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Economic growth and the matters of inflation and unemployment: Evidence from ASEAN-5

Elaine, Ee-Lin Tee[1]
Pei-Tha Gan[2+]
Fatimah Salwa Abd Hadi[3]
Zainizam Zakaria[4]

[1,2,3,4]Department of Economics, Faculty of Management and Economics, Universiti Pendidikan Sultan Idris, 35900 Tanjong Malim, Perak. Malaysia.
[1]Email: elaine.tee0111@hotmail.com
[2]Email: gan.pt@fpe.upsi.edu.my
[3]Email: fatimahsalwa@fpe.upsi.edu.my
[4]Email: zainizam@fpe.upsi.edu.my

(+ Corresponding author)

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ABSTRACT

The purpose of this study is to examine the relationship between economic growth, inflation, and unemployment. One notable feature of empirical research is the rarity of studies that examine the effects of unemployment and inflation on economic growth in different economic environments, despite the large number of studies that look into these two variables. The study also incorporates interest rates and exchange rates as control variables. This study employs time series data spanning from 1994 to 2020 for selected 5 countries of the Association of Southeast Asian Nations (ASEAN), namely Indonesia, Malaysia, Singapore, Thailand, and the Philippines, under diverse economic conditions. The analysis utilises the autoregressive distributed lag (ARDL) method to examine the relationships between economic growth and its determinants. The empirical results of the study reveal: (1) Economic growth benefits from reducing inflation, interest rates, and exchange rates, underscoring their positive impact on development; and (2) Elevated unemployment rates hinder economic growth. These findings provide policy implications for policymakers in managing inflation, unemployment, interest rates, and exchange rates to foster sustained economic development.

Contribution/ Originality: Lack of studies investigates the relationship between economic growth and its determinants, namely inflation, unemployment, interest rate, and exchange rate, under various economic conditions. Moreover, analysis of the relationships between the variables at different time horizons will produce a robust and reliable result, which may assist policymakers in making economic predictions.

1. INTRODUCTION

The impact of inflation and unemployment on economic growth is undeniably significant. These variables can introduce challenges to the functioning of an economy, ultimately affecting its overall growth. Typically, government initiatives to reduce unemployment through expansionary monetary policies may trigger inflationary pressures. A high inflation rate can result in lower investment and hinder economic growth (Tenzin, 2019). On the other hand, a decrease in the unemployment rate and an increase in the cost of goods and services may temporarily cause inflation. Despite the recognition that inflation and unemployment pose substantial obstacles to economic growth, a lingering question remains regarding the potential for further investigation in this area to enhance our understanding of the relationship between economic growth, inflation, and unemployment. A noteworthy feature of

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empirical studies is the limited discussion on the impact of inflation and unemployment on economic growth in various economic conditions, despite the extensive research investigating these two variables individually.

The objective of this study is to examine the relationship between economic growth, inflation, and unemployment across various economic conditions, providing policymakers with valuable guidance in designing effective economic policies and making informed decisions. The study also includes two important control variables, namely the interest rate and the exchange rate. Five ASEAN countries, specifically Indonesia, Malaysia, the Philippines, Singapore, and Thailand, are included in this study. The relationship between economic growth and its determinants, including inflation, unemployment, interest rate, and exchange rate, is examined using the ARDL method proposed by Pesaran and Shin (1999).

The subsequent section of the study is structured in the following manner: Section 2 outlines the model design and econometric methods used in the analysis. The findings and analysis are presented in Section 3. Section 4, in conclusion, discusses the findings derived from the investigation.

2. EMPIRICAL LITERATURE

The influence of inflation and unemployment on economic growth may vary across countries, time series, and methodologies (Akinsola & Odhiambo, 2017). Multiple empirical studies (Baharumshah, Slesman, & Wohar, 2016; Barro, 2013; Fischer, 1983;Valdovinos, 2003) say that high inflation rates can slow down economic growth. However, there are also examples where there is a statistically significant positive relationship between inflation and economic growth, such as in Bangladesh (Sumon & Miyan, 2017; Uddin & Rahman, 2023), or in European(Kryeziu & Durguti, 2019). High inflation rates can shrink the actual returns of savings, leading to frictions in financial markets that limit access to credit, constrain investment, reduce investment efficiency, and ultimately decelerate economic growth (Huybens & Smith, 1998). However, some empirical studies reveal an inverse relationship between inflation and economic growth (Barro, 1995; López-Villavicencio & Mignon, 2011). Furthermore, it has been suggested that the relationship between inflation and economic growth may be inconspicuous when the inflation rate is relatively low (Arawatari, Hori, & Mino, 2018).

Regarding unemployment, a persistently high unemployment rate not only results in a loss of human resources (Anghel, Anghelache, & Manole, 2017) but also hampers economic growth within a country (Obst, 2022; Seip & Zhang, 2022). It signifies an inefficient utilization of labor resources (Hjazeen, Seraj, & Ozdeser, 2021) and leads to lower consumption and weakened real investment, among other adverse effects (International Labor Organization, 2011). Consequently, poor labor market performance can detrimentally affect long-term growth prospects (Mareš & Sirovátka, 2005). Some studies suggest a negative relationship between unemployment and economic growth in the long run (Impin & Kok, 2021). For instance, utilizing the ARDL method, Al-Sawaiea (2020) demonstrates a negative relationship between the unemployment rate and economic growth in Jordan. Conversely, Banda, Ngirande, and Hogwe (2016) uncover that the unemployment rate and economic growth have a positive relationship in South Africa. Furthermore, Salim, Safia, and Issa (2017) find that the unemployment rate positively impacts economic growth in Tanzania, employing dynamic ordinary least squares.

In addition to inflation and unemployment, other explanatory variables, such as interest and exchange rates, play significant roles in influencing economic growth and cannot be overlooked. Obamuyi and Olorunfemi (2011) argue that the interest rate is a valuable monetary policy tool for fine-tuning economic growth. High interest rates can reduce aggregate demand through decreased investment spending and weaker consumption, potentially stimulating higher saving rates and subsequent economic growth (McKinnon, 1973; Shaw, 1973). However, previous research has yielded mixed results regarding the relationship between the interest rate and economic growth, employing various analytical mechanisms (Arrow, 2017; Bertola & Caballero, 1994; Drobyshevsky, Bogachkova, Trunin, & Sinelnikova-Muryleva, 2017; Njie & Badjie, 2021; Oroud, Almahadin, Alkhazaleh, & Shneikat, 2023; Wickens, 2008). Similarly, the exchange rate also influences economic growth, particularly its

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impact on international trade levels (Liu, 2019; Morina, Hysa, Ergün, Panait, & Voica, 2020).Morina et al. (2020)found a significant negative relationship between the exchange rate and economic growth using the z-score and standard deviation methods. Karahan and Colak (2020) revealed a negative causal relationship between the exchange rate and economic growth in Turkey through the Granger causality test. The negative relationship is consistent with the studies by Seraj, Bahramian, Alhassan, and Shahabad (2020) and Mawutor et al. (2023). However, as Amassoma (2016) and Mwinlaaru and Ofori (2017) highlight, empirical studies on the connection between the exchange rate and economic growth produce contradictory findings. Given the complex and multifaceted nature of the relationship between these variables, alongside inflation, unemployment, and other factors, it is important to comprehensively understand their interplay and provide valuable insights for policymakers to formulate effective economic policies.

3. MODELS AND ECONOMETRIC METHOD

This study uses the statistical investigation approach proposed by Faria and Carneiro (2001) to examine the relationship between economic growth and its determinants (i.e., inflation, unemployment, interest rate, and exchange rate). The statistical investigation is part of the process of acquiring and learning information to seek meaning from and learn more about observed phenomena to inform decisions and actions (Karmel, 1963). Hence, it is necessary to collect the numerical facts for the statistical approach since it is impossible without them. A scientific method is employed for a statistical investigation since it concerns empirical data. Statistical devices like collection, classification, analysis, and interpretation would help to a imply search for knowledge in statistical investigation. Methods and techniques in statistical investigation are important in gathering and learning about observed phenomena (Raluca, 2017).

