Economic Forecast of the Wealthiest Gulf Countries Using ARIMA Model

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Abstract:

Gulf Cooperation Council (GCC) members are considered one of the fastest growing economies. This paper aims to empirically forecast the economic activity of the biggest GCC countries: Qatar, Saudi Arabia, and the United Arab Emirates. An Auto-Regressive Integrated Moving Average (ARIMA) model of the Gross Domestic Product in the three countries is obtained using the Box-Jenkins methodology during the 1980-2020 period. The appropriate models for the three economies are of ARIMA (0,2,1), the forecasts are at a 95% confidence level and predicts a growth in the three understudy countries for the upcoming five years.

Keywords: ARIMA model; GDP; forecasting; Gulf Cooperation Council.

JEL Classification: C22; C53; O53.

Introduction

Gulf Cooperation Council (GCC) is an economic and political agreement between six Arab countries; Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates. It was established in 1981 (GCC 2021). These countries differ in size and population but are located close to one another in the Middle East region. The countries have low debt, high foreign reserve and are rich in oil stocks. The GCC economy is the largest in the Middle East and the fastest growing in the world. GCC is known to be the biggest oil producer and it has the largest fuel and gas reserve.

The cooperation economic development can be classified into different eras. The first, during the 1990s when the region witnessed remarkable economic growth. The increase in oil prices played a major role in GCC development, despite the 1991 Gulf war. Following that in the 2000s, the economy of the GCC members continued to boom, taking advantage of the high oil prices. The black gold industry remained a vital source of revenue accompanied with an industrial and commercial development in the region (Vohra 2017, Ab Rahman and Abu-Hussin2009). In 2003, Customs Union was officially established between GCC countries for the liberalization of trade and flow of products with no tariff barriers (GCC 2021). Afterwards, the fall in oil prices in 2008 demonstrated an adverse impact on the government budget and economic growth of the GCC countries (Vohra 2017).

Forecasting the future macroeconomic outcomes of GCC is vital to obtain a better insight of the economic indicators of the understudy countries and to anticipate future monetary activities of the region. Gross Domestic Product (GDP) is a standard statistic to forecast and measure the economy's size and to track cyclical changes inside the country (Leamer and Leamer 2009). This study aims to obtain accurate forecasts for the GDP of the leading GCC members from 2021 till 2025. These leading members are Qatar, Saudi Arabia (KSA), and the United

Arab Emirates (UAE). While there are different techniques to forecast time series, this research relies on Auto-Regressive-Integrated-Moving-Average model, known as ARIMA, to anticipate GDP future values.

Numerous studies have been conducted on GDP forecast using ARIMA models and Box and Jenkins methodology, but it remains the challenge of recent work. The significance of this research is that it is not limited to the analysis of one specific country, rather a GDP prediction of three leading GCC members. Furthermore, to the best of our knowledge, there has not been any previous analysis aimed to forecast the overall economic activity of the under-study countries; although several researches investigated various aspects of the GCC economy.

The remaining of the paper is organized as follows. Section 1 describes a brief literature review, while Section 2 discusses and explains the data and methodology followed. In Section 3 the empirical results and forecasting output are presented. Section 4 concludes.

1. Literature Review

There are numerous studies that forecast economic activity and growth using ARIMA model and following the 'Box and Jenkins' method. GDP is a macroeconomic measurement directly linked to a country's development; hence, it is crucial to investigate its statistics and predict future data (Ning *et al.* 2010). Previous studies can be classified into three groups. The first includes the GDP growth rate forecast, while the second concentrates on GDP per capita prediction, and the third group contains the studies that investigate and forecast GDP values.

Among the first group, Dinh (2020) implement an ARIMA model to forecast China and Vietnam's economic growth using credit GDP ratio of the 1996-2017 period. The best obtained fit models are ARIMA (2,3,5) and ARIMA (2,3,1) for China and Vietnam respectively. Results indicate that China's growth rate is faster than that of Vietnam. In addition, Maity and Chatterjee (2012) examine India's GDP growth anticipation, through analyzing 60 years period using ARIMA (1,2,2). Their results indicate a raise in the GDP rate for the upcoming years. Within the same context, Dritsaki (2015) utilizes ARIMA (1,1,1) model for real GDP rate in Greece, data is arranged from 1980 to 2013. Following the Box- Jenkins technique, the author anticipates growth for the years 2014, 2015, and 2016 at 1.56%, 2.85%, and 3.12%.

