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Natural Gas Production Forecasts in Iraq for the Period (1984-2022) Using ARIMA Time Series Models

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ABSTRACT

Objective: *This study predicted natural gas production in Iraq for the period (1984–2022) using ARIMA (Auto Regressive Integrated Moving Average) time series models.* ***Method:*** *The research relied on historical data of gas production to build a model capable of forecasting future trends, while analysing seasonal fluctuations and patterns.* ***Result:*** *The results demonstrated the efficiency of the ARIMA model in estimating future production based on past data patterns.* ***Novelty:*** *This study contributes to optimal planning for the exploitation of natural resources in Iraq.*

INTRODUCTION

Natural gas with oil extraction represents a fundamental pillar of Iraq's energy sector. Its production is intrinsically linked to crude oil extraction operations, and this vital resource holds significant importance by adding value to the national economy—whether through electricity generation, feeding petrochemical industries, or potential export opportunities to boost government revenues.

In practice, however, managing this resource faces substantial challenges, primarily due to inadequate infrastructure for gathering and processing, which leads to the wasteful flaring of copious quantities of gas and consequent severe environmental and health impacts. This issue is further complicated by the significant fluctuations in associated gas production over the past two decades, driven by Iraq's volatile security, political, and economic conditions.

In this context, accurate forecasting of gas production takes on critical strategic importance. Reliable predictions enable optimal planning for infrastructure development, efficient allocation of resources between domestic consumption and export, and support environmental commitments by reducing gas flaring. There is a pressing need for advanced analytical tools capable of modelling the complex patterns in production trends.

Theoretical and Methodological Framework

This study adopts an integrated scientific methodology based on ARIMA (Autoregressive Integrated Moving Average) models, renowned for their ability to analyse complex time series data. Combining the strengths of autoregressive analysis, regression, and moving averages, ARIMA provides an ideal tool for understanding the dynamics of associated gas production and forecasting its future trajectory.

A comprehensive set of analytical tools will be employed, including the Dickey-Fuller test to assess data stationarity, autocorrelation functions to identify change patterns, and precise informational criteria to select the optimal model. The accuracy of results will be evaluated using multiple statistical metrics to ensure forecast reliability.

From an applied perspective, the study aims to achieve multi-level objectives: establishing a robust historical production database, analyzing influencing factors, generating quantitative forecasts for decision-making, and developing future scenarios to support sustainable energy policies in Iraq. These efforts align with the country's pursuit of balancing development needs with international environmental commitments.

Question

Given the challenges facing Iraq's energy sector, particularly in managing associated natural gas, the main question of the study arises:

"What is the optimal model for forecasting natural gas production in Iraq for the period (1984-2022) using ARIMA time series models?"

This includes analysing the accuracy of these models in predicting future production and how they can be used to improve strategic planning.

Hypothesis

The study assumes that:

a. ARIMA models can accurately forecast gas production in Iraq based on historical data.
b. There are clear patterns (trends, seasonal fluctuations) in production data that can be statistically modelled.
c. Using these models contributes to improving the efficiency of gas management and reducing waste.

Objectives

a. Analyse time series data of gas production in Iraq to identify trends.
b. Build an optimal ARIMA model that aligns with the data.
c. Characteristics.
d. Forecast future production of gas and evaluate the model's accuracy using statistical metrics (e.g., MSE, RMSE).
e. Provide recommendations for policymakers to maximise the utilisation of this resource and reduce the environmental impact of gas flaring.

Significance

a. Economically: Accurate forecasting helps optimise investments in gas infrastructure and reduces financial losses due to waste.
b. Environmentally: It minimises gas flaring (one of Iraq's largest sources of emissions) in line with the country's commitments to climate agreements.
c. Academically: It contributes to the literature on statistical modelling in natural resource management in oil-producing countries.

RESEARCH METHOD

1. Data Collection: Reliance on sources such as the Iraqi Ministry of Oil and OPEC.
2. Exploratory Analysis: Use of graphical tools (time plots, ACF, PACF) to detect trends and seasonality.
3. ARIMA Modeling:
   - Determine model order (p, d, q) using AIC and BIC criteria.
   - Test stationarity (Dickey-Fuller test).
4. Evaluation: Measure model accuracy using metrics like MAE and MAPE.
5. Forecasting: Estimate future gas production and validate the results' reliability.

Temporal and Spatial Boundaries

- Temporal Scope: The study covers the period from 1984 (after major political changes) to 2022.
- Spatial Scope: Limited to Iraq.

Theoretical and Practical Inference

- Theoretically: Literature confirms that ARIMA is one of the most effective models for forecasting economic time series, as seen in similar studies on Gulf countries' gas production.
- Practically: The results can support Iraq's plans to achieve self-sufficiency in domestic gas by 2034.

