Specific Macro Factors Affecting Economic Growth During the COVID-19 Pandemic : Evidence from EAGLEs

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Abstract

The study was conducted to assess the impact of macro factors on economic growth in emerging and growth-leading economies (EAGLEs) during the COVID-19 pandemic. The study applied a Bayesian simulation method, and the empirical results exhibited an ambiguous impact of trade openness and the number of internet users on economic growth in these countries during the COVID-19 outbreak. Besides, in response to the economic downturn caused by the COVID-19 pandemic, countries have loosened monetary and fiscal policies simultaneously. However, policy rate reduction was found to be less efficient in the countries previously applying low-interest rates. The evidence showed that reasonable pandemic control measures formed a basis for fastening economic recovery.

Keywords : **COVID-19 pandemic, economic growth, EAGLEs**

JEL Classification Codes : E620, E430, O4

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The World Health Organization (WHO) announced a strange virus in Wuhan, China, on December 31, 2019. China officially confirmed that the detected virus was a new Coronavirus - SARS-CoV-2 or COVID-19 on January 7, 2020. The first 282 infections were recorded in China, Thailand, Japan, and South Korea on January 20, 2020 (WHO, 2020). Contrary to the initial subjective judgment about this virus's danger, the pandemic has spread quickly on a global scale. WHO officially declared the outbreak of the coronavirus disease as a "global pandemic" on March 11, 2020. So far, the world has recorded more than 100

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million cases and more than two million deaths. In succession, countries worldwide have undergone enormous economic losses and implemented lockdowns to control the disease spread of COVID-19, which has exerted a broadening influence on almost every country. The level of the damage caused to national economies by COVID-19 is estimated to exceed any earlier outbreak like Ebola, Severe acute respiratory syndrome (SARS), or the Middle East respiratory syndrome coronavirus (MERS) (Shretta, 2020). The negative economic effects of the COVID-19 pandemic are considered to be much more severe than even the recent 2007–2008 financial crisis (IMF, 2020). According to IMF data (2021b), the global economy experienced a 3% decline in 2020, and the total loss to the global economy in 2020 and 2021 from the pandemic crisis could reach approximately 9 trillion U.S. dollars, making it become the worst economic recession since the Great Depression of 1929–1933 (Gopinath, 2020).

Many studies have been published on the impacts of economic crises (Bagliano & Morana, 2012; Bentolila et al., 2018; Bezemer, 2011; Gaiotti, 2013; Jagannathan et al., 2013; Mian & Sufi, 2010; Stiglitz, 2010). However, the cause of the global recession of 2020 is unprecedented in modern economic history. The COVID-19 pandemic has generated a new kind of economic downturn, and its determinants differ from the previous ones. Therefore, it is not surprising that the analysis of the impact of COVID-19 on economic growth has attracted wide attention. Most studies on the current pandemic focused on the effect of one or some general factors but ignored specific factors on economic growth. The present research has emphasized the specific key macro factors impacted due to COVID-19 in the analysis, including explanatory variables such as trade openness, internet users, COVID-19 infection rate, central bank policy rate, and government budget expenditure.

Furthermore, it is to be noted that the pandemic has just broken out since 2020, so observations on its impacts are too sparse to conduct large sample research. There is a way out for this situation: Contrary to frequency-based inference, the Bayesian framework, which is capable of interpreting results in terms of probability, regardless of data sample size, can mitigate the effect of a small sample (Zondervan-Zwijnenburg et al., 2017). The Bayesian setting's advantages and challenges have been presented in a significant number of studies (Kruschke, 2011; Thach et al., 2019; Thach, 2020). For this reason, the Bayesian simulation method is applied to assess the impacts of featured macroeconomic factors on the economic growth in EAGLE countries in the context of COVID-19. These economies are rapidly growing in imperfect financial systems. Furthermore, they have achieved relatively high trade openness, so they can easily change in good global demand, especially in the complicated epidemic rendering the global supply chain excoriated.

This study is expected to understand the specific factors that affect the economic growth of emerging countries such as EAGLEs. The empirical findings obtained using a Bayesian approach will be a robust basis for appropriate policy responses during the COVID-19 pandemic and similar diseases in the future.

Research on Economic Impacts of Diseases

The current pandemic has been going on in a globalized world where national financial markets and production networks are closely interconnected. Whole or partial lockdowns have broken global value chains. Declines in trade and services have harmed economic growth around the world. According to the optimistic and pessimistic scenarios of the WTO (2020), international trade is predicted to drop by 13% and 32%, respectively. McKibbin and Fernando (2020), by applying computable general equilibrium, predicted that the world economy would lose 2.4 trillion USD if the disease scale is equal to that of the Hong Kong flu and 9 trillion USD if equivalent to that of the Spanish flu. Ozili and Arun (2020) argued that coronavirus control measures like social distancing or lockdown that lead to the closure of financial markets, corporate offices, and businesses could negatively contribute to overall economic growth. According to the estimation of the National Bureau of Statistics of China (2020), the total value added of industrial enterprises in this country fell by 13.5% in the first two months of

2020, the peak period of disease control. As estimated by the International Labor Organization (ILO, 2020), the number of global unemployment could range from 5.3 million –24.7 million people from an initial level of 188 million in 2019. The report of Lusca (2020) showed that the global growth rate would decline from 2.9% in 2019 to –3% in 2020; emerging and developing countries could obtain an economic growth rate of –1% in 2020 compared to that of 3.7% in 2019. Lusca (2020) compared the damage caused by COVID-19 to that of other epidemics occurring in the post-war period (Table 1).

It can be inferred from Table 1 that the COVID-19 exceeds all past epidemics or pandemics so far in terms of damage. Though starting out recently, the COVID-19 pandemic has drawn several empirical studies. Baker et al. (2020) revealed that uncertainty induced by COVID-19 is much higher than what was during the 2008–2009 Great Recession, even close to the level of the Great Depression in the United States. Chu and Fang (2020) claimed that COVID-19 has increased economic policy uncertainty, prompting enterprises to postpone their investment decisions. Hence, the economy shrinks. Specifically, Sahoo and Ashwani (2020) estimated the losses caused by the current pandemic to the Indian economy. The Indian economy could acquire just a growth rate of 0.5% in an optimistic scenario, but in the worst scenario, the country faced a growth rate of from –3% to –7% in 2020 (In fact, according to IMF (2021), its economic growth shrank by 10.3% in 2020). The impact of the COVID-19 on Indian economic sectors in the best-to-worst scenario is that the production sector could decrease from 5.5% to 20%, import from 13.7% to 20.8%, export from 17.3% to 25%, and the small and medium enterprises sector from 2.1% to 5.7% in 2020.

