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Economic Growth Analysis And Forecasting Towards Unemployment Rate Using Arima Model

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Abstract Gross Domestic Product (GDP) is the standard measure of the value added created through the production of goods and services in a country during a certain period. It is used to determine the economic performance of the country. If GDP growth of a country shows a decreasing trend continuously then it will lead the country into recession. In this paper, the GDP growth of Malaysia is observed and forecasted using the ARIMA model for the next 5 years using IBM SPSS. Moreover, the study determined the relationship between economic growth and unemployment rate. The results showed that past economic downturn was mainly about the unfortunate economics or financial crisis such as Asian financial crisis, US economic downturn and pandemic of COVID-19. Furthermore, the forecasted GDP growth graph of the year 2021 to 2026 Malaysia GDP growth showed a decreasing trend after the year 2023 until 2026. It was confirmed that the relationship between economic growth and unemployment rate followed Okun's law. Therefore, the Malaysian government should take effective measures to overcome the decreasing trend that will occur in the year 2023 to 2026. This research can be carried forward by forecasting the GDP growth of Malaysia using different models such as the Artificial Neural Network (ANN) model and compare with the ARIMA results obtained in this research.

Keywords: Economy, GDP, Forecasting, ARIMA Model, Box and Jenkins

1. Introduction

Economic growth is the key indicator in determining the development of a country and the best measure of economic growth is by using gross domestic product (GDP). GDP provides an economic snapshot of a country whether it is growing or contracting. Recently, the world economic growth decreased drastically because of the pandemic of Covid-19 that was due to the spreading of Covid-19

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virus. This pandemic also affected the most developed countries' GDP growth including Malaysia's GDP growth. The economic growth of Malaysia has decreased sharply in 2020 due to the closure of the economy during the Movement Control Order (MCO) since March 2020 to curb the transmission of the COVID-19 virus. According to The Straits Times, by the second quarter of 2020, Malaysia has the worst GDP contraction in history [1]. If the GDP growth of Malaysia continues to decrease as the years go by, the unemployment rate in Malaysia will increase and this will lead Malaysia to be in the country that is facing a crisis. To avoid this situation happening, the GDP growth of Malaysia from 1961 to 2020 has been observed and GDP growth of Malaysia is forecasted for the next 5 years using ARIMA model. Then, we analysed the relationship between GDP growth and unemployment rate in Malaysia.

2. Materials and Methods

2.1 Data

The data from the World Development Indicator, World Bank has been used by [3], [4] and [5] to forecast the GDP growth. Therefore, we also used the annual data from the World Bank for this analysis. The data used in this study are the annual GDP growth of Malaysia from 1961 to 2020 which is the total of 59 observations. This satisfies the rules of having more than 50 observations in Box-Jenkins's approach of time series forecasting [6].

2.2 GDP growth

The trend of Gross Domestic Product (GDP) growth of Malaysia from 1961 to 2020 is observed using a graphical method where a line graph GDP Growth versus Year 1961 to 2020 will be plotted using IBM SPSS version 25.

The steps to plot the line graph in SPSS are firstly, import the data that is obtained from Excel. Next, select analyze then select forecasting. Under forecasting choose a sequence chart. Lastly, a line graph GDP versus year 1961 to 2020 is obtained.

2.3 ARIMA model

This model is a statistical model that uses time series data which is the past value to forecast the future trends of data. ARIMA uses three variables which is (p,d,q), p is autoregressive order, d is the degree of differencing and q is the order of moving-range.

When X_t is non-stationary series, ARIMA(p,1,q) model is

$$\Delta X_t = c + \alpha_1 \Delta X_{t-1} + \cdots + \alpha_p \Delta X_{t-p} + \varepsilon_t - \theta_1 \varepsilon_{t-1} - \cdots - \theta_q \varepsilon_{t-q} \qquad Eq.\ 1$$

Where X_t is the data of stationary time series, $\Delta X_t = X_t - X_{t-1}$, α_p is the autoregressive model parameters, c is the constant of ARIMA parameters, θ_q is the moving average model parameters, and ε_t is the error term that possesses white noise.