RESULTS AND DISCUSSION

First: The geological composition of areas where natural gas is found

Iraq is an important part of the large sedimentary basin, which has made it ideal for the formation of oil and gas deposits in large commercial quantities. The geological environment of Iraq was shaped by its location between the Arabian Shield rocks in the west and the Iranian Plateau rocks in the east, which slope gradually towards Iraq and form the basis of the sedimentary basin's structure [1].

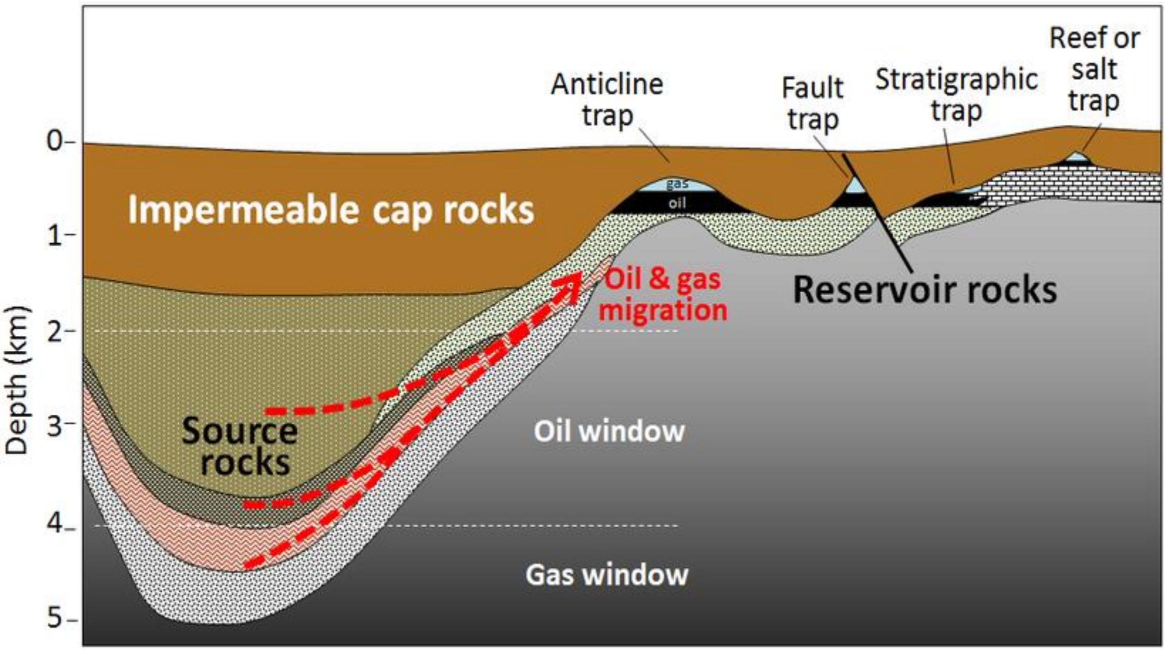
As a result of geological developments caused by the movement of land masses, which led to the emergence of sedimentary rock elevations, some of which appeared above the earth's surface in modern geological eras after the sedimentary basins had been filled with large deposits following the flooding of most of Iraq by the ancient Tish Sea.

These formations covered most of Iraq. In the sedimentary plain, formations from the fourth period prevail, while formations from the third and second periods are spread across the northern and western edges of the first region, adjacent to the older formations from the first period in the far north-east and far west of Iraq. As a result of the gradient in the region, the distribution pattern of these formations was consistent with the rise and fall of ancient sea levels, which had an impact on the variation in the ages of these formations [2].

From the above, we conclude that several geological conditions must be present in order to obtain commercial quantities of oil and gas in Iraq, the most important of which are:

1. **Source rocks:** These are the primary material from which oil originated, which is difficult to identify today due to the presence of oil in other rocks, although many specialists believe that most of it is found in soft sediments rich in organic matter and in a reducing environment [3], [4].
2. **Reservoir:** After oil and gas are formed in source rocks (shale), this does not mean that they remain in these rocks, because their continuous accumulation underground means an increase in the pressure exerted on them, this leads to a reduction in the size of the rock and a reduction or elimination of the voids in it. Since these voids contain hydrocarbons (oil and gas), they are released along with it. Since gas and oil are less dense than water, they leave their places of formation and rise to the upper layers, which is known as 'oil migration,' as shown in Figure 1.

