Impacts of COVID-19 and Related Government Policies on the Returns of the US Dollar Against the Malaysian Ringgit

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Abstract: Research Questions: What are the implications of COVID-19 and the related government policies on the returns of the United States dollar (USD) against the Malaysian Ringgit? **Motivation:** The implications of a global-scale pandemic on the exchange rate are not frequently examined, especially on the role of government policies. The exchange rate movement will affect Malaysia's economic performance as an open economy. Moreover, the suitability of government responses to the COVID-19 pandemic in exchange rate management should be investigated for future policymaking. **Ideas:** This paper estimates the exchange rate relationship with a few economic variables, including COVID-19 confirmed and death cases, by accounting for the high volatility in the exchange rate movement. **Data:** Daily data from March 3, 2020, to October 29, 2021, are analysed. The data are the confirmed and death cases of COVID-19, the COVID-19 response tracker (stringency index, containment and health index, economic support index, and government responses index), the return of the United States dollar against the Malaysian Ringgit, the weighted average of the 3-month interbank rate, FTSE Bursa Malaysia KLCI, West Texas Intermediate oil price and the United States 3-month treasury bill interest rate. The data is available from Bank Negara Malaysia, Our World in Data Databases, Blavatnik School of Government (University of Oxford), Yahoo Finance and Federal Reserve Bank of St. Louis. **Method: The** generalised autoregressive conditional heteroskedasticity estimation is deployed. **Findings:** An increase in the confirmed cases depreciates the value of the Malaysian Ringgit. Besides, the economic support initiatives bring the opposite effect. Other government policies lack robust evidence to show a significant impact on the exchange rate. Although COVID-19 and economic initiatives have an economically insignificant effect, comparing the coefficients show that the economic support initiatives could revert the implications of COVID-19 on the exchange rate. Furthermore, the stock market appreciates the examined exchange rate. **Contributions:** This paper provides empirical evidence of the impact of COVID-19 and the effectiveness of related responses in the Malaysian context. Besides, a few policy suggestions are given.

Keywords: COVID-19, exchange rate, GARCH, Malaysian Ringgit, government policy
JEL Classification: F31, H51, I18

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1. Introduction

One of the largest economic challenges in recent decades, the COVID-19 pandemic, has been linked to supply chain disruptions (Shahed *et al.*, 2021), a rising unemployment rate (Petrosky-Nadeau and Valletta, 2020; Su *et al.*, 2021), and influencing the equity market (Brueckner and Vespignani, 2021; Yiu and Tsang, 2021). These impacts, in turn, severely affect global economic growth (Vidya and Prabheesh, 2020) as consumption, investment, and global trade are lowered (Sawada and Sumulong, 2021).

In response to the pandemic, most governments imposed a series of movement and economic restrictions, nationwide or in specific states, to curb the spread of the disease for a specific duration. The Malaysian government is no exception. Nonetheless, economic activities were inevitably deterred by these policies. Therefore, the Malaysian government has launched fiscal stimulus packages to sustain the economy and jobs. According to the International Monetary Fund (n.d), the first fiscal stimulus package was launched at the end of February 2020, followed by several stimulus packages, including direct fiscal injections and indirect fiscal measures such as the withdrawal of pension funds. Besides, the Central Bank of Malaysia also provides grants for small-medium enterprises and targeted loan relief measures to the affected groups or individuals (Bank Negara Malaysia, n.d). Generally, all measures are expected to bring positive implications to the economy.

Though recent studies proposed the potential impact of the pandemic on the exchange rate, studies on whether government policies play any role in the relationship are limited. This paper aims to contribute to the existing literature by clarifying how the Malaysian government's responses affect the exchange rate market. This paper focuses on the time between March 3, 2020, to October 29, 2021, to achieve this objective. During that period, most of the population received two doses of vaccination, and the linkage between the pandemic and the exchange rate is expected to weaken following it. The Malaysian Ringgit (MYR) against the United States dollar (USD) is selected to represent the exchange rate market performance as it is the main international currency and is frequently used for international transactions.

Figure 1 illustrates the monthly average movement of USD against MYR during that period. The MYR appreciated from RM4.35 to USD1 to roughly RM4.05 to USD1 from March 2020 to January 2021. The possible factor behind the appreciation is the government's swift response, such as the fiscal injections. During this period, the average daily confirmed cases were below 700, and the average number of death cases was merely a single digit. Nonetheless, the average daily confirmed and death cases then rose to four and three digits, coinciding with the MYR depreciation. Due to fiscal constraints, the ability of the Malaysian government to launch economic stimulus packages at the previous magnitude has also been limited (Lim, 2020).

To better understand if the relationship between the pandemic and exchange rate performance is affected by government policies, this paper includes the government policies responding to the COVID-19 pandemic in the model by utilising the data from the COVID-19 government response tracker compiled by the University of Oxford. To date, this is the first paper that examines the influence of the COVID-19 pandemic on the value of the United States dollar against the Malaysian Ringgit (USD/MYR). It contributes to future policymaking as the output provides information on how a large-scale pandemic could affect the USD to MYR exchange rate. More importantly, knowledge about the effectiveness of the applied policies is essential for the government to react faster in responding to a similar challenge in the future. This paper is organised as below. Section 2 contains a review of the previous studies. Section 3 presents the methodology and data deployed to discover the impact of the pandemic on the USD to MYR exchange rate. The results are available in Section 4. Finally, Section 5 concludes the paper.

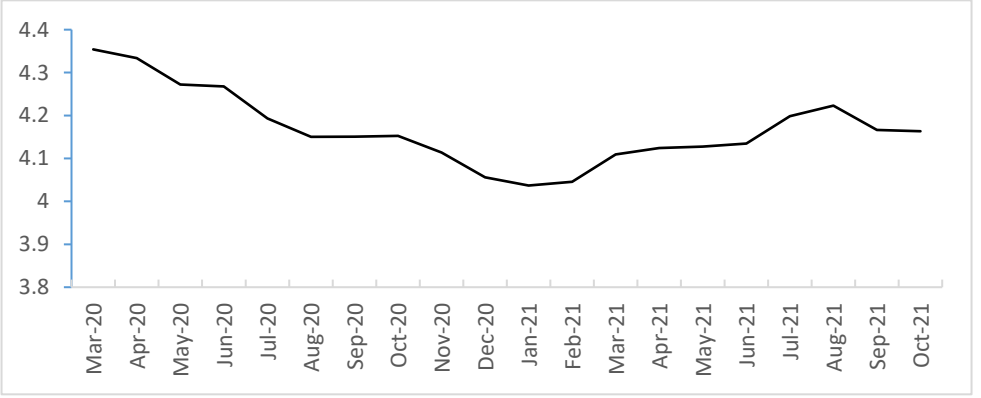

Figure 1: The average daily USD against MYR from March 3, 2021, to October 29, 2021

2. Literature Review

Previous studies examine the impact of COVID-19 on the exchange rate using the time series analysis except for Feng *et al.* (2021), who utilise the panel data. The previous paper is categorised into two parts. The first part focuses on the pandemic's repercussions on the exchange rate. The second part discusses the impact of the pandemic on other economic variables; the exchange rate is treated as a control variable.

