Oil Extraction Costs and Long Run Economic Growth in Iraq

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Abstract. *General Background The food and beverage sector in Indonesia, particularly the cake and snack category, exhibits significant growth driven by rising population numbers, urban expansion, and shifting consumer lifestyles. Specific Background Local culinary enterprises are capitalizing on domestic shifts from imported goods to home-produced items while utilizing modern digital trade platforms to reach broader audiences. Knowledge Gap Despite growing interest in artisanal food businesses, comprehensive empirical assessments integrating marketing mix frameworks, segmentation approaches, and digital adoption for legacy cookie brands remain limited. Aims This study examines the implementation of marketing strategies utilized by J&C Cookies Bandung in an effort to boost sales volume. Results The findings indicate that J&C Cookies effectively applies comprehensive marketing tactics, including digital marketing, branding, product development, pricing, distribution, and promotion, alongside a well-integrated 7P marketing mix and STP approach that successfully expands market share and raises sales. Novelty This research provides a contextual evaluation of combining traditional artisanal manufacturing with omnichannel digital distribution and targeted demographic positioning within the Indonesian cookie industry. Implications These insights offer a strategic benchmark for similar food and beverage enterprises seeking to adapt their marketing frameworks to contemporary digital business environments*

Keywords: Digital Marketing, Marketing Mix, STP, J&C Cookies, Strategy Marketing

1. Introduction

Iraq holds the worlds proven oil reserves, about 147 billion barrels. This makes Iraq a key player in energy markets. Iraq relies heavily on oil money for stability (BP Statistical Review, 2023),The link between oil extraction costs and economic growth, in Iraq is a not well studied part of energy economics. Iraq's unique history of sanctions, wars and poor infrastructure has changed how oil is extracted for the thirty years (Alkafaji & Abdulkareem 2021).

The cost of getting oil out of the ground includes different parts like the money spent on running the operations the money needed to buy new equipment the costs to keep everything working properly the money spent on keeping things safe and the funds used to update technology so that the oil can be produced more effectively (Al-Rubaie & Hassan 2020). In Iraq these costs have been greatly affected by problems, old and worn-out equipment rules from other countries that limit what can be done and the need to rebuild a lot after many wars happened (Jiyad, 2021). To be effective in the promotion of good economic conditions, the decision makers and planners must know what effect these expenditures have on the economy.

The idea of oil prices affecting the economy and being studied came from a theory called pot economics. This theory implies that if the cost of producing oil rises, the profits from oil diminish. This suggests that oil does not contribute to the income and growth of the nation as much as it could have (Hotelling, 1931; Solow, 1974). In oil-dependent countries like Iraq, however, the situation is more complicated. In this sense, the cost of oil extraction affects not only the income but also government revenue, employment, foreign income, and the general balance of the economy (Sachs & Alberstein 2001).

Previous work has largely concentrated upon oil price volatility. Its impact on the economy. The cost of producing oil has not been examined sufficiently as a potential determinant of economic performance (Hamilton, 2009; Kilian, 2009). This is the first study that fills the gap of understanding of how oil extraction costs, as a unique factor, impact on the economic development of Iraq.The timing of this study is critical with the recent developments in oil extraction technology, shifts in global energy patterns and the ongoing efforts by Iraq to develop its oil sector infrastructure.

This study is mainly designed to evaluate the impact of oil extraction costs on the development of Iraq. We use econometric methods that control for long-term trends, short-term fluctuations and possible structural breaks. Specifically, we plan to: (1) use cointegration analysis to test for the existence of an equilibrium relationship between extraction costs and economic growth; (2) analyze the short-run dynamics of the economy using Vector Error Correction Models; (3) examine causal relationships using Granger causality tests; (4) test the robustness of the results to different diagnostic tests and model specifications; and (5) conclude with policy recommendations for sustainable economic development in Iraq.
This research adds to the existing literature in a number of ways. First, it provides empirical evidence on the relationship between extraction costs and economic growth for a major oil-producing developing country. Secondly, it applies econometric techniques appropriate to the specific characteristics of the Iraqi economy, which incorporates possible breaks

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in the system. Finally, it provides relevant policy implications for improving resilience in countries highly exposed to natural resources. In the end, it establishes a methodology that others can apply when examining comparable matters in different oil-exporting countries.

2. Literature Review

2.1 Theoretical Foundations

The relationship between natural resource extraction costs and economic growth is based on the principles derived from classical resource economics. Hotelling's (1931) seminal analysis of resources showed that the optimal extraction path for a resource must account for all economic rent, including extraction costs, when deciding on production quantities and when evaluating its influence on economic welfare. This suggests that when the extraction costs increase, the net present value of the resource stock decreases. This reduces the potential contribution of these assets to wealth and economic growth.

Solow's (1974) model generalized this approach by adding resources to growth theory. It implies that resource-based economies face particular challenges in sustaining growth over long horizons. These countries need to keep on investing the proceeds from resource rents, in capital such as factories or technology, to make up for the loss of resources. Rising costs of extraction, means, investments have less resources to work with.Harwick (1977) comments, that can choke growth, or indeed bring it to a halt if that is allowed to happen.

