta_6 lnTR_{t-1} + \beta_7 lnHealth_{t-1} + \sum_{i=1}^{n} \theta_1 \Delta lnGDP_{t-i} + \sum_{i=0}^{m} (\theta_2^- \Delta OR_{t-1}^- + \theta_2^+ \Delta OR_{t-1}^+) + \sum_{i=0}^{m} \theta_3 \Delta lnCAP_{t-i} + \sum_{i=0}^{m} \theta_4 \Delta lnEMP_{t-i} + \sum_{i=0}^{m} \theta_5 \Delta lnPOP_{t-i} + \sum_{i=0}^{m} \theta_6 \Delta lnTR_{t-i} + \sum_{i=0}^{m} \theta_7 \Delta lnHealth_{t-i} + \varepsilon_t \tag{12}$$

The coefficients β_2^+ and θ_2^+ quantify the long-term and short-term favorable effects of petroleum revenues on economic output per individual, while β_1^- and θ_2^- measure corresponding negative impacts in the Iranian context. To verify asymmetric cointegration among variables, the bounds testing methodology is implemented within the ARDL framework. Furthermore, the Wald examination procedure evaluates potential disparities between positive and negative petroleum revenue effects, testing the null hypothesis of symmetric responses (H_0: $\beta^+ = \beta^-$ and $\theta^+ = \theta^-$) in both extended and immediate time horizons. For empirical analysis, this investigation utilizes annual time-series data spanning 1990-2023, sourced from the World Development Indicators (WDI) repository. All econometric computations and model calibrations were performed using the EViews 13 statistical software package.

5. Results and Discussions

Table 1 summarizes the descriptive statistics for the primary variables analyzed in this study. The average GDP per capita stands at \$3,673.55, with a coefficient of variation (CV) of 0.53, suggesting substantial variability in this measure from 1990 to 2023. In contrast, oil rents as a percentage of GDP average 21.58%, accompanied by a CV of 0.26, reflecting relative stability in this variable. The mean population growth rate is recorded at 1.33%, while employment in the industrial sector constitutes 38.67% of the total employed population in Iran. The latter shows minimal variability (CV = 0.04), indicating a stable employment landscape within the sector. Per capita health expenditure averages \$231.58, but this variable has the highest relative variability (CV = 0.65), pointing to significant volatility in health expenditure. These statistics elucidate the central tendency and dispersion characteristics of the key variables under investigation.

The results of unit root test, shown in Table 2, evaluate the stationarity properties of the variables in this analysis. The findings reveal a heterogeneous order of integration among the variables, which has significant implications for the selection of an appropriate econometric model. Specifically, the variables LOR (oil rent), LPOP (population growth rate), and LHEALTH (health expenditure per capita) are stationary at their level forms, evidenced by ADF test statistics of -4.67, -5.05, and -4.24, respectively, all of which are significant at the 1% level. This indicates an absence of a unit root, allowing these variables to be included in the model without the need for differencing. Conversely, the variables LGDP (gross domestic product per capita), LCAP (capital), LEMP (industrial employment), and LTR (trade openness) exhibit nonstationarity at the level but attain stationarity upon first differencing.

Table 1. Summary of variables

Variables	Average	Max	Min	CV
GDP per capita ($)	3673.55	8114.08	1038.11	0.53
Oil rent (%GDP)	21.58	31.61	10.88	0.26
Population growth rate	1.33	2.71	0.19	0.36
Employment (industry-%total)	38.67	41.58	35.54	0.04
Capital (M$)	105257.5	234107.2	16735.1	0.59
Trade openness (%GDP)	44.27	58.56	29.22	0.14
Health exp. Per capita($)	231.58	505.33	59.89	0.65

Source: Research findings

Table 2: Summary of unit root test results

Variables	ADF test (t-statistic)		
	Level	First difference	Order of integration
LGDP	-1.49 (0.80)	-4.31***(0.00)	I(1)
LOR	-4.67 ***(0.00)	-	I(0)
LCAP	-1.78 (0.68)	-4.34***(0.00)	I(1)
LEMP	-1.98 (0.58)	-4.56***(0.00)	I(1)
LPOP	-5.05***(0.00)	-	I(0)
LTR	-2.44 (0.35)	-4.32***(0.00)	I(1)
LHEALTH	-4.24*** (0.01)	-	I(0)

*,**,*** implies 10%, 5%, 1% levels of significant respectively

Source: Research findings

The stationarity analysis reveals a combination of level-stationary and first-difference stationary variables, validating the application of autoregressive distributed lag methodology. This modeling strategy provides reliable parameter estimates while appropriately addressing the integration characteristics of the dataset. As evidenced in Table 3, the bounds testing procedure confirms strong evidence of cointegration, with the empirical F-statistic (52.83) surpassing all benchmark critical values across conventional significance thresholds. This robust finding demonstrates a stable equilibrium relationship persists among the economic indicators, notwithstanding their differing integration orders. The ARDL framework's ability to simultaneously model transient adjustments and permanent relationships makes it particularly suitable for this empirical investigation, enhancing the credibility of resultant policy recommendations and predictive applications.