According to Narayan (2020a), the time-varying Narayan and Popp unit root test suggests that the stationarity of the Japanese yen against the US dollar has changed following the COVID-19 outbreak. Particularly, the stationarity has changed from non-stationary to stationary. In other words, the COVID-19 pandemic is unlikely to have a persistent effect on the Yen-USD movement. Narayan (2020b) concludes that during the COVID-19 pandemic, the Japanese yen, Canadian dollar, and the Great British pound showed an explosive pattern because the null hypothesis of a unit root was rejected. Iyke (2020) covers several currencies from developed and developing countries to determine the ability of the COVID-19 pandemic to predict their exchange rate volatility and return against the USD in GARCH models. The results show that the forecasting ability of COVID-19 is stronger in the 5-day ahead forecast than in the 1-day ahead forecast. Besides, Narayan (2021) reports that the explanatory power of the exchange rate shocks on its movement has increased after the pandemic.

Furthermore, the interest rate differential has Granger caused the exchange rate in Brazil, Russia, India, Indonesia, China and South Africa during the COVID-19 pandemic, showing an indirect influence of the pandemic on the interest rate-exchange rate nexus (Garg and Prabheesh, 2021). Devpura (2021) discovered a statistically significant effect of the COVID-19 pandemic on the value of the Euro to USD only for short periods. Hoshikawa and Yoshimi (2021) observe the Korean stock market and exchange rate reactions to the COVID-19 pandemic. Besides, the impact of exchange rate interventions by the Korean authorities is also studied. Among the notable findings related to the exchange rate is that new COVID-19 cases led to currency appreciation seven days after the cases were registered. It could be due to repurchasing activity by the investors. Death cases have the opposite effect. Nonetheless, these effects are small and will be enlarged via their impact on the foreign holding of the Korean won. Finally, the interventions in the exchange rate have a marginal effect on the exchange rate.

Konstantakis *et al.* (2021) examine how the exchange rate between the Euro and the US dollar behaves before and after the COVID-19 pandemic. COVID-19 affects the exchange rate movement and increases its volatility. Benzid and Chebbi (2020) also find that the USD

volatility against the Sterling, Yuan and Euro increased after COVID-19 was confirmed and death cases rose. Finally, Feng *et al.* (2021), through the system GMM method on the panel data of 20 countries, shows that the COVID-19 confirmed cases and government economic support reduce the exchange rate volatility.

As for the second stream, Brueckener and Vespignani (2021) investigate COVID-19's impact on the stock market in Australia, with the exchange rate as one of the control variables. From their vector autoregressive model estimation, the COVID-19 new cases led to currency appreciation of the Australian dollar. The appreciation effect has also been found in the EUR/USD by Aloui (2021), who studied the quantitative easing transmission channel during the pandemic. The author further explains that currency appreciation weakens the effect of quantitative easing. Lastly, Rai and Garg (2021) estimate the relationship between the stock market and exchange rate in Brazil, Russia, India, Indonesia, China, and South Africa (BRIICS) countries. They summarise that the negative dynamics correlation between the stock market and the exchange rate market during the COVID-19 pandemic has shown that the capital outflow after the pandemic outbreak caused a decline in the stock market but a better exchange rate. This paper fills the knowledge gap by examining the impact of COVID-19 on the Malaysian Ringgit, an emerging country exposed to global trade. Besides, the effect of government responses to COVID-19 is also evaluated. Both areas have not been covered in the literature.

3. Conceptual Framework, Methods and Data

This section begins with the presentation of the conceptual framework. Theoretically, the impact of the pandemic will influence fluctuations in exchange rates for several reasons. Firstly, the pandemic is an unexpected event, and it is expected to exert a dominant explanatory power of exchange rate shocks over other factors based on the random walk hypothesis. The argument is even relevant if the pandemic persists for an extended period which causes the exchange rate to reflect the shocks of pandemics (Narayan, 2021). Iyke (2020) also suggests that a pandemic could be unexpected and informative in explaining exchange rate returns. It is because in the efficient market hypothesis, an asset return, which could include the exchange rate, reflect all information. However, the effect of COVID-19 on the exchange rate market, according to the efficient market hypothesis, could be temporary (Narayan, 2020a). Otherwise, a pandemic could facilitate the formation of a bubble in the currency market if the exchange rate market is inefficient (Narayan, 2020b).

Moreover, a pandemic creates capital outflows and negative market sentiment, exposing the currency to depreciation and greater exchange rate volatility (Iyke, 2020; Padhan and Prabheesh, 2021; Feng *et al.*, 2021). The depreciation effect caused by the pandemic coincidences with the smaller interest differential between domestic and global markets. The smaller differential weakens the demand for domestic currency following the monetary easing policy implemented globally (Garg and Prabhessh, 2021). Lastly, Feng *et al.* (2021) report that government interventions to curb the spread of COVID-19 could have ambiguous effects on asset markets. For instance, social distancing could negatively affect stock market volatility, while some intervention policies could improve stock market liquidity. In the context of this paper, the same effect could occur in the exchange rate market. In summary, the exchange rate could influence the exchange rate return according to the random walk and efficient market hypotheses. Moreover, the negative market sentiment also affects the currency markets through international capital movement. Besides, government intervention to curb the pandemic could have mixed impacts, depending on the intervention's effect on the economy.

Instead of examining the exchange rate behaviour in a random walk framework, this paper adopts the conceptual framework that the COVID-19 pandemic could affect the economic

fundamentals (Padhan and Prabheesh, 2021, Feng *et al.*, 2021; Garg and Prabhessh, 2021). Subsequently, it will influence the demand and supply of the Malaysian Ringgit. This paper applies the GARCH (1,1) models proposed by Bollerslev (1986) to investigate the relationship between the variables. The GARCH (1,1) model is applied because of the high volatility in the exchange rate movement. Moreover, the GARCH (1,1) model could capture the exchange rate volatility process and is a common method in the related literature (Cartwright and Raibko, 2015). As an implication of the conceptual framework, the mean equation of the GARCH model consists of a few selected determinants of the exchange rate. In particular, the mean equation and the variance equation for this GARCH (1,1) model can be illustrated by Equations (1) and (2), respectively.

$$ERR_t = \beta_0 + \beta_1 X + \varepsilon_t \quad (1)$$

$$\sigma_t^2 = \gamma_0 + \gamma_1 \mu_{t-1}^2 + \alpha_1 \sigma_{t-1}^2 \quad (2)$$

where ERR is the exchange rate growth rate, and X are all independent variables examined in this paper. These variables are the change of daily new confirmed cases of COVID-19 ($CONF$), the change of daily new death cases caused by COVID-19 ($DEATH$), government policies to handle the COVID-19, Malaysia interest rate ($MYIR\_3M$), international oil price ($LNOIL$), stock market index of Malaysia ($LNSTOCK$), and US interest rate ($USIR$). β_0, β_1, γ_0, γ_1 and α_1 are the parameters. Finally, ε_t is the zero-mean error term with the conditional variance shown by Equation (2). The error distribution is assumed to be normal.