A related idea that makes this connection clear is the resource curse hypothesis, initially proposed by Sachs and Warner in 1995 and revisited in 2001. This theory predicts that resource abundant countries will grow at a slower rate in comparison to other countries. The factors include Dutch Disease, whereby resource exports cause currency appreciation which harms other sectors; poor institutions which mismanage resource wealth; and a disincentive to diversify the economy. These challenges may be exacerbated by rising costs of extraction. They reduce the benefits of having abundant resources, but still have the same institutional and structural problems. Ross (2019) supports this view, arguing that rising costs may exacerbate the effects of resource wealth.

2.2 Empirical Evidence on Resource Costs and Economic Growth

There is limited research that uses data to analyze the relationship between extraction costs and economic growth, as most research has examined the relationship between resource prices and production costs.Hamilton (2009) examined the effect of oil supply shocks on economic growth in the US. He discovered that supply-side shocks, typically signifying that extraction costs severely hinder GDP growth. Kilian (2009) also distinguished between oil price shocks that are demand-driven and those that are supply-driven. He demonstrated that disruptions in supply associated with production expenses have a more prolonged adverse impact on economic activity.

Arezki and Nabli (2012) studied how natural resource extraction affects growth in Middle Eastern countries, including Iraq. They found that economies that depend on resources are more likely to be affected by changes in extraction costs because they don't have economic diversity. Their analysis of panel data showed that a 1% rise in extraction costs is linked to a 0.8% drop in GDP growth over three years.. This link is different for each country depending on the quality of its institutions and the structure of its economy.

Newer studies are starting to include extraction cost factors in studies about resource economics. Bjornland et al. (2019) Examined the operations of the Norwegian oil industry. They discovered that advancements in technology that reduce extraction expenses positively impact the entire economy. This results from investments, increased employment, and additional government funding. Their Vector Autoregression (VAR) analysis revealed that a 10% decrease in extraction expenses results in a 1.5% increase in GDP growth over a two-year period.

2.3 Iraq-Specific Economic Research

Studies on Iraq's oil economy have primarily focused on the impacts of events, trade embargoes, and reconstruction efforts rather than the expenses involved in oil extraction. Jiyad (2021) investigated the changes in the Iraqi oil sector since 2003 and found that extraction costs had greatly increased because of safety concerns, aging infrastructure, and the need for help from foreign experts. The financial implications of these rising costs were not the focus of the study.

Al-Rubaie and Hassan (2020) investigated the performance of the Iraqi oil production and found that the costs of extraction were much higher than in other areas as a result of the aging infrastructure, safety expenditures, and slow government processes. Their study showed that lowering oil extraction costs could improve the financial position of Iraq and stimulate economic growth. They refrained from using numbers to show this relationship.

Alkafaji and Abdulkareem (2021) investigated the relationship between oil revenue and economic growth in Iraq, using data from 1980-2018. They found that an increase in oil revenue led to economic growth, but that this relationship weakened over time, perhaps as a result of higher extraction costs and poorer extraction techniques. The cost of oil extraction was not treated as a separate variable in their analysis.

Abbas and Al-Shuhaib (2019) also analyzed the effects of changes in the oil sector on the Iraqi economy. Improved techniques

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for oil extraction and cost reduction post-2014 led to economic improvement. Their research used a difference-in-differences approach. It showed that more efficient oil operations led to faster development in some regions.This showed that the price of getting oil affects the economy.

2.4 Methodological Approaches in Energy Economics

The econometric investigation of energy-growth relationships has evolved considerably over time. Modern studies use advanced time series methodologies to investigate the non-stationarity, cointegration and structural breaks issues. Ozturk (2010) summarized the major findings of the studies on the energy-growth relationship and emphasized the importance of using proper econometric methods to determine true causal relationships and to avoid obtaining misleading results. Vector Error Correction Models (VECM) have emerged as the standard method for analyzing long-term relationships in energy economics. Apergis and Payne (2010) showed that VECM works well in the analysis of the relationship between energy consumption and growth in a number of countries. VECM is able to identify short-term changes and long-term equilibrium, while controlling for endogeneity issues. The Autoregressive Distributed Lag (ARDL) models are preferred for their ability to incorporate variables with mixed orders of integration and to yield robust results even with small samples. The bounds testing approach for ARDL models was proposed by Pesaran et al. (2001). Today, ARDL models are commonly used in energy economics to find cointegration relationships, as they can avoid unit root tests.

2.5 Research Gaps and Contributions

Literature Review I have reviewed the literature. This research is designed to fill a number of gaps. First, there are no studies that have investigated extraction costs as a determinant of economic growth in oil-producing countries. A large portion of the literature focuses on the role of oil prices or the revenue (profit) generated, rather than the costs associated with extracting oil.

The second study, on Iraq, did not use econometric methods to test the relationship between the oil industry and economic growth, especially given the unique history of Iraq. The existing literature has largely ignored structural breaks in the relationship between oil and the economy, which is an important consideration for Iraq, given its history of sanctions, conflicts and major regime changes.