By using the statistical investigation approach proposed by Faria and Carneiro (2001) the modified economic growth model is given by the following equation:

$$y_t = \alpha_1 + \alpha_2 y_{t-1} - \alpha_3 inf_{t-1} - \alpha_4 ue_{t-1} - \alpha_5 int_{t-1} - \alpha_6 ex_{t-1} + \mu_t \quad (1)$$

Where *y* denotes economic growth, *inf* denotes inflation, *un* denotes unemployment, *int* denotes interest rate, *ex* denotes exchange rate, and μ_t denotes error term. The equation indicates that inflation and unemployment have a negative impact on economic growth, as explained in theoretical literature. An increase in inflation and unemployment resulted in slow economic growth. Also, high interest rates increase the cost of money and end up with low economic growth. In addition, the expected appreciation of the exchange rate would facilitate economic growth.This study's data was obtained from the International Monetary Fund and the World Bank. The time series data cover from 1994 to 2020 for selected ASEAN-5 countries (Indonesia, Malaysia, Singapore, Thailand, and the Philippines). All data is displayed as a percentage. Table 1 delivers a description of the variable chosen.

Table 1. Variables description.

Variables	Description	Source
ly	The logarithm of real GDP growth; real gross domestic product (GDP) growth $= \frac{current\ year's\ real\ GDP - Previous\ year's\ real\ GDP}{\text{previous year's real GDP}}$ x 100	International monetary fund
linf	The logarithm of inflation; Inflation $= \frac{Consumer\ Price\ Index_1 - Consumer\ Price\ Index_0}{Consumer\ Price\ Index_0}$ x 100	International monetary fund
lun	The logarithm of unemployment; Unemployment rate $= \frac{Unemployed}{Labour\ force}$ x 100	International monetary fund
lint	The logarithm of interest rate (Money market rate)	International monetary fund
lex	The logarithm of exchange rate (2010=100)	World bank

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Prior to the ARDL estimation, three approaches of unit root, namely the augmented Dickey-Fuller (ADF), Phillips Perron (PP), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS), are applied to check the stationarity of the variables (i.e., economic growth (*y*), inflation (*inf*), unemployment (*ue*), interest rate (*int*), and exchange rate (*ex*). In detail, the ADF test is widely used to crosscheck for data stationarity. Although the PP test is found to be more powerful than the ADF test, the PP test, just like the ADF test, is criticized for its low power if the process is stationary but with a root close to the non-stationary boundary (Brooks, 2008). The performance of the KPSS test is excellent compared to the ADF and PP tests (Zhang & Cheng, 2009). When there is a disagreement between the tests, the results of KPSS will be prioritized since it has an astounding performance (Afriyie, Twumasi-Ankrah, Gyamfi, Arthur, & Pels, 2020). Table 2 presents the null hypothesis for three approaches to unit root (i.e., the ADF, PP, and KPSS).

Table 2. Null hypothesis for the measurements.

Measures	Null hypothesis
Augmented dick fuller (ADF) Phillips-perron (PP)	Unit root
Kwiatkowski-Phillips-Schmidt-shin (KPSS) test	Stationarity

To overcome the stationarity of the regressors, Autoregressive Distributed Lag (ARDL) is the most appropriate relationship method. This approach is suitable for this study, irrespective of whether the variables have unit roots (Pesaran, 1997). It captures the short-run and long-run models. Hence, an estimation of error correction in ARDL was written as (2):

$$\Delta y_t = c + \beta_1 ly_{t-1} + \beta_2 linf_{t-1} + \beta_3 lue_{t-1} + \beta_4 lint_{t-1} + \beta_5 lex_{t-1} + \sum_{k=1}^{p} \alpha_{1k} \Delta ly_{t-k} + \sum_{k=1}^{p} \alpha_{2k} \Delta linf_{t-k} + \sum_{k=1}^{p} \alpha_{3k} \Delta lue_{t-k} + \sum_{k=1}^{p} \alpha_{4k} \Delta lint_{t-k} + \sum_{k=1}^{p} \alpha_{5k} \Delta lex_{t-k} + u_t;\ \Delta \text{ is the first difference} \quad (2)$$

Bounds testing procedures can be used to verify the relationship between economic growth and the independent variables (Pesaran, Shin, & Smith, 2001). The null hypothesis is $H_0 = \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$, which means there is no long-run relationship. While the alternate hypothesis is at least one of the $H_1 \neq \beta_1$, which means there is a long-run relationship. The null hypothesis uses the F-statistic estimation. If the F-test is greater than the upper bound critical value, it rejects the H_0 and all the variables in the study are cointegrated. When the F-test is smaller than the lower bound critical value, the H_0 is accepted, indicating that all variables have no relationship. There is an inconclusive decision when the variables fall between the lower and upper bounds. However, the bound test is rendered invalid in the presence of an integrated stochastic trend of I(2) because it crashes the bound test assumptions that the variables are either I(0), I(1) or mutually cointegrated (Chigusiwa, Bindu, Mudavanhu, Muchabaiwa, & Muzambani, 2011). The lag order selection is also based on the Akaike Information Criterion (AIC).

4. RESULTS AND DISCUSSION

The unit root tests of ADF, PP, and KPSS in each country suggest that the time series data on the variables are mixed, i.e., $I(0)$ and $I(1)$ see Table 3. Table 4 presents the estimation of the ARDL of Equation 2 based on the Akaike Information Criterion (AIC) (*Note* that the insignificant and incorrect expected sign variables are not reported in the table). There is a long-run relationship between economic growth and inflation in Indonesia, Singapore, Thailand, and the Philippines, except Malaysia; this result does not vary from the recent studies (see (Karahan & Colak, 2020; Rehman, Cismas, & Milin, 2022;Sinha, 2022)). A long-run relationship is detected between economic growth and interest rates in all countries, consistent with recent studies (see (Njie & Badjie, 2021; Oroud et al., 2023)). Economic growth and exchange rate also have a long-term relationship in Indonesia, Singapore, and Thailand; this result is similar to the findings obtained by Mawutor et al. (2023). On the other hand, a significant short-run relationship is found between economic growth and inflation in Malaysia, only; this result does not differ

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from the recent studies (see (Bahloul, 2023; Mhamad & Ibrahim, 2022)). Economic growth and unemployment are significant in the short run in Indonesia, Malaysia and the Philippines, except in Singapore and Thailand; this result is similar to the findings found by Al-kasasbeh (2022). Economic growth and exchange rate have a significant relationship in the short run in Malaysia and the Philippines, except in Indonesia, Singapore, and Thailand; this result is consistent with the recent work of Seraj et al. (2020).

Table 3. Unit root test results.