Table 3: Bound cointegration test results

Model	**LGDP=f(LOR,LCAP,LTR,LEMP,LHEALTH,LPOP)**					
F-statistic	52.83					
Sample size	10%		5%		1%	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
30	2.27	3.49	2.73	4.16	3.86	5.69
35	2.19	3.37	2.59	3.90	3.59	5.23
Asymptotic	1.92	2.89	2.17	3.21	2.73	3.90

Source: Research findings

The long-run estimates obtained from the NARDL model indicate significant relationships between GDP per capita (LGDP) and its core determinants, underscoring the presence of asymmetric effects due to oil rent shocks (Table 4). These results enhance our comprehension of the structural dynamics inherent in resource-dependent economies. The coefficient of LCAP is both positive and highly significant (0.421, p=0.00), implying that a 1% increase in capital accumulation corresponds to approximately a 0.42% increase in GDP per capita. This finding aligns with neoclassical growth theory, which positions physical capital as a key driver of productivity enhancements and long-term economic growth. Table 4 shows a positive and significant effect of employment in the industrial sector on Iran's per capita income. A 1 percent increase in this variable is expected to raise GDP per capita by 2.09 percent, assuming other factors remain constant. This result emphasizes the transformative impact of industrialization on economic output and the creation of high-value employment, highlighting the essential structural transitions from traditional sectors to industry. The population growth variable carries a negative coefficient, though it does not significantly influence long-term per capita income. This could be attributed to factors such as an expanding labor force and declining efficiency in the use of public goods and natural resources. Trade openness shows a statistically significant negative effect on GDP per capita, with a 1% rise in openness linked to a 1.28% decline in per capita output. These findings challenge the common assumption that trade liberalization always boosts economic growth, suggesting instead that increased openness may foster import dependency—particularly in economies reliant on commodity exports. Supporting this view, studies have documented negative or mixed impacts of trade openness on growth in resource-dependent countries. For instance, research on the Republic of Congo reveals that overreliance on natural resource exports undermines economic performance (Mbingui & Etoka-Beka, 2021). Similar patterns in Sub-Saharan Africa show that commodity dependence and structural trade barriers limit the benefits of openness (Moyo & Khobai, 2018). In contrast, some studies find positive effects of trade openness in more diversified economies or where industrial policies are robust, as seen in Nepal (Rana, 2020) and certain regions of Pakistan and Ghana (Jawaid, 2014). The empirical findings demonstrate a strong positive relationship between healthcare investment and economic performance, with statistical significance at conventional levels. Our estimates indicate that each percentage point growth in per capita health expenditures leads to a 0.58% enhancement in national income levels. This finding highlights the crucial role of investing in population health as a driver of workforce efficiency and sustainable economic growth through better health indicators. Regarding petroleum revenue fluctuations, the study identifies economically meaningful long-term asymmetric impacts. Unexpected increases in hydrocarbon earnings associate with 0.48% GDP per capita growth, primarily through expanded fiscal space and government investment opportunities. These results align with previous country-specific research documenting how resource windfalls can stimulate public sector activity and broader economic expansion (Haque, 2020; Behroznia, 2015). Surprisingly, a negative oil rent shock also shows a positive effect, with a coefficient of 0.44%. This may reflect adaptive policy responses and structural adjustments that follow declining oil revenues. In Iran, negative shocks have led to reforms in resource allocation, public expenditure efficiency, and economic diversification, ultimately enhancing long-term growth resilience. Such findings counter the traditional view that negative oil shocks uniformly harm growth and instead highlight the importance of policy flexibility in resource-dependent economies. While positive oil shocks often lead to increased revenues and some growth benefits, negative shocks can trigger countercyclical policies that help stabilize the economy and promote diversification, as shown in studies of Algeria, Saudi Arabia, and Nigeria (Driouche *et al.*, 2020; Olayungbo, 2019; Algahtani, 2016).