Fourth, the literature does not examine the role of extraction costs on different economic indicators, limiting important policy implications. This study attempts to bridge these gaps by providing a comprehensive econometric analysis of the effects of extraction costs on economic growth in Iraq.It uses time-series techniques that control for structural breaks and non-stationarity, and provides comprehensive policy recommendations based on reliable empirical evidence.

3. Methodology

3.1 Theoretical Framework

#Humanized task

The opportunity cost of environmental degradation: An application to Amazonian deforestation (English) The theoretical underpinning that this version of the analysis rests on is based on a production function. The function brings the costs of natural resource extraction into the center of production cost drivers. Based on the work of Solow (1974) and Hartwick (1977), we develop a model of growth. In such models, economic growth depends on capital and labor, and also on the net input of natural resources. Diminishing returns to resource use with increasing costs of natural resource extraction.

The överall form of the model can be expressed as:

$$Yt = At\ Kt\alpha\ Lt\beta\ (Rt/Ct)\gamma \quad (1)$$

Where Yt is GDP, At is total factor productivity, Kt is capital stock, Lt is labor, Rt is oil resources, and Ct is oil extraction costs. The value of the oil reserves is given. That value decreases when the extraction costs rise. By taking logs and expressing everything in growth terms, the model becomes:

$$\Delta \ln Yt = \alpha_0 + \alpha_1 \Delta \ln Kt + \alpha_2 \Delta \ln Lt + \alpha_3 \Delta \ln Rt - \alpha_4 \Delta \ln Ct + \varepsilon t \quad (2)$$

This allows us to analyze the sensitivity of economic growth to changes in extraction costs, denoted Ct, in the presence of other growth determinants. We focus on extraction costs and economic growth.

3.2 Econometric Methodology

3.2.1 Unit Root Testing

Before proceeding with cointegration analysis, we test for the presence of unit roots in all variables using multiple approaches to ensure robustness. We employ the Augmented Dickey-Fuller (ADF) test (Dickey & Fuller, 1981), Phillips-Perron (PP)

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test (Phillips & Perron, 1988), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test (Kwiatkowski et al., 1992). The ADF test regression is specified as:

$$\Delta y_t = \mu + \beta t + \delta y_{t-1} + \Sigma_{i=1}^{k} \varphi_i \Delta y_{t-i} + \varepsilon_t \quad (3)$$

where the null hypothesis is H_0: $\delta = 0$ (unit root exists) against H_1: $\delta < 0$ (series is stationary).

3.2.2 Structural Break Testing

Given Iraq's turbulent economic history, we employ the Zivot-Andrews (1992) unit root test with structural breaks to account for potential changes in the data generating process. This test allows for one endogenous structural break in the series and is particularly relevant for Iraq given major events such as the Gulf War (1991), UN sanctions (1990-2003), Iraq War (2003), and ISIS conflict (2014-2017).

The Zivot-Andrews test regression includes break terms:

$$\Delta y_t = \mu + \beta t + \delta y_{t-1} + \theta DU_t + \gamma DT_t + \Sigma_{i=1}^{k} \varphi_i \Delta y_{t-i} + \varepsilon_t \quad (4)$$

where DU_t and DT_t are dummy variables capturing breaks in intercept and trend, respectively.

3.2.3 Cointegration Analysis

We employ the Johansen (1988) cointegration procedure to test for long-run relationships among the variables. The Johansen method is based on the Vector Error Correction representation:

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \ldots + \Gamma_{k-1} \Delta X_{t-k+1} + \Pi X_{t-k} + \varepsilon_t \quad (5)$$

where X_t is a vector of endogenous variables, and Π contains information about long-run relationships. The rank of Π determines the number of cointegrating relationships.

3.2.4 Vector Error Correction Model (VECM)

After we confirm that cointegration holds we estimate a VECM so we can study both short-run dynamics and long-run equilibrium relationships. The VECM specification, for our variables is:

$$\Delta lnGDP_t = \alpha_1 + \Sigma_{i=1}^{n} \beta_{1i} \Delta lnGDP_{t-i} + \Sigma_{i=1}^{n} \gamma_{1i} \Delta lnEXTC_{t-i} + \Sigma_{i=1}^{n} \delta_{1i} \Delta lnOILP_{t-i} + \lambda_1 ECT_{t-1} + \varepsilon_{1t} \quad (6)$$

where GDP is real gross domestic product, EXTC is oil extraction cost per barrel, OILP is oil production, ECT is the error correction term, and λ_1 represents the speed of adjustment to long-run equilibrium.

3.2.5 Autoregressive Distributed Lag (ARDL) Model

As a robustness check we also use the ARDL bounds testing approach introduced by Pesaran et al. (2001). This approach is effective for our analysis since it does not require all variables to be integrated of the same order. It also operates dependably when the sample size is limited.
The ARDL model specification is:

$$\Delta lnGDP_t = \alpha_0 + \Sigma_{i=1}^{p} \alpha_{1i} \Delta lnGDP_{t-i} + \Sigma_{i=0}^{g} \alpha_{2i} \Delta lnEXTC_{t-i} + \Sigma_{i=0}^{r} \alpha_{3i} \Delta lnOILP_{t-i} + \Sigma_{i=0}^{s} \alpha_{4i} \Delta lnGOVR_{t-i} + \beta_1 lnGDP_{t-1} + \beta_2 lnEXTC_{t-1} + \beta_3 lnOILP_{t-1} + \beta_4 lnGOVR_{t-1} + \varepsilon_t \quad (7)$$

Here GOVR is the abbreviation, for government oil revenues. In the example, p, q, r, and s represent the lag lengths, selected based on information criteria.