These rock layers are highly porous and permeable and are known as reservoir rocks [5]. Oil and natural gas are able to move within reservoir rocks due to differences in pressure, and they continue to move until they are contained within oil traps (such as domes and closed folds). Hydrocarbons accumulate in these traps according to their density, with gas at the top, followed by oil and then water. The reservoirs must be capped by impermeable rocks that prevent the flow of hydrocarbons, called cap rocks.



Source: Mohamed Haytham Ahmed Kamal, former source, p. 27.

Figure 1. The formation of oil or gas in source rocks and how it migrates to reservoir rocks (oil migration).

3. **Cap rocks:** When oil and gas accumulate during their migration, they must collide with impermeable upper layers that stop the flow of oil or gas upwards or downwards. The upper layers are called cap rocks or roofs, while the lower rocks are called lock barriers. These rocks consist of evaporites (anhydrites and salt rocks) as well as shale and impermeable limestone rocks [6].

Second: Natural gas installation

Definition Of Natural Gas

The term ‘natural gas’ refers to gas that rises to the surface of the earth from underground reservoirs whose composition varies significantly, and which may or may not be directly associated with crude oil reservoirs. A vivid example of this is the ‘eternal flame’ in Kirkuk, which burns continuously as a result of gas leaking from the Kirkuk field through cracks. When analysed, the gas contains at least 95% hydrocarbons, with the remaining 5% consisting of nitrogen and carbon dioxide, accompanied in some cases by a small percentage of hydrogen sulphide [7].

The main hydrocarbon is methane, which is the cleanest and most volatile of the paraffins [8]. Heavier paraffins with higher boiling points, such as ethane, propane, butane, hexane and heptane, are found in decreasing proportions. Between 70% and 100% of the hydrocarbons in natural gas may consist of methane, while pentane and heavier hydrocarbons rarely constitute more than 1-2% by volume and may be so small as to constitute between 0.1-0.2% by volume.

From this, natural gas can be defined as:

a mixture of hydrocarbon and non-hydrocarbon components found in rock reservoirs beneath the earth's surface along with crude oil, and it can also be found in fields containing only natural gas (free gas).

Third: Types of natural gas:

The nature of natural gas deposits underground varies. They may be mixed with oil, due to the pressure and temperature of the reservoir containing them, or they may exist freely in their own fields with a small percentage of oil [9].

There are two types of natural gas in Iraq:

1- Gas associated with oil (associated gas)

This is gassing whose production cannot be controlled, as it accompanies the production of crude oil, where a dissolved quantity is released with each barrel of oil due to pressure and temperature conditions. Most of these gases separate from the oil when it emerges from underground to the surface, where atmospheric pressure prevails. To preserve these gases, the produced oil is received in gas separation and cooling units.

Associated gas production rates depend on oil production rates, and this type of gas is the main source of natural gas in Iraq.

Associated gas contains a lower percentage of methane than free gas and a higher percentage of impurities [10].

2- Non associated gas (free gas)

This is gas extracted from independent natural gas reservoirs. Unlike associated gas, its production can be easily controlled and programmed according to demand, unlike associated gas, whose production cannot be controlled because it is linked to crude oil production. There are free gas deposits in the Arab world, with Algeria being the largest producer of this type of gas, followed by the United Arab Emirates and Qatar. Globally, 40% of gas reserves are associated with oil, and 60% are non-associated [11]. It contains methane and ethane, with methane accounting for between 70 and 100% [12]. This type of gas is classified into two categories:

a. Field gas: This is gas found in reservoirs with formation water below it and no oil layer between the gas and water [13].
   Gas fields in Iraq were not developed until recently, when it became necessary to provide more gas to meet the requirements of industrial projects that use gas either as a feedstock (feed) for petrochemical and fertiliser projects or as industrial fuel for power stations and other facilities. Examples of this type of gas field include Jamgal, Kura Mor, Wartawi and Damirq. These fields mostly contain gas with a high percentage of methane, including the Anfal gas field.
b. Dome gas: Dome gas forms a gas dome above oil or water because gas is lighter than oil and oil is lighter than water, so that the oil reservoir takes on different shapes, including a dome-like shape [9].