Table 4: NARDL model (Long run) results: ARDL (1,0,1,1,1,2,2)

Variable	Coefficient	Std.Error	t-Statistic	Prob
LCAP	0.421***	0.04	10.47	0.00
LEMP	2.099***	0.55	3.75	0.00
LPOP	-0.004	0.02	-0.17	0.86
LTR	-1.288***	0.19	-6.46	0.00
LHEALTH	0.575***	0.03	15.89	0.00
LOR^+	0.478***	0.10	4.72	0.00
LOR^-	0.445***	0.08	5.35	0.00
C	-3.574***	0.90	-3.96	0.00

Source: Research findings

The short-run dynamics in Table 5 reveal important insights into the factors influencing Iran's GDP per capita. The negative and significant error correction term (ECT) indicates a stable long-run equilibrium among the variables, with the economy correcting deviations within a year. In the short term, population growth positively affects GDP per capita, with a 1% increase linked to a 0.055% rise. This could stem from increased labor force participation. Trade openness negatively impacts per capita income, though its short-run effect is smaller, suggesting it takes time for trade distortions to manifest. Health expenditure shows a significant short-run positive effect, where a 1% increase results in a 0.167% rise in GDP per capita, highlighting the immediate benefits of health investments. However, lagged health spending has a negative impact, possibly due to diminishing returns. Interestingly, both positive and negative oil rent shocks have significant negative coefficients, suggesting that increases in oil rents do not immediately boost per capita income, likely due to inefficiencies and policy responses associated with the Dutch Disease phenomenon.

Table 5: NARDL model (Short run) results: ARDL (1,0,1,1,1,2,2)

Variable	Coefficient	Std.Error	t-Statistic	Prob
COINTEQ*	-1.266***	0.045	-27.71	0.00
D(LEMP)	0.044	0.288	0.153	0.87
D(LPOP)	0.055***	0.012	4.26	0.00
D(LTR)	-0.861***	0.081	-10.67	0.00
D(LHEALTH)	0.167***	0.033	4.96	0.00
D(LHEALTH(-1))	-0.507***	0.056	-9.04	0.00
D(LOR^+)	0.022	0.027	0.82	0.41
D(LOR^-)	0.046	0.029	1.58	0.12
D(LOR^+(-1))	-0.391***	0.054	-7.14	0.00
D(LOR^-(-1))	-0.106***	0.034	-3.07	0.00
R^2	0.98	D.W	2.78	-
F-statistic	183.99	Prob	0.00	-

Source: Research findings

Empirical analysis across different time horizons consistently validates the phenomena described by the Resource Curse and Dutch Disease hypotheses in Iran's economic context. The immediate adverse consequences of petroleum price volatility, compounded by challenges stemming from trade openness and excessive reliance on hydrocarbon income, demonstrate that fossil fuel abundance has failed to generate enduring economic progress. Rather, it has precipitated systemic imbalances, constrained sectoral diversification, and heightened exposure to international commodity market instability. These outcomes necessitate comprehensive policy interventions aimed at revenue source diversification, institutional capacity building, and optimized fiscal management - particularly during periods of energy price uncertainty - to mitigate petroleum dependency risks and establish balanced economic development pathways. As demonstrated in Table 6, petroleum market fluctuations exert directionally imbalanced influences on economic expansion metrics. The calculated F-statistic (3.181) and χ^2 value (6.363) both achieve statistical significance at conventional thresholds, leading to rejection of the symmetry null hypothesis regarding crude oil price impacts on national income levels.

Table 6: Results of asymmetry tests

Variable	Statistic	Value	Probability
	Long run		
LOR	F-statistic	2.359	0.148
	Chi-square	2.359	0.124
	Short run		
LOR	F-statistic	6.180**	0.027
	Chi-square	6.180**	0.012
	Joint (Long-run and short-run)		
LOR	F-statistic	3.181*	0.075
	Chi-square	6.363**	0.041

Source: Research findings

To evaluate the stability of the estimated coefficients, we applied the CUSUM and CUSUMQ tests, which examine the cumulative sum and the cumulative sum of squared residuals, respectively. As shown in Figures 1 and 2 at the 5% significance level, both statistics remain within the critical bounds, indicating no structural instability in the model. Therefore, the results confirm that the estimated equation is stable, and the coefficients are reliable at the 5% significance level.