Variables	ADF		PP		KPSS		Decision
	Level	1st difference	Level	1st difference	Level	1st difference	
Indonesia							
y	-3.049 (2)	-10.21 (2)***	-3.233 (5)*	-10.95 (13)***	0.092 (7)	0.095 (13)	*I*(0)
inf	-4.448 (2)*	-10.20 (2)***	-3.557 (9)**	-10.22 (4)***	0.046 (6)	0.028 (4)	*I*(0)
ue	-1.937 (2)	-10.23 (2)***	-1.947 (1)	-10.23 (3)***	0.243 (8)***	0.156 (3)	*I*(1)
int	-3.091 (8)	-5.321 (8)***	-3.173 (1)*	-10.21 (6)***	0.084 (8)	0.047 (6)	*I*(0)
ex	-2.819 (2)	-10.20 (2)***	-2.835 (6)	-10.58 (12)***	0.118 (8)*	0.126 (12)	*I*(1)
Malaysia							
y	-4.051 (2)*	-10.23 (2)***	-3.267 (8)*	-12.06 (23)***	0.073 (6)	0.160 (23)	*I*(0)
inf	-3.929 (2)**	-10.23 (2)***	-3.244 (14)*	-11.45 (10)*	0.099 (6)	0.117 (10)	*I*(0)
ue	-1.827 (6)	-10.28 (6)***	-1.823 (0)	-10.28 (4)***	0.135 (7)*	0.156 (5)	*I*(1)
int	-2.331 (2)	-10.21 (4)***	-2.501 (4)	-10.21 (3)***	0.148 (8)**	0.058 (3)	*I*(1)
ex	-2.449 (2)	-10.31 (2)***	-2.665 (5)	-10.31 (3)***	0.127 (8)*	0.055 (3)	*I*(1)
Singapore							
y	-2.913 (4)	-7.292 (4)***	-3.262 (8)*	-12.72 (24)***	0.132 (6)*	0.176 (24)	*I*(1)
inf	-2.853 (6)	-6.833 (6)***	-2.901 (7)	-11.32 (18)***	0.155 (8)**	0.104 (18)	*I*(1)
ue	-1.927 (2)	-10.23 (2)***	-2.027 (4)	-10.23 (2)***	0.179 (8)**	0.106 (2)	*I*(1)
int	-2.422 (12)	-10.25 (12)***	-2.613 (4)	-10.25 (3)***	0.126 (8)*	0.059 (2)	*I*(1)
ex	-2.048 (6)	-10.21 (2)***	-1.484 (8)	-10.50 (8)***	0.204 (9)**	0.149 (8)	*I*(1)
Thailand							
y	-2.780 (2)	-10.24 (4)***	-3.029 (4)	-10.53 (11)***	0.080 (7)	0.105 (11)	*I*(0)
inf	-3.593 (2)**	-10.22 (2)***	-3.430 (16)*	-10.28 (4)***	0.084 (7)	0.053 (10)	*I*(0)
ue	-2.514 (4)	-10.20 (4)***	-2.494 (7)	-10.48 (12)***	0.138 (8)*	0.122 (12)	*I*(1)
int	-2.429 (2)	-10.22 (10)***	-2.577 (3)	-10.22 (1)***	0.146 (8)*	0.045 (1)	*I*(1)
ex	-2.101 (12)	-10.20 (12)***	-2.101 (0)	-10.20 (1)***	0.216 (8)***	0.217 (1)	*I*(1)
The Philippines							
y	-1.487 (12)	-6.303 (12)***	-1.698 (4)	-10.32 (9)***	0.124 (6)*	0.263 (9)	*I*(1)
inf	-2.457 (12)	-6.797 (12)***	-3.641 (19)**	-11.88 (10)***	0.067 (4)	0.097 (10)	*I*(0)
ue	-1.409 (2)	-10.20 (6)***	-1.556 (3)	-10.20 (2)***	0.139 (8)*	0.158 (2)	*I*(1)
int	-2.224 (12)	-10.42 (2)***	-2.353 (4)	-10.42 (2)***	0.193 (8)**	0.080 (2)	*I*(1)
ex	-1.579 (12)	-10.22 (12)***	-1.629 (4)	-10.22 (4)***	0.208 (9)**	0.184 (4)	*I*(1)

Notes: ***, ** and * denotes rejection of null hypothesis at 1%, 5% and 10%, respectively. The critical value was obtained from McKinnon (1973) for ADF and PP to examine the null hypothesis of unit root against the stationarity. The numbers within bracket for the PP and KPSS statistics represent the bandwidth selected based on Newey and West (1994) method using Bartlett Kernel.

One can adopt the bound test estimation to support the presence of long-run relationships among the variables (Pesaran, Shin, & Smith, 2000). Table 5 displays the results of the bounds test. According to the results, the computations of the F-statistic recorded are higher than the lower bound (2.65) and upper bound (3.81) at a significance level for all countries. The long-run coefficients of the variables are presented in Table 6. The long-run coefficients of inflation are -1.21 in Indonesia, 0.55 in Malaysia, 0.38 in Singapore, -0.52 in Thailand, and -0.49 in the Philippines. Whereas the long-run coefficients of unemployment are 0.82 in Indonesia, 3.99 in Malaysia, 0.02 in Singapore, -0.23 in Thailand, and 2.86 in the Philippines. As for the interest rate, the long-run coefficients are -0.17 in Indonesia, -1.87 in Malaysia, 0.27 in Singapore, 1.09 in Thailand, and -0.51 in the Philippines. The long-run coefficients of the exchange rate are -4.69 in Indonesia, 3.89 in Malaysia, 1.70 in Singapore, -7.32 in Thailand, and 4.07 in the Philippines. Based on the above discussion, although some coefficients' relationship signs are not favourable, these results do not degrade the relationship deduced from Table 4.

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Table 4. ARDL results from 1994 to 2020.

Regressor	Indonesia	Malaysia	Singapore	Thailand	The Philippines
	Coef.	Coef.	Coef.	Coef.	Coef.
$\Delta linf_{t-3}$		-1.306 [-1.88]***			
Δlue_{t-1}	-1.685 [-2.01]**				
Δlue_{t-2}	-1.607 [-1.97]*				
Δlue_{t-3}	-1.624 [-1.97]*	-4.208 [-2.74]***			-2.447 [-1.74]*
Δlue_{t-4}					-2.927 [-1.83]*
Δlue_{t-5}	-1.898 [-1.74]*	-2.322 [-1.84]*			
Δlue_{t-6}	-1.898 [-1.74]*	-2.322 [-1.84]*			
Δlue_{t-7}	-1.853 [-1.70]*	-2.11 [-1.716]*			
Δlex_{t-4}		-9.229 [-4.53]***			-5.712 [-1.81]*
Δlex_{t-8}		-9.229 [-4.53]***			
y_{t-1}	-0.676 [-3.08]***	-0.562 [-3.32]***	1.448 [3.28]***	-0.502 [-1.77]*	-0.787 [-1.75]*
inf_{t-1}	-0.818 [-3.97]***		-0.546 [-3.22]***	-0.26 [-2.11]**	-0.389 [-2.71]***
int_{t-1}	-0.113 [-1.68]*	-1.05 [-2.47]**	-0.392 [-2.41]**	-0.548 [-2.49]**	-0.404 [-1.83]*
ex_{t-1}	-3.171 [-2.93]**		-2.462 [-1.97]*	-3.677 [-1.96]*	
Constant	16.69 [3.32]***	-10.22 [-1.97]*		18.71 [2.10]**	-16.60 [-1.95]*
R2	0.734	0.663	0.594	0.679	0.324
Adjusted R2	0.484	0.457	0.036	0.223	-0.38
LM test (F-statistics)	9.923 [0.000]	1.046 [0.431]	0.057 [0.945]	1.219 [0.307]	2.162 [0.127]
Heteroscedasticity	0.809 [0.746]	1.378 [0.135]	0.231 [1.000]	0.836 [0.731]	0.629 [0.945]

Note: *, ** and *** indicate significance at 10 per cent, 5 per cent and 1 per cent levels respectively, comparing critical t statistics from standard t-table. [ ] represents t-ratio. LM test refers to Breush-Godfrey serial correlation LM test (Godfrey, 1996).

Table 5. Bound testing for relationship analysis from 1994 to 2020.

Critical bound's value at 5 per cent level
Lower bound: 2.65
Upper bound: 3.81

Countries	Computed F-statistic (Microfit)	Wald test (Prob)
Indonesia	4.029	0.007
Malaysia	4.030	0.006
Singapore	4.954	0.002
Thailand	4.591	0.004
The Philippines	3.918	0.007

Source: Pesaran and Pesaran (1997), Table F: Case Intercept and no trend.

Table 6. Long-run elasticities from 1994 to 2020.

Regressor	Indonesia	Malaysia	Singapore	Thailand	The Philippines
inf	-1.21	0.55	0.38	-0.52	-0.49
ue	0.82	3.99	0.02	-0.23	2.86
int	-0.17	-1.87	0.27	1.09	-0.51
ex	-4.69	3.89	1.70	-7.32	4.07

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The Ramsey Reset Test is a statistical analysis to check the presence of other misspecifications in the regression model. The null hypothesis that the model has no specification error is accepted, indicating that the regression model has the correct functional form. The R^2 in this model is relatively good, with high coefficients more than 30% for five countries. The model is free from heteroscedasticity and serial correlation. The Ramsey RESET Test confirms the absence of misspecification in a regression model. Generally, plots of CUSUM and CUSUMSQ confirm that Equation 2 is stable over the sample period (see Figure 1, Figure 2, Figure 3, Figure 4, and Figure 5).