In the GARCH model, conditional variance is an ARMA process which differs from the ARCH model, which assumes the conditional variance is an AR model. This paper tests the existence of the ARCH effect before conducting the GARCH model since the ARCH effect justifies the decision to estimate the model using the GARCH estimation. The ARCH test is conducted on the residual generated by regressing the exchange rate growth rate on its first autoregressive term. The null hypothesis of the ARCH test is that there is no ARCH effect. Furthermore, there are a few restrictions on the parameters in the variance equation to ensure strict positivity of conditional variances and stationarity. These restrictions are $\gamma_0>0$ $\gamma_1>0$, $\alpha_1>0$ and $\gamma_1 + \alpha_1 < 1$. Finally, the absence of the ARCH effect and serial correlation in the GARCH models is tested to examine the performance of the GARCH model. The correlogram of standardised residual squared is referred to determine serial correlation. EViews Statistical Software is deployed for this estimation.

All data is estimated in raw form except for the stock market index and oil price, in which both variables are transformed into the natural logarithm form. Since the oil price data recorded a negative value on April 20, 2020, a constant value is added to all oil price observations so that the negative value becomes one. After that, the created variable is transformed into a natural logarithm. It is worth highlighting that since the daily data is collected for estimation, the output and inflation effects are not considered in this paper. Nonetheless, the stock market variable in the GARCH estimation could capture the effect of economic growth and price level at a high frequency.

The data begins from March 3, 2020, to October 29, 2021. Table 1 presents the data sources for the variable applied in this paper. This paper measures the exchange rate's return by calculating the exchange rate's growth rate. The direct quote for the Malaysian Ringgit is used to obtain the exchange rate return. An increase (decline) in the exchange rate indicates that the MYR depreciates (appreciates) against the USD. The influence of COVID-19 is represented by its confirmed cases and death cases. Iyke (2020) and Feng *et al.* (2021) also applied both variables to measure the effect of the COVID-19 pandemic.

Table 1: Data source

Data	Sources
The value of the United States Dollar against the Malaysian Ringgit	Bank Negara Malaysia
Daily COVID-19 new confirmed cases	Our World in Data Databases
Daily COVID-19 new death cases	Our World in Data Databases
Stringency index	Blavatnik School of Government, University of Oxford
Containment and health index	Blavatnik School of Government, University of Oxford
Economic support index	Blavatnik School of Government, University of Oxford
Government responses index	Blavatnik School of Government, University of Oxford
The weighted average of the 3-month interbank rate	Bank Negara Malaysia
FTSE Bursa Malaysia KLCI	Yahoo Finance
West Texas Intermediate oil price	Federal Reserve Bank of St. Louis
US 3-month treasury bill interest rate	Federal Reserve Bank of St. Louis

Four government COVID-19 intervention policy indicators published by the Blavatnik School of Government, University of Oxford, are deployed to observe how these interventions or policies affect the exchange rate. These policies are expected to play a role in affecting the recovery and resilience of the economic sector. According to Hale *et al.* (2021), COVID-19-related policies are showcased via the stringency index (*STRINGENCY*), the containment and health index (*CONTAIN*), the economic support index (*ECONOMIC*) and the government response index (*RESPONSE*). Each of these indices reflects different policy aspects of government responses, and some aspects are included in more than one index. These policy aspects are containment and closure policies (8 policy indicators), economic policies (2 policy indicators) and health system policies (5 policy indicators). The stringency index indicates the degree of lockdown policies. It covers all eight containment and closure policies (involving restrictions on schools, workplaces, public places, gathering activities, transportation, home confinement, internal movement and international movement) and health system policies (i.e., public information campaign). Otherwise, the containment and health index observes the lockdown restrictions. It expands the coverage of the stringency index to another five indicators of health system policies which are testing policy, contact tracing, facial coverings policy, vaccination policy, and elderly people protection policies.

Otherwise, the economic support index measures the economic support to alleviate the impact of the pandemic in terms of income and debt relief. In contrast, the government response index measures the level of government responses to the pandemic, including all indicators included in the stringency index, containment and health index and economic support index. All indexes are ordinal. These four types of government policies are tested individually in this study.

This paper also includes a few control variables to account for other factors that could affect the exchange rate returns. These variables are also applied in previous papers and supported by economic theories. First, the weighted average of the Malaysian 3-month interbank rate is collected to gauge the implication of domestic interest rate changes on the exchange rate. Theoretically, a change in the domestic interest rate could affect the relative returns between domestic and foreign assets. Hence, the demand for domestic and the value of the domestic currency will change. At the same time, the impact could be the opposite if a rising interest rate increases the business operating costs, causing the expectation that economic activities will slow down in the future. It is worth mentioning that the previously

available data will be used to replace the missing daily data. Yiu and Tsang (2021) and Feng *et al.* (2021) also include an interest rate variable with a similar objective for their study.

The oil-exporting revenue has played a significant role in the fiscal performance of the Malaysian government. Hence, the oil price movement is proxied by the West Texas Intermediate oil price. Nonetheless, the increasing import following a rise in oil revenue could bring the opposite effect. Brueckner and Vespignani (2021) and Konstantatiks *et al.* (2021) also examine the same factor. Otherwise, the FTSE Bursa Malaysia KLCI measures the stock market performance in Malaysia. An active stock market will affect the demand and supply of the MYR, causing the return of MYR to change eventually. Lastly, the US 3-month treasury bill rate shows the US monetary policy, which could affect the value of USD/MYR externally. Typically, a rise in the US interest rate will cause the MYR to depreciate. Fang and Zhang (2021) also examined the influence of foreign interest rates when investigating the Chinese Renminbi during the COVID-19 pandemic.

This paper adopts three strategies to test the sensitivity of the results. First, instead of using the 3-month interest rate, the 1-month interest rate is deployed. Second, the normal error distribution in the GARCH estimation is replaced by the t-statistics error distribution. Third, ARDL and EGARCH models are estimated as alternative methods. Lastly, forecastability is used to determine the forecast performance of the estimated GARCH model. For this exercise, a shorter sample, covering data from March 3, 2020, to June 30, 2021, is estimated. After that, the root mean square error (RMSE) and mean absolute error (MAE) of the forecast from July 1, 2021, to October 29, 2021, is observed.

4. Result Discussions

When the ARCH effect is conducted on the return of USD/MYR, the ARCH is confirmed when the p-value of the chi-square is 0.000. These results justify that utilising a GARCH model is appropriate in this paper. The breakpoint unit root test is also conducted to determine the stationarity properties of the data, involving the innovative and addictive break types. The examined unit root equation is assumed to contain intercept only or intercept and trend components; the breakpoint for the former and latter is assumed to be found in the intercept and trend, respectively. The results are not presented here to save space and are available upon request. All variables are stationary at level, except for the new COVID-19 confirmed cases when the unit root equation is set to have intercept and trend components, and the break is addictive. In this case, the variables are treated as stationary at the level. Therefore, all variables are examined in their level form.