On the other hand, Eissa (2020) derives forecast assumptions of GDP per capita while applying ARIMA model for Egypt and Saudi Arabia, following the Box Jenkin methodology. The models are ARIMA (1,1,2) and ARIMA (1,1,1) respectively and the result presents a continuous rise in GDP per capita in both countries for the upcoming 10 years. Moreover, Voumik and Smrity (2020) forecast in their study Bangladesh real per capita GDP of a yearly series from 1972 till 2019 to anticipate the economy for the next decade using ARIMA (0,2,1). The study analysis a growth in Bangladesh's economy. Zhang and Rudholm (2013) consider Sweden's GDP per capita of the 1993-2009 period to predict future values. The authors employ three models Auto Regressive Integrated Moving Average (ARIMA), Vector Autoregression (VAR), and First Order Autoregressive (AR), and conclude that all three methods are adequate in short run forecasting. Noting that ARIMA and AR perform better.

Within the last group, Abonazel and Abd-Elftah (2019) use annual GDP data of Egypt from 1956 till 2016, to estimate the country's economic activity for 10 years ahead. ARIMA (1,2,1) model based on Box- Jenkins approach is applied, and results indicate an increasing trend from 2017 to 2026. Similarly, Agrawal (2018) attempts to forecast the Indian economy using quarterly GDP time series from 1996 to 2017. The research selects AR (1) and MA (2) specification and finds a long run prediction of the GDP series.

Furthermore, Wabomba *et al.* (2016) examine the GDP forecast of Kenya using ARIMA (2,2,2) model based on a time period of 1960-2012. The study also follows the Box-Jenkins method and predicts growth from 2013 till 2017, within a 95% confidence range. Likewise, Zakai (2014) also follows the Box-Jenkins approach while considering ARIMA (1,1,0) as the best fit to analyze Pakistan forecast of annual GDP, while operating a time series from 1953 till 2012. An increase in Pakistan's GDP in the upcoming 13 years is predicted. On the other hand, Judi (2007) projected non-oil GDP value of the United Arab Emirates employing an ARIMA model. The data spans 1970-2006 period. GDP was estimated to raise until the end of the year 2020.

Many studies adopted the ARIMA model to forecast the economy and its activity. This paper uses annual GDP series to predict future economic outcomes of the three leading GCC countries based on the ARIMA modeling and Box-Jenkins approach.

2. Data

2.1. Data Selection

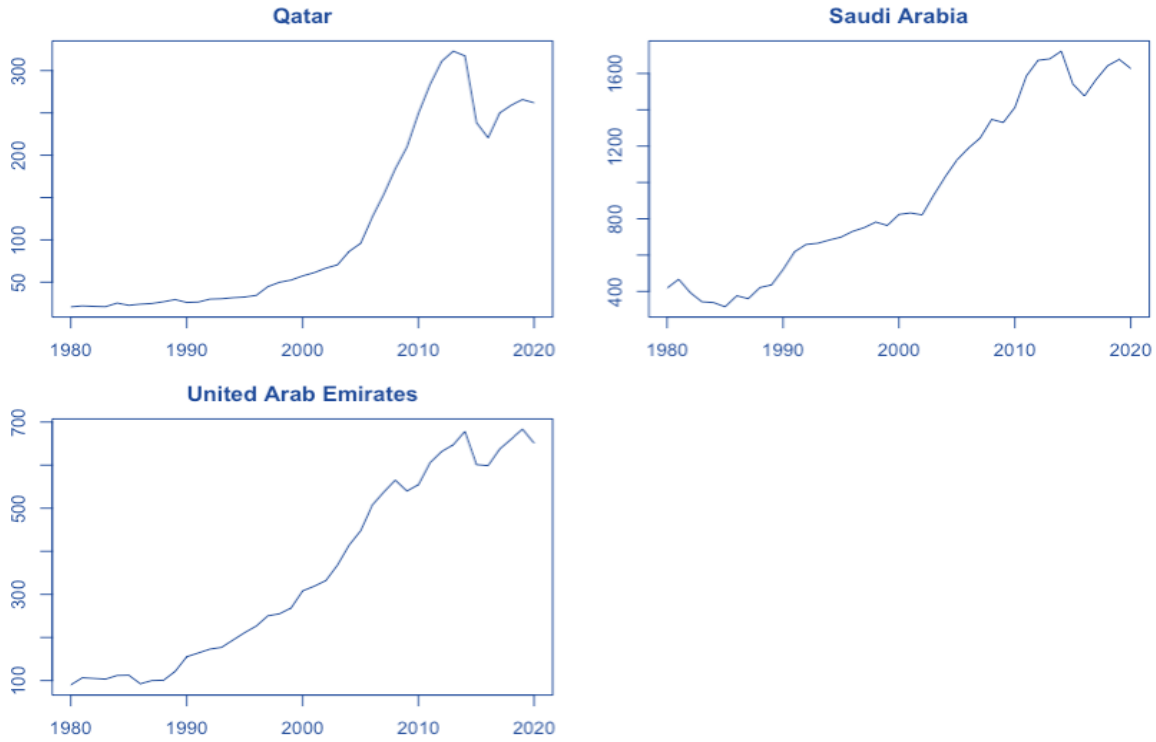
To forecast GDP for the next five years (2021 to 2025) of Qatar, Saudi Arabia, and the United Arab Emirates, we use annual GDP (PPP, international dollars) variable. The data span the 1980-2020 period, indicating 41