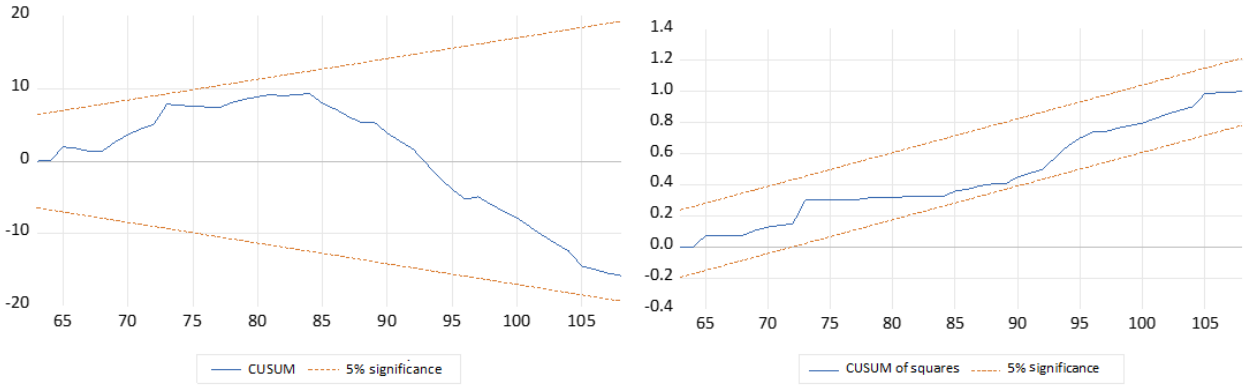

Figure 1. CUSUM and CUSUMSQ test Indonesia.

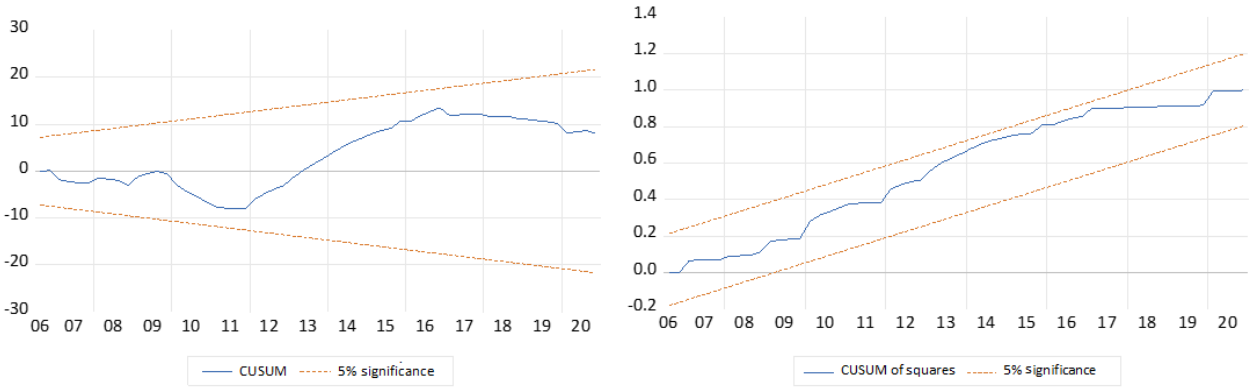

Figure 2. CUSUM and CUSUMSQ test Malaysia.

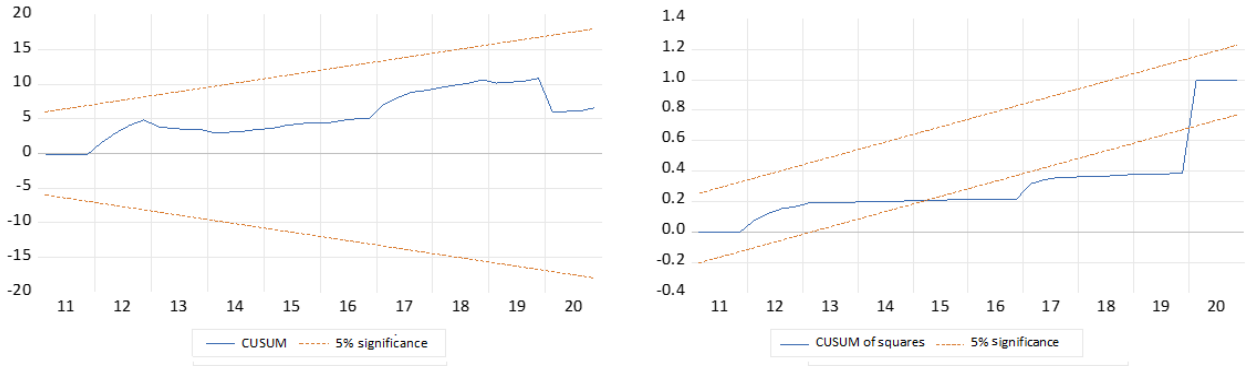

Figure 3. CUSUM and CUSUMSQ test Singapore.

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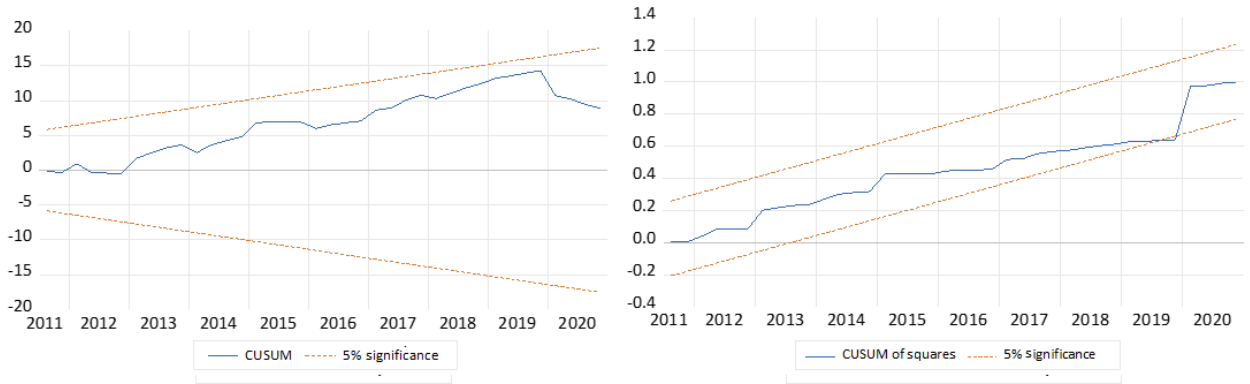

Figure 4. CUSUM and CUSUMSQ test Thailand.

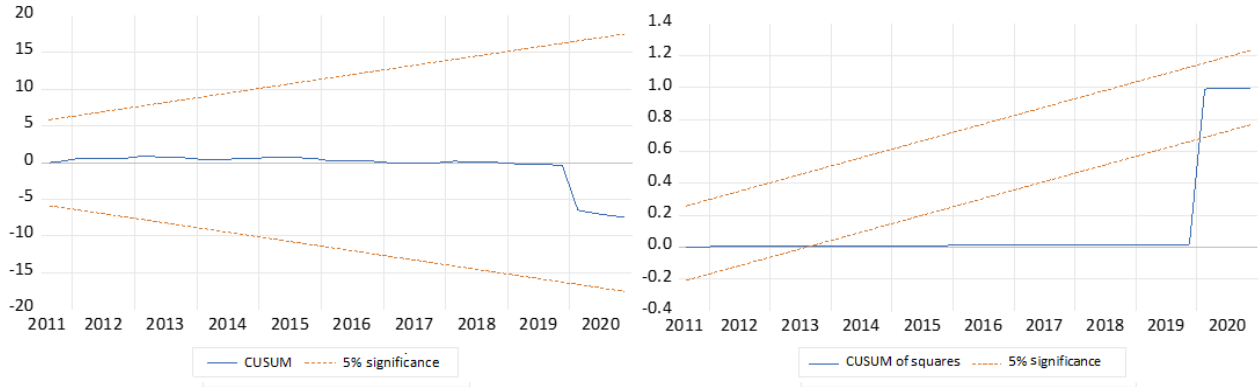

Figure 5. CUSUM and CUSUMSQ test The Philippines.