3.2.6 Granger Causality Testing

We apply Granger causality tests within the VECM framework to investi¬gate the relationship between costs of extraction and economic growth. Since variables evolve simultaneously in the course of time, these variables are cointegrated and causality may emerge emanating from two sources. One runs causality, showing how changes in the cost of extraction affect GDP growth in the short run. This is seen in the lagged differences of the variables. Or, one may consider causality induced from the error correction part of the model. This term captures the manner in which the system reverts to long-run equilibrium after a shock.

To test whether extraction costs have a statistically significant effect on GDP growth, we look at the GDP growth equation. We test if the coefficients of the lagged extraction costs and the error correction term are jointly significant. If yes, it means

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that past extraction costs help predicting GDP growth both in the short and long run. Such information allows us to estimate if changes in costs of extraction have any effect on economic growth.

3.3 Data and Variables

3.3.1 Data Sources and Sample Period

The analysis covers the period from 1990 to 2022, providing 33 data points that demonstrate the evolution of the Iraqi economy over different phases of political and economic conditions. The data come from the Central Bank of Iraq (CBI), the Iraqi Ministry of Oil (MoO), the International Monetary Fund (IMF), the World Bank (WB), the Energy Information Administration (EIA), and the BP Statistical Review of World Energy.

3.3.2 Variable Definitions

Economic Growth (GDP): Real GDP growth rate is defined as the change in real GDP per year (in 2010 prices) in percentage terms. Economic growth (GDP) is a measure of economic performance and is the main dependent variable in our analysis.

Oil Extraction Costs (EXTC): The average cost of extracting one barrel of oil (in constant 2010 US dollars) including operating costs, capital costs amortized over the lifetime of the production, maintenance costs, and security costs (especially unique to operating in Iraq). These costs of oil extraction (EXTC) are calculated using data from the Iraqi Ministry of Oil and the oil companies working in Iraq.

Oil Production (OILP): Total extraction of crude oil is quantified in million barrels daily. The information is sourced from the Iraqi Ministry of Oil. Is validated against IEA and OPEC data. Oil Production (OILP) helps control for the scale of oil operations.

Government Oil Revenues (GOVR): The share of government revenue that comes from oil expressed as a percentage of government income. Government Oil Revenues (GOVR) shows how important the oil sector is to the budget and is the channel through which Oil Extraction Costs (EXTC) influence public finances.

Oil Price (PRICE): The average price of Iraqi crude oil exports measured in constant 2010 US dollars per barrel. The figures come from IEA and the Iraqi Ministry of Oil. Oil Price (PRICE) controls for price influences that could mix up the link between Oil Extraction Costs (EXTC) and economic growth.

Investment (INV): fixed capital formation, shown as a percentage of GDP shows how much the country invests in long-term assets. Investment (INV) reflects how oil sector profits and Oil Extraction Costs (EXTC) might change investment.

Inflation (INF): The change, in consumer prices. Inflation (INF) serves to regulate macroeconomic stability, which may influence the connection between Oil Extraction Costs (EXTC) and Economic Growth (GDP).

3.4 Model Specification

The empirical models are designed to reflect how extraction expenses impact growth. They examine both direct and indirect methods. Direct methods imply that the expense of resource extraction impacts growth negatively. Indirect methods imply that cost impacts variables, which subsequently influence growth. These models help show the picture of how extraction costs play a role, in economic development. The primary VECM specification includes the following long-run relationship:

$$lnGDP_t = \beta_0 + \beta_1 lnEXTC_t + \beta_2 lnOILP_t + \beta_3 lnGOVR_t + \beta_4 lnPRICE_t + \beta_5 INV_t + u_t \quad (8)$$

We expect $\beta_1 < 0$, indicating that higher extraction costs reduce economic growth, while β_2, β_3, β_4, $\beta_5 > 0$, reflecting positive effects of production, government revenues, oil prices, and investment on growth.

3.5 Diagnostic Tests

To ensure the reliability of our econometric findings, we conduct a series of diagnostic tests. We utilize the Breusch-Godfrey LM test to assess autocorrelation. We additionally assess heteroscedasticity using the Breusch-Pagan test. We analyze if the residuals conform to a distribution by applying the Jarque-Bera test. We utilize both the CUSUM and CUSUM-sq tests to evaluate parameter stability. In addition, we conduct robustness analyses on lags specifications. We also consider techniques to the evaluation of the cost of extraction. We consider sub-samples to check whether our results are stable over time. This helps to rule out that our findings are driven by modeling choices or particular time periods.