Narender and Kumar (2021) showed that the COVID-19 pandemic has devastated the Indian aviation industry. The national banking sector has also faced several significant challenges (Mohania & Mainrai, 2020). Gupta (2020) commented that India's economic outlook in 2020 – 2021 due to the impact of COVID-19 would be very bleak. The most apparent effect of the COVID-19 pandemic on the economy is disruption of the global supply chain when countries implement social distancing or lockdown. Inoue and Todo (2020) simulated that Tokyo's lockdown for a month led to damages to Tokyo and other parts of Japan due to the supply chain disruption. Their results indicated a 5.3% reduction in this country's annual GDP. Hayakawa and Mukunoki (2021) used the data set on finished machinery products of import and export enterprises in Japan and its trading partner countries

Table 1. ***Influential Epidemics and Pandemics in the Post-War Period***

Year	Event	Sphere of Influence	Rate of Infection or Death	Global Economic Loss
1981	HIV AIDS pandemic	Global	More than 70 million infections, 36.7 million deaths	
2003	SARS epidemic	Four continents, 37 countries	8,098 cases, 744 deaths	40 billion USD – 54 billion USD
2009	Swine flu pandemic (H1N1)	Global	151,700 – 575,500 deaths	45 billion USD – 55 billion USD
2012	MERS epidemic	27 countries	1,879 symptomatic cases, 659 deaths	10 billion USD
2013	Ebola virus epidemic in West Africa	22 countries	28,646 cases of infection, 11,323 deaths	53 billion USD
2015	Zika virus pandemic	76 countries	2,656 cases of microcephaly or central nervous system malformation were reported	7 billion USD – 18 billion USD
2019	COVID-19	Global	4.1 million confirmed cases, 283,000 deaths by May 2020	9 trillion USD

Source : Lusca (2020).

from January 2019 to June 2020 to assess the impact of COVID-19 on the global supply chain. According to these authors, global exports of finished machinery products fell from US$1,551 billion to US$1,287 during their study period.

The results revealed that COVID-19 had a negligible impact on the demand for finished machinery products in the importing countries; still, the trade of machinery products has been seriously affected by the high level of COVID-19 infection in the exporting countries of finished machinery products and countries that export machinery parts to finished machinery product exporters. Hasanat et al. (2020) revealed that the pandemic has severely affected e-businesses in Malaysia. It was explained that many e-commerce businesses in Malaysia rely on merchandise products from China, and the heavily affected manufacturing industries in China reduced or stopped the imports into Malaysia. Consequently, the Malaysian trade sector, including e-commerce, faced great losses. Owing to the global supply chain disruption, numerous countries have focused on domestic markets, for example, India with a mission called "Atmanirbhar Bharat," or China with the "Dual Circulation" strategy, to drive their countries out of the crisis as soon as possible (Gupta, 2021). Vidya and Prabheesh (2020) analyzed trade interconnectedness among leading countries, including Canada, China, France, Germany, Hong Kong, India, Italy, Japan, Indonesia, Netherlands, Russia, Singapore, South Korea, the UK, and the US. It was observed that trade density decreased significantly from 0.833 in 2018 to 0.429 in 2020Q1. The COVID-19 has caused severe consequences in France, Germany, Italy, the USA, and the UK. Although the COVID-19 pandemic has impacted the Chinese import and export activities, the relative position of this country in the trade network has not changed considerably.

Baker et al. (2020) discovered that no disease in history has had such a significant impact on stock markets. Mazur et al. (2020) revealed that the US stock market witnessed the biggest crash in history. According to the Dow Jones Industrial Average data, the market fell 26% in just four days. However, this study revealed that the influence of COVID-19 on different sectors was not the same. Enterprises in software, health care, and natural gas experienced impressive growth in profits; whereas, companies in entertainment, hospitality, real estate, and crude petroleum lost more than 70% of their market capitalization. This study also addressed the US policy response to COVID-19. Pichler et al. (2020) analyzed the input-output linkages across sectors in the context of the COVID-19 spreads in the UK. Their research model showed that gross output and consumption in the UK decreased by 27% after two months of lockdown; while the manufacturing industry experienced major supply shocks; the transportation industry faced demand-side shocks; and the hotel and restaurant industries experienced both types of shock simultaneously. Bloom et al. (2021), through a survey of 2,500 US businesses, assessed the effect of COVID-19 on firm performance in this country. The results exhibited a strong negative impact of the pandemic on business performance, with the deepest decline in the second quarter of 2020 equivalent to a 29% loss in revenue. As for the business type, the authors noted that the offline businesses experienced a 40% decline in performance, while the online businesses lost by only 10%. Women and black business owners reported a more significant decline in sales; those with social and humanities degrees suffered the most significant losses, while those with technical degrees were the least affected.

Zhang (2021) used panel data from 31 provinces in China to evaluate the influence of broadband on economic growth in this country during the COVID-19. The results demonstrated that broadband had reduced China's economic damage in the first months of 2020 while the new coronavirus was spreading across the country; moreover, broadband impacted China's economic growth more during the pandemic than in normal times.

Al-Thaqeb et al. (2020) affirmed that COVID-19 has primarily affected the economic policy uncertainty index. According to Bernanke (1983), an increase in the economic policy uncertainty index could postpone personal investment and consumption decisions as consumers focus on necessities. Consequently, output decreases sharply. Caggiano et al. (2017) stated that a high policy uncertainty index is responsible for significant unemployment volatility. Coccia (2021) analyzed the correlation between lockdown time, the number of infections, the number of deaths by COVID-19, and economic growth among different countries. During the first wave of the pandemic, countries with a short-run lockdown (about 15 days), such as Austria, Portugal, and Sweden, recorded, on an average, a higher number of infections than ones with extended closings (about 60 days), such as France, Italy, and Spain.