observations. The variable is derived from International Monetary Fund Database. Furthermore, to simplify and compare the GDP values of the three countries, GDP variables are log transformed.

2.2. Data Description

The visual analysis of GDP in Qatar, KSA, and the UAE from 1980 till 2020 is presented in Figure 1. The time series in the three countries show an exponential increase throughout the mentioned period. Qatar's GDP reached its maximum at 322.99 billion US dollars in 2013 and declined gradually to reach 261.98 billion US dollars in 2020. Whereas in KSA, GDP extended to its maximum at 1,722.862 billion US dollars in 2014 and decreased to 1,627.305 billion US dollars in 2020. UAE GDP extended to its peak at 678.3 billion US dollars in 2014 and dropped by 11.7% in 2016, to raise subsequently to 650.829 billion US dollars in 2020.

Figure 1. Annual GDP of Qatar, KSA and the UAE (in billion US dollars)



Source: International Monetary Fund Database, 2021.

A summary statistic of the GDP variable used in our study is presented in Table 1. These descriptive statistics include the minimum, median, mean, maximum, and standard deviation values. Table 1 suggests that Saudi Arabia has the highest GDP on average, equivalent to 961.3 billion US dollars. In addition, Saudi Arabia experiences the highest dispersion with 479.873 points. GDP in Qatar ranges from 20.86 to 322.99 billion US dollars and that of the United Arab Emirates is between 90.06 to 683.52 billion US dollars.

Table 1. Summary Statistics – GDP, in billion US dollars

	Qatar	KSA	UAE
Minimum	20.86	315.20	90.06
Median	57.40	821.30	308.18
Mean	114.38	951.30	351.37
Maximum	322.99	1,722.90	683.52
St. Deviation	106.38	479.87	216.21
Observations	41	41	41

Source: Authors' Calculations using R Software, 2021.

3. Methodology

3.1. Autoregressive Integrated Moving Average (ARIMA) Models

Autoregressive Integrated Moving Average (ARIMA) model has become a popular model after George Box and Gwilym Jenkins approach in the early 1970s. It is acknowledged as univariate time series and presents a forecasting approach. The ARIMA model comprises of: Autoregressive (AR), differencing, and Moving-Average (MA) processes.

Autoregressive Process (AR)

The autoregressive (AR) process states that the time series linearly depends on its own preceding values and a stochastic term. The model is of order p and it forecasts the variable when a correlation between time series value and its predecessors exists. The AR (p) model is expressed as:

$$Y_t = c + \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + \ ... + \alpha_p Y_{t-p} + \epsilon_t \quad (1)$$

Moving Average Process (MA)

A moving average model (MA) process includes q lags and states that the time series relies on the current and preceding values of a stochastic term. The MA(q) is as follows:

$$Y_t = \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \ ... + \ \theta_q \varepsilon_{t-q} \quad (2)$$

Autoregressive Moving Average Model (ARMA)

ARMA combines both AR and MA process. The ARMA model (p, q) is estimated as:

$$Y_t = c + \alpha_1 Y_{t-1} + \ ... + \alpha_p Y_{t-p} + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \ ... + \ \theta_q \varepsilon_{t-q} \quad (3)$$

where:t is time $(t \ = \ 1, 2, ... \ N)$, c is a constant, α_p and θ_q are the coefficients, and the random variable ε_t is the stochastic term.

Autoregressive Integrated Moving Average Model (ARIMA)

ARIMA (p, d, q) models denote an extension of ARMA process. They are employed in non-stationary cases, in which one or more initial differentiation step is applied to remove non-stationarity. The three parameters of ARIMA are: autoregressive order (p), differencing degree (d), and moving average order (q). The ARIMA (p, d, q) model is expressed as follows:

$$\Delta Y_t = c + \alpha_1 \Delta Y_{t-1} + \ ... ... + \alpha_p \Delta Y_{t-p} + \epsilon_t + \theta_1 \varepsilon_{t-1} + \ ... + \ \theta_q \varepsilon_{t-q} \quad (4)$$

Box Jenkins Method

George Box and Gwilym Jenkins (1970) propose four steps to conduct ARIMA modeling, these steps are: identification, estimation, diagnostic checking, and forecasting. They are recognized as the Box-Jenkins method.