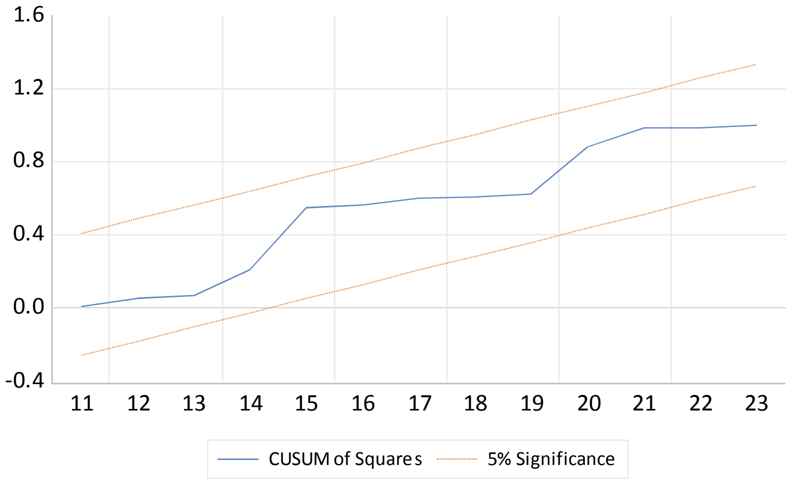

Fig 1. Result of CUSUMQ

Source: Research findings

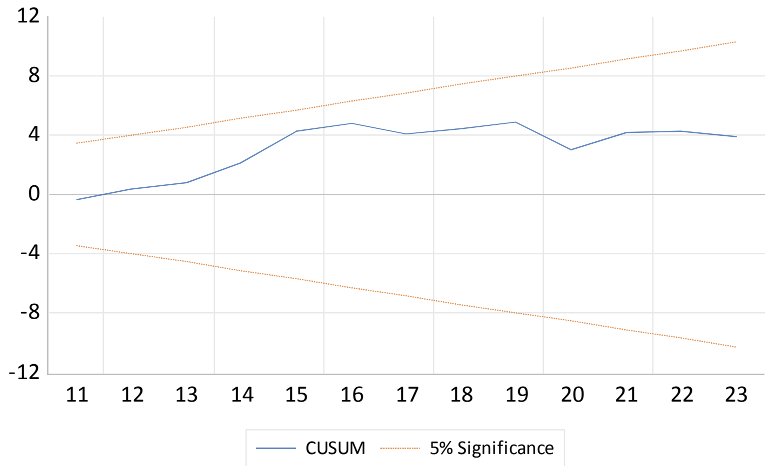

Fig 2. Result of CUSUM

Source: Research findings

6. Conclusion and policy recommendation

This study employs the nonlinear autoregressive distributed lag (NARDL) methodology to explore the influence of oil rents and various macroeconomic variables on Iran's economic performance from 1990 to 2023. Long-run estimates indicate that capital accumulation, industrial employment, and health expenditures are significant contributors to GDP per capita growth, which is consistent with established growth theory. Conversely, trade openness has a detrimental impact on economic performance, potentially reflecting structural inefficiencies or a reliance on imports. Crucially, both positive and negative oil rent shocks yield statistically significant long-term effects (0.478 and 0.445, respectively), underscoring the persistence of Iran's economic dependence on volatile oil revenues. These findings lend empirical support to the resource curse hypothesis; rather than generating sustainable growth, oil rents appear to distort economic structures and impede diversification efforts. The short-run dynamics reveal a more nuanced interaction between oil rents and economic performance. While population growth and current health expenditures exhibit immediate positive impacts on GDP per capita, oil rent shocks—both positive and negative—are associated with unexpectedly negative coefficients in the short term. These findings imply that sudden surges in petroleum revenues could potentially distort resource distribution patterns, trigger domestic currency overvaluation, and inadvertently suppress non-hydrocarbon industries - characteristic manifestations of Dutch Disease economics. Furthermore, the statistically meaningful negative coefficient of the equilibrium restoration parameter demonstrates a self-correcting mechanism in the macroeconomic system, verifying its inherent capacity to gradually return to steady-state conditions following temporary disruptions. Collectively, these results highlight the dual challenge facing Iran: maximizing oil revenues for developmental purposes while counteracting their destabilizing macroeconomic effects. To navigate these challenges, policymakers should emphasize structural reforms aimed at diminishing oil dependency and advancing economic diversification. Key recommendations include enhancing institutional quality and transparency in the management of oil revenues to improve allocative efficiency and mitigate rent-seeking behaviors. Strengthening the tax framework and building fiscal buffers via the National Development Fund will be essential for stabilizing public expenditures amidst oil price volatility. Furthermore, targeted investments in human capital, particularly in health and education, are critical for fostering long-term productivity improvements. Supporting productive sectors such as agriculture and manufacturing, complemented by strategic trade policies, will also contribute to inclusive growth and labor market development. Implementing these strategies can steer Iran towards a more resilient, diversified, and sustainable economic framework.

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Conflicts of Interest

The authors declare no potential conflict of interest with respect to the research, authorship, or publication of this article.

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