Nevertheless, the number of deaths in countries with a short-run lockdown was lower than in those with a long-run lockdown (5.4% vs. 17.2%). However, even so, by August 2020, countries with longer lockdowns experienced a faster reduction in mortality (−1.9% vs. −0.72%). Besides, statistical figures indicated that a more prolonged shutdown had harmed more GDP growth: the average shrinkage of GDP (2010 index = 100) from 2019 Q2 to 2020 Q2 in countries implementing a 2-month lockdown was around −21%, while that in countries with a 15-day lockdown was only about −13%. The data also indicated that countries with a high level of investment in health (as per GDP) obtained a lower mortality rate and a shorter closing duration, thereby mitigating the negative impact of the pandemic on economic growth.

Thus, it can be seen that although the influence of the COVID-19 on economic activities has drawn much attention, most studies are carried out at the corporate or industrial level; while research at the country level is descriptive due to the limitation of observations. To the best of our knowledge, there are no empirical studies on the impacts of specific macro factors on economic growth in the context of the COVID-19 pandemic. Besides, there has been no research published on the effects of the pandemic in EAGLEs. So, this study adopted a Bayesian simulation method to overcome small sample effect to assess the effects of specific macroeconomic factors on economic growth in EAGLEs.

Research Method and Model

This study analyzes the impacts of specific macro factors on economic growth in EAGLEs during the COVID -19 pandemic. EAGLEs are a group of countries ranked by the research organization Banco Bilbao Vizcaya Argentaria (BBVA research) in 2010 to identify all the emerging economies expected to largely contribute to the world GDP growth in the next decade. EAGLEs are categorized into two groups. EAGLEs are expected to have incremental GDP in the next decade greater than the average GDP of the G6 members (G7 excluding the US) and contribute 64.3% to the global GDP in 2015 – 2025 (BBVA, 2016). These are Bangladesh, Brazil, China, Egypt, India, Indonesia, Iran, Malaysia, Mexico, Nigeria, Pakistan, Philippines, Russia, Turkey, and Vietnam. The second group is NESTs, including countries expected to have incremental GDP in the next decade lower than the average GDP of the G6 members but higher than Italy's GDP (G6 minimum). This group includes Algeria, Argentina, Chile, Colombia, Ethiopia, Iraq, Kazakhstan, Libya, Morocco, Mozambique, Myanmar, Peru, Finland, Romania, Saudi Arabia, South Africa, Sri Lanka, Thailand, United Arab Emirates, and Uzbekistan.

Though a great variety of factors influence economic growth, in the context of an economic crisis resulting from the pandemic, most countries have loosened their monetary and fiscal policies to support the economy, therefore, policy interest rate and government budget expenditure need to be included as notable variables in a growth model (Table 2). A comprehensive study on the effects of macroeconomic policy responses on growth tendency will benefit the policy process to fasten economic recovery for the post-crisis period in EAGLEs. Therefore, we propose the first two hypotheses as follows:

- **H1 :** A lower policy rate tends to promote real GDP growth.
- **H2 :** Higher government budget expenditure tends to enhance real GDP growth.

Besides, because of the global supply chain disruption at the time of the disease outbreak, we also investigate how trade openness (Table 2) affects economic growth. Based on Lusca (2020), Inoue and Todo (2020), and

Table 2. *Summary of Variables*

	Variable	Notation	Data Source
Dependent	Real GDP growth in 2020 (%)	GDP_{2020}	World Bank (2021)
Independent	Real GDP growth in 2019(%)	GDP_{2019}	World Bank (2021)
	Trade openness (Trade, % of GDP)	*OpE*	World Bank (2021)
	Internet users (Number of internet users, % of population)	*Internet*	World Bank (2021)
	COVID-19 infection rate (Number of cases, % of population)	*Covid*	Worldometer (2021)
	Central bank policy rate (%)	*INT*	Trading Economics (2021)
	Government budget expenditure (% of GDP)	*FIS*	IMF (2021a)

Table 3. *Simulation Summaries*

Likelihood	$GDP_{2020} \sim N(\mu, \delta)$
Priors :	
Simulation 1	$\alpha_i \sim N$ (0; 1)
	$\delta^2 \sim$ Invgamma (0,01; 0,01)
Simulation 2	$\alpha_i \sim N$ (0; 10)
	$\delta^2 \sim$ Invgamma (0,01; 0,01)
Simulation 3	$\alpha_i \sim N$ (0; 100)
	$\delta^2 \sim$ Invgamma (0,01; 0,01)
Simulation 4	$\alpha_i \sim N$ (0; 1,000)
	$\delta^2 \sim$ Invgamma (0,01; 0,01)
Simulation 5	$\alpha_i \sim N$ (0; 10,000)
	$\delta^2 \sim$ Invgamma (0,01; 0,01)

Note. i = 1, 2, 3, 4, 5, 6, 7.

Hayakawa and Mukunoki (2021), we supposed that the countries with high trade openness are likely to suffer more from the pandemic; hence, the third hypothesis is as follows:

➪ **H3 :** Higher trade openness tends to decrease GDP growth.

Also, furthermore, under social distancing and lockdowns carried out in many countries, internet-based commercial transactions have become the optimal solution to business communications, so we incorporate the internet users variable in the model.

➪ **H4 :** More internet users tend to positively contribute to GDP growth.

Finally, this study will evaluate how the disease spread affects economic growth, measured by the percentage of infections (Table 2). If the disease is quickly controlled, the economies could rapidly return to normality, facilitating higher economic growth. Thus, it is hypothesized that :

➪ **H5 :** Lower COVID-19 infection rate increases GDP growth.

.

Our general econometric model is specified as follows :

$$GDP_{2020} = \beta_1 + \beta_2 GDP_{2019} + \beta_3 OpE + \beta_4 Internet + \beta_5 Covid + \beta_6 INT + \beta_7 FIS + \varepsilon_{i,t}. \quad (1)$$

The study is conducted to estimate the influence of specific macro factors on economic growth in the COVID-19 context in EAGLEs; therefore, all the data used in this paper is from 2020, except for information on trade openness (% of GDP) available from 2018. Since the majority of previous studies utilized mainly frequent methods, prior information is not available. Block et al. (2011) specified the standard Gaussian distributions for prior distributions. Hence, five simulations will be performed with respect to the specified priors (Table 3).