4. Data Analysis and Results

4.1 Descriptive Statistics and Preliminary Analysis

Table 1 displays the descriptive statistics of each variable in the analysis. The figures reveal a transformation in Iraq's economic indicators over the sample period, mirroring a chaotic political and economic history..

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Table 1. Descriptive Statistics (1990-2022)

Variable	Mean	Std. Dev.	Minimum	Maximum	Skewness	Kurtosis	Jarque-Bera
GDP Growth (%)	2.47	12.68	-33.09	56.42	1.82	8.94	47.23***
Extraction Cost ($/barrel)	18.45	8.73	6.80	42.15	1.35	4.12	9.84***
Oil Production (mb/d)	2.89	1.24	0.45	5.15	-0.23	2.89	0.34
Gov. Rev.	87.34	12.67	58.90	98.70	-1.45	4.78	12.56***
Oil Price ($/barrel)	45.78	28.94	12.30	108.50	0.67	2.34	2.89
Investment (% GDP)	16.23	7.89	3.45	32.10	0.45	2.67	1.23
Inflation (%)	15.67	18.43	-2.10	76.60	2.12	7.89	35.67***

Note: *** denotes significance at 1 percent level. mb/d=million barrels per day.

GDP growth is volatile with a standard deviation of 12.68 percent. This means that GDP growth is highly variable and at times GDP growth may drop sharply in wars and then likely recover fast. The largest GDP decline was -33.09% in 1991 during the Gulf War. The highest GDP growth, fifty-six point four two percent happened in 2004 after oil exports resumed following the Iraq War. Oil extraction costs vary a lot from six dollars and eighty cents per barrel in the 1990s to forty-two dollars and fifteen cents per barrel in 2007. The average oil extraction cost over the period was eighteen dollars and forty-five cents per barrel.

Iraq depends heavily on oil revenue. The share of oil revenue in total government revenue averages eighty-seven point three four percent. Never drops below fifty-eight point nine zero percent. This strong dependence makes the economy very sensitive to changes, in oil extraction costs because when oil extraction costs rise the government earns less and spends less.

4.2 Unit Root Test Results

Table 2 shows the results of unit root tests for all variables both in levels and in differences. The results of unit root tests give evidence about the integration properties of the variables. This suggests that the ARDL methodology is a fit because ARDL methodology can handle variables, with different integration orders.

Table 2: Unit Root Test Results

Variable	Levels			First Differences		
	ADF	PP	KPSS	ADF	PP	KPSS
lnGDP	-2.14	-2.08	0.78***	-5.67***	-5.89***	0.12
lnEXTC	-1.89	-1.76	0.82***	-4.23***	-4.35***	0.15
lnOILP	-2.34	-2.45	0.65**	-6.12***	-6.08***	0.09

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lnGOVR	-3.15**	-3.08**	0.45	-7.23***	-7.34***	0.08
lnPRICE	-1.67	-1.72	0.89***	-5.45***	-5.52***	0.11
INV	-2.78*	-2.65*	0.54	-6.89***	-6.95***	0.06

Note: ***, **, * indicate significance at 1%, 5%, and 10% levels, respectively. Critical values: ADF/PP: -3.59 (1%), -2.93 (5%), -2.60 (10%); KPSS: 0.74 (1%), 0.46 (5%).

Most variables appear to be non-stationary, in levels but become stationary in differences. This indicates that variables are integrated of order one, I(1). However the government oil revenues variable and the investment variable show some evidence that stationarity already exists in levels. This mix of integration orders supports the use of an ARDL approach.

4.3 Structural Break Analysis

The Zivot-Andrews test results, which appear in Table 3 show that there are breaks in the key variables. The presence of breaks is clear, from the Zivot-Andrews test results and it confirms that our approach to account for Iraqs turbulent economic history is sound.

Table 3: Zivot-Andrews Structural Break Unit Root Test Results

Variable	ZA Statistic	Break Date	Critical Value (5%)	Conclusion
lnGDP	-5.23	2003	-4.80	Stationary with break
lnEXTC	-4.67	2007	-4.80	Unit root with break
lnOILP	-5.89	1991	-4.80	Stationary with break
lnGOVR	-6.12	2003	-4.80	Stationary with break

The dates where the break was found match events in Iraqs recent past: 1991 (impact of the Gulf War on production) 2003 (Iraq War and change in leadership) and 2007 (height of violence between different groups and problems, with production). These breaks support the need to include structural break dummies in our models.

4.4 Cointegration Analysis

The Johansen cointegration test results, shown in Table 4 show that there are run relationships between the variables. The Johansen cointegration test results, shown in Table 4 show that there are run relationships between the variables. The Johansen cointegration test results, shown in Table 4 show that there are run relationships, between the variables.

Table 4: Johansen Cointegration Test Results

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Max-Eigen Statistic	0.05 Critical Value
None *	0.7845	98.67	69.82	45.23	33.88
At most 1 *	0.6234	53.44	47.86	28.91	27.58
At most 2	0.4567	24.53	29.80	17.88	21.13

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At most 3	0.2134	6.65	15.49	6.65	14.26

Note: * denotes rejection of the hypothesis at the 0.05 level. CE = Cointegrating Equations.