Forth: The importance of natural gas:

Natural gas is used in many areas, reflecting its importance, including:

1- Energy source:

Natural gas is used as a source of thermal energy, including:

a. Natural gas is the ideal fuel for the oil industry in oil and gas production facilities, whether in the fields or in the refining and processing industry, gas liquefaction, petrochemicals, and fertilisers.
b. Natural gas is an important source of thermal energy, as the amount of thermal energy that can be obtained from every 6,000 cubic feet of gas is approximately equal to the heat obtained from burning one barrel of crude oil, which makes it preferable to oil and coal as an energy source [8].
c. Natural gas is used as fuel in steam and gas power plants to generate electricity .
d. Gas is one of the best types of fuel known for domestic use, especially in cooking, cooling and heating, given its ease of use and flexibility, as well as its high thermal energy, as mentioned above in paragraph (b) [7].
e. It is used in a number of industries, especially those that require copious amounts of energy, such as the metal industries (iron and steel, aluminium), the cement and brick industries, and the chemical industries.
f. Natural gas in its liquid form is used as fuel for transportation and competes with petrol in this activity for reasons including [14]:
   1) It does not require chemical additives such as lead or organic materials.
   2) It is easier to use in engines.
   3) The octane rating of liquid gas is higher than that of automotive gasoline [8].
g. It is used in the agricultural sector in cotton and grain drying processes and in incubators.
h. It is used as fuel for steam boilers used in drinking water desalination processes.

2- Raw material in industry:

Natural gas is a raw material in the production of a wide variety of petrochemical products, and the petrochemical industry is one of the most important industries the country's economic and social development plan is based on. Since no alternative existed to satisfy the requirements of the expanding number of people for industrial goods than installation of petrochemical industries and supplying of the agriculture by the required fertilizers and dressings that double the production repeatedly petrochemistry is developed with an accelerated rate. There are a lot of improvements in the fields of processing methods and improvement of the specifications to respond to the consumers' requirements at the competitive prices, so this industry would be a good substitution for the traditional engineering materials.

3- Production of Natural Gas in Iraq

Iraq holds one of the significant natural gas reserves in the world, proven reserves are more than 132 TCF, ranking 12th globally as the reserves are concentrated in the southern part. But a large chunk of this gas is burned off as flares or because there is no use for it.

Table 1. Shows the quantities of natural gas production in Iraq for the period 1984-2022 million standard cubic meters/ year.

Production Quantity	Sunnah	Production Quantity	
14152	2004	5290	1984
14370	2005	6844	1995
15516	2006	8524	1986
17520	2007	11173	1987
16887	2008	13820	1988
18692	2009	16310	1989
20496	2010	12872	1990
21386	2011	3719	1991
22364	2012	6848	1992
24513	2013	7237	1993
29326	2014	7255	1994
29870	2015	7795	1995
31358	2016	8138	1996
32699	2017	10326	1997
28738	2018	13122	1998
30275	2019	14561	1999
30730	2020	14540	2000
14152	2021	14719	2001
14370	2022	13755	2002
		9781	2003

Source: Central Bureau of Statistics for the years 1984-2022.

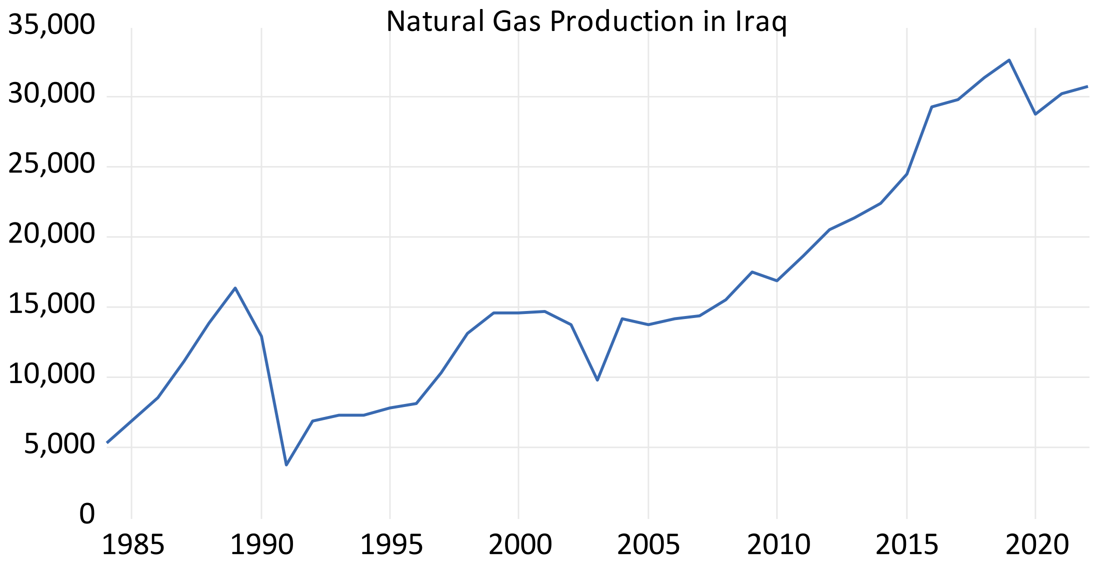


Figure 2. Shows the amount of natural gas production in Iraq for the period (1984-2022).