The informative priors are specified from the weakest to the strongest (Table 3). After running the simulations, we conducted a Bayes factor test and a model test to select the best fit. Furthermore, a sensitivity analysis will be performed to ensure model robustness.

Analysis and Results

Brief Overview on Impact of COVID-19 on Economic Growth in EAGLEs

Table 4 demonstrates that the negative effects of COVID-19 on economic growth are much larger in EAGLEs than in the remaining world: the average decline in 2020 compared to 2019 is –6.8% for EAGLEs and –8.22% for NESTs; whereas, the figure is –6.64% for the whole world (Table 4). This implies the very high vulnerability of EAGLEs economies to the COVID-19 shock.

Table 4. ***Impact of COVID-19 on Economic Growth in EAGLEs and the World***

Country	GDP Growth in 2019	GDP Growth in 2020	Change
		EAGLEs	
Bangladesh	8.15%	3.80%	–4.35%
Brazil	1.14%	–5.80%	–6.94%
China	6.00%	2.30%	–3.70%
Egypt	5.56%	3.55%	–2.01%
India	4.18%	–10.29%	–14.47%
Indonesia	5.03%	–1.50%	–6.53%
Malaysia	4%	–6%	–10.00%
Mexico	–0.30%	–8.95%	–8.65%
Nigeria	2.21%	–4.3%	–6.51%
Pakistan	1.91%	–0.39%	–2.30%
Philippines	6.04%	–8.26%	–14.30%
Russia	1.34%	–4.12%	–5.46%
Turkey	0.92%	–4.99%	–5.91%
Vietnam	7.02%	2.91%	–4.11%
		NESTs of EAGLEs	
Algeria	0.80%	–5.46%	–6.26%
Chile	1%	–6%	–7.00%
Colombia	3.26%	–8.18%	–11.44%

Kazakhstan	4.50%	–2.69%	–7.19%
Morocco	2.20%	–6.97%	–9.17%
Mozambique	2.28%	–0.50%	–2.78%
Myanmar	6.50%	1.99%	–4.51%
Peru	2.18%	–13.94%	–16.12%
Poland	4.10%	–3.60%	–7.70%
Romania	4.08%	–4.80%	–8.88%
South Africa	0%	–8%	–8.00%
Thailand	2.36%	–7.15%	–9.51%
UAE	1.68%	–6.57%	–8.25%
	The World		
The World	2.28%	–4.36%	–6.64%

Source : IMF (2021b).

Note. NESTs are potential EAGLEs. The second group is NESTs, including countries expected to have incremental GDP in the next decade lower than the average GDP of the G6 members but higher than Italy's GDP (G6 minimum). This group includes Algeria, Argentina, Chile, Colombia, Ethiopia, Iraq, Kazakhstan, Libya, Morocco, Mozambique, Myanmar, Peru, Finland, Romania, Saudi Arabia, South Africa, Sri Lanka, Thailand, United Arab Emirates, and Uzbekistan.

Table 5 shows the parameters of the monetary and fiscal policies of EAGLEs during the pandemic. All researched countries except Turkey loosened their monetary policy through interest rate reduction in 2020. Similarly, the fiscal policy is significantly loosened to support the economy.

Table 5. ***Macroeconomic Policy Responses in EAGLEs During the COVID -19 Pandemic***

Country	Central Bank Policy Rate (%)		Government Budget Expenditure (% GDP)	
	INT_{2019}	INT_{2020}	FIS_{2019}	FIS_{2020}
		EAGLEs		
Bangladesh	5.00%	4.00%	5.36%	6.80%
Brazil	4.50%	2.00%	6.01%	16.78%
China	2.50%	2.20%	6.31%	11.89%
Egypt	12.75%	8.75%	7.41%	7.49%
India	4.40%	3.50%	8.22%	13.08%
Indonesia	5.00%	3.75%	2.23%	6.31%
Malaysia	3.00%	1.75%	3.69%	6.53%
Mexico	7.25%	4.25%	2.35%	5.80%
Nigeria	13.50%	10.25%	4.76%	6.74%
Pakistan	12.00%	7.50%	8.98%	8.01%
Philippines	4.00%	2.00%	1.78%	8.06%
Russia	6.25%	4.25%	–1.92%	5.28%

Turkey	10.50%	15.50%	5.65%	7.88%
Vietnam	6.00%	3.00%	3.29%	6.02%
		NESTs		
Algeria	1.00%	0.50%	5.64%	11.49%
Chile	1.75%	0.50%	2.65%	8.70%
Colombia	4.25%	1.75%	2.51%	9.48%
Kazakhstan	9.25%	9.00%	0.57%	5.27%
Morocco	2.30%	1.50%	4.13%	7.79%
Mozambique	13.50%	10.25%	0.15%	7.06%
Myanmar	10.00%	9.50%	3.92%	6.02%
Peru	2.25%	0.25%	1.37%	9.41%
Poland	1.50%	0.10%	0.74%	10.46%
Romania	2.50%	1.50%	4.56%	9.59%
South Africa	6.50%	3.50%	6.22%	14.09%
Thailand	1.25%	0.50%	0.82%	5.21%
UAE	2.50%	1.50%	0.76%	9.90%

Source : IMF (2021b) and Trading Economics (2021).

Bayesian Regression Outcomes

Table 6 shows a considerable decline in the GDP growth of EAGLEs in 2020. The average GDP growth of EAGLEs was 3.3% in 2019, but –4.43% in 2020; the highest GDP growth rate was 8.1% in 2019, but just 3.8% in 2020; the lowest GDP growth rate was –0.3% and –13.94% in 2019 and 2020, respectively.