To examine the robustness of the above results, this study further analyses two economic disturbance periods, namely the first quarter of 1998 to the fourth quarter of 2003 (which comprises the Asian financial crisis, dot-com bubble, and SARS outbreak (Carson & Clark, 2013; Goodnight & Green, 2010; World Health Organization, 2003)[1]) and the first quarter of 2008 to the fourth quarter of 2020 (which comprises the global financial crisis, European Debt Crisis, and COVID-19 pandemic (Beker, 2014; Shereen, Khan, Kazmi, Bashir, & Siddique, 2020)[2]). These two periods were selected because various economic conditions may produce unexpected results due to the fluctuations of inflation and unemployment. The results are presented in Table 7 (covering from 1998 to 2003 and from 2008 to 2020) (*Note* that the insignificant and incorrect expected sign variables are not reported in the table).

Table 7 shows a significant long-run relationship is observed between economic growth and its determinants, namely inflation, unemployment, and the interest rate in ASEAN-5 during the first and second-time horizons. Economic growth and exchange rate have a long-run relationship in four countries, except Singapore during the first time horizon and the Philippines during the second time horizon. In the short run, the results show that economic growth and inflation have a significant relationship in four countries except Thailand during the first time horizon, but these two variables are significant in ASEAN-5 during the second time horizon. Economic growth and unemployment are significant in the short-run in ASEAN-5, except in the Philippines, for both time horizons. Economic growth and interest rates have a significant short-run relationship in ASEAN-5 for both time horizons. Economic growth and exchange rate are significant in the short-run in four countries except Thailand in the first time horizon and the Philippines in the second time horizon.

[1]Asian Financial Crisis occurred from July 1997 to December 2008 Dot-com bubble triggered from 1998 until March 2000 SARS outbreak in February 2003.

[2] Global Financial Crisis happened from mid-2007 to early 2009 (Chen, Mrkaic, & Nabar, 2019), European Debt Crisis started in late 2010 until 2012 COVID-19 pandemic.

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Table 7. Model coefficients in short-run and long-run from 1998 to 2003 and 2008 to 2020.

Regressor	Quarterly period from									
	1998 to 2003 (First time horizon)					2008 to 2020 (Second time horizon)				
	Indonesia	Malaysia	Singapore	Thailand	The Philippines	Indonesia	Malaysia	Singapore	Thailand	The Philippines
	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.
Δly_{t-1}						-12.76 [-3.64]***	-1.415 [-2.38]**	-4.195 [-3.82]***		
Δly_{t-2}							-1.415 [-2.38]**	-4.279 [-5.32]***		
Δly_{t-3}								-4.394 [-5.47]***		
$\Delta linf_{t-1}$	-0.797 [-14.7]***	-19.69 [-419]***	-0.575 [-3.645]***			-0.712 [-3.44]***	-5.539 [-3.06]***		-1.356 [-4.73]***	
$\Delta linf_{t-2}$			-0.575 [-3.645]***			-0.712 [-3.44]***	-5.539 [-3.06]***		-1.329 [-4.63]***	
$\Delta linf_{t-3}$			-0.591 [-3.65]***	-0.240 [-3.55]**		-0.712 [-3.44]***	-6.437 [-3.59]***		-1.336 [-4.67]***	
$\Delta linf_{t-4}$						-1.193 [-3.16]***	-1.678 [-4.41]***		-1.121 [-4.90]***	
$\Delta linf_{t-5}$						-1.315 [-3.70]***	-1.792 [-4.27]***		-0.853 [-3.71]***	
$\Delta linf_{t-6}$						-1.315 [-3.70]***	-1.792 [-4.27]***		-0.871 [-3.80]***	
$\Delta linf_{t-7}$						-1.315 [-3.70]***	-1.576 [-3.95]***		-0.858 [-3.79]***	
Δlue_{t-1}		-21.12 [-338]***	-14.43 [-7.99]***	-2.003 [-5.53]***		-1.110 [-2.07]*	-9.840 [-3.57]***		-2.977 [-1.98]*	

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Regressor	Quarterly period from									
	1998 to 2003 (First time horizon)					2008 to 2020 (Second time horizon)				
	Indonesia	Malaysia	Singapore	Thailand	The Philippines	Indonesia	Malaysia	Singapore	Thailand	The Philippines
	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.
Δlue_{t-2}			-14.43 [-7.99]***	-2.003 [-5.53]***		-1.110 [-2.07]*	-9.840 [-3.57]***		-3.095 [-2.06]*	
Δlue_{t-3}			-14.41 [-8.00]***	-1.990 [-7.47]***		-1.110 [-2.07]*	-9.840 [-3.57]***		-2.937 [-1.94]*	
Δlue_{t-4}									-8.63 [-4.42]***	
Δlue_{t-5}									-7.686 [-3.74]***	
Δlue_{t-6}									-7.721 [-3.76]***	
Δlue_{t-7}									-7.965 [-3.93]***	
$\Delta lint_{t-1}$	-0.508 [-3.92]***	-15.37 [-165]***		-1.513 [-9.66]***					-5.105 [-4.50]***	
$\Delta lint_{t-2}$	-0.510 [-3.92]***	-15.37 [-165]***							-5.040 [-4.46]***	
$\Delta lint_{t-3}$	-0.510 [-3.92]***	-15.37 [-165]***					-3.440 [-2.64]**		-5.181 [-4.68]***	
$\Delta lint_{t-4}$		-0.506 [6.312]***							-3.021 [-5.00]***	
$\Delta lint_{t-5}$									-2.400 [-3.56]***	
$\Delta lint_{t-6}$									-2.424 [-3.59]***	
$\Delta lint_{t-7}$									-2.461 [-3.63]***	

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Regressor	Quarterly period from									
	1998 to 2003 (First time horizon)					2008 to 2020 (Second time horizon)				
	Indonesia	Malaysia	Singapore	Thailand	The Philippines	Indonesia	Malaysia	Singapore	Thailand	The Philippines
	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.
Δlex_{t-1}							-10.01 [-2.79]**			
Δlex_{t-2}							-10.01 [-2.79]**			
Δlex_{t-3}						-7.199 [-3.02]***	-7.797 [-2.29]**			
y_{t-1}	-1.009 [-22.4]***	-1.125 [-56.2]***	-0.768 [-6.75]***	-0.779 [-10.1]***	-0.693 [-4.86]***					
inf_{t-1}	-0.806 [-13.4]***	-20.59 [-131]***								-1.46 [-2.61]**
ue_{t-1}		-21.94 [-164]***			-0.772 [-2.15]*			-29.55 [-4.28]***		
int_{t-1}				-1.185 [-6.44]***						-2.044 [-2.04]*
ex_{t-1}	-2.241 [-22.2]***			-2.682 [-2.18]*	-4.605 [-4.51]***	-8.118 [-3.59]***		-56.51 [4.30]***	-47.98 [-5.12]***	
Constant	9.646 [17.9]***	-54.61 [-12.0]***		12.52 [2.29]*	21.24 [4.54]***	-1.592 [-0.74]	-59.95 [-4.96]***	279.7 [4.20]***	218.9 [5.00]***	
R^2	0.999	1.000	0.974	0.998	0.938	0.566	0.768	0.876	0.894	0.564
Adjusted R^2	0.997	1.000	0.916	0.991	0.864	0.111	0.490	0.546	0.481	0.173
LM tesT	1.212	1.197	0.873	1.519	0.549	0.933	0.048	0.095	4.539	0.595
(F-statistics)	[0.35]	[0.36]	[0.47]	[0.32]	[0.60]	[0.41]	[0.95]	[0.91]	[0.06]	[0.57]
Heteroscedasticity	1.159	0.458	2.661	2.977	0.367	1.103	1.342	0.929	0.570	1.297
(F-statistics)	[0.42]	[0.91]	[0.09]	[0.09]	[0.96]	[0.41]	[0.25]	[0.59]	[0.89]	[0.30]

Note: *, ** and *** indicate significant at 10 per cent, 5 per cent and 1 per cent levels respectively comparing critical t statistics from standard t-table. [ ] represents t-ratio. LM test refers to Breusch-Godfrey serial correlation LM test (Godfrey, 1996).