Figure 2 illustrates that natural gas production in Iraq has undergone several distinct phases:

Growth Phase (1985–1990):

This period witnessed rapid growth in natural gas production, increasing from approximately 5,000 million m³ to over 15,000 million m³. This improvement is attributed to attempts to develop gas infrastructure and to connecting certain oil fields with early utilization projects for associated gas.

Decline Phase (1991–1993):

This stage was characterized by a sharp decline in production, dropping to less than 5,000 million m³. The decline is explained by the conditions of the international economic embargo imposed on Iraq, which led to an almost complete paralysis in the development and investment of natural gas fields.

Relative Stability Phase (1994–2003):

During this phase, production fluctuated between 7,000–15,000 million m³, with only minor variations. This relative stability reflects limited investment and weak technical capacity for the development of gas fields.

Gradual Recovery Phase (2004–2010):

Production began to recover gradually after 2003, rising from 12,000 to 17,000 million m³. This recovery is attributed to political and economic changes, as well as the opportunities granted to foreign companies through participation contracts and oil licensing rounds.

Rapid Growth with Slight Decline Phase (2010–2022):

Iraq experienced a continuous increase in natural gas production, rising from 15,000 to 30,000 million m³. A slight decline followed, bringing production down to 29,000 million m³, before a modest rebound to 31,000 million m³. This growth is linked to the expansion of oil licensing rounds and the concurrent utilization of associated gas in southern fields (Basra, Maysan, Dhi Qar), in addition to projects aimed at reducing gas flaring [15]. The temporary decline, however, is attributed to the COVID-19 pandemic, which caused a slowdown in growth and production not only in Iraq but also globally.

General Trend:

The overall trend reveals that natural gas production in Iraq has followed an upward trajectory in the long term, despite intermittent periods of decline and contraction. This development reflects the significant role of natural gas in the Iraqi economy.

Time Series Methods for Natural Gas Production

Time series are one of the most valuables statistical techniques for the analysis of time-dependent data because their scope is to discover temporal patterns, cyclical, and seasonal variations and to predict the future value of the variables of interest. These series are applied in areas including economics, management, social sciences, engineering, and other science fields.

A time series is a sequence of observations over a time interval. The observations in this research are a monthly series of associated gas production in Iraq from 1984 to 2022. Time series analysis has the following features:

- Dependence on temporal ordering (Temporal Dependence)
- Presence of patterns (Trends, Seasonality, Cyclicity).
- Non-stationarity of statistical distribution over time (non-stationarity)

1. Definition of Time Series

Time series consist of a collection of numerical values of some variable or phenomenon measured through time at regular intervals (e.g. daily, monthly, quarterly, or annually). The aim of the time series is to detect the main components including overall trend (Trend), seasonal variations (Seasonality), cycles (Cycles), and irregular variations (Irregular variations).

2. Study Methodology

The methodology of this study is based on the following:

a. Identifying the research problem: Analysing time series for the purpose of forecasting future values.
b. Data selection: Quantitative data distributed over time.
c. Applying statistical methods: Using time series analysis models to
d. extract patterns.
e. Model construction: Employing ARIMA models due to their flexibility in analysing economic phenomena.
f. Model testing: Verifying the model’s adequacy using statistical criteria such as AIC and SIC.
g. Forecasting: Using the selected model to generate future values and validate its accuracy.

3. Time Series Methods

There are multiple methods for time series analysis, among the most prominent:

a. Moving Averages Method.

b. Exponential Smoothing Method.
c. Autoregressive Models.
d. ARIMA (Autoregressive Integrated Moving Average).
e. Seasonal Models (SARIMA).
f. Artificial Neural Networks (ANN).
g. Box–Jenkins Method.

4. ARIMA Models

Time series analysis represents a fundamental process in quantitative forecasting methods, as it relies on past and present data to provide a clear picture of the future behavior of the studied phenomenon, as well as the influencing factors and patterns affecting it. The modeling process is characterized by specific features that can be inferred, serving as a primary objective in time series analysis.

The ARIMA model (Autoregressive Integrated Moving Average) is one of the most important statistical models for time series analysis. It is used to forecast future values based on past values and random fluctuations.

- AR (Autoregressive): Depends on previous values of the variable.
- I (Integrated): Aims to stabilize the time series through differencing.
- MA (Moving Average): Relies on forecasting through previous random errors.
- ARIMA(p,d,q) Model Estimation
- Enter the specified values, e.g., ARIMA (1 ,1).
- Display estimated coefficients: φ_1, θ_1, and constant.
- Present quality criteria such as AIC and SIC (BIC) for model selection.