Both the trace statistic and the maximum eigenvalue statistic show that there are two cointegrating relationships, at the 5 percent significance level. This confirms that run equilibrium relationships exist among GDP, extraction costs, oil production, government revenues and other control variables.
The normalized cointegrating equation (long-run relationship) is:

lnGDP = 8.45 - 0.23lnEXTC + 0.67lnOILP + 0.34lnGOVR + 0.18lnPRICE + 0.12INV (9)
*(t-stat) (-4.67)*** (5.23)*** (3.89)*** (2.45)** (2.78)****

The long-run coefficient on extraction costs (-0.23) indicates that a 1% increase in extraction costs is associated with a 0.23% decrease in GDP in the long run, confirming our theoretical expectation.

4.5 Vector Error Correction Model Results

Table 5 shows the VECM estimation results. It focuses on the GDP growth equation, a GDP growth equation that is my main interest.

Table 5: VECM Results - GDP Growth Equation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Error Correction Term	-0.387	0.098	-3.95	0.001***
ΔlnEXTC(-1)	-0.145	0.067	-2.16	0.041**
ΔlnEXTC(-2)	-0.098	0.054	-1.81	0.083*
ΔlnOILP(-1)	0.234	0.089	2.63	0.016**
ΔlnGOVR(-1)	0.167	0.078	2.14	0.043**
ΔlnPRICE(-1)	0.089	0.045	1.98	0.060*
ΔINV(-1)	0.078	0.034	2.29	0.032**
C	0.023	0.015	1.53	0.140

Note: ***, **, * indicate significance at 1%, 5%, and 10% levels, respectively. Δ denotes first difference.

The error correction term coefficient is negative at -0.387 and highly significant. This confirms that there is a run relationship between the variables. It also shows that 38.7 percent of any disequilibrium is corrected each year. This means the system adjusts quickly toward equilibrium. It takes 2.6 years for the full adjustment to take place.

In the run changes in extraction costs have a significant negative impact on GDP growth.. The one-period lag and two-period lag show negative coefficients. This suggests that increases in extraction costs hurt growth not just right away but continue to have negative effects, over time. The impact persists beyond the period.

4.6 ARDL Model Results

As a robustness check we estimate an ARDL(2,2,1,1,1) model. This model was chosen using the Akaike Information Criterion. Table 6 shows the results of the bounds test for cointegration.

Table 6: ARDL Bounds Test for Cointegration

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Test Statistic	Value	k
F-statistic	6.847	5

Significance	I(0) Bound	I(1) Bound
10%	2.08	3.00
5%	2.39	3.38
2.5%	2.70	3.73
1%	3.06	4.15

The F-statistic of 6.847 is higher than the value, for the 1% significance level, which shows cointegration among the variables and it also supports the ARDL approach that we used.

Table 7 shows the run ARDL coefficients. These results match the findings from the VECM analysis.

Table 7: ARDL Long-Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
lnEXTC	-0.231	0.067	-3.45	0.002***
lnOILP	0.689	0.123	5.60	0.000***
lnGOVR	0.328	0.089	3.69	0.001***
lnPRICE	0.174	0.078	2.23	0.036**
INV	0.115	0.045	2.56	0.018**
C	8.234	1.567	5.25	0.000***

I find that the ARDL long-run coefficient for extraction costs is –0.231 which is almost identical, to the VECM result of –0.23. This close match gives me confidence that our findingsre robust. It shows that when extraction costs increase by 10 percent GDP will decrease by 2.31 percent in the run.

4.7 Granger Causality Test Results

Table 8 shows the results of the Granger causality test using the VECM framework.

Table 8: Granger Causality Test Results

Null Hypothesis	Chi-sq	df	Prob.	Decision
EXTC does not Granger cause GDP	12.67	2	0.002***	Reject
GDP does not Granger cause EXTC	8.23	2	0.016**	Reject

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OILP does not Granger cause GDP	15.34	2	0.000***	Reject
GOVR does not Granger cause GDP	9.78	2	0.008***	Reject

The results show that there is a two-way Granger causality between extraction costs and GDP growth. This means that when extraction costs go up economic growth goes down. During periods of economic difficulty, it becomes increasingly challenging and costly to extract resources. This reciprocal relationship indicates that feedback effects are present. These impacts can result in more severe economic fluctuations within Iraq's oil-dependent economy.

4.8 Diagnostic Tests

Table 9 presents the diagnostic test outcomes for the VECM model to ensure that the econometric results are reliable.

Table 9: Diagnostic Test Results

Test	Statistic	Prob.	Conclusion
Breusch-Godfrey LM (Autocorrelation)	2.34	0.126	No autocorrelation
Breusch-Pagan (Heteroscedasticity)	18.67	0.289	Homoscedastic
Jarque-Bera (Normality)	4.56	0.102	Normally distributed
Ramsey RESET (Specification)	1.78	0.183	Correctly specified

Every test that evaluates issues in the model indicates that our model is accurate. There is no evidence of problems such as the data being correlated over time, variations in data, the absence of patterns, or errors in the model's configuration. The tests referred to as CUSUM and CUSUM-sq (not presented here) also indicate that the model numbers remain relatively stable throughout the timeframe we examined.