2.3.1 Box and Jenkins Approach

In the Box and Jenkins approach, the first step is the identification step. It is a step to choose an ARIMA model based on the data. Then, in the estimation step, the parameters used are estimated followed by diagnostic checking where the model's adequacy is checked. If the model achieves its satisfaction, then it will proceed with forecasting. If not then it will return to the first step which is the identification.

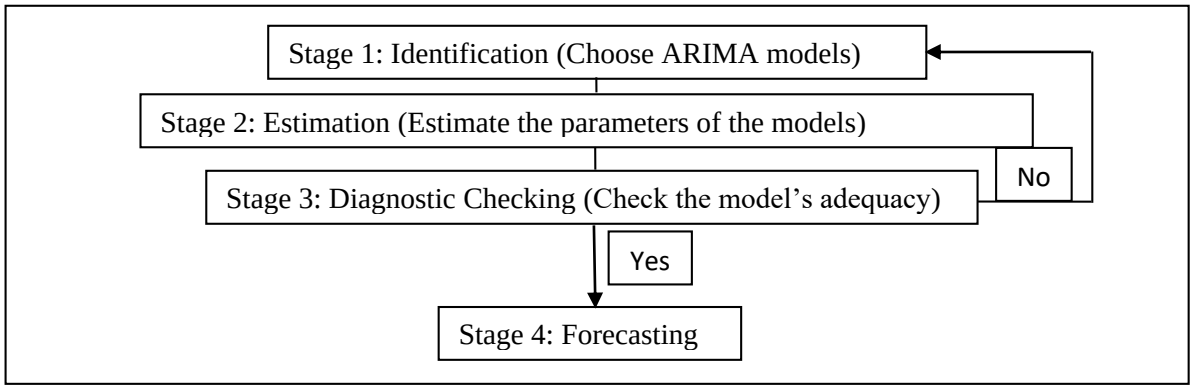

Figure 1: Stages in Box-Jenkins Approach, Source: Abonazel & Abd Eiftah (2019)

2.4 GDP growth and unemployment rate

The unemployment rate in Malaysia is studied based on the forecasted economic growth. The unemployment rate data is obtained from the World Development Indicator, World Bank. The data is used to plot the line graph so that it is easy to analyse.

The steps to plot the line graph in IBM SPSS:

Firstly, import the data of GDP growth and unemployment rate that is obtained from Excel. Next, select analyze followed by selecting forecasting. Under forecasting choose a sequence chart. Lastly, a line graph GDP and Unemployment rate versus Year 1991 to 2020 is obtained.

3. Results and Discussion

3.1 Description of the GDP growth

Figure 2 shows the graph of Malaysia GDP growth from 1961 to 2020.

