FORECASTING PERFORMANCE IN IRAQI STOCK EXCHANGE FOR THE OIL PRICE THROW THE GM (1,2) MODEL AND THE IMPACTS ON ECONOMIC GROWTH

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ABSTRACT

Iraq's oil industry is the country's main source of income. Iraq's manufacturing sector has always been heavily dependent on the country's oil exports. Since the end of the Iraq War, Iraq has expanded its output and is currently the region's second-largest producer. For this investigation, the grey model was run using data on the monthly international price of Iraqi oil from October 2020 through September 2022. Researchers evaluated the MAPE and accuracy rate to choose which model to employ for oil price forecasting, and we found that the GM(2,1) model was the best fit for capturing the dynamics of the Iraqi oil market (precision rate = 96%, MAPE = 4%).

KEYWORDS

oil price, grey model, forecasting.

PAPER INDEX

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INTRODUCTION

Petroleum, commonly known as crude oil, is a naturally occurring liquid that may be converted into fuel and is found deep below the Earth's surface. Petroleum is a fossil fuel formed from the gradual breakdown of organic matter; it is burned to generate energy, heat buildings and machinery, and is also used in the production of plastics. As a result of its widespread use, the petroleum industry has significant sway in international affairs, and the wealth and business of countries such as Iraq, Saudi Arabia, and the United Arab Emirates are heavily invested in the sector. The study attempted to highlight the causal relationship between oil prices in the stock market and economic growth in Iraq. The study is based on the hypothesis that there is a bidirectional causal relationship between economic growth and global oil prices. Therefore oil prices will have a significant impact on the structure of economic growth in Iraq.

Iraq is one of the world's largest oil producers but is in an unstable political and economic situation. According to OPEC data, Iraq is rated fifth in the world, behind Venezuela, Saudi Arabia, Canada, and Iran. It should be noted that from 1986 until 2008, it was ranked second.

Oil was found inside Iraqi territory at the beginning of the twentieth century, and the first oil well was dug by the reigning British authorities in Iraq in 1902, but the notion of creating the global oil industry did not become popular until after World War II.

Since the sixties and seventies, Iraq's oil wealth has contributed to the country's rapid economic expansion, which in turn has contributed to the country's development and radical transformation. Iraq has some of the world's greatest oil reserves, with an estimated (147) billion barrels of known reserves. This amounts to over 20% of the world's total oil reserves. Oil is a lifeblood for Iraq, making it one of the world's most dependent nations. In the past ten years, oil sales have paid for more than 99 percent of exports, 85 percent of government spending, and 42 percent of GDP (GDP). This over-reliance on oil makes the economy vulnerable to fluctuations, and budget constraints limit room for manoeuvring in response to economic downturns. Iraq's unemployment rate in January 2021 was over 10 percentage points greater than it had been before COVID-19, at 22.7 percent, in a country of 40,2 million people. The oil and COVID-19 shocks of 2020 jolted the economy, but it is beginning to show signs of recovery. Following a significant decline of 11.3% in 2020, real GDP is predicted to have increased by 1.3% in 2021. As oil output rises and COVID19 limitations are relaxed, domestic economic activity is expected to return to pre-pandemic levels.

The oil sector worked to increase Iraqi revenues, which resulted in financial growth in the budget, which prompted the Iraqi government to increase spending on training, jobs, education, developing infrastructure, and increasing the salaries of government employees.

The grey system theory, of which Professor Deng is the proponent, includes grey prediction. A new model, GM(2,1), is presented to alter the linear structure of the GM(1,1) model and broaden the range of applications for grey prediction theory. Among the family of grey prediction models, it stands out as particularly significant.

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The GM(2,1) modeling approach is an offshoot of the GM(1,1) approach and satisfies the same mechanisms. The GM(1,1) model uses an accumulating generation operator (AGO) to reduce the noise in raw data and reveal hidden patterns.