4.9 Robustness Checks

To ensure our findings are robust, we perform additional verifications:

Alternative Extraction Cost Metrics: We recalibrate the model applying various extraction cost specifications, such as costs per barrel of reserves operational expenses that exclude capital investments and inflation-adjusted costs utilizing distinct base years. The key finding that increased extraction costs correlate with growth remains consistent across all tests, with values ranging from –0.19 to –0.28.

Sub-sample Analysis: We split the data into two sections, prior to 2003 and following 2003, due to rule changes. The relationship of extraction costs to lower growth is seen in both panels. It is more stable after 2003 (-0.31) than before 2003 (-0.18). That may mean the economy is more integrated, and the government more able to absorb cost hikes.

Alternative Lag Structures: We tested for lags of from 1 to 4 periods in both the VECM and ARDL models.While the numbers vary somewhat, the negative relationship between extraction costs and growth is statistically significant across all specifications..

5. Discussion

5.1 Interpretation of Key Findings

The empirical results show that the oil production costs have an adverse impact on Iraqi economic growth. Iraq's long-run elasticity is -0.23, meaning its economy is somewhat sensitive to changes in oil production costs. Over the period under study, a 10% increase in oil extraction costs would reduce GDP by 2.3%.

This is an important result for understanding how the Iraqi economy works and the problems faced by oil-dependent economies in general.The degree to which this relates shows how Iraq is also reliant on oil. Oil revenues make up the majority

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of the government's finances and the export earnings. With the rising costs of oil extraction, the total rent from oil is getting lower.

This reduces government revenue, constrains public investment, and depresses the broader economy. The error correction coefficient -0.387 reflects that the economy reacts relatively rapidly to extraction cost shocks and that most of the adjustment occurs in 2-3 years. Extraction costs and economic growth exhibit a two-sided causality, such that each can also affect the other and lead to a more severe boom and bust cycle in the economy.

During an economic downturn, a corresponding decrease in government and private investment leads to deferred maintenance – culminating in crumbling and, increasingly, dangerous roads and bridges. All of this drives up extraction costs, which then impede growth.This could set up a cycle that keeps an economy in stasis for periods too long.

5.2 Differing from Global Data

Our findings are consistent with the literature on the resource curse, though the magnitude and channel are different from those in other oil producers. Unlike Norway, as studied in Bjornland et al. (2019), Iraq is more responsive to extraction costs, which can be explained by its more diversified economy, weaker institutions, and less technological know-how.Iraq's negative extraction cost elasticity at –0.23 is far outside the usual range of –0.08 to –0.15 for developed oil producing countries. This magnitude is less than the minus 0.35 to minus 0.45 range found in some sub-Saharan African oil countries, as outlined in Ross, 2019. This is a median position such that Iraq has enough oil reserves and production capacity to insulate cost shocks but on the other hand, Iraq still has weak institutions and virtually no economic diversification.Iraq exhibits a fast error correction rate of 38.7 percent which is higher than those slower adjustments often found in more diversified economies.This means that the concentrated economy of Iraq exaggerates the effect on the short-term and the response to the shocks in the oil industry.

5.3 Transmission Mechanisms

Extraction costs have a substantial impact on the economic growth of Iraq through a number of channels:

Fiscal Channel: extraction expenses reduce government oil revenue. Government revenue is over 95% from oil exports. When oil revenue falls, the government is compelled to cut spending. This leads to lower government investment and reduced social programmes. All of this is detrimental to development. There is a relationship between oil revenue and GDP growth. The long-run elasticity is 0.67, which shows the importance of this channel.

Investment Channel: Rising extraction costs reduce the profitability of oil projects and deter investment by both domestic and foreign firms in the oil industry. Due to the large role of the oil sector in the Iraqi economy, lower oil investments have a multiplier effect across various sectors of the economy. This happens through direct connections to different sectors.

External Sector Channel: Higher extraction costs lead to lower revenues from oil exports. This affects the balance of payments and foreign currency availability. This can lead to import restrictions, pressure for the currency to depreciate and reduced access to the inputs and equipment needed for growth.

Confidence Channel: Higher extraction costs are often a sign of problems within the oil industry. These problems may be related to security, infrastructure or weak institutions. This can reduce investor confidence. It also leads to capital flight, making economic growth harder..

5.4 Structural Break Analysis Implications

The Observance of Disruptions in 1991, 2003 and 2007: The 1991, 2003 and 2007 Release Sciences from Close-Up: Disruptions grew larger than the disruptions between those years The years 1991, 2003, and 2007 The recognition that the 1991, 2003 and 2007 editions were underrated can now make use of a direct comparison/competing growth analysis to look at factors of change growth rates illustrates the impact of large political and economic events for the neighboring growth relationship between Extract and Growth. Following the Gulf War in 1991, destruction of infrastructure, restricted access to technology and difficult operating conditions along with UN sanctions imposed a dramatic rise in costs associated with extraction.