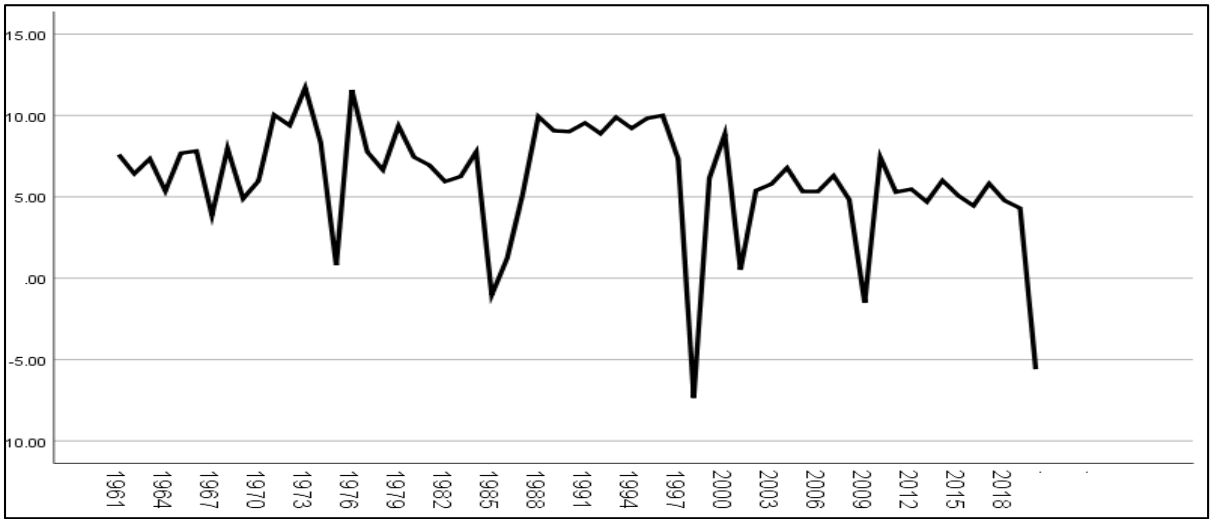

Figure 2: GDP growth versus year 1961 to 2020, Source: World Development Indicator, World Bank

From the year 1961 to 1973 the GDP growth was stable but after 1973 it has a slower GDP growth, after 2 years GDP began to decline drastically until 1975 because recession occurs that leads to the increase in cost of food, fuel, unit labour costs and interest rates [9]. Then, in 1976 GDP growth

recovered from 0.8 % to 11.56 % because of consumer spending especially for automobiles and the massive disinvestment to a modest investment in business inventories [9].

In 1976 to 1984 the GDP growth was stable. However, Malaysia GDP growth declined sharply from 7.76 % to -1.02% in 1985 due to US high-interest rate policy which is known as Volker shock [10]. It lasted for one year and in 1986 to 1988 the GDP continued to rise back to 9.94%.

In 1989 to 1996, GDP growth was stable, but it decreased sharply after that until 1998 due to Asian financial crisis where Malaysia experienced the biggest stock market plunge in the region [11]. Asian financial crisis first started in Thailand and spread to the other Asian Countries and affected the finance and banking sectors [12]. The National Economic Recovery Plan was introduced and launched by Dr Mahathir bin Mohamad, the Prime Minister of Malaysia in July 1998 [13]. This plan was used in stages to stabilize the local currency, financial market, restore market confidence, restructure corporate debt, recapitalize and restructure the banking sector and strengthen the economy [13]. Fortunately, the GDP growth continued to increase back from -7.35% in 1999 to 8.86% in 2000.

In the year 2001, GDP declined back because of the negative effect of the US economic slowdown and the global downturns that resulted in declining manufacturing production and negative export growth [14]. In 2002, the GDP slowly increased back to 5.39%. In 2003 until 2008, GDP growth was stable then it decreased drastically to -1.51% in 2009 because of the low performance in trade and investment due to the financial crisis faced by the US that was caused by excessive lending by banks, especially housing loans [15]. Malaysia's economy shows signs of stabilization after the implementation of large fiscal and monetary policy stimulus [16]. Next year until 2019, Malaysia GDP growth will be at a stable state.

In 2020, GDP growth decreases sharply lower than GDP in 2009 and is the second worst contraction after 1998. The decreases are due to the First Movement Control Order (MCO) which is known as "lockdown" that was implemented by Malaysia's government to reduce the spread of Coronavirus (Covid-19) to the citizens. Lockdown closes most of the economy sectors including closes the borders of the country. The lockdown lasted in a few stages which are MCO 1.0, MCO 2.0 and MCO 3.0 due to the sudden increase of Covid-19 cases. The Malaysian government will loosen the restriction as the MCO increases so that it will help to recover the economy. As days go by, Malaysia's government introduces the Vaccine Immunization Programmed to all the citizens to curb the spreading of Covid-19 cases and believe in a full economic recovery [17]. Citizens are implementing new norms by following the Standard Operating Procedure (SOP) where face masks are required whenever they leave their house.

3.2 Forecasting using ARIMA model

3.2.1 Identification

Firstly, the autocorrelation function and partial correlation function of the GDP growth data are determined to check the stationarity.