3.2. Model Identification

The appropriate model identification starts by evaluating whether the time series is stationary or not, through plotting the initial data and implementing unit root tests (such as Augmented Dickey and Fuller). Afterwards, the differencing degree is selected accordingly. Next, the Autocorrelation (ACF) and the partial autocorrelation (PACF) functions are used to identify the parameters of the ARMA model.

Model Estimation

The parameters estimation of the selected ARIMA (p, d, q) model is through computation of algorithms practice. Non-linear minimum-square estimate or Maximum Likelihood Estimate (MLE) remain the most common methods used. ARIMA models with different orders are estimated. The best fit is selected on the basis of minimum Akaike's Information Criterion (AIC) and Bayesian Information Criteria (BIC) of the assessed tentative models.

Diagnostic Checking

The purpose of this step is to check the adequacy of the selected model, and if it is good fit to forecast. The model residuals should follow a normal distribution, be constant in variance and mean over time, and has no serial

correlation with each other. If any of the assumptions are violated, adjustments in step one should be considered to build the best fitted model.

Model Forecasting

The selected ARIMA model is considered adequate after the residual diagnosis and it forecasts on the basis of its own past values and that of the stochastic term to predict future time series.

4. Empirical Results

4.1. Model Identification

Graphically the three GDP plots over the 1980-2020 period for Qatar, KSA, and the UAE demonstrate a non-stationary nature and trend components (see Figure 1). In addition, the Augmented Dickey and Fuller (ADF) unit root test results presented in Table 2 confirms a non-stationary nature of lnGDP under the 1% significance level (p-value > 0.01). The GDP values of the three countries are transformed into stationary at second difference where the p-value is now smaller than 0.01. Therefore, d = 2 presents the differencing degree of lnGDP series for the three cases (Qatar, KSA, and the UAE).

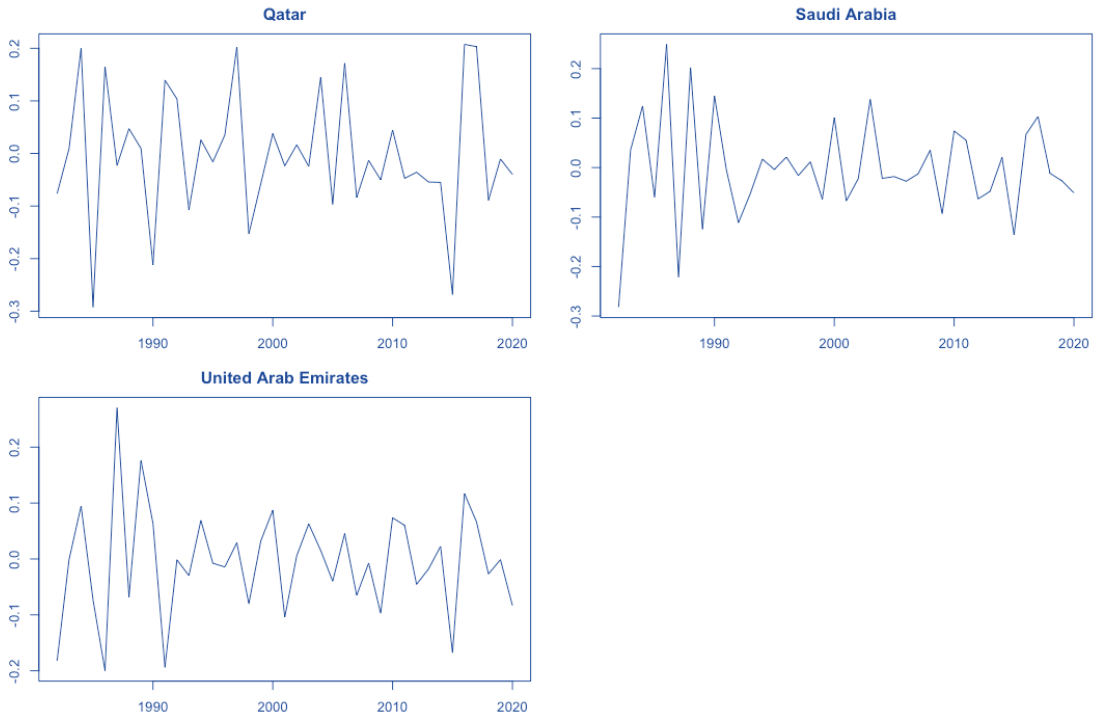
Table 2. Augmented Dickey and Fuller (ADF) Unit Root Test