Such as the 2003 Iraq War and regime change disrupted production. Infrastructure was initially destroyed. Yet innovative technology and foreign capital allowed the long-term costs of extraction to decline. Spiking violence and the global financial crisis of 2007, dramatically amplified the costs of pursuing oil.

These structural breaks signify that Iraq's economy has undergone a transformation vis-a-vis oil extraction costs, turning more sensitive to cost fluctuations as the country became more integrated into markets and oil-dependent after the political transition in 2003. I know the importance of those changes.

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5.5 Policy Implications

The findings have important policy implications for the design of economic development policy in Iraq:

Lowering Extraction Costs: Given that extraction costs are a major barrier to growth, policies to reduce these costs should be at the forefront of growth strategies. This includes investing in extraction technologies, improving security, modernizing infrastructure, and increasing operational efficiency through better management and international partnerships.

Economic Diversification: The substantial sensitivity of growth to extraction costs highlights the urgency for economic diversification. Reducing dependence on oil revenues would reduce the exposure of the economy to fluctuations in extraction costs. It would provide alternative sources of growth when costs for oil production are high.

Financial Management: The government should create stabilization funds. Use counter-cyclical fiscal policies to insulate the economy from swings in extraction costs. This entails building reserves in times of low extraction costs so that public investment can continue in high cost periods.

Institutional Development: Improving governance, reducing corruption and strengthening frameworks can reduce extraction costs by creating a more predictable and efficient environment for oil companies.

5.6 Limitations and Future Research

This study has some limitations, despite the fact that it reveals some insights into the relationship between extraction costs and growth in Iraq. First, the small sample size of 33 observations reduces the power of some tests, although this is partially compensated by the use of relevant small-sample methods. Second, the quality of data used to estimate extraction costs under war and sanctions may be subject to considerable error. Such problems were reduced by using multiple data sources and cross-checks. Third, the study focuses on general relationships and does not examine regional or sectoral differences within Iraq, which may reveal more information about the relationship between extraction costs and growth. Future research could incorporate data to test for differences in the relationship between extraction costs and growth across various regions, investigate how specific institutions affect the relationship between extraction costs and growth, and/or combine data from other oil-producing nations impacted by conflict in order to identify common patterns and inform evidence-based policy recommendations.

6. Conclusion

To the best of my knowledge, this is the first paper to analyse the oil production costs and economic growth nexus in Iraq through an econometric approach. Employing advanced time series methods that take Iraq's economic and political environment into account, the authors.

The main result that is reported is that a 10 percent increase in the cost of oil extraction is associated with a long-run decrease in Iraq's GDP by about 2.3 percent. 30.8 percent of this adjustment takes place within a year.

A stable negative relationship is supported by the VECM and ARDL estimations. Granger causality tests reveal a bi-directional causality between oil extraction costs and economic growth. This suggests that in the event of an economic collapse in Iraq, oil extraction costs could rise and further damage the economy.

The analysis of the structural break shows that there are changes in 1991, 2003 and 2007. These are the Gulf War, the Iraq War and the peak of violence, respectively. The disruptions show that political instability and war have transformed the financial system of Iraq and have increased its sensitivity to the costs of oil extraction.

The findings have important policy implications for Iraqi leaders. First, reducing the costs of oil extraction by improving technology, developing infrastructure and enhancing security should be a top priority. Moreover, the high dependence on oil extraction costs highlights the need for Iraq to diversify its economy to reduce its reliance on oil revenue. Better fiscal regulations, such as stabilization funds and counter-cyclical measures, could help protect the economy from shocks of rising oil extraction costs.

The paper is the first econometric analysis of oil extraction costs in a large oil-producing developing country and adds to the literature in the energy economics field. The tests that incorporate breaks and different cointegration tests provide a good model that other resource-dependent countries can use.

The implications are wider than just Iraq, applying to other developing countries whose economies are heavily dependent on natural resources. The finding that costs of oil extraction can create cycles that can amplify fluctuations suggests that the resource curse might be worse than believed when factoring in changes in production costs. This is relevant for development policies in resource-rich nations with weak institutions and limited diversification.

For the community, the results underscore the importance of investing in institution building, infrastructure and promoting diversification in resource-dependent economies. International banks and aid organizations should factor in the costs of oil extraction when designing support packages for developing countries that produce oil.

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Iraq's long-term growth strategy must focus on breaking the dependence of its economy on oil extraction costs. Continued investment in people, infrastructure and institutions is necessary. Even though Iraq has oil wealth, that wealth needs to be converted into sustainable wealth by reducing the costs of oil extraction and diversifying the economy.

The research continues to be relevant as Iraq seeks to rebuild its economy and its oil industry after years of chaos.As global energy markets shift and new extraction techniques emerge, the impact of oil extraction costs on performance will be a key driver of Iraq's long-term prospects.

To sum up, the results of this study suggest that the oil extraction cost is an under-examined factor of economic growth in resource-dependent countries. The strong negative result for Iraq together with the feedback loops and policy implications offers insights for researchers and policy makers on a sustainable future in oil exporting countries. The methods and findings set a base for studies on oil extraction costs, in other resource-heavy economies over time.

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