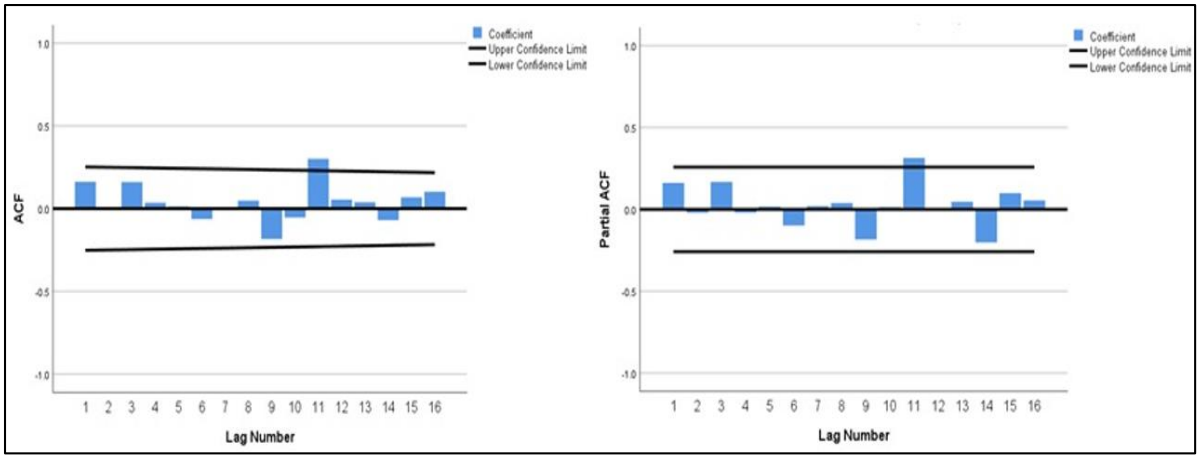

Figure 3: Autocorrelation function and Partial autocorrelation function of Malaysia GDP growth (annual)%

Figure 3 shows the results from SPSS of the Autocorrelation and Partial Autocorrelation Function of the GDP growth graph. The figures show that there are some coefficients that are not in the 95% confidence interval, this indicates that the graph is not stationary and required for differencing. The differencing is done in IBM SPSS version 25 to filter the series that are not in the 95% confidence interval. After that, it will proceed to the estimation step.

3.2.2 Estimation

Estimation steps help us to estimate which ARIMA models are suitable for us to use. All the estimated ARIMA model are summarized based on their model selections which are R-squared (R2), Root Mean Square Error (RMSE), Mean Absolute Percentage Error (MAPE), Mean Absolute Error (MAE), Normalized Bayesian Information Criterion (BIC) and Ljung-Box statistics.

Table 1: Comparison of different ARIMA models

ARIMA model					Ljung-Box Q		
	R2	RMSE	MAE	Normalized BIC			Table value at
					Statistics	DF	5%
(2,1,1)	0.085	3.581	2.324	2.828	17.435	15	0.2940
(2,1,0)	0.290	3.823	2.373	2.890	20.789	16	0.187
(1,1,0)	-0.290	4.176	2.651	2.997	2.997	17	0.016

From table 1, we observed that the value of the model selection for ARIMA (2,1,1) is the most fitted model because it has the lowest value of R2, RMSE, MAPE, MAE, normalized BIC, and the Ljung-Box Q. The Ljung-Box Q showed the Q value of the model which is 17.435 with the degree of freedom of 15.

Table 2: ARIMA (2,1,1) model parameters

			Estimate	SE	t	Sig.
GDP Growth (annual)%	Constant		-0.066	0.041	-1.602	0.115
	AR	Lag 1	0.146	0.157	0.930	0.356
		Lag 2	-0.075	0.154	-0.488	0.627
	Difference		1	-	-	-
	MA		0.998	2.037	0.490	0.626

From table 2, it is the model parameters of ARIMA (2,1,1). Therefore, the most fitted ARIMA model is ARIMA (2,1,1) and the suggestion of the parameters are:

$$X_t = -0.066 + 0.146X_{t-1} - 0.075X_{t-2} + \varepsilon_t + 0.998\varepsilon_{t-1} \qquad Eq\ 2$$

Where the data of the stationary time series has a constant of -0.066, 0.146 and -0.075 are the autoregressive model parameters and 0.998 is the moving average parameter. Then, the step is continued with diagnostic checking.