Next, Table 2 to Table 5 shows the impact of COVID-19 on the exchange rate in different categories of COVID-19 measures. The estimated GARCH model shows no ARCH effect and serial correlation at a 5% significance level. The correlogram diagrams are not reported here to conserve space and are available upon request. Hence, the performance of these models is considered satisfactory. Further, RMSE and MAE are roughly 0.23 and 0.17, respectively. To recap, RMSE and MAE measure the average distance between the predicted and actual exchange rate growth rates. Since the exchange rate growth rate ranges from 2.2 to –2.3 during the sample period, the forecasting ability of the GARCH model is considered reasonable. Furthermore, RMSE and MEA are similar in all models in Table 2 to Table 5, showing that the forecasting performance is not affected by different independent variables in a model.

Table 2: GARCH output (Stringency index)

Model 1 Mean equation	Coefficient	p-value	Model 2 Mean equation	Coefficient	p-value
CONF	1.86E-05	0.0701	CONF	1.89E-05	0.0624
DEATH	-4.21E-05	0.9328	DEATH	-4.23E-05	0.9319
STRINGENCY	0.0021	0.0703	STRINGENCY	0.0022	0.0602
MYIR_3M	0.1395	0.0006	MYIR_3M	0.1834	0.0003
Constant	-0.4232	0.0004	LNOIL	0.0631	0.1893
			Constant	-0.8034	0.0084
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0097	0.0000	Constant	0.0099	0.0000
Residual term	0.3425	0.0000	Residual term	0.3532	0.0000
GARCH term	0.5809	0.0000	GARCH term	0.5698	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	0.0259 (0.8723)		ARCH effect test	0.0042 (0.9484)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.227		RMSE	0.227	
MAE	0.174		MAE	0.174	
Model 3 Mean equation	Coefficient	p-value	Model 4 Mean equation	Coefficient	p-value
CONF	1.84E-05	0.092	CONF	1.87E-05	0.0845
DEATH	-9.69E-05	0.8332	DEATH	-9.89E-05	0.8297
STRINGENCY	0.0022	0.077	STRINGENCY	1.65E-03	0.2310
MYIR_3M	0.1893	0.0001	MYIR_3M	2.33E-01	0.0000
LNOIL	0.0569	0.2286	LNOIL	4.39E-02	0.3509
LNSTOCK	-3.5543	0.0085	LNSTOCK	-3.5172	0.0102
Constant	-0.7812	0.0089	USIR	-0.3234	0.1665
			Constant	-7.53E-01	0.0122
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0107	0.0000	Constant	1.08E-02	0.0000
Residual term	0.3336	0.0000	Residual term	0.3383	0.0000
GARCH term	0.5722	0.0000	GARCH term	0.5657	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	0.0243 (0.8761)		ARCH effect test	0.0135 (0.9076)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.231		RMSE	0.230	
MAE	0.178		MAE	0.177	

Notes: The value in the parentheses indicates the p-value of the ARCH effect test.

The findings offer a few conclusions. First, a rise in confirmed COVID-19 cases would lead to a depreciation of the MYR value against the USD at a 10% significance level. Otherwise, the death cases show a negative coefficient sign but are statistically insignificant. Hence, this study supports Garg and Prabheesh (2021) and Feng *et al.* (2021) that the unexpected pandemic outbreak could cause capital outflows and negative market sentiment in Malaysia. However, the impact could be economically insignificant, as shown by the relatively small coefficient size of both COVID-19 indicators. For example, the coefficient size of confirmed cases is 1.87E-05, as shown by Model 4 in Table 2. Iyke (2020) also found that the variable's coefficient is small.

Table 3: GARCH output (Containment and health index)

Model 1 Mean equation	Coefficient	p-value	Model 2 Mean equation	Coefficient	p-value
CONF	1.86E-05	0.0978	CONF	1.87E-05	0.0964
DEATH	-3.92E-05	0.9305	DEATH	-3.97E-05	0.9291
CONTAIN	0.0015	0.3966	CONTAIN	0.0015	0.3795
MYIR_3M	-0.0423	0.4572	MYIR_3M	0.0211	0.7611
Constant	-0.0306	0.8742	LNOIL	0.0289	0.7093
			Constant	-0.2084	0.6502
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0035	0.0021	Constant	0.0003	0.002
Residual term	0.1288	0.0000	Residual term	0.1263	0.0000
GARCH term	0.8267	0.0000	GARCH term	0.8304	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	2.2371 (0.1347)		ARCH effect test	2.3217 (0.1276)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.226		RMSE	0.226	
MAE	0.174		MAE	0.174	
Model 3 Mean equation	Coefficient	p-value	Model 4 Mean equation	Coefficient	p-value
CONF	1.94E-05	0.0977	CONF	1.95E-05	0.0965
DEATH	-4.59E-05	0.9137	DEATH	-4.52E-05	0.9151
CONTAIN	0.0015	0.3927	CONTAIN	1.18E-03	0.5714
MYIR_3M	-0.0232	0.7155	MYIR_3M	-5.49E-03	0.9348
LNOIL	0.0207	0.7922	LNOIL	2.84E-03	0.9738
LNSTOCK	-4.0631	0.0057	LNSTOCK	-4.0359	0.0067
Constant	-0.1614	0.7238	USIR	-0.201	0.5445
			Constant	-8.30E-02	0.8718
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0033	0.0022	Constant	3.28E-03	0.0221
Residual term	0.1197	0.0000	Residual term	0.1168	0.0000
GARCH term	0.8371	0.0000	GARCH term	0.8397	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	3.5179 (0.0607)		ARCH effect test	3.6709 (0.0554)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.230		RMSE	0.230	
MAE	0.177		MAE	0.177	

Notes: The value in the parentheses indicates the p-value of the ARCH effect test.

Furthermore, statistical evidence substantiates that Malaysian government policies influence the performance of the Malaysian Ringgit. In particular, a higher stringency index (economic support index) leads to the MYR depreciation (appreciation) in almost all estimated models. These summaries are anticipated because the ease of economic activities positively impacts economic performance. If the economic activities are restricted, the negative economic prospects will lower the demand for the Malaysian Ringgit. Moreover, the financial support provided by the Malaysian government managed to prevent the economy from further recession, improving the Malaysian Ringgit's performance.