The lowest trade openness is 28.98%, while the highest trade openness is 210.4%, and the average trade openness of EAGLEs is 71.15%. The average internet penetration rate of EAGLEs is 59.25%; the highest percentage of internet users is 99.15%, while the lowest internet penetration is 10%. The lowest proportion of infections is 0.025%; whereas, the highest proportion of infections is 5.02%, and the average rate of infections is 1.77%. The highest interest rate is 15%, while the lowest interest rate is just 0.1%, and the average interest rate is 4.19%. The average government budget expenditure (% GDP) of EAGLEs is 30.5%, the largest and smallest budget expenditures are 12.65% and 51.17%, respectively (Table 6).

Table 6. *Descriptive Statistics of the Research Variables*

Variable	Mean	Std. Dev.	Min	Max
GDP_{2020}	–4.43%	0.0437	–13.94%	3.80%
GDP_{2019}	3.30%	0.0226	–0.30%	8.10%
OpE	71.15%	0.4331	28.98%	210.40%
Internet	59.25%	0.2319	10.00%	99.15%
Covid	1.77%	0.0180	0.003%	5.02%
INT	4.19%	0.0396	0.10%	15.50%
FIS	30.50%	0.0908	12.65%	51.17%

Table 7. ***Bayesian Factor Test and Model Test Results***

	Chains	Avg DIC	Avg log (ML)	Avg Log BF	*P*(*M*|*y*)
Simulation 1	3	–94.3896	27.3007	1	0.9988
Simulation 2	3	–93.4464	20.5843	–6.7164	0.0012
Simulation 3	3	–93.2653	12.6521	–14.6486	0
Simulation 4	3	–93.2134	4.6988	–22.6019	0
Simulation 5	3	–93.2955	–3.534	–30.8347	0

The Bayes factor test results show that the more Log BF and Log ML estimates and the less DIC average, the better the model. As recorded in Table 7, Simulation 1 is superior to the other simulations. The Bayes model test result also indicates that the first simulation obtains the highest posterior probability. Therefore, this simulation is chosen for further analysis.

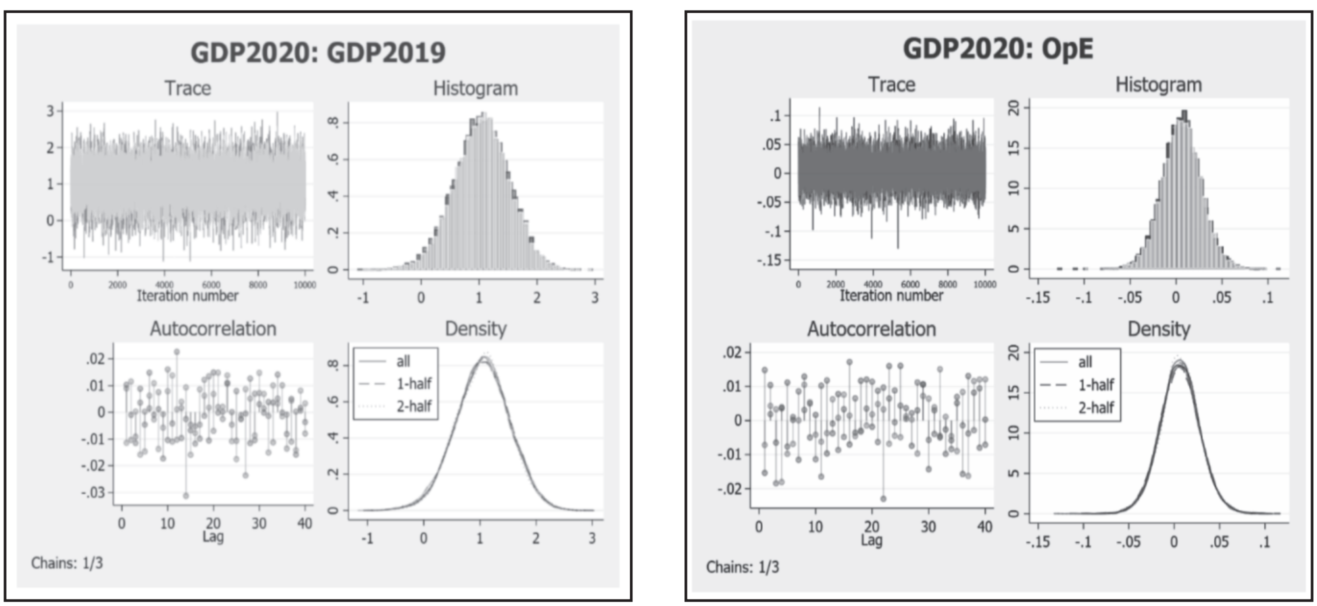
To ensure the efficiency of Markov chain Monte Carlo (MCMC) inference, we need to check for MCMC chain convergence for all the model parameters. Some popular tests such as trace plots and autocorrelation plots are available for this purpose.

The autocorrelation plots show no positive lags, and the trace plots traverse quickly through the posterior distributions. Altogether, these diagnostics indicate no sign of non-convergence of MCMC (Figure 1). Therefore, we can conclude that the MCMC chains have converged to the stationary distribution.

To check for model robustness, let us specify various priors with the mean ranging from –0.5 to 0.5 (Table 8). If the posterior distributions are not much sensitive to changes in prior distributions, model validity can be concluded.

Table 8 demonstrates that in case we vary the normal priors in a range between –0.5 and 0.5 with an even space of 0.1, no considerable distinctions between posterior summaries, including posterior means, MCSEs, and credible intervals, are observed.