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Table 8. Bound testing for relationship analysis from 1998 to 2003 and 2008 to 2020.

Critical bound's value at 5% level				
Upper bound: 3.81				
Lower bound: 2.65				
Countries	**1998 to 2003 (1st time horizon)**		**2008 to 2020 (2nd time horizon)**	
	Value	**Probabilities**	**Value**	**Probabilities**
Indonesia	111.5	0.000	4.281	0.011
Malaysia	2.744	0.079	14.44	0.000
Singapore	23.00	0.000	12.01	0.000
Thailand	106.1	0.000	8.631	0.004
The Philippines	7.332	0.004	4.158	0.017

Source: Pesaran and Pesaran (1997), Table CI (iii): Case Intercept and no trend.

The long-run relationship is established by the bound testing, as shown in Table 8, which presents the bound testing for relationship analysis from 1998 to 2003 and 2008 to 2020. The results reveal that the F-statistic value of the four countries was above the upper bound from 1998 to 2003. It implies that the variables have a relationship. However, the bound test result for Malaysia is inconclusive since the value of the F-statistic lies between the lower and upper bounds. From 2008 to 2020, the results show evidence of a relationship among the variables since the F-statistic value is higher than the upper bound in five selected countries.

Table 9 presents the long-run coefficients of the individual countries for two time horizons. From 1998 to 2003, the long-run inflation and exchange rate coefficients were negative (0.799 and 2.221), whereas unemployment and interest rates were positive (1.656 and 0.457) in Indonesia. The long-run coefficients of inflation and unemployment are negative (19.30 and 19.50), whereas the interest rate and exchange rate are positive (13.22 and 17.67) in Malaysia. The long-run coefficients of inflation (0.923), unemployment (20.21), interest rate (22.80), and unemployment (23.75) in Singapore are positive. Inflation and unemployment record positive long-run coefficients (0.720 and 2.805), but the interest rate and the exchange rate show negative long-run coefficients (1.521 and 3.443) in Thailand. The long-run inflation and interest rate coefficients are positive (0.466 and 1.799) in the Philippines. Conversely, unemployment and the exchange rate show negative long-run coefficients (1.114 and 6.645). From 2008 to 2020, the negative long-run coefficients were 0.073, 0.052, and 0.073 for inflation, unemployment, and interest rate, respectively, in Indonesia. Only the exchange rate shows positive long-run coefficients (0.696). In Malaysia, inflation, unemployment, interest rate, and exchange rate are negative (18.82, 26.70, 8.37, and 26.13). In Singapore, inflation and interest rates have negative long-run coefficients (0.206 and 0.771), whereas unemployment and exchange rates have positive long-run coefficients (16.62 and 31.78). In Thailand, inflation, unemployment, and the interest rate show positive long-run coefficients (1.560, 2.754, and 6.151), whereas the exchange rate has a negative long-run coefficient (57.67). In the Philippines, unemployment has a positive long-run coefficient (17.14), whereas inflation, interest rate, and exchange rate are negative (8.848, 12.39, and 47.57).

Table 9. Long-run Coefficient from 1998 to 2003 and 2008 to 2020.

From 1998 to 2003 (1st time horizon)					
Countries	**Indonesia**	**Malaysia**	**Singapore**	**Thailand**	**The Philippines**
Regressor	**Coef.**	**Coef.**	**Coef.**	**Coef.**	**Coef.**
Inf	-0.799	-18.30	0.923	0.720	0.466
Ue	1.656	-19.50	20.21	2.805	-1.114
Int	0.457	13.22	22.80	-1.521	1.799
Ex	-2.221	17.67	23.75	-3.443	-6.645
From 2008 to 2020 (2nd time horizon)					
Regressor	Coef.	Coef.	Coef.	Coef.	Coef.
Inf	-0.073	-18.82	-0.206	1.560	-8.848
Ue	-0.052	-26.70	16.62	2.754	17.14
Int	-0.073	-8.370	-0.771	6.151	-12.39
Ex	0.696	-26.13	31.78	-57.67	-47.57

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The R^2 of the estimated model is more than 86% for the first time horizon (from 1998 to 2003). However, the R^2 is relatively low for the second time horizon (from 2008 to 2020), which is in the range of 11 percent to 48%, but overall the model is satisfactory with a number of diagnostic tests. The estimated equation is free from heteroscedasticity and the serial correlation LM test. The plots of CUSUM and CUSUMSQ from 1998 to 2003 (see Figure 6, Figure 7, Figure 8, Figure 9, and Figure 10) and from 2008 to 2020 (see Figure 11, Figure 12, Figure 13, Figure 14, and Figure 15) stay within the critical 5% bounds. It implies that the estimated parameters are stable over the period.

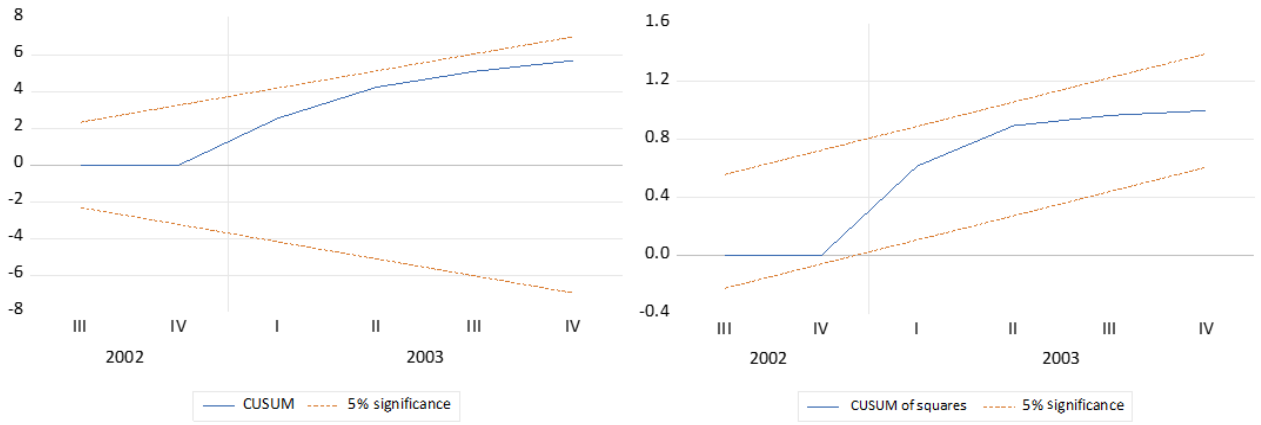

Figure 6. CUSUM and CUSUMSQ Indonesia (1998-2003).

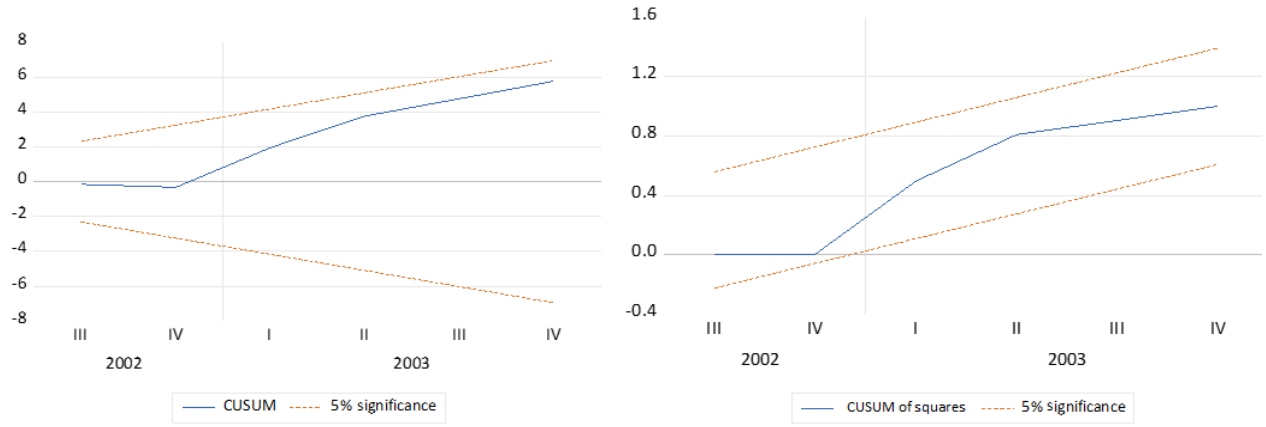

Figure 7. CUSUM and CUSUMSQ Malaysia (1998-2003).