5. Measuring and Analyzing the ARIMA Model for Forecasting Natural Gas Production

Eight different models were estimated for forecasting based on the ARIMA approach, including the Moving Average model with two periods (MA (2), the Simple Exponential Smoothing model, and Holt's Simple Exponential model. The dataset consisted of 39 observations representing annual periods. Accordingly, the ARIMA (1,0,0) model was identified as the most suitable estimator for forecasting natural gas production values. The forecasts generated by this model indicate a continuous and sustained increase in production during the period 2023–2034, with an annual growth rate of 1.0275, at a highly significant statistical level ($p = 0.0000$). Thus, the ARIMA (1,0,0) model represents the best estimated model, as demonstrated in Table 2, when compared with other estimates according to statistical and econometric criteria.

The values of the Akaike Information Criterion (AIC) and the Hannan–Quinn Criterion (HQC) for the optimal lags were the lowest among all estimated models, with the AIC recorded at 15.69. Similarly, the Root Mean Square Error (RMSE) was the lowest across all estimated models, at 2500.31, as shown in Table 3. Furthermore, the estimated model outperformed the other statistical and econometric measures, such as the RUNS test and the variance difference test (VAR), as illustrated in Table 4 comparing predictive models and identifying the most appropriate one.

The probability value (p) was statistically insignificant and greater than 5% ($p \geq 0.05$), which reflects the robustness of the model's estimation. Additionally, the Test for Randomness of Residuals was also statistically insignificant (P-value = 0.87), relating to values above and below the median, with a test statistic of 389.6, thereby further confirming the validity of the ARIMA (1,0,0) model as the best forecasting tool.

Table 2: Selected Model for Forecasting Natural Gas Production

Forecast Summary

Forecast model selected: ARIMA (1,0,0)

Number of forecasts generated: 12.

Table 2. ARIMA Model Summary.

Parameter	*Estimate*	*Stnd. Error*	*t*	*P-value*
AR (1)	1.02751	0.0226886	45.2876	0.000000

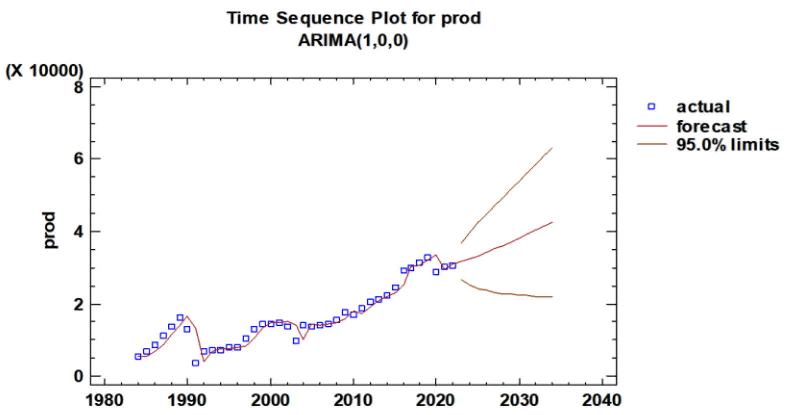
Source: Statistical Program Outputs Statgraphıcs.

Table 3. Estimated Forecasting Metrics for Natural Gas Production Models Estimation Period.

Model	*RMSE*	*MAE*	*MAPE*	*ME*	*MPE*	*AIC*	*HQC*	*SBIC*
(A)	3030.09	2257.64	21.126	983.203	-0.243822	16.084	16.0993	16.1266
(B)	2548.95	1810.9	17.481	652.368	-0.0270967	15.7382	15.7535	15.7808
(C)	2891.11	1998.33	21.7108	141.917	-1.20333	15.9901	16.0054	16.0327
(D)	2773.04	1896.56	18.8095	340.332	-5.42256	15.958	15.9886	16.0433
(E)	2500.31	1648.29	16.9271	219.589	-2.8515	15.6996	15.7149	15.7423
(F)	2529.53	1679.02	16.8328	219.11	-3.9415	15.7229	15.7382	15.7655
(G)	2531.51	1657.39	16.8825	227.508	-2.6375	15.7757	15.8063	15.861
(H)	2539.1	1727.66	17.2716	197.825	-3.13262	15.833	15.8789	15.9609