Figure 1. ***Trace Plots and Autocorrelation Plots for MCMC Convergence Test***



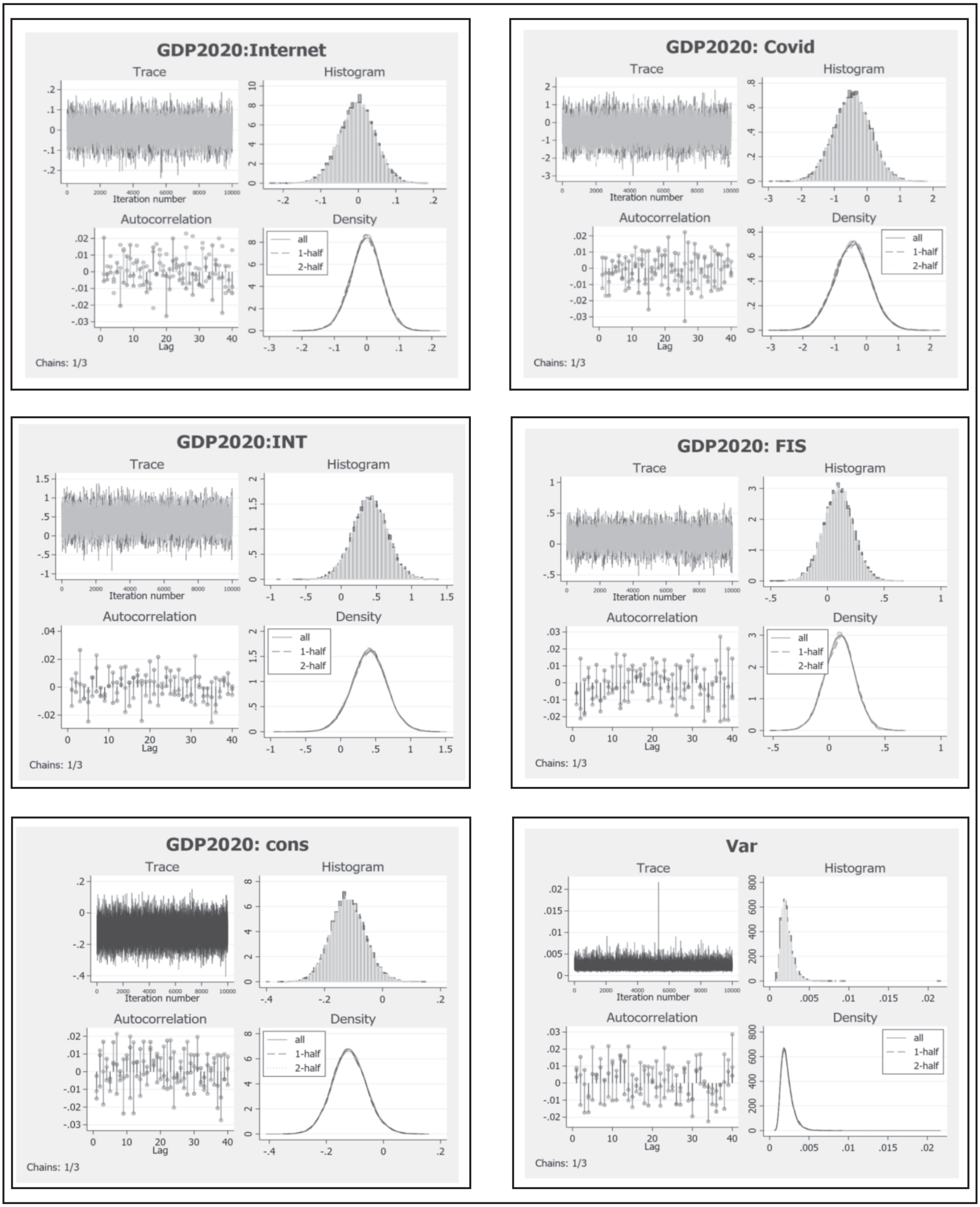

GDP2020:Internet
Trace
Histogram
Iteration number
Autocorrelation
Density
Lag
all
1-half
2-half
Chains: 1/3
GDP2020: Covid
Trace
Histogram
Iteration number
Autocorrelation
Density
Lag
all
1-half
2-half
Chains: 1/3
GDP2020:INT
Trace
Histogram
Iteration number
Autocorrelation
Density
Lag
all
1-half
2-half
Chains: 1/3
GDP2020: FIS
Trace
Histogram
Iteration number
Autocorrelation
Density
Lag
all
1-half
2-half
Chains: 1/3
GDP2020: cons
Trace
Histogram
Iteration number
Autocorrelation
Density
Lag
all
1-half
2-half
Chains: 1/3
Var
Trace
Histogram
Iteration number
Autocorrelation
Density
Lag
all
1-half
2-half
Chains: 1/3