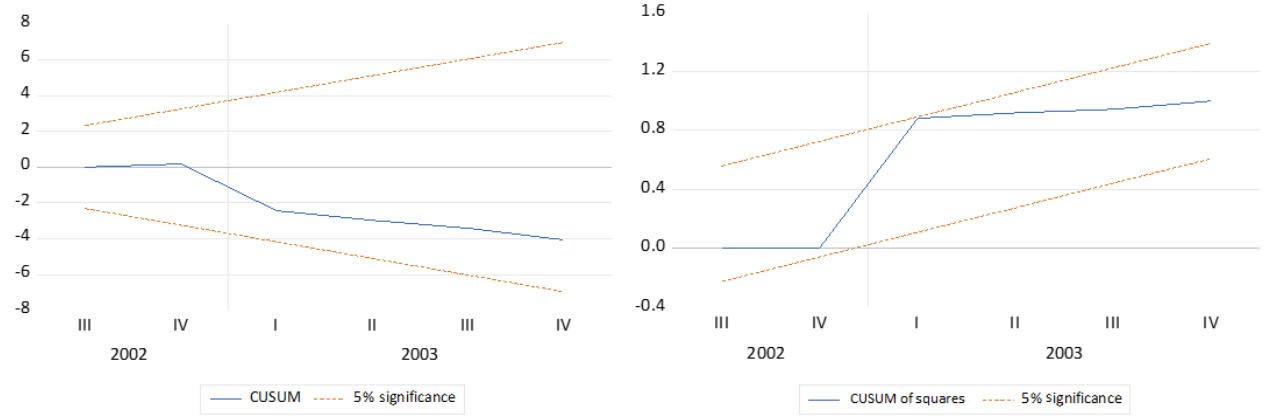

Figure 8. CUSUM and CUSUMSQ Singapore (1998-2003).

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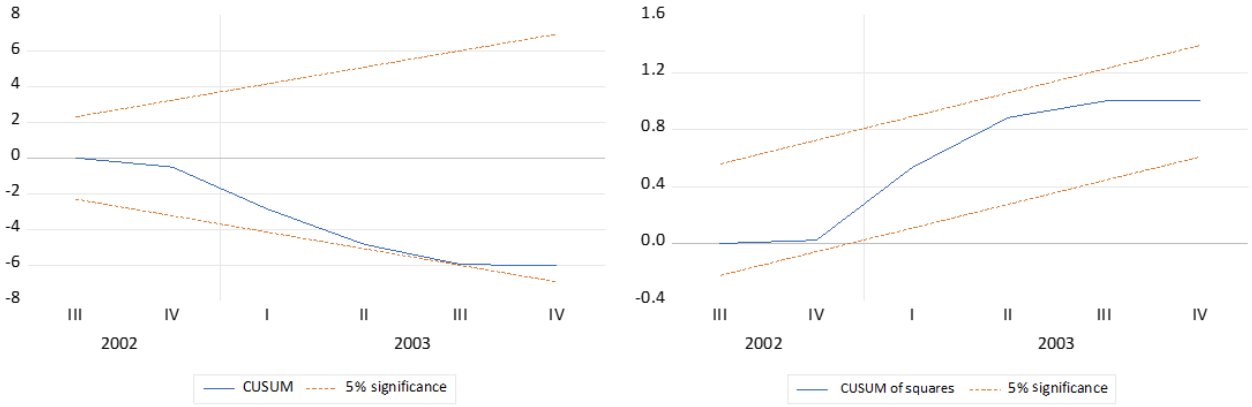

Figure 9. CUSUM and CUSUMSQ Thailand (1998-2003).

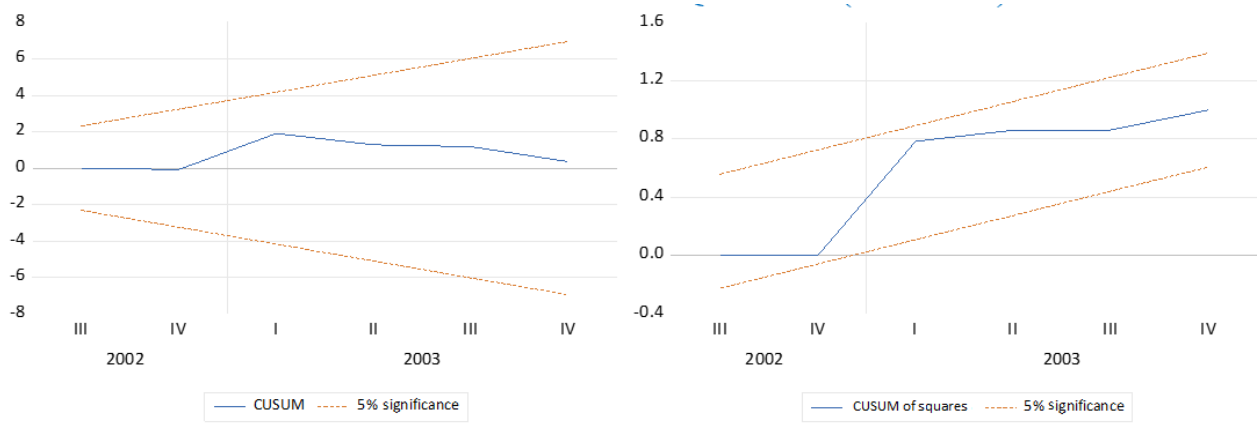

Figure 10. CUSUM and CUSUMSQ the Philippines (1998-2003).

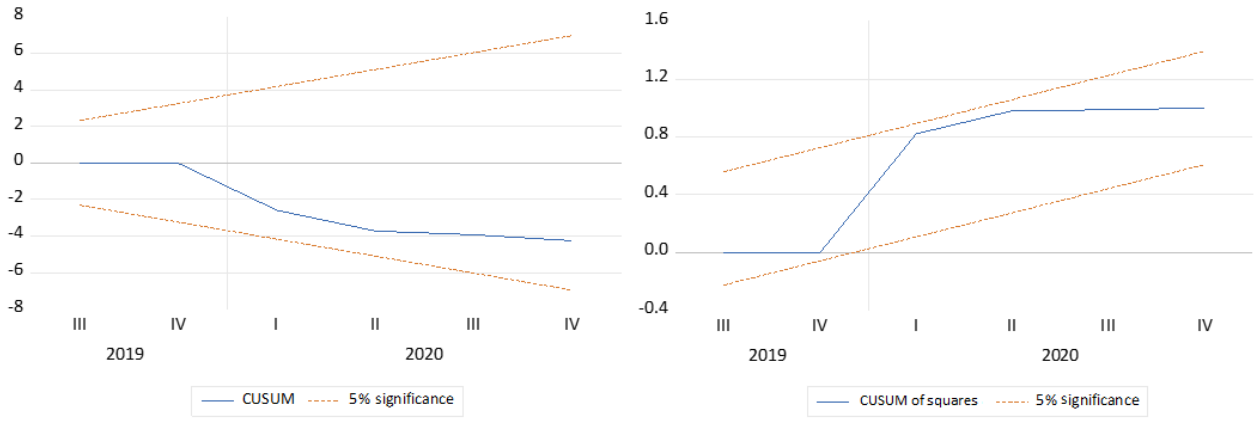

Figure 11. CUSUM and CUSUMSQ Indonesia (2008-2020).