Table 4: GARCH output (Economic support index)

Model 1 Mean equation	Coefficient	p-value	Model 2 Mean equation	Coefficient	p-value
CONF	2.07E-05	0.0458	CONF	1.97E-05	0.0742
DEATH	-1.85E-05	0.9717	DEATH	-2.05E-05	0.9649
ECONOMIC	-0.0054	0.0000	ECONOMIC	-0.0047	0.0000
MYIR_3M	0.0777	0.0683	MYIR_3M	-0.0969	0.0810
Constant	0.2392	0.0754	LNOIL	0.0033	0.9660
			Constant	0.5164	0.2409
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0113	0.0000	Constant	0.0046	0.0013
Residual term	0.3308	0.0000	Residual term	0.1505	0.0000
GARCH term	0.5641	0.0000	GARCH term	0.7937	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	0.0305 (0.8613)		ARCH effect test	1.1560 (0.2823)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.224		RMSE	0.225	
MAE	0.173		MAE	0.173	
Model 3 Mean equation	Coefficient	p-value	Model 4 Mean equation	Coefficient	p-value
CONF	2.01E-05	0.0804	CONF	1.99E-05	0.0826
DEATH	-3.47E-05	0.9375	DEATH	-8.50E-05	0.8600
ECONOMIC	-0.0039	0.0003	ECONOMIC	-4.66E-03	0.0000
MYIR_3M	-0.0947	0.0707	MYIR_3M	1.91E-01	0.0015
LNOIL	-0.0073	0.9253	LNOIL	-5.42E-03	0.9165
LNSTOCK	-3.9883	0.0076	LNSTOCK	-3.7362	0.0018
Constant	0.4969	0.2562	USIR	-0.781	0.0001
			Constant	4.43E-02	0.8982
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0048	0.0012	Constant	0.0132	0.0000
Residual term	0.1497	0.0000	Residual term	0.3191	0.0000
GARCH term	0.791	0.0000	GARCH term	0.5459	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	1.6941 (0.1931)		ARCH effect test	0.1614 (0.6879)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.231		RMSE	0.230	
MAE	0.178		MAE	0.178	

Notes: The value in the parentheses indicates the p-value of the ARCH effect test.

Additionally, the coefficient size of the stringency index and economic support index is smaller than other explanatory variables, except for COVID-19 indicators. For example, the stringency index and economic support index's coefficient size in Model 4 in Table 2 and Table 4 are 1.65E-03 and –4.66E-03, respectively. Two points can be summarised by interpreting these coefficient sizes. First, both policies have a more impactful effect on the exchange rate than the pandemic. Second, the appreciation effect of government economic support steps surpasses the depreciation effect caused by the rising confirmed COVID-19 cases. Otherwise, the containment and health steps and the level of government response to COVID-19 are statistically insignificant determinants of USD/MYR return.

Table 5: GARCH output (government response index)

Model 1 Mean equation	Coefficient	p-value	Model 2 Mean equation	Coefficient	p-value
CONF	1.89E-05	0.0931	CONF	1.89E-05	0.0919
DEATH	-3.66E-05	0.9351	DEATH	-3.72E-05	0.9337
RESPONSE	0.0014	0.4492	RESPONSE	0.0015	0.4279
MYIR_3M	-0.0482	0.3972	MYIR_3M	-0.0275	0.6918
Constant	-0.0139	0.9447	LNOIL	0.0284	0.7140
			Constant	-0.1894	0.6824
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0035	0.0022	Constant	0.0034	0.0021
Residual term	0.1281	0.0000	Residual term	0.1254	0.0000
GARCH term	0.8274	0.0000	GARCH term	0.8312	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	2.2776 (0.1313)		ARCH effect test	2.3706 (0.1236)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.227		RMSE	0.227	
MAE	0.174		MAE	0.174	
Model 3 Mean equation	Coefficient	p-value	Model 4 Mean equation	Coefficient	p-value
CONF	1.96E-05	0.0932	CONF	1.97E-05	0.092
DEATH	-4.34E-05	0.9183	DEATH	-4.27E-05	0.9198
RESPONSE	0.0014	0.4383	RESPONSE	0.0011	0.6310
MYIR_3M	-0.028	0.6617	MYIR_3M	0.009	0.8935
LNOIL	0.0204	0.7945	LNOIL	0.0004	0.9961
LNSTOCK	-4.0617	0.0060	LNSTOCK	-4.031	0.0072
Constant	-0.1464	0.7500	USIR	-0.2217	0.5052
			Constant	-0.0554	0.9157
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0033	0.0022	Constant	0.0033	0.0021
Residual term	0.1193	0.0000	Residual term	0.1159	0.0000
GARCH term	0.8374	0.0000	GARCH term	0.8404	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	3.5644 (0.0590)		ARCH effect test	3.7411 (0.0533)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.231		RMSE	0.231	
MAE	0.178		MAE	0.178	

Notes: The value in the parentheses indicates the p-value of the ARCH effect test.

The following discussion covers the control variables. First, the effect of the domestic 3-month interbank rate is ambiguous from Table 2 to Table 5. Although the variable is statistically significant in Table 2, the same conclusion is found in Table 4 only. Next, the oil price has a statistically insignificant depreciation effect on the value of the MYR. Third, a better stock market increases the demand for MYR since it could prompt future investments from foreign investors. The coefficient sign from Table 2 to Table 5 suggests that a one per cent increase in the stock index could cause the Malaysian Ringgit to appreciate by 0.03 to 0.04 per cent. Please note that the coefficient value is divided by 100 since a level-log model is estimated here. Lastly, a higher 3-month treasury bill interest rate in the US has a statistically insignificant appreciation effect on the MYR. Observing the variance equation shows that residual and GARCH terms are statistically significant. It suggests that the past news will affect the variance of the residual and the existence of heteroscedasticity, respectively. Besides, the conditional variance stationarity is achieved since both coefficients are more than zero and the total of both coefficients are less than one.

Table 6: GARCH output (Stringency index, Malaysian 1-month interbank rate)

Model 1 Mean equation	Coefficient	p-value	Model 2 Mean equation	Coefficient	p-value
CONF	1.89E-05	0.0701	CONF	1.91E-05	0.644
DEATH	-2.85E-05	0.9328	DEATH	-2.51E-05	0.9606
STRINGENCY	0.0017	0.0703	STRINGENCY	0.0017	0.1726
MYIR_1M	0.1921	0.0006	MYIR_1M	0.2427	0.0014
Constant	-0.4772	0.0004	LNOIL	0.0445	0.3912
			Constant	-0.7713	0.0285
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0100	0.0000	Constant	0.0104	0.0000
Residual term	0.3289	0.0000	Residual term	0.3394	0.0000
GARCH term	0.5871	0.0000	GARCH term	0.5743	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	0.0212 (0.8841)		ARCH effect test	0.0078 (0.9299)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.225		RMSE	0.224	
MAE	0.173		MAE	0.172	
Model 3 Mean equation	Coefficient	p-value	Model 4 Mean equation	Coefficient	p-value
CONF	1.99E-05	0.0865	CONF	2.02E-05	0.0805
DEATH	-4.66E-05	0.9135	DEATH	-4.51E-05	0.9177
STRINGENCY	8.50E-04	0.5111	STRINGENCY	3.26E-04	0.8315
MYIR_1M	0.0789	0.3674	MYIR_1M	0.1492	0.0899
LNOIL	0.0539	0.4368	LNOIL	0.0213	0.7824
LNSTOCK	-4.0927	0.0540	LNSTOCK	-4.0803	0.0054
Constant	-0.4609	0.2845	USIR	-0.3601	0.1927
			Constant	-0.3822	0.4173
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0037	0.0009	Constant	0.0042	0.0010
Residual term	0.1279	0.0000	Residual term	0.1373	0.0000
GARCH term	0.8266	0.0000	GARCH term	0.8115	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	2.9860 (0.0844)		ARCH effect test	2.3528 (0.1251)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.229		RMSE	0.229	
MAE	0.178		MAE	0.177	

Notes: The value in the parentheses indicates the p-value of the ARCH effect test.