1. LITERATURE REVIEW

Recent years have seen a proliferation of research aimed at advancing grey prediction theory, and as a result, numerous optimized algorithms have arisen, vastly increasing the range of grey prediction's potential applications. Here is a quick synopsis of relevant works:

The grey prediction technique, which Song, F., and et al (2014) employed, is a valuable tool for analyzing small datasets and making predictions for the near future. Among the many significant grey models, the GM(2,1) model stands out. They suggested a structure-optimized GM(2,1) model (SOGM(2,1)) to enhance accuracy and predictability. There are three new insights within grey prediction theory that have come out of this research. After constructing a new grey equation with an optimized structure using the background sequence and the inverse accumulating generated sequence, SOGM(2,1) model parameters are estimated using the method of least errors. Second, using the obtained temporal response function, a reflection equation is formed, and the process of solving it is derived. Finally, they proposed a different approach to determining the initial values of the temporal response function. A subsequent engineering evaluation uses the new model to anticipate highway settlement. The results demonstrate the efficacy and practicality of SOGM(2,1) compared to other models[1]. According to research by Junxu Liu et al (2020), load forecasting is crucial for ensuring the power system's reliability and efficiently allocating energy resources. In this study, we implement load forecasting of the power system using the grey model theory. In this study, we apply the grey model theory to implement medium- and long-term load forecasting. We also employ the posterior difference technique to evaluate the model's performance in this context.

At last, a case study is presented to evaluate the technique's effectiveness [2]. In addition, LiangZeng and ChongLiu (2023) created a novel approach to forecasting China's per capita living electricity consumption using the grey modelling technique, keeping in mind the aforementioned a variety of and mashup of shift patterns. As a result, this work provided an improved version of the DGM(2,1) model by introducing the polynomial component to investigate the growth patterns of different time-series sequences. This was accomplished by fixing the modeling error in the traditional DGM(2,1) model. This motivates the development of a brand-new model (denoted DGM(2,1,kn)) for estimating the future electricity needs of China's population. To help with the development of electrical power policies, forecasts of China's per capita living electricity consumption in 2020 and 2025 have been developed[3]. A brief overview of GM(1,1) models was provided by Evans, M. (2014), who also draws attention to a trend-based alternative to traditional grey prediction theory. This method provides an alternate strategy for estimating the parameters of the fundamental first-order differential equation of the GM (1,1). Parameter estimates obtained using this alternative method are demonstrated to be more accurate, and the method's straightforward graphical structure makes it simple to see. In this study, a more universal generalization of the Grey-Verhulst model is proposed. When applied to the intensity of steel use in the United Kingdom, yields very solid multi-step forward predictions.

2. METHODOLOGY

2.1. THE GM (2,1) MODELS

The appropriate grey one-by-one model is for exponential pattern sequences; also, it is used to show changes in monotonic patterns. While for other non-monotonic wave, such as development sequences or satiate sequences that is sigmoid, we are able to use GM two by one [5,6].

2.2. THE GM (2,1) MODEL

For raw data sequences $A^{(0)} = (a^{(0)}(1), a^{(0)}(2), \ldots\ldots, x^{(0)}(n))$, let it a generation accumulation and inverse accumulation generation be[5,7,8] $A^{(1)} = (a^{(1)}, a^{(1)}(1), a^{(1)}(2), \ldots\ldots, a^{(1)}(n))$ and $b^{(1)}A^{(0)} = (b^{(1)}a^{(0)}(2), \ldots\ldots, b^{(1)}a^{(0)}(n))$, where $b^{(1)}a^{(0)}(k) = a^{0}(k) - a^{(0)}(k-1)$, $k = 2,3,\ldots,n$ and the adjacent sequence of neighbour mean a generation of$A^{(1)}\ be\ Y^{(1)} = \left(y^{(1)}(2), y^{(1)}(3), \ldots\ldots, y^{(1)}(n)\right)$.

Then

$$\mathrm{b}^{(1)}\mathrm{a}^{(0)}(\mathrm{k}) + \mathrm{b}_1\mathrm{a}^{(0)}(\mathrm{k}) + \mathrm{b}_2\mathrm{y}^{(1)}(\mathrm{k}) = \mathrm{c} \quad (2.\ 1)$$

Is show that GM(2,1) model ;

$$\frac{d^2a^{(1)}}{dt^2} + \alpha_1\frac{da^{(1)}}{dt} + b_2a^{(1)} = c \quad (2.2)$$