Table 8. *Sensitivity Analysis with Respect to Prior Choice*

	GDP_{2009}	*OpE*	*Internet*	*Covid*	*INT*	*FIS*
			Mean			
$\beta_i \sim N$ (–0, 5; 1)	0.8701	0.0065	–0.0111	–0.6406	0.3464	0.0951
$\beta_i \sim N$ (–0, 4; 1)	0.9043	0.0061	–0.0096	–0.5979	0.3584	0.0949
$\beta_i \sim N$ (–0, 3; 1)	0.9389	0.0064	–0.0075	–0.5638	0.3700	0.0946
$\beta_i \sim N$ (–0, 2; 1)	0.9786	0.0061	–0.0060	–0.5221	0.3810	0.0951
$\beta_i \sim N$ (–0, 1; 1)	1.0041	0.0064	–0.0045	–0.4862	0.3925	0.0925
$\beta_i \sim N$ (0; 1)	1.0373	0.0060	–0.0022	–0.4484	0.4098	0.0918
$\beta_i \sim N$ (0,1; 1)	1.0700	0.0062	–0.0010	–0.4139	0.4151	0.0933
$\beta_i \sim N$ (0,2; 1)	1.1002	0.0063	0.0007	–0.3699	0.4300	0.0933
$\beta_i \sim N$ (0,3; 1)	1.1342	0.0061	0.0021	–0.3370	0.4418	0.0939
$\beta_i \sim N$ (0,4; 1)	1.1678	0.0063	0.0042	–0.3009	0.4497	0.0927
$\beta_i \sim N$ (0,5; 1)	1.1978	0.0067	0.0056	–0.2629	0.4628	0.0914
			MCMC			
$\beta_i \sim N$ (–0,5; 1)	0.4979	0.0220	0.0489	0.5685	0.2541	0.1358
$\beta_i \sim N$ (–0,4; 1)	0.4982	0.0222	0.0491	0.5717	0.2530	0.1350
$\beta_i \sim N$ (–0,3; 1)	0.4920	0.0219	0.0489	0.5738	0.2515	0.1361
$\beta_i \sim N$ (–0,2; 1)	0.4905	0.0219	0.0486	0.5663	0.2499	0.1349
$\beta_i \sim N$ (–0,1; 1)	0.4863	0.0216	0.0481	0.5649	0.2522	0.1356
$\beta_i \sim N$ (0; 1)	0.4863	0.0219	0.0483	0.5655	0.2513	0.1357
$\beta_i \sim N$ (0,1; 1)	0.4851	0.0219	0.0483	0.5629	0.2513	0.1344
$\beta_i \sim N$ (0,2; 1)	0.4822	0.0218	0.0486	0.5690	0.2505	0.1355
$\beta_i \sim N$ (0,3; 1)	0.4804	0.0218	0.0484	0.5667	0.2492	0.1335
$\beta_i \sim N$ (0,4; 1)	0.4841	0.0219	0.0486	0.5667	0.2496	0.1340
$\beta_i \sim N$ (0,5; 1)	0.4800	0.0217	0.0486	0.5686	0.2478	0.1340
			Monte-Carlo Standard Error (MCSE)			
$\beta_i \sim N$ (–0,5; 1)	0.0030	0.0001	0.0003	0.0033	0.0015	0.0008
$\beta_i \sim N$ (–0,4; 1)	0.0031	0.0001	0.0003	0.0033	0.0015	0.0008
$\beta_i \sim N$ (–0,3; 1)	0.0030	0.0001	0.0003	0.0033	0.0015	0.0008
$\beta_i \sim N$ (–0,2; 1)	0.0029	0.0001	0.0003	0.0033	0.0015	0.0008
$\beta_i \sim N$ (–0,1; 1)	0.0029	0.0001	0.0003	0.0033	0.0015	0.0008
$\beta_i \sim N$ (0; 1)	0.0028	0.0001	0.0003	0.0033	0.0015	0.0008
$\beta_i \sim N$ (0,1; 1)	0.0029	0.0001	0.0003	0.0033	0.0015	0.0008
$\beta_i \sim N$ (0,2; 1)	0.0028	0.0001	0.0003	0.0033	0.0014	0.0008
$\beta_i \sim N$ (0,3; 1)	0.0028	0.0001	0.0003	0.0033	0.0014	0.0008
$\beta_i \sim N$ (0,4; 1)	0.0028	0.0001	0.0003	0.0033	0.0014	0.0008
$\beta_i \sim N$ (0,5; 1)	0.0028	0.0001	0.0003	0.0033	0.0014	0.0008
			[95% Cred. Interval]			
$\beta_i \sim N$ (–0,5; 1)	–0.1462	–0.0368	–0.1093	–1.7724	–0.1744	–0.1785

	1.8162	0.0501	0.0823	0.4802	0.8355	0.3577
$\beta_i \sim N$ (–0,4; 1)	–0.1127	–0.0381	–0.1084	–1.7226	–0.1548	–0.1762
	1.8560	0.0501	0.0854	0.5160	0.8472	0.3586
$\beta_i \sim N$ (–0,3; 1)	–0.0600	–0.0368	–0.1061	–1.6814	–0.1351	–0.1781
	1.8715	0.0500	0.0871	0.5621	0.8534	0.3570
$\beta_i \sim N$ (–0,2; 1)	–0.0115	–0.0368	–0.1041	–1.6365	–0.1266	–0.1761
	1.9243	0.0494	0.0879	0.5883	0.8623	0.3595
$\beta_i \sim N$ (–0,1; 1)	0.0195	–0.0366	–0.1012	–1.5923	–0.1143	–0.1805
	1.9481	0.0492	0.0888	0.6298	0.8846	0.3579
$\beta_i \sim N$ (0; 1)	0.0587	–0.0373	–0.0990	–1.5559	–0.0900	–0.1772
	1.9736	0.0498	0.0923	0.6728	0.9049	0.3565
$\beta_i \sim N$ (0,1; 1)	0.0856	–0.0370	–0.0991	–1.5250	–0.0903	–0.1763
	2.0112	0.0499	0.0932	0.7034	0.9026	0.3522
$\beta_i \sim N$ (0,2; 1)	0.1428	–0.0366	–0.0973	–1.4864	–0.0715	–0.1796
	2.0303	0.0499	0.0944	0.7627	0.9248	0.3569
$\beta_i \sim N$ (0,3; 1)	0.1551	–0.0368	–0.0940	–1.4310	–0.0569	–0.1736
	2.0566	0.0494	0.0968	0.7913	0.9298	0.3532
$\beta_i \sim N$ (0,4; 1)	0.2098	–0.0367	–0.0930	–1.4074	–0.0464	–0.1760
	2.1016	0.0501	0.0994	0.8207	0.9449	0.3527
$\beta_i \sim N$ (0,5; 1)	0.2431	–0.0353	–0.0913	–1.3623	–0.0239	–0.1782
	2.1254	0.0502	0.1007	0.8675	0.9488	0.3557

Discussion

According to the results depicted in Table 9, Internet and Covid exert negative effects on GDP_{2020}, while OpE, INT, and FIS are positively related to GDP_{2020}.In contrast to frequentist inference, the Bayesian approach has intuitive interpretations of results when allowing forecasting the probability of the impacts of the independent variables on the dependent variable.

The results in Table 10 point out that with a low probability of 61.5%, the impact of trade openness on economic growth is weak. Therefore, we do not have strong evidence to accept hypothesis H3. Theoretically, trade openness drives economic growth by exporting goods and services, improving efficiency in allocating resources, and aggregate factor productivity through the diffusion of knowledge and technology (Rivera-Batiz & Romer, 1991). Numerous studies have affirmed the vital role of trade openness for economic growth (Marelli & Signorelli, 2011; Nasreen & Anwar, 2014; Zahonogo, 2016). However, COVID-19 has forced countries to close their borders, which has disrupted import-export activities, and international trade has been adversely affected; thus, the positive effects of trade openness on economic growth have been mitigated during the pandemic. Countries with a higher proportion of internet users tend to obtain lower economic growth during the pandemic. Still, we could not accept or reject hypothesis H4 because of a 51% probability of this effect.