The impact of COVID-19 and government policy is first examined by replacing the domestic interest rate with a 1-month interest rate; see Table 6 to Table 9 for the results. The model performance measured by the ARCH effect, autocorrelation and forecastability according to RMSE and MAE is similar to those in Table 2 to Table 5. Based on the findings, the impact of the confirmed and death cases is largely supported. As for the COVID-19-related measures, only the economic support index has a statistically significant and robust effect in all estimated models, and its appreciation effect on the MYR remains unchanged. Hence, this paper shows the positive impact of the policies that aim to offer economic support in sustaining MYR against USD. While the coefficient size of the economic support policy is larger compared to other government policies, which is similar to those of Table 4, the coefficient size becomes larger in Model 4 of Table 8 compared to that of Table 4, in which the coefficient increases from –4.66-E03 to -0.0046.

Table 7: GARCH output (Containment and health index, Malaysian 1-month interbank rate)

Model 1 Mean equation	Coefficient	p-value	Model 2 Mean equation	Coefficient	p-value
CONF	1.79E-05	0.0832	CONF	1.86E-05	0.0948
DEATH	-3.56E-05	0.9438	DEATH	-4.50E-05	0.9210
CONTAIN	-0.0030	0.0575	CONTAIN	0.0019	0.2654
MYIR_1M	0.2311	0.0001	MYIR_1M	0.1023	0.2952
Constant	0.6419	0.0002	LNOIL	0.0547	0.4349
			Constant	-0.5827	0.1987
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0102	0.0000	Constant	0.0039	0.0008
Residual term	0.3441	0.0000	Residual term	0.1414	0.0000
GARCH term	0.5735	0.0000	GARCH term	0.8122	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	0.0170 (0.8962)		ARCH effect test	1.7090 (0.1911)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.224		RMSE	0.223	
MAE	0.172		MAE	0.172	
Model 3 Mean equation	Coefficient	p-value	Model 4 Mean equation	Coefficient	p-value
CONF	1.92E-05	0.0989	CONF	1.96E-05	0.0909
DEATH	-5.20E-05	0.9027	DEATH	-4.96E-05	0.9087
CONTAIN	0.0018	0.2913	CONTAIN	0.0011	0.5992
MYIR_1M	0.0947	0.3027	MYIR_1M	0.1477	0.1061
LNOIL	0.0519	0.4604	LNOIL	0.0246	0.7511
LNSTOCK	-4.0673	0.0058	LNSTOCK	-4.0604	0.0058
Constant	-0.5493	0.2242	USIR	-0.3002	0.3006
			Constant	-0.4537	0.3668
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0035	0.0008	Constant	0.0039	0.0009
Residual term	0.1265	0.0000	Residual term	0.1340	0.0000
GARCH term	0.8291	0.0000	GARCH term	0.8172	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	3.0686 (0.0798)		ARCH effect test	2.5601 (0.1096)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.226		RMSE	0.229	
MAE	0.175		MAE	0.176	

Notes: The value in the parentheses indicates the p-value of the ARCH effect test.

On the other hand, the stringency index, containment and health index and government response have a statistically significant impact on the exchange rate only in the basic model in Table 6, Table 7 and Table 9, respectively. Similarly, these policy measurements' coefficient size is considered economically insignificant yet larger than those of COVID-19 indicators. Due to its statistical insignificance, this paper does not explain its coefficient for brevity. As for the control variables, the results largely align with those reported in Table 2 to Table 5. The conclusions from the variance equation in Table 2 to Table 5 remain intact in this sensitivity test.

Table 8: GARCH output (Economic support index, Malaysian 1-month interbank rate)

Model 1 Mean equation	Coefficient	p-value	Model 2 Mean equation	Coefficient	p-value
CONF	2.08E-05	0.0518	CONF	2.10E-05	0.0466
DEATH	-1.58E-05	0.9757	DEATH	-1.24E-05	0.9809
ECONOMIC	-0.0051	0.0000	ECONOMIC	-0.0047	0.0001
MYIR_1M	0.0833	0.1906	MYIR_1M	0.1443	0.1183
Constant	0.2176	0.2283	LNOIL	0.0393	0.5038
			Constant	-0.1028	0.8220
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0109	0.0000	Constant	0.0112	0.0000
Residual term	0.3011	0.0000	Residual term	0.3139	0.0000
GARCH term	0.5911	0.0000	GARCH term	0.5783	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect tests	0.0293 (0.8642)		ARCH effect tests	0.0183 (0.8925)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.225		RMSE	0.224	
MAE	0.173		MAE	0.172	
Model 3 Mean equation	Coefficient	p-value	Model 4 Mean equation	Coefficient	p-value
CONF	2.06E-05	0.0752	CONF	1.96E-05	0.0989
DEATH	-4.24E-05	0.9242	DEATH	-6.30E-05	0.8964
ECONOMIC	-0.0031	0.0417	ECONOMIC	-0.0046	0.0006
MYIR_1M	0.0019	0.9875	MYIR_1M	0.1220	0.2580
LNOIL	0.0404	0.5638	LNOIL	-0.0427	0.6015
LNSTOCK	-3.9971	0.0088	LNSTOCK	-3.8806	0.0022
Constant	0.0318	0.9533	USIR	-0.6562	0.0015
			Constant	0.3476	0.5614
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0048	0.0010	Constant	0.0110	0.0000
Residual term	0.1449	0.0000	Residual term	0.2386	0.0000
GARCH term	0.7958	0.0000	GARCH term	0.6348	0.0000
Diagnostic test			Diagnostic test		
ARCH effect test	1.9287 (0.1649)		ARCH effect test	0.2619 (0.6088)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.228		RMSE	0.230	
MAE	0.176		MAE	0.178	

Notes: The value in the parentheses indicates the p-value of the ARCH effect test.

Table 9: GARCH output (government response index, Malaysian 1-month interbank rate)

Model 1 Mean equation	Coefficient	p-value	Model 2 Mean equation	Coefficient	p-value
CONF	1.81E-05	0.0783	CONF	1.88E-05	0.0910
DEATH	-3.37E-05	0.9470	DEATH	-4.33E-05	0.9237
RESPONSE	0.0032	0.0504	RESPONSE	0.0019	0.2946
MYIR_1M	0.2365	0.0001	MYIR_1M	0.1007	0.3228
Constant	-0.6696	0.0003	LNOIL	0.0576	0.4084
			Constant	-0.5967	0.2031
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0102	0.0000	Constant	0.0037	0.0007
Residual term	0.3471	0.0000	Residual term	0.1382	0.0000
GARCH term	0.5710	0.0000	GARCH term	0.8163	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	0.0170 (0.8963)		ARCH effect test	1.8425 (0.1747)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.224		RMSE	0.223	
MAE	0.173		MAE	0.172	
Model 3 Mean equation	Coefficient	p-value	Model 4 Mean equation	Coefficient	p-value
CONF	1.95E-05	0.0946	CONF	1.99E-05	0.0861
DEATH	-5.01E-05	0.9063	DEATH	-4.71E-05	0.9132
RESPONSE	0.0018	0.3231	RESPONSE	9.44E-04	0.6759
MYIR_1M	0.0944	0.3306	MYIR_1M	0.1477	0.1230
LNOIL	0.0541	0.4394	LNOIL	0.0244	0.7547
LNSTOCK	-4.0679	0.0600	LNSTOCK	-4.0609	0.0060
Constant	-0.5618	0.2320	USIR	-0.3201	0.2695
			Constant	-0.4411	0.4069
Variance equation	Coefficient	p-value	Variance equation	Coefficient	p-value
Constant	0.0035	0.0008	Constant	0.0039	0.0009
Residual term	0.1251	0.0000	Residual term	0.1332	0.0000
GARCH term	0.8309	0.0000	GARCH term	0.8181	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	3.1804 (0.0745)		ARCH effect test	2.6013 (0.1068)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.227		RMSE	0.230	
MAE	0.176		MAE	0.177	

Notes: The value in the parentheses indicates the p-value of the ARCH effect test.