Theorem: For the sequences$A^{(0)}A^{(1)}Y^{(1)}\ and\ b^{(1)}a^{(0)}$, as defined above, let

$$\mathrm{B} = \begin{bmatrix} -\mathrm{a}^{(0)}(2) & -\mathrm{y}^{(1)}(2) & 1 \\ -\mathrm{a}^{(0)}(3) & -\mathrm{y}^{(1)}(3) & 1 \\ \cdots & \cdots & \cdots \\ -\mathrm{a}^{(0)}(\mathrm{n}) & -\mathrm{y}^{(1)}(\mathrm{n}) & 1 \end{bmatrix}$$

$$\mathrm{Y} = \begin{bmatrix} b^{(1)}a^{(0)}(2) \\ b^{(1)}a^{(0)}(3) \\ \cdots \\ b^{(1)}a^{(0)}(n) \end{bmatrix} = \begin{bmatrix} a^{(0)}(2) - a^{(0)}(1) \\ a^{(0)}(3) - a^{(0)}(2) \\ \cdots \\ a^{(0)}(n) - a^{(0)}(n-1) \end{bmatrix}$$

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Also, in the least squares parametric sequence$\hat{a}$ have estimated the $= [b_1, b_2, c]^T$ Of the G.M (2,1) is used as follows:

$$\hat{b} = (C^T C)^{-1} C^T Y \quad (2.3)$$

Theorem: For the solution of the G.M two by one winterization equation depend the steps [9,10]:

1. If $A^{(1)^*}$ is a unique solution of $\frac{d^2a^{(1)}}{dt^2} + b_1\frac{da^{(1)}}{dt} + b_2a^{(1)} = b$ and $\bar{A}^{(1)}$the general solution of the corresponding homogeneous equation $\frac{d^2a^{(1)}}{dt^2} + b_1\frac{da^{(1)}}{dt} + b_2a^{(1)} = 0,$ Then $A^{(1)} + \bar{A}^{(1)}$ represents a universal method for solving the whitening equation for GM(2,1).
2. The general solution to the preceding homogeneous equation requires satisfying the following three conditions: (i) if the defining equation for a $r^2 + c_1r + b_2 = 0$ has two distinct real roots $r_1, r_2,$

$$\bar{A}^{(1)} = c_1e^{r_1t} + c_2e^{r_2t} \quad (2.4)$$

when the repeated root r is the characteristic equation,

$$\bar{A}^{(1)} = e^{rt}(c_1 + c_2t); \quad (2.\ 5)$$

when the two complex conjugate roots are the characteristic equation

$$r_1 = b + i\beta \; and \; r_2 = b - i\beta$$

$$\bar{X}^{(1)} = e^{\alpha t}(c_1cos\beta t + c_2sin\beta t) \quad (2.6)$$

3. In particular, one of the following three scenarios may represent a solution to the winterization equation:

A. The characteristic equation root isn't zero,$A^{(1)^*} = C.$

B. In the characteristic equation, zero is one of the2 distinct roots of,$A^{(1)^*} = Ca.$

C. In the characteristic equation, zero is the only root of,$A^{(1)^*} = Ca^2.$

2.3. EVALUATE PRECISION OF FORECASTING MODELS

To test the accuracy and the performance of the proposed model used, some statistical tests and measurements, including residual test, MAPE, precision Rate and Posterior Ratio(c) [6,8].

2.3.1. RESIDUAL TEST

Step1: calculate the relative error and absolute percentage error presented as follows:

$$\Delta^{(0)}(i) = \left| a^{(0)}(i) - \hat{a}^{(0)}(i) \right| \qquad i = 1,2,3,\ldots,n \text{(2.14)}$$

$$\varnothing(i) = \frac{\Delta^{(0)}(i)}{a^{(0)}(i)} \times 100\% \qquad i = 1,2,3,\ldots,n \text{ (2.15)}$$

Step 2: calculate the two-step minimum and maximum of the relative error:

$$\Delta_{min} = min \left| \Delta^{(0)}(i) \right| \text{ (2.16)}$$

$$\Delta_{max} = max \left| \Delta^{(0)}(i) \right| \text{ (2.17)}$$

Step 3: find grey incidence coefficient

$$\gamma\left(\hat{a}^{(0)}(k), a^{(0)}(k)\right) = \frac{\Delta_{min} + p \,.\, \Delta_{max}}{\Delta_{0i}(k) + p \,.\, \Delta_{max}} \text{ (2.18)}$$