As a foundation for e-commerce, the internet plays an essential role in promoting economic growth. However, residents in countries with high internet penetration tend to increase savings, postpone consumption, and investment decisions, access a variety of information about the pandemic, so an economic crisis comes faster. This phenomenon comes from the Keynesian paradox of savings. A decline in economic growth occurred with a 79%

Table 9. ***Bayesian Simulation Outcomes***

GDP_{2020}	Mean	Std. Dev.	MCSE	Median	Equal-tailed [95% Cred. Interval]	
GDP_{2019}	1.0373	0.4863	0.0028	1.0458	0.0587	1.9736
OpE	0.0060	0.0219	0.0001	0.0060	–0.0373	0.0498
Internet	–0.0022	0.0483	0.0003	–0.0015	–0.0990	0.0923
Covid	–0.4484	0.5655	0.0033	–0.4441	–1.5559	0.6728
INT	0.4098	0.2513	0.0015	0.4118	–0.0900	0.9049
FIS	0.0918	0.1357	0.0008	0.0941	–0.1772	0.3565
_cons	–0.1184	0.0604	0.0003	–0.1194	–0.2345	0.0038
var	0.0022	0.0008	0.0000	0.0020	0.0012	0.0041
Avg acceptance rate	1					
Avg efficiency: min	0.9923					
Max Gelman-Rubin Rc	1					

Table 10. ***Probabilistic Test***

GDP_{2020}	Mean	Std. Dev.	MCSE
prob (GDP_{2020} : GDP_{2019}) > 0	0.9818	0.1338	0.0008
prob (GDP_{2020} : *OpE*) > 0	0.6148	0.4866	0.0028
prob (GDP_{2020} : *Internet*) < 0	0.5145	0.4998	0.0029
prob (GDP_{2020} : *Covid*) < 0	0.7874	0.4092	0.0024
prob (GDP_{2020} : *INT*) > 0	0.9457	0.2266	0.0013
prob (GDP_{2020} : *FIS*) > 0	0.7611	0.4264	0.0025

probability in countries with a high proportion of infections; this result supports hypothesis H5. Countries performing more effective disease control recover economic growth at more rapid rates and largely contribute to fast economic recovery. Good disease control allows for strongly enhancing all economic activities. Even industries heavily damaged by the pandemic as tourism and air transportation can recover when domestic markets are well exploited.

Interestingly, countries having established higher policy interest rates before the crisis tend to achieve better growth with a probability of 95%; thus, hypothesis H1 is rejected. The outbreak of the current epidemic is a shock of unprecedented scale and nature. The main solution taken so far to curb the pandemic spread is global blockade and quarantine, which has led to the stagnation of economies. Liquidity problems for households and businesses, coupled with growing volatility, have worsened financial markets' performance. Since the pandemic broke out, EAGLEs have loosened monetary policy to support economic growth. Low-interest-rate monetary policy has faced a liquidity trap. Thus, the monetary policy, implemented in the countries where low-interest rates were established long before, is ineffective.

On the contrary, this policy is more effective for countries having maintained high interest rates. Interest rate reduction tends to have a positive impact on the economy. Similar to the monetary policy, fiscal policy has been loosened during the pandemic to support growth. A higher level of budget spending tends to positively contribute to economic growth with a 76% probability, meaning that we accept hypothesis H2. Public investment increase in crisis time has promoted aggregate demand and economic growth, compensating for a considerable decrease in private investment. In the context of the pandemic, governments have provided fiscal packages to support businesses and households. This is also considered a key solution to stimulate aggregate demand and restore economic growth.

Conclusion and Policy Implications

There exist a variety of determinants and factors of economic growth, but the growth process during the COVID-19 pandemic is greatly affected by notable specific macro factors, such as infection rate, policy rate, and government expenditure. The research has evaluated the effects of the featured macro factors on economic growth in EAGLEs in the context of the pandemic. The results show that the impacts of trade openness and internet users on economic growth during the COVID-19 are rather weak, with a probability of just 61% and 51%, respectively. This is because extreme disease control measures weaken the positive effect of trade liberalization on economic growth. The Keynesian paradox of savings can explain the ambiguous effect of internet users.

Furthermore, the study finds that economies with better disease control and lower infection rates tend to recover faster, with a 76% probability. When the pandemic started, some countries temporarily sacrificed economic benefits for control measures. Once the disease was quickly controlled, those economies could rapidly return to normality. Vietnam and Taiwan are countries that had a remarkable pattern of reasonable pandemic control. Effective disease control has helped these countries restore economic performance. Also, when the pandemic broke out, most countries reduced policy rates to support businesses. However, an expansionary monetary policy is effective only for countries having ever implemented high interest rates, with a probability of 95%, while countries with low policy rates have faced a liquidity trap. Finally, during the pandemic, increases in budget expenditure are likely to support the economy, with a 76% probability.

From the perspective of macroeconomic policy, many economists believe that to overcome the crisis caused by the COVID-19 shock, it is necessary to use policy tools, where fiscal policy and monetary policy play a very supportive role. Policy analysts agree on the need to use budgets to bail out businesses, people, and economies (Benmelech & Tzur-Ilan, 2020). Huge economic stimulus packages have been introduced, and even monetizing budget deficits in the current situation is the option of many countries. However, countries need to implement a reasonable fiscal policy to avoid overusing this tool; otherwise, this can expand public debt, threatening financial stability.

Limitations of the Study and Scope for Further Research

Due to the level of data access, this study considers only a few specific factors important to economic growth, so further studies should consider other factors such as FDI inflows and the level of financial development for a more comprehensive assessment. In addition, further research may examine the factors affecting economic recovery after the pandemic.

Authors' Contribution

Dr. Thach formed the idea and developed a quantitative design to undertake the empirical study. Dr. Thach and Dr. Hai verified the analytical methods and supervised the study. Mr. Linh and Dr. Hac were responsible for the literature review and proposed hypotheses. Ms. Ngoc and Dr. Hai gained the research data and contributed ideas to improve the research paper. The numerical computations were done by Mr. Linh using Stata 16. Mr. Linh wrote the manuscript under the guidance of Dr. Thach. Dr. Thach edited the final manuscript.

Conflict of Interest

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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