3.2.3 Diagnostic Checking

Next, is diagnostic checking where the model's adequacy is checked by determining whether the errors possess a white noise.

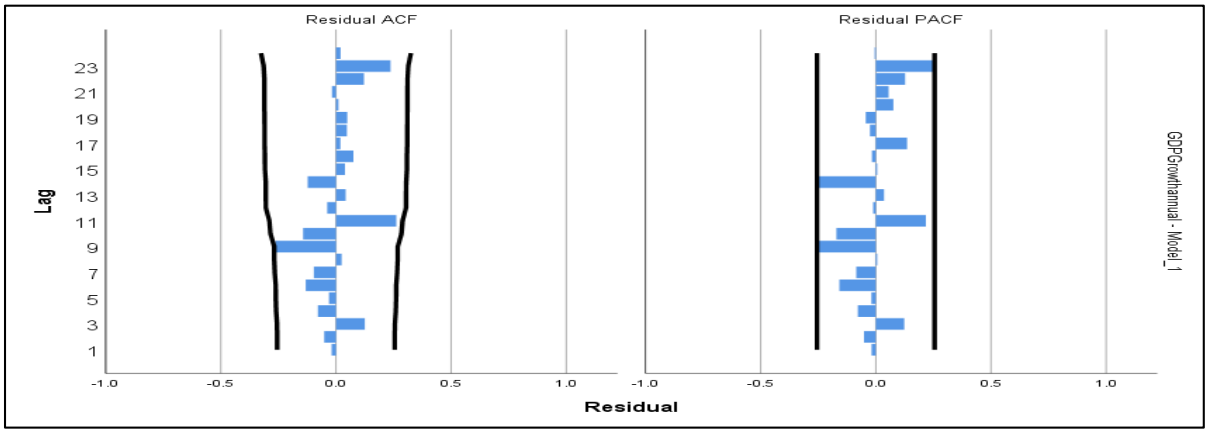

Figure 4: Residuals of Autocorrelation function and Partial autocorrelation function

As we can see in figure 4 the residuals of ARIMA (2,1,1), all ACF residuals and PACF residuals are within the confidence bound. This ensures that the residuals possess a white noise and satisfy the model adequacy. Therefore, this step can proceed with forecasting.

3.2.4 Forecasting

ARIMA model (2,1,1) is used to forecast the GDP growth of Malaysia from 2021 to 2026. In table 3 we can see the value of the forecasted GDP for the next five years.

Table 3: Forecasted GDP growth using SPSS

		2021	2022	2023	2024	2025	2026
GDP Growth (annual)%	Forecast	2.6711	4.5600	4.1545	3.8923	3.8234	3.7720