Of which the distinguishing coefficient p is 0.5

Step 4: find the degree of grey incidence

$$\gamma\left(\hat{a}^{(0)}, a^{(0)}\right) = \frac{1}{n}\sum_{i=1}^{n} \gamma\left(\hat{a}^{(0)}(i), a^{(0)}(i)\right) \quad \text{(2.19)}$$

the GM model is qualified if

$$\gamma\left(\hat{a}^{(0)}, a^{(0)}\right) > 0.6, \ when\, p = 0.5$$

2.3.2. MEAN ABSOLUTE PERCENTAGE ERROR (MAPE)

To ensure that your forecasting model is as comprehensive as possible, you might use the Mean Absolute Percentage Error metric. Here is how we characterize it [7,9,10]:

$$MAPE = \frac{1}{n}\sum_{k=2}^{n} \left| \frac{a^{(0)}(k) - \hat{a}^{(0)}(k)}{a^{(0)}(k)} \right| \times 100\% \qquad \text{(2.20)}$$

Where $x^{(0)}(k)$: The actual value in period k

$\hat{x}^{(0)}(k)$: Estimated worth for a k-period forecast.

And there are four levels of MAPE achievement:

Precision rank	MAPE
Highly accurate	MAPE≤0.01
Good	MAPE≤0.05
Reasonable	MAPE≤0.1
Inaccurate	MAPE≤0.15

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The more depressed the MAPE, the higher the forecasting model's precision. In general, the MAPE below 0.01 is an exact model and the MAPE between 0.01 - 0.05 is a good model with passable accuracy.

2.3.3. PRECISION RATE(P)

For further information on how close the stated prediction quantity is to the actual value, see the section "Precision Rate" below, where p is the precision rate [7,11,12,13].

$p =$ 1-MAPE (2.21)

Precision rank	MAPE
Highly accurate	MAPE≤0.99
Good	MAPE≤0.95
Reasonable	MAPE≤0.90
Inaccurate	MAPE≤0.90

The higher precision is the higher precision rate the forecasting model can achieve. In general, a precision rate greater than 0.99 is an exact model, and a precision rate between 0.99 -0.95 is a good model with fit accuracy.

3. APPLICATION

3.1. DATA DESCRIPTION

The data of this study has been taken from the world bank site, which demonstrates the monthly oil price of Saudi Arabia in the international market from Oct- 2020 to Sep- 2022.

Table 1. Represents the Monthly oil price of Saudi Arabia

	1	2	3	4	5	6	7	8	9	10	11	12
2018	69.05	65.78	70.27	75.17	77.59	79.44	74.25	77.42	82.72	75.47	58.71	53.8
2019	61.89	66.03	68.39	72.8	64.49	66.55	65.17	60.43	60.78	60.23	62.43	66

3.2. MODEL SPECIFICATION

In the previous section, the collected data has been described to perform the grey model GM (2,1).To make the appropriate model for forecasting the oil price.

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3.3. FITTING GM(2,1) MODEL

By using the OLS method, the parameters of the GM(2,1) model has been estimated depending on equation (2.3) with values of **a** and **b** (0.001734 and 0.00012), respectively.

$$\hat{a} = [a, b]^T = \begin{bmatrix} 0.001734 \\ 0.00012 \end{bmatrix}$$

Table 2. The actual predicted, and error values

Ordinality	Actual data $x^{(0)}(k)$	Model value $\hat{x}^{(0)}(k)$	Error $\varepsilon(k) = x^{(0)}(k) - \hat{x}^{(0)}(k)$	Relative error $\Delta_k = \frac{\lvert \varepsilon(k) \rvert}{x^{(0)}(k)}$
2	36.39	33.99	2.40	0.07
3	38.25	35.46	2.79	0.07
4	43.92	46.67	-2.75	0.06
5	49.47	51.99	-2.52	0.05
6	56.44	58.77	-2.33	0.04
7	60.43	65.27	-4.84	0.08
8	59.87	60.40	-0.53	0.01
9	62.8	58.78	4.02	0.06
10	68.58	74.31	-5.73	0.08
11	70.12	71.28	-1.16	0.02
12	65.68	64.18	1.50	0.02
13	69.09	67.01	2.08	0.03
14	78.51	76.09	2.42	0.03
15	76.45	79.83	-3.38	0.04
16	70.56	72.54	-1.98	0.03
17	80.33	78.04	2.29	0.03
18	89.41	91.95	-2.54	0.03
19	107.07	104.72	2.35	0.02
20	103.32	101.35	1.97	0.02
21	108.29	106.29	2.00	0.02
22	113.77	111.81	1.96	0.02
23	100.84	98.71	2.13	0.02
24	93.76	94.34	-0.58	0.01