The second sensitivity analysis assumes that the error terms are distributed according to the t-statistic. The results are reported in Table 10 to Table 13. The model performance is mostly satisfactory, except for the basic model in Table 12, where the correlogram detects correlation. Again, COVID-19 affects the exchange rate via the number of confirmed cases. Its coefficient size is similar to those reported in Table 2 to Table 5, ranging from 1.81E-05 to 2.12E-05. The insignificance of the degree of stringency is proven again in this robustness analysis. Although the effect could be small in magnitude, the economic support policy will appreciate the value of USD/MYR among the government policies; its coefficient size is also larger than the coefficients of COVID-19 confirmed and death cases. Similar to the previous robustness analysis, the coefficient size of economic support policy in Model 4 of Table 12 is taken to interpret the coefficient. The value –0.0054 and is similar to the previous robustness. Most other control variables are statistically insignificant, and their coefficient sign supports the previous results. There is consistent proof that a better stock market performance inflates the value of MYR against USD, albeit with a slightly larger coefficient (roughly 4.8 across

Table 10 to Table 13). The conditional variance stationarity is also found in this sensitivity analysis. The residual term and the GARCH term in the variance equation are similar to the baseline estimation displayed in Table 2 to Table 5.

Table 10: GARCH output (Stringency index, error distribution: student's t)

Model 1 Mean equation	Coefficient	p-value	Model 2 Mean equation	Coefficient	p-value
CONF	2.00E-05	0.0329	CONF	2.00E-05	0.0323
DEATH	2.72E-05	0.9528	DEATH	2.73E-05	0.9524
STRINGENCY	0.0011	0.3040	STRINGENCY	0.0011	0.3079
MYIR_3M	0.0511	0.3076	MYIR_3M	0.0752	0.2224
Constant	-0.1838	0.1945	LNOIL	0.0413	0.4286
			Constant	-0.4189	0.2218
Variance equation			Variance equation		
Constant	0.009	0.0048	Constant	0.0088	0.0054
Residual term	0.2544	0.0009	Residual term	0.2515	0.0009
GARCH term	0.6602	0.0000	GARCH term	0.6546	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	0.1743 (0.6763)		ARCH effect test	0.1971 (0.6571)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.224		RMSE	0.224	
MAE	0.172		MAE	0.172	
Model 3 Mean equation	Coefficient	p-value	Model 4 Mean equation	Coefficient	p-value
CONF	1.86E-05	0.0495	CONF	1.89E-05	0.0462
DEATH	-1.06E-05	0.9806	DEATH	-1.22E-05	0.9777
STRINGENCY	0.001	0.3312	STRINGENCY	7.37E-04	0.5321
MYIR_3M	0.0989	0.0930	MYIR_3M	0.1276	0.0489
LNSTOCK	-4.7504	0.0001	LNSTOCK	-4.7738	0.0001
LNOIL	0.0448	0.3687	LNOIL	0.0161	0.7523
Constant	-0.4771	0.1457	USIR	-0.2844	0.1612
			Constant	-0.3652	0.2759
Variance equation			Variance equation		
Constant	0.0098	0.0054	Constant	0.0104	0.0041
Residual term	0.2427	0.0018	Residual term	0.2578	0.0015
GARCH term	0.6509	0.0000	GARCH term	0.6313	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	0.2498 (0.6172)		ARCH effect test	0.1700 (0.6801)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.231		RMSE	0.232	
MAE	0.178		MAE	0.179	

Notes: The value in the parentheses indicates the p-value of the ARCH effect test.

Table 11: GARCH output (Containment and health index, error distribution: student's t)

Model 1 Mean equation	Coefficient	p-value	Model 2 Mean equation	Coefficient	p-value
CONF	1.94E-05	0.0382	CONF	1.94E-05	0.0373
DEATH	1.88E-05	0.9672	DEATH	1.87E-05	0.9672
CONTAIN	0.0020	0.155	CONTAIN	0.00198	0.1568
MYIR_3M	0.0616	0.2412	MYIR_3M	0.0865	0.1772
Constant	-0.26984	0.1163	LNOIL	0.0425	0.4131
			Constant	-0.5119	0.1548
Variance equation			Variance equation		
Constant	0.0089	0.0047	Constant	0.0088	0.0053
Residual term	0.2565	0.0008	Residual term	0.2541	0.0008
GARCH term	0.6491	0.0000	GARCH term	0.6532	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	0.2015 (0.6535)		ARCH effect tests	0.2251 (0.6352)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.223		RMSE	0.223	
MAE	0.171		MAE	0.171	
Model 3 Mean equation	Coefficient	p-value	Model 4 Mean equation	Coefficient	p-value
CONF	1.81E-05	0.0552	CONF	1.84E-05	0.0510
DEATH	-1.72E-05	0.9683	DEATH	-1.70E-05	0.9688
CONTAIN	0.0018	0.1865	CONTAIN	0.0014	0.3997
MYIR_3M	0.1077	0.0801	MYIR_3M	0.1302	0.0478
LNSTOCK	-4.7163	0.0001	LNSTOCK	-4.7429	0.0001
LNOIL	0.0454	0.3616	LNOIL	0.0204	0.6885
Constant	-0.5546	0.1087	USIR	-0.2467	0.2496
			Constant	-0.4386	0.2180
Variance equation			Variance equation		
Constant	0.0097	0.0052	Constant	0.0102	0.0042
Residual term	0.2456	0.0017	Residual term	0.2575	0.0015
GARCH term	0.6497	0.0000	GARCH term	0.6337	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	0.2561 (0.6128)		ARCH effect test	0.1881 (0.6645)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.230		RMSE	0.231	
MAE	0.178		MAE	0.178	

Notes: The value in the parentheses indicates the p-value of the ARCH effect test.