Variable	Level		First Difference		Second Difference		Differencing Degree
	Statistics	p-value	Statistics	p-value	Statistics	p-value	
lnGDP- Qatar	- 1.89	0.62	- 1.99	0.58	- 4.67	0.01	d=2
lnGDP- KSA	- 2.08	0.54	- 3.74	0.04	- 4.94	0.01	d=2
lnGDP- UAE	- 1.02	0.92	- 3.28	0.09	- 4.71	0.01	d=2

Note: H_0 time series have unit root (p-value > 0.01, fail to reject H_0); H_1 time series do not follow unit root.
Source: Authors' Calculations using R Software, 2021.

The plot of lnGDP variable at the second difference of the three understudy countries is presented in Figure 2. The figure satisfies the stationarity and non-trending pattern for the adjusted series of the three samples in this study.

Figure 2. Time Series Plot of lnGDP at Second Difference

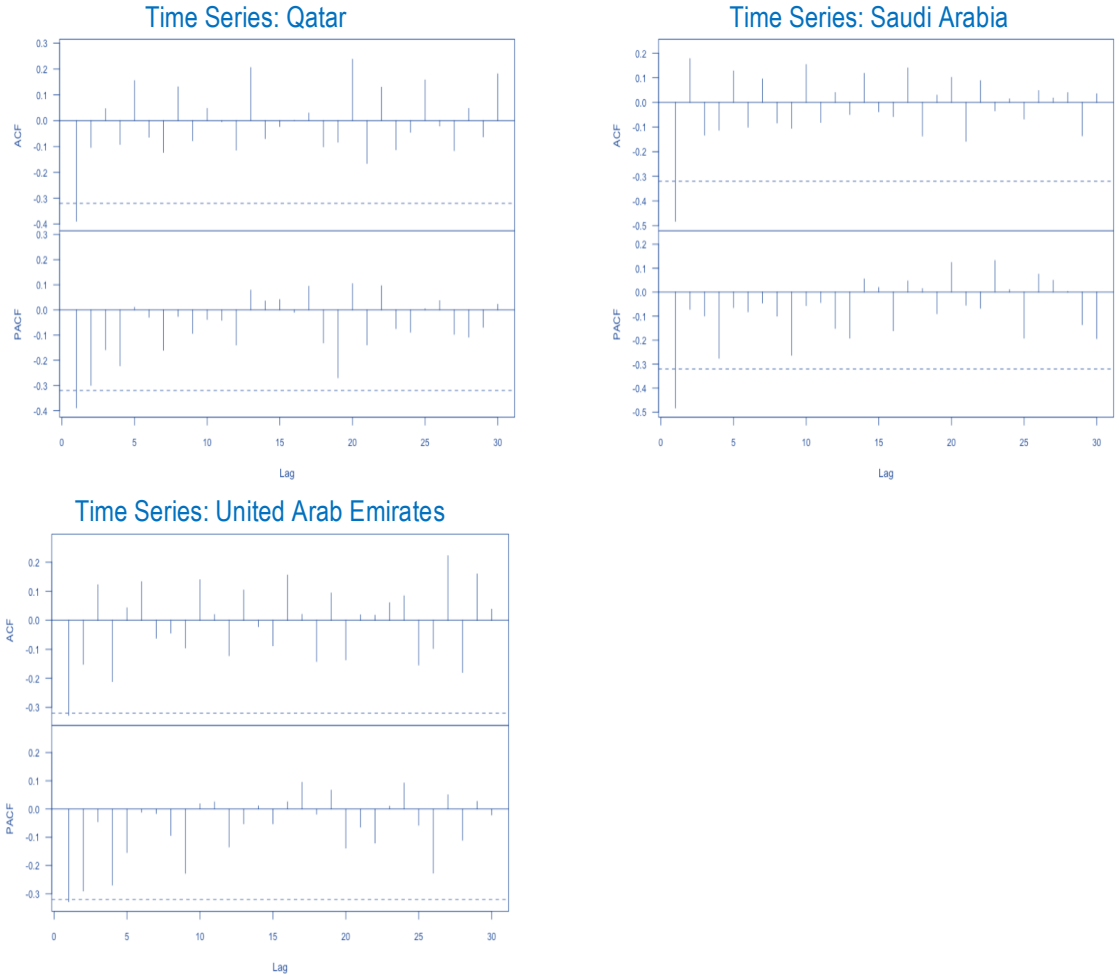


Source: Authors' Calculations using R Software, 2021.