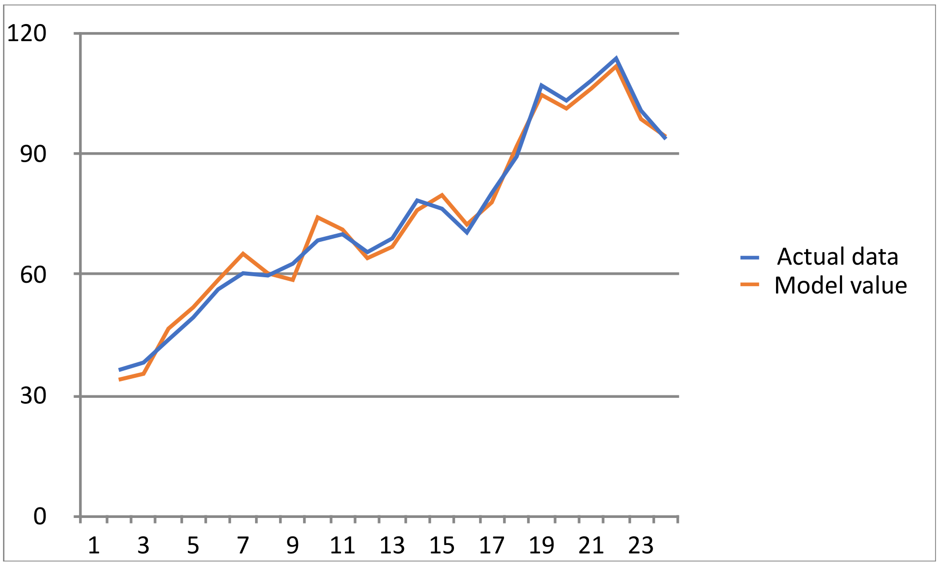

Figure 1. The scatter plot of the actual and predicted values of oil price

To test the performance of the proposed model, some statistical tests and measurements, including MAPE and precision Rate. from the above table represent model value and MAPE by GM(2,1) model, which is defined depending on eq (2.20).

Table 3. Represent the accuracy of the model

Test	GM (2,1)
MAPE	0.04
P	0.96

The data in the table above shows that the model has a high degree of accuracy, as measured by the precision rate, p, which is proportional to the degree of agreement between the forecasted amount and the actual value. p is specified as 0.96 in Eq. (2.21).

3.4. GOODNESS OF FIT

GM (2, 1) is a time series model then the goodness of fit of the model should be tested by using the Augmented Dickey-Fuller test statistic; the results were as follow:

Table 4. Represent ADF test for the monthly oil price

Test	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.258028	0.0034

Table 4 explains that the p-value of the ADF test equals (0.0034), and it is less than (0.05). This result indicates that the model is significant.

Table 5. Demonstrates the forecasted values for three periods of time.

Period	Forecasted	Confidence Interval	
Oct-22	95.76216	91.99667	99.52765

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Nov-22	98.3088	94.54331	102.0743
Dec-22	90.0592	86.29371	93.82469

4. CONCLUSIONS

From the results, we conclude that:

1. The petroleum sector constitutes approximately (85%) of budget revenues, (99%) of export revenues and (42%) of the gross domestic product (GDP) in Iraq, and any changes in oil prices will affect all economic activities in Iraq.
2. (GM(2,1) model is more adequate for the series that it has a few data to forecast in short terms).
3. From the results, it can be concluded that the GM(2,1) model is highly accurate to represent the behavior of the Oil price rate in Iraq.
4. The study shows that the MAPE for GM (2,1) model is equal to (0.04), which does not need large data and displays high prediction accuracy.
5. The model's great accuracy is indicated by the fact that the defined precision rate p equals (0.96), where p is the rate at which the statement of the forecast quantity matches the original value.
6. Depending on the Augmented Dickey-Fuller test statistic goodness of fit of the model has been tested; the p-value of the test equals (0.0034), and it is less than (0.05). This result indicates that the model is significant.

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