All estimated models are also examined using the augmented autoregressive distributed lag (ARDL) estimation since some papers with similar objectives deployed that method. A few noticeable results can be summarised. First, the ARDL estimations do not prove that the confirmed COVID-19 cases have any statistical significance impact. Second, the statistical insignificance of the death cases is still supported, although the coefficient signs change from negative to positive. Third, the stock market's appreciation effect on the exchange rate is also supported. We argue that the GARCH estimator provides a more reliable output in this research because of the ARCH effect on the exchange rate data. Moreover, the estimated ARDL models encounter non-normality and heteroskedasticity. The results are available upon request.[1]

[1] Following the suggestion of reviewers, EGARCH model is estimated as well to examine the results. In general, the EGARCH (1,1) model supports the depreciation effect of new cases of COVID. Besides, stock market and economic support policy also influence the exchange rate growth. However, this paper prefers the GARCH model because (i)

Table 12: GARCH output (Economic support index, error distribution: student's t)

Model 1 Mean equation	Coefficient	p-value	Model 2 Mean equation	Coefficient	p-value
CONF	2.04E-05	0.7566	CONF	2.12E-05	0.0246
DEATH	-2.45E-05	0.9919	DEATH	4.39E-05	0.9247
ECONOMIC	-0.0022	0.3835	ECONOMIC	-0.0047	0.0001
MYIR_3M	-0.026	0.8777	MYIR_3M	0.0274	0.6577
Constant	0.2037	0.6769	LNOIL	0.0311	0.5511
			Constant	0.1482	0.6757
Variance equation			Variance equation		
Constant	0.1119	0.3757	Constant	0.0109	0.0031
Residual term	0.1500	0.2903	Residual term	0.2556	0.0010
GARCH term	0.6000	0.1603	GARCH term	0.6219	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	23.9814 (0.0000)		ARCH effect test	0.0479 (0.8268)	
Correlogram	correlation		Correlogram	No correlation	
RMSE	0.224		RMSE	0.224	
MAE	0.172		MAE	0.172	
Model 3 Mean equation	Coefficient	p-value	Model 4 Mean equation	Coefficient	p-value
CONF	1.97E-05	0.039	CONF	1.95E-05	0.0434
DEATH	-1.05E-07	0.9998	DEATH	-9.85E-06	0.9822
ECONOMIC	-0.0039	0.0004	ECONOMIC	-0.0054	0.0000
MYIR_3M	0.0479	0.4220	MYIR_3M	0.1170	0.0774
LNSTOCK	-4.7398	0.0001	LNSTOCK	-4.9228	0.0000
LNOIL	0.0330	0.5047	LNOIL	-0.0412	0.4708
Constant	0.0429	0.8990	USIR	-0.7071	0.0001
			Constant	0.3997	0.2907
Variance equation			Variance equation		
Constant	0.0127	0.0031	Constant	0.0162	0.0034
Residual term	0.2525	0.0021	Residual term	0.2823	0.0020
GARCH term	0.6027	0.0000	GARCH term	0.5378	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	0.0725 (0.7977)		ARCH effect test	0.2490 (0.6178)	
Correlation	No correlation		Correlation	No correlation	
RMSE	0.232		RMSE	0.232	
MAE	0.179		MAE	0.179	

Notes: The value in the parentheses indicates the p-value of the ARCH effect test.

RMSE and MEA of EGARCH are higher or the same as those of the GARCH model, (ii) the asymmetric effect is found only when economic support policy is estimated and (iii) ARCH effect and serial correlation are still found in all models except for the cases of economic support policy. Also, as highlighed by a reviewer, the Brent Crude oil price could be an leading indicator compared to other oil prices. Estimating the model using the Brent Crude oil price does not change the impact of COVID-19 found in this paper. All results are available upon request.

Table 13: GARCH output (Government response index, error distribution: student's t)

Model 1 Mean equation	Coefficient	p-value	Model 2 Mean equation	Coefficient	p-value
CONF	1.97E-05	0.0351	CONF	1.97E-05	0.0343
DEATH	2.24E-05	0.9611	DEATH	2.22E-05	0.9611
RESPONSE	0.0019	0.1892	RESPONSE	0.0019	0.1903
MYIR_3M	0.0574	0.2802	MYIR_3M	0.0825	0.2041
Constant	-0.2579	0.1485	LNOIL	0.0427	0.4122
			Constant	-0.5033	0.1708
Variance equation			Variance equation		
Constant	0.0089	0.0048	Constant	0.0088	0.0054
Residual term	0.2558	0.0008	Residual term	0.2533	0.0009
GARCH term	0.6500	0.0000	GARCH term	0.6542	0.0000
Diagnostic tests			Diagnostic tests		
ARCH effect test	0.1967 (0.6574)		ARCH effect test	0.2206 (0.6386)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.224		RMSE	0.224	
MAE	0.172		MAE	0.171	
Model 3 Mean equation	Coefficient	p-value	Model 4 Mean equation	Coefficient	p-value
CONF	1.85E-05	0.0505	CONF	1.89E-05	0.0460
DEATH	-1.31E-05	0.9759	DEATH	-1.23E-05	0.9774
RESPONSE	0.0017	0.2494	RESPONSE	0.0011	0.5364
MYIR_3M	0.1031	0.1002	MYIR_3M	0.1269	0.0551
LNSTOCK	-4.7046	0.0001	LNSTOCK	-4.7398	0.0001
LNOIL	0.0458	0.3587	LNOIL	0.0184	0.7191
Constant	-0.5385	0.1283	USIR	-0.2684	0.2214
			Constant	-0.4025	0.2750
Variance equation			Variance equation		
Constant	0.0096	0.0054	Constant	0.0102	0.0043
Residual term	0.2442	0.0018	Residual term	0.2563	0.0016
GARCH term	0.6514	0	GARCH term	0.6344	0
Diagnostic tests			Diagnostic tests		
ARCH effect test	0.2507 (0.6166)		ARCH effect test	0.1764 (0.6745)	
Correlogram	No correlation		Correlogram	No correlation	
RMSE	0.231		RMSE	0.233	
MAE	0.178		MAE	0.179	

Notes: The value in the parentheses indicates the p-value of the ARCH effect test.

5. Conclusion

This paper investigates the impact of the COVID-19 pandemic and COVID-19-related policies on USD/MYR using the GARCH estimation. A few noticeable findings can be summarised. First, the results suggest that the confirmed cases have a depreciation effect on USD/MYR. However, the impact of the confirmed cases is economically insignificant. Second, the economic support policies appreciate the value of MYR against USD, substantiating the arguments that the government's effort to stimulate the economy will affect the economy positively. Although the effect could be economically insignificant, the coefficient size of economic support initiatives is larger than that of COVID-19, implying that these initiatives could revert the depreciation effect caused by COVID-19. Third, evidence shows that the stricter policy limiting the economy and human movement, the more depreciation pressure on the USD/MYR. However, the statistical significance is not robustly supported by the robustness analysis. Fourth, the stock market performance has a robust positive effect on the value of MYR.

The insignificant economic impact of the confirmed cases of COVID-19 implies that the pandemic is not the direct factor that depreciated MYR. However, lower demand for domestic products and the uncertainties caused by the pandemic could influence USD/MYR via its influence on the stock market. Hence, the authorities should not underestimate the effect of the pandemic. Additionally, the Malaysian authorities should be more proactive in using fiscal resources to support the exchange rate should a similar event happen again, following the robust conclusion that these policies appreciated MYR against USD.

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