After the series transformation to stationary at d=2, the following step is to determine the other parameters in the ARIMA models (p and q). We consider ACF and PACF for each country and they are presented in Figure 3.

Both ACF and PACF lags recommend significant autocorrelation at a maximum lag of one for the three cases, suggesting a possible MA (1) and AR (1) for the three equations. The recommended fit model for GDP series in the three explored countries is ARIMA (1,2,1). However, since the estimated ACF and PACF are relatively complex and identification of ARIMA (1, 2, 1) is not certain and straight forward, other tentative models are estimated. The best fit for each country is selected by comparing different goodness-of-fit measures (minimum AIC and BIC) of the ARIMA models estimates.

Figure 3. ACF and PACF plot of lnGDP at Second Difference.



Source: Authors' Calculations using R Software, 2021.

4.2. Model Estimation

The AIC and BIC results of the tentative ARIMA models are presented in Table 3. The best fit model for the Qatar sample is ARIMA (0,2,1) with a minimum AIC and BIC of -62.32 and -58.99 respectively. That of KSA and UAE is ARIMA (0,2,1) as well; with minimum AIC equal to -79.47 and BIC is -76.14 for KSA sample and AIC is equivalent to -82.60 and BIC is -79.23 for the UAE sample.

Table 3. Comparison of tentative ARIMA models

Model	Qatar		KSA		UAE	
	AIC	BIC	AIC	BIC	AIC	BIC
ARIMA (1,2,1)	-60.90	-65.90	-78.72	-73.73	-81.72	-76.73
ARIMA (0,2,1)	-62.32	-58.99	-79.47	-76.14	-82.60	-79.23
ARIMA (1,2,0)	-56.61	-53.28	-76.37	-73.04	-73.16	-69.84

Source: Authors' Calculations using R Software, 2021.

The estimated results, along with the standard error (SE) and probability value (Prob.) of the best fitted model ARIMA (0,2,1) for Qatar, KSA, and the UAE is presented in Table 4. The MA coefficient is statistically significant in all three models at the 1% level of significance. Indicating that the GDP series depends on the past one-year value of the stochastic term.

Table 4. Parameter Estimates

Coefficients	Qatar			KSA			UAE		
	Estimate	S.E.	Prob.	Estimate	S.E.	Prob.	Estimate	S.E.	Prob.
MA (1)	-0.68	0.14	0.00***	-0.83	0.24	0.00***	-0.89	0.12	0.00***

Note: Statistical significance: * = 10%, ** = 5%, *** = 1%.
Source: Authors' Calculations using R Software, 2021.

The estimated regression equations of ARIMA (0,2,1) for the three countries, comprise as follow:

$$\text{Qatar: } \Delta^2 \ln \text{GDP}_t = -0.6822 \varepsilon_{t-1} \quad (5)$$

$$\text{Saudi Arabia: } \Delta^2 \ln \text{GDP}_t = -0.8248\ \varepsilon_{t-1} \quad (6)$$

$$\text{United Arab Emirates: } \Delta^2 \ln \text{GDP}_t = -0.8909\ \varepsilon_{t-1} \quad (7)$$

where: $\Delta^2 \ln \text{GDP}$ represents the second difference of Gross Domestic Product natural logarithms across time t and ε_{t-1} is the stochastic error term of the preceding values from the previous year.

4.3. Residual Diagnostics

To check the robustness of the estimated model to forecast, a diagnostic checking is performed according to the Box-Jenkins approach. Results of the residual assumptions are presented in Figure 4 (see *Appendix*). The variance of the error terms in the three models are equal, thus, the assumption of homoscedasticity is not violated. ACF of the residuals show independence of variance; no autocorrelation among the error terms is concluded. Furthermore, the Q-Q plot points in the figure seem to form a straight line, this suggests that the residual follows a normal distribution. Hence, the estimated model is a good fit to forecast.

4.4. Forecasting

Following ARIMA (0,1,2) residual diagnostics checking; equations (5), (6), and (7) are respectively used to forecast the annual GDP of Qatar, Saudi Arabia, and the United Arab Emirates for the next five years (2021 – 2025).

The predicted GDP values of the three understudy countries are given in Table 4. A high forecasting power is concluded with a 95% confidence interval. The GDP forecast of Qatar is expected to gradually increase from 261.98 billion US dollars in 2020, to reach 270.72 billion US dollars in 2025. Whereas Saudi Arabia GDP value is estimated to be 1,734.01 billion US dollars in 2025 compared to 1,627.3 billion US dollars in 2020. The United Arab Emirates GDP is expected to continue to boom throughout the years and extent to 738.25 billion US dollars in 2025.