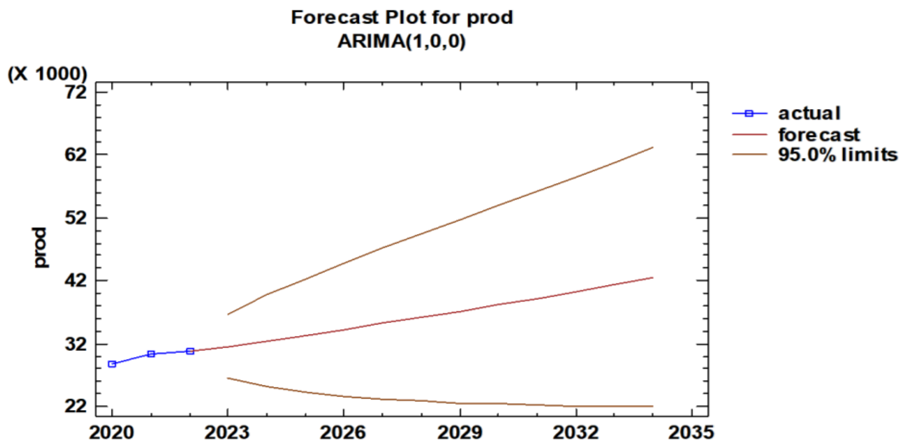
Source: Statistical Program Outputs Statgraphıcs.

Figure 3 and 4 also indicates the quality of the estimate of the Goodness estimation of the convergence or conformity of the real values of the data with the values predicted by the estimated model (ARIMA1,0,0) for the past period (1984-2022). The predicted values for the subsequent period (2023-2034) are also within the upper limits and lower limits of the confidence limits with a probability of 95% as shown in the table.



Source: Statistical Program Outputs Statgraphıcs

Figure 3. Time series of natural gas production quantities according to the ARIMA (0.0.1) model.



Source: Statistical Program Outputs Statgraphıcs.

Figure 4. Natural Gas Production Forecast by ARIMA Model (0.0.1).

Table 4 of Figure 5 and Figure 6 also show that there is no problem of residuals autocorrelation and the case of partial correlations, so that the volume of gas production will become (33336.7) units in 2025 and reach (4256.3) in 2034, and these predicted values fall within the limits of the upper and lower confidence with a probability of 95% as shown in Table 5.

Table 4 shows the estimation of the autocorrelation of residuals according to the ARIMA model (0,0,0,1).

Estimated Autocorrelations for residuals

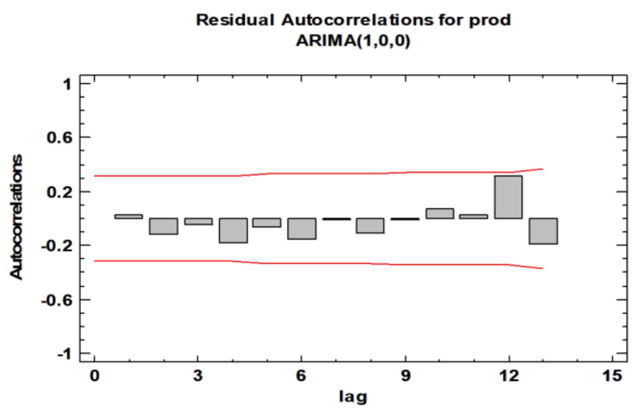
Data variable: prod

Model: ARIMA (1,0,0). Lower 95.0%.

Table 4. Shows the estimation of the autocorrelation of residuals according to the ARIMA model (0,0,0,1).

Lag	*Autocorrelation*	*Stnd. Error*	*Prob. Limit*	*Prob. Limit*
1	0.0276762	0.160128	-0.313846	0.313846
2	-0.118284	0.160251	-0.314086	0.314086
3	-0.0440025	0.162474	-0.318444	0.318444
4	-0.177711	0.162779	-0.319042	0.319042
5	-0.0622972	0.16768	-0.328648	0.328648
6	-0.151049	0.168273	-0.329809	0.329809
7	-0.00659905	0.171714	-0.336554	0.336554
8	-0.109399	0.171721	-0.336567	0.336567
9	-0.0126112	0.173498	-0.340051	0.340051
10	0.0738904	0.173522	-0.340097	0.340097
11	0.0254272	0.174327	-0.341675	0.341675
12	0.315529	0.174422	-0.341861	0.341861
13	-0.188383	0.18849	-0.369435	0.369435

Source: Statistical Program Outputs Statgraphıcs.



Source: Statistical Program Outputs Statgraphıcs.

Figure 5. shows the autocorrelation function of the residue according to the ARIMA model (1,0,0).

Table 5 shows the estimation of partial residual correlation according to the ARIMA model (0,0,1) Estimated Partial Autocorrelations for residuals.