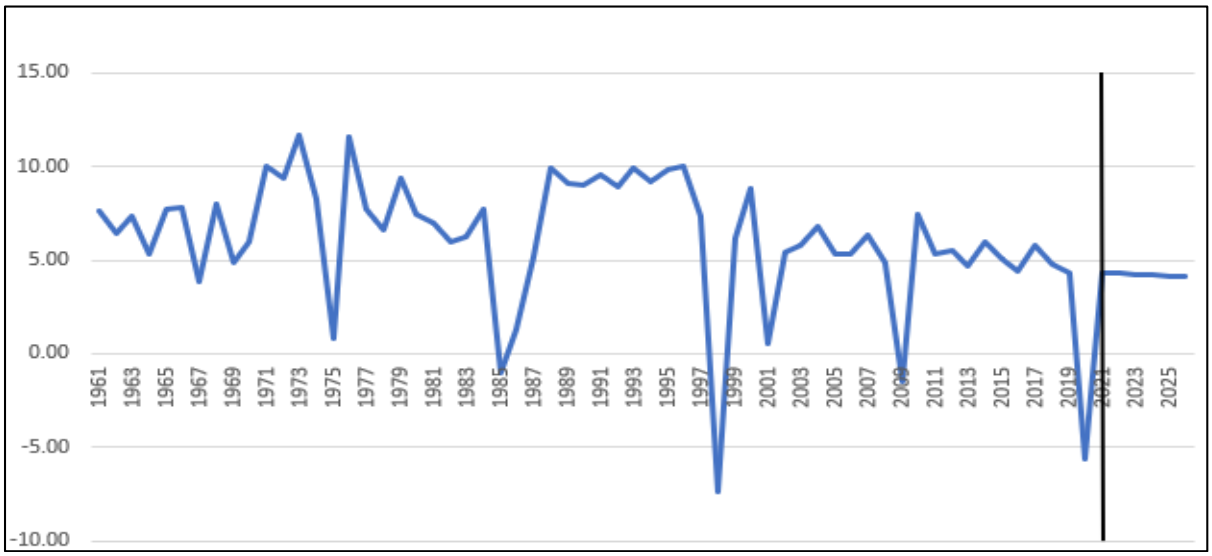

Figure 5: Forecasted GDP growth of Malaysia versus year

Figure 5 shows the graph of the forecasted GDP growth of Malaysia from 2021 to 2026. As we can see that the GDP of Malaysia will increase back in 2021 to 2023 but will slightly decrease back in 2024 to 2026. Therefore, it is concluded that Malaysia GDP growth will decrease starting from the year 2023 to 2026 due to the financial crisis. This is because based on the past economic growth trend most of the economic downturn is due to the financial crisis. Financial crisis will always happen as the world has currency.

3.2.5 Comparison forecasted GDP in SPSS with forecasted GDP in Microsoft Excel

The forecasted GDP growth in SPSS is compared with the forecasted GDP growth in Microsoft Excel and SPSS. As we can see in table 4 the forecasted GDP in SPSS and Microsoft Excel showed almost the same results where the value of forecasted GDP growth of Malaysia in 2021 will be increasing until 2023 and will decrease back for the next few years until 2026.

Table 4: Comparison of Forecasted GDP growth in SPSS and Microsoft Excel

			2021	2022	2023	2024	2025	2026
GDP Growth (annual)%	Forecast	SPSS	2.6711	4.5600	4.1545	3.8923	3.8234	3.7720
		Microsoft Excel	4.3643	4.3138	4.2634	4.2129	4.1624	4.1119

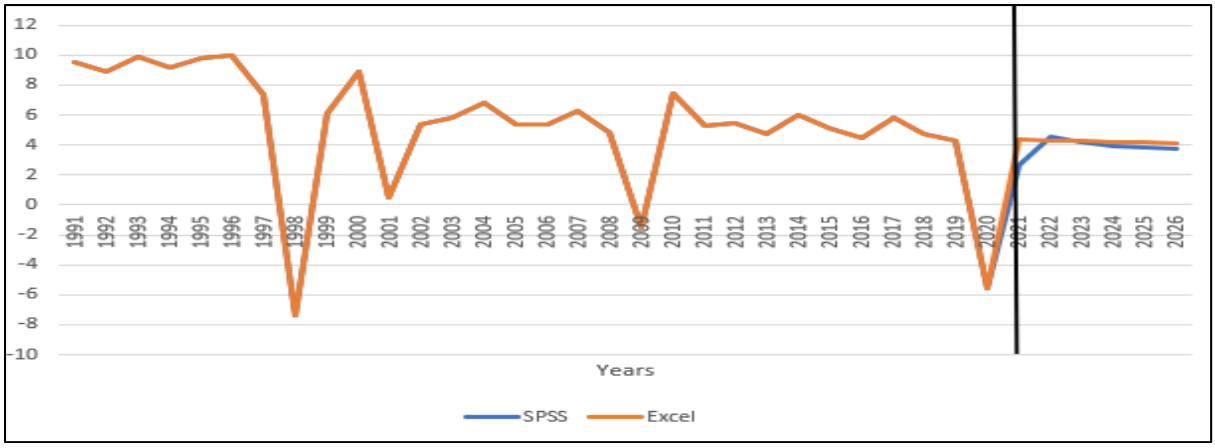

Figure 6: The graph of the forecasted GDP from SPSS and Microsoft Excel versus the year 1991 to 2026

From the figure 6, the graph of the forecasted GDP in SPSS and Microsoft Excel also showed the same results where the GDP will increase in 2021 and decrease back in 2026. Therefore, the method to implement the forecasting using ARIMA model on Box and Jenkins approach in SPSS is validated.