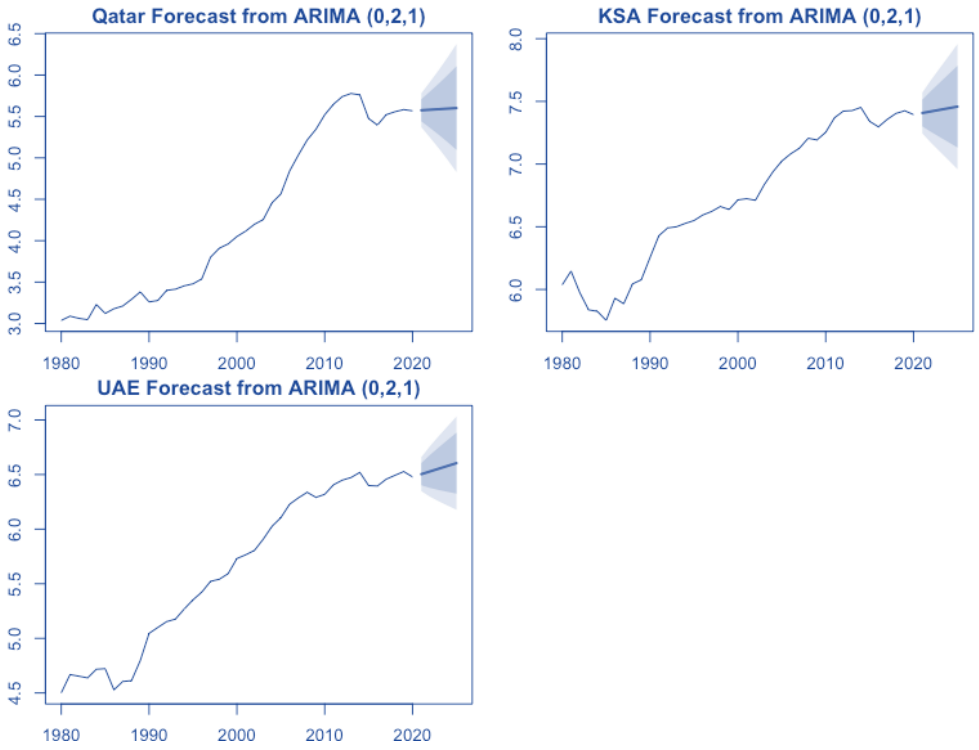
Table 5. Forecasted Values of GDP in billion US dollars

Year	Qatar			KSA			UAE		
	Forecast	95% Confidence Interval		Forecast	95% Confidence Interval		Forecast	95% Confidence Interval	
	GDP	Lower	Upper	GDP	Lower	Upper	GDP	Lower	Upper
2021	263.72	215.13	323.28	1648.11	1401.04	1938.75	667.44	571.48	779.52
2022	265.47	189.54	371.81	1669.18	1299.15	2144.59	684.48	542.86	863.04
2023	267.23	166.39	429.17	1690.51	1211.66	2358.60	701.95	520.46	946.74
2024	268.99	144.91	499.36	1712.13	1130.47	2593.06	719.87	500.61	1035.17
2025	270.78	125.07	586.24	1734.01	1053.19	2854.96	738.25	482.05	1130.61

Source: Authors' Calculations using R Software, 2021.

The actual and forecasted lnGDP for the next 5 years in Qatar, KSA, and the UAE is presented in Figure 5 with a 95% confidence interval. The plot indicates a continuous rise and an upward trend in the future predicted values of lnGDP. Comparing the three trends, United Arab Emirates has a steeper increase, and the economic growth in Qatar is projected to slightly grow.

Figure 5. Time series plot for actual and forecasted lnGDP using ARIMA (0,2,1).



Source: Authors' Calculations using R Software, 2021.

Conclusion

The GDP forecast model is a significant contribution to government and policy makers. It is critical for future planning and to understand the economy well-being. Forecasting techniques help in decision making and choosing to implement new ideas and technologies. Many researchers use the ARIMA model to calculate the GDP future value of a country (Judi 2007, Zakai 2014, Wabomba 2016, Abonazel and Abed-Elftah 2019).

This paper aims to develop an empirical forecast of GDP in Qatar, Saudi Arabia, and the United Arab Emirates using the ARIMA model. The growth in GCC economies has been of interest for researchers. An annual GDP series from 1980 to 2020 is used in this study. The model ARIMA (0,2,1) is recognized as the best suited model to predict GDP in the three cases.