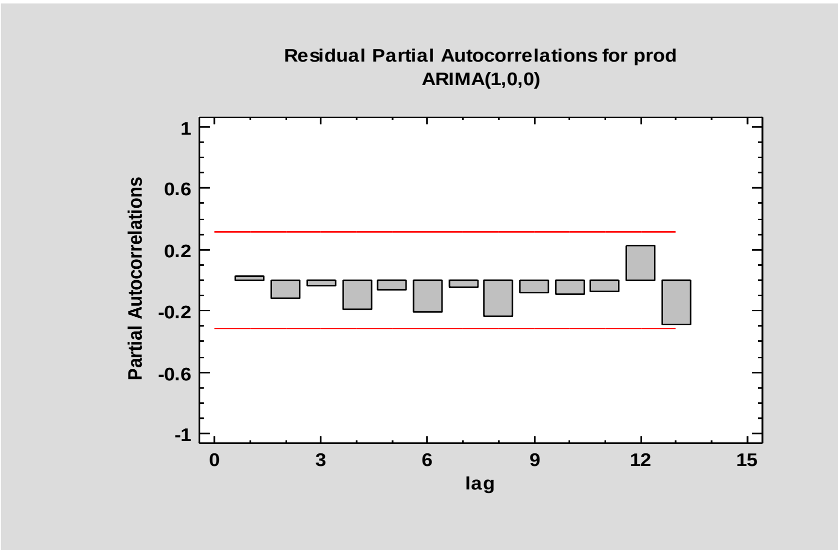
Data variable: prod

Model: ARIMA (1,0,0).

Table 5. Shows the estimation of partial residual correlation according to the ARIMA model (0,0,1) Estimated Partial Autocorrelations for residuals.

Lag	*Partial Autocorrelation*	*Stnd. Error*	*Lower 95.0% Prob. Limit*	*Upper 95.0% Prob. Limit*
1	0.0276762	0.160128	-0.313846	0.313846
2	-0.119142	0.160128	-0.313846	0.313846
3	-0.0376036	0.160128	-0.313846	0.313846
4	-0.192608	0.160128	-0.313846	0.313846
5	-0.0671276	0.160128	-0.313846	0.313846
6	-0.210695	0.160128	-0.313846	0.313846
7	-0.0442955	0.160128	-0.313846	0.313846
8	-0.231449	0.160128	-0.313846	0.313846
9	-0.0847928	0.160128	-0.313846	0.313846
10	-0.0920825	0.160128	-0.313846	0.313846
11	-0.067543	0.160128	-0.313846	0.313846
12	0.226158	0.160128	-0.313846	0.313846
13	-0.288481	0.160128	-0.313846	0.313846

Source: Statistical Program Outputs Statgraphıcs.



Source: Statistical Program Outputs Statgraphıcs.

Figure 6. Shows the partial correlation function according to the ARIMA model (1,0,0).

Table 6. Upper and Lower Confidence Limits with 95% Probability for Estimating the ARIMA Model (0.0.1) for Prediction.

		Lower 95.0%	*Upper 95.0%*
Period	*Forecast*	*Limit*	*Limit*
2023	31575.4	26512.8	36638.0
2024	32444.1	25185.4	39702.9
2025	33336.7	24322.4	42351.1
2026	34253.9	23698.3	44809.5
2027	35196.3	23226.9	47165.6
2028	36164.6	22864.7	49464.5
2029	37159.5	22586.1	51732.9
2030	38181.9	22374.9	53988.8
2031	39232.3	22219.7	56244.9
2032	40311.7	22112.7	58510.6
2033	41420.7	22047.9	60793.5
2034	42560.3	22020.7	63099.8

Source: Statistical Program Outputs Statgraphıcs.

CONCLUSION

Fundamental Finding : The production of natural gas in Iraq has increased continuously for the period 1984–2022 to reach 30,730 million standard cubic meters in 2022, despite fluctuations during this time, and the results of the use of the standard ARIMA (0,0,1) model indicated that natural gas production will continue to increase for the period 2023–2034 to reach 42,560 million standard cubic meters in 2034 with an annual growth rate of 1.027, while the results of using the ARIMA model for forecasting were good in estimation, standard, and statistical aspects since the real production values were close to the estimated values with very high statistical significance, making them reliable for predicting future values of natural gas production in Iraq until 2034. **Implication :** These findings emphasize the importance of paying great and increasing attention to the natural gas industry in production and consumption in Iraq, including the development of infrastructure and investment to enhance the environment for the development of natural gas industries. **Limitation :** However, in light of the increasing consumption of natural gas in Iraq and the high percentage of losses of natural gas associated with oil production, where a large portion is flared, there remains a widening gap between production and consumption, currently bridged by costly imports from neighboring countries that also cause environmental harm. **Future Research :** It is necessary to further explore strategies to maximize the use of associated gas and reduce flaring, which represents a missed financial, economic, social, and environmental opportunity, while also developing recommendations for sustainable policies to balance production, consumption, and environmental concerns.

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