3.3 Relationship between economic growth and unemployment rate

The relationship of the GDP growth and unemployment rate are determined using the graph plotted in SPSS.

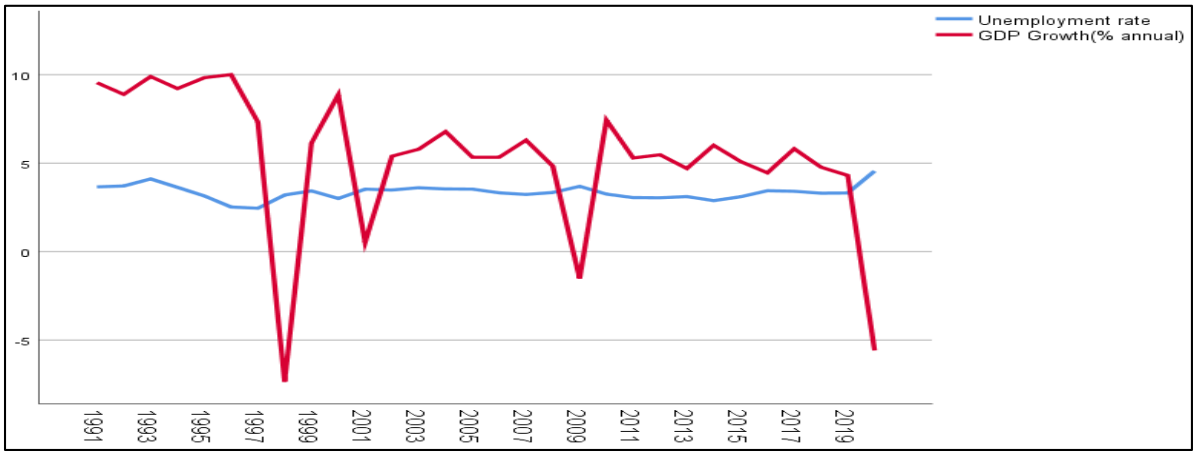

Figure 7: GDP and unemployment rate graph versus year 1991 to 2020 using SPSS

In figure 7, the GDP growth affects the rising of the unemployment rate. In the year 1998 the unemployment rate rose when the GDP growth of Malaysia decreased drastically due to the Asian Financial Crisis. The slowdown of the US economy in 2001 caused the economic growth of Malaysia to decline drastically and increase the unemployment rate. In 2009, the Global Financial Crisis occurred and affected GDP growth as well as the unemployment rate. The Pandemic of Covid-19 happened in the year 2020 which caused the GDP growth to drop and increased the unemployment rate. This follows Okun's law where GDP growth and the unemployment rate are inversely proportional. When the GDP growth decreases this will affect the unemployment rate in Malaysia. This follows Okun's law where it states that there is a negative relationship between economic growth and unemployment rate.

4. Conclusion

In conclusion, economic growth creates wealth for the country. Observing the trend of economic growth allows Malaysia to learn from the past economic downturns. The findings showed that the past economic downturn was mainly about the unfortunate economics or financial crisis such as Asian financial crisis, US economic downturn and in 2020 it was disrupted by the existence of a new species of virus that causes a pandemic of Covid-19. Forecasting GDP of Malaysia helps investors to determine whether it is a suitable time to invest in Malaysia. In this research, we developed an ARIMA model to forecast the GDP growth of Malaysia from 2021 to 2026 by using Box-Jenkins's time series approach. Furthermore, the forecasting was developed using Microsoft Excel and the results obtained are similar. Therefore, the method used in this study is verified. The relationship between GDP growth and unemployment rate are inversely proportional. Therefore, Okun's laws are relatable in Malaysia. This study suggests that the Malaysian government should take a precaution step and be aware of the coming situation by gearing up the economic growth in Malaysia. This research can be continued by forecasting the GDP growth of Malaysia using different models such as the Artificial Neural Network (ANN) model and comparing it with ARIMA model. Other than that, this research can be continued by forecasting 10 years of Malaysia GDP growth.

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