Empirical results show that the forecasted data is reliable, and the series is consistent and statistically significant. The analysis suggests continuous growth in the three GCC nations for the upcoming five years. However, many factors and unexpected shocks might influence GDP. For instance, the COVID-19 pandemic has a negative impact on global economic activities.

A possible limitation of this study is the number of observations of the GDP series. This study is restricted to the use of annual GDP from 1980 till 2020 because of data availability. Although such a number of observations is suitable for a forecast by means of the ARIMA model. For future work, researchers are encouraged to compare several forecasting techniques like exponential smoothing, vector autoregressive, and neural networks.

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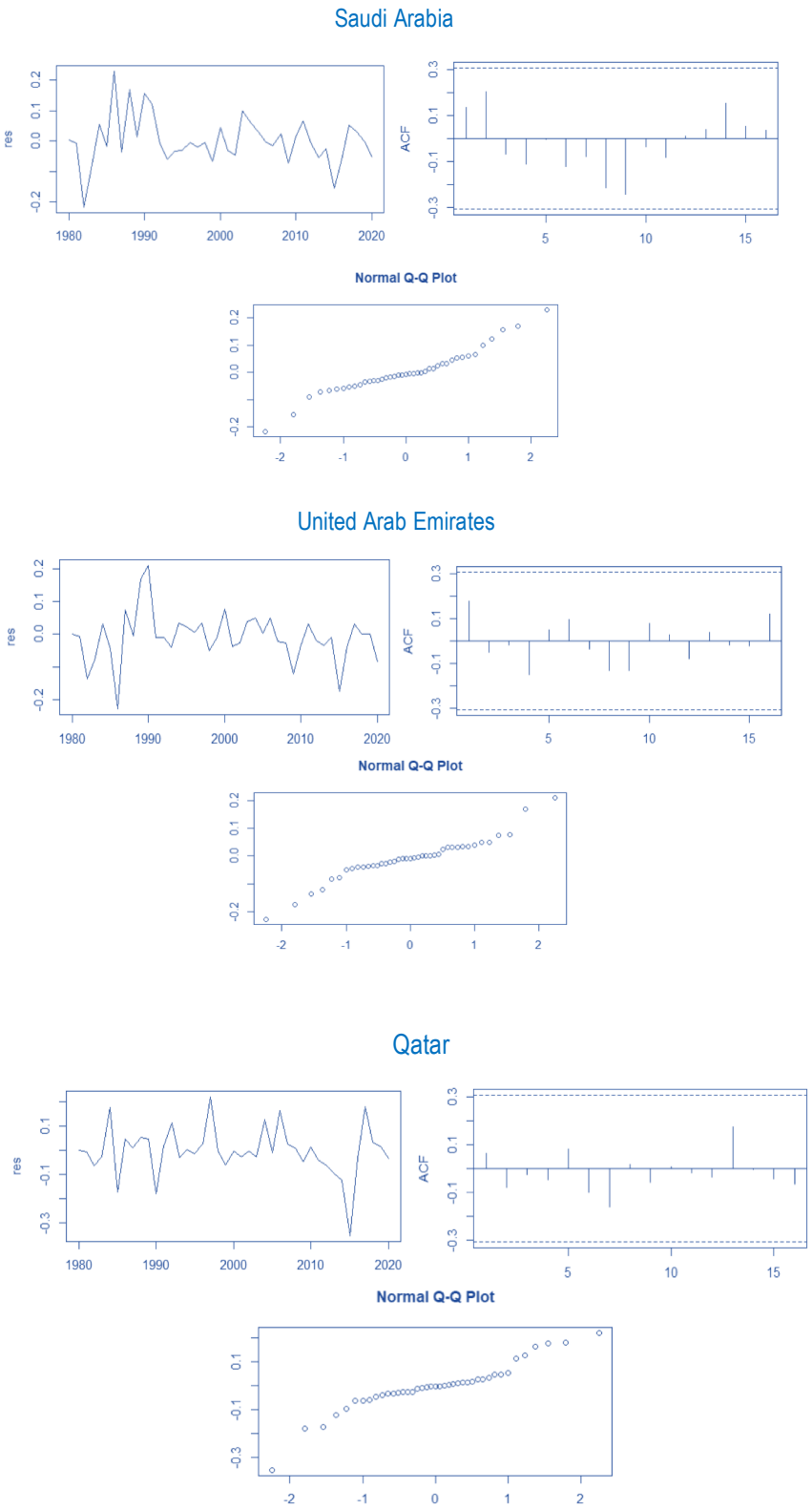
APPENDIX

Figure 4. Residual analysis plot of the ARIMA (0, 2, 1)



Source: Authors' Calculations using R Software, 2021