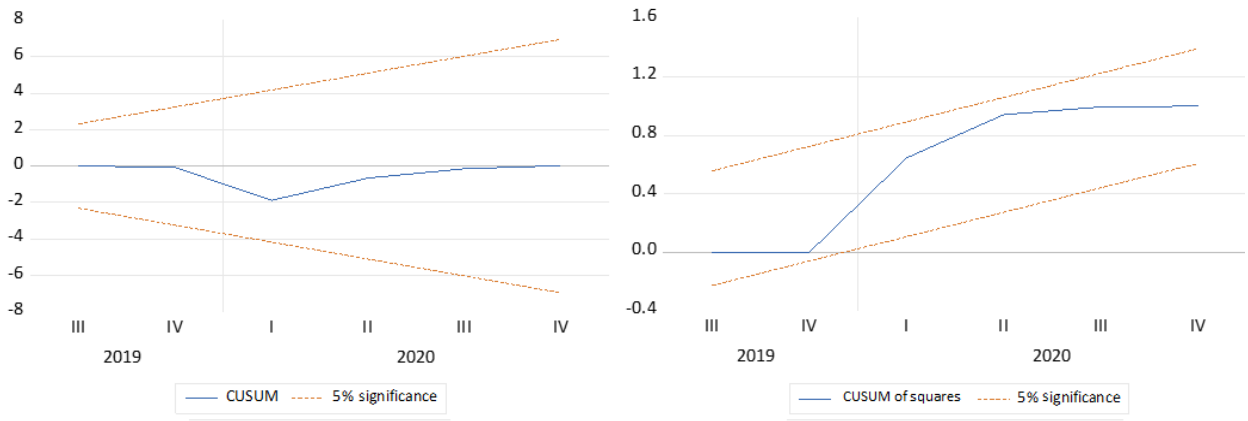

Figure 12. CUSUM and CUSUMSQ Malaysia (2008-2020).

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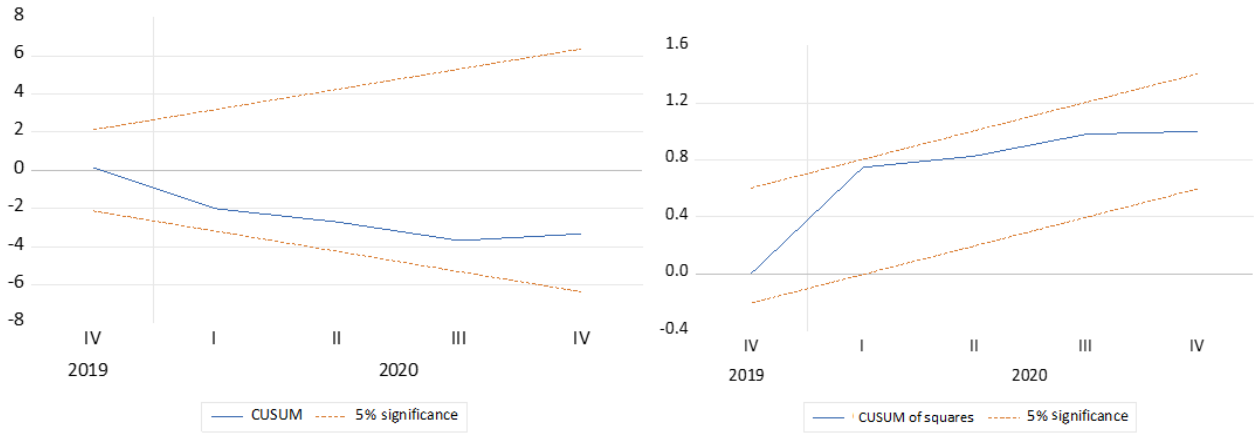

Figure 13. CUSUM and CUSUMSQ Singapore (2008-2020).

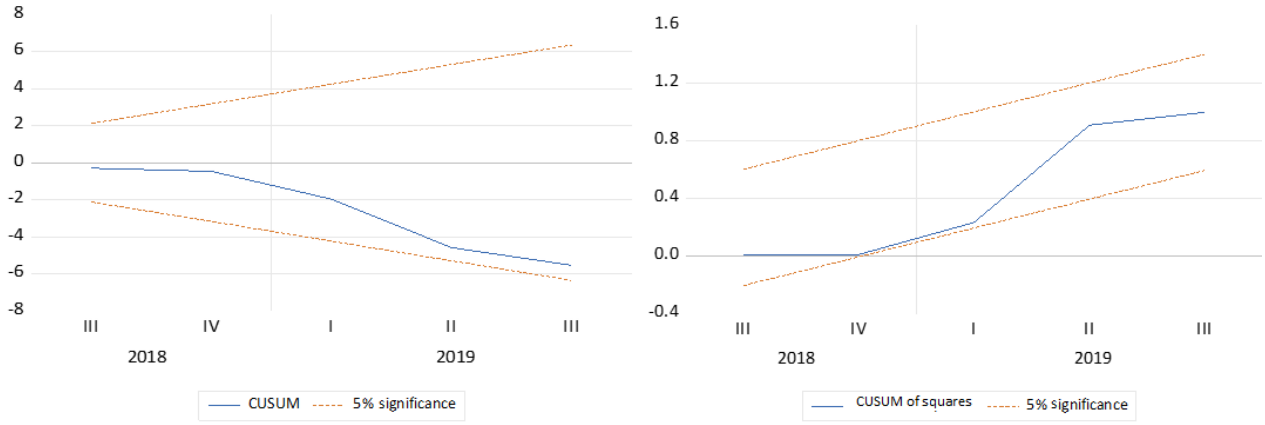

Figure 14. CUSUM and CUSUMSQ Thailand (2008-2020).

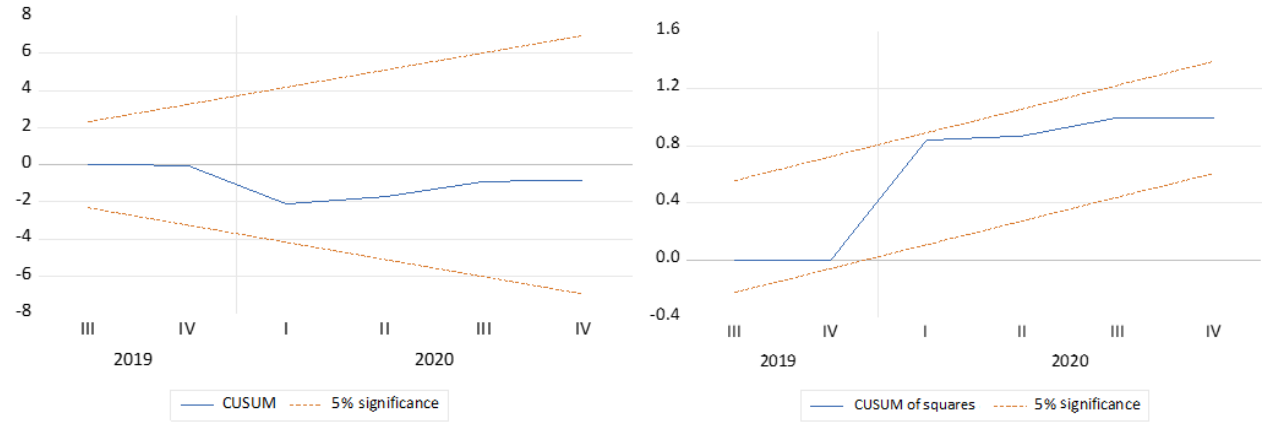

Figure 15. CUSUM and CUSUMSQ the Philippines (2008-2020).

5. CONCLUSION

The paper evaluates the relationship between economic growth and its determinants (i.e., inflation, unemployment, interest rate, and exchange rate) in five ASEAN countries. The results from the ARDL estimation reveal that (1) economic growth benefits from reducing inflation, interest rates, and exchange rates, underscoring their positive impact on development, and (2) elevated unemployment rates hinder economic growth. These findings offer valuable insights for policymakers, aiding informed decisions on managing inflation, unemployment, interest rates, and exchange rates to foster sustained economic development.

In an effort to promote economic growth, the main target of the government is controlling inflation. Therefore, the central bank can use interest rates as a monetary policy instrument to monitor the inflation rate (Taderera,

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Raynold, & Mishi, 2021) in order to maintain a low inflation rate. High interest rates plummet economic growth by reducing aggregate demand and encouraging savings. Next, vocational education and training should be provided to equip the workers with the right skills. In addition, the prioritization of financial and non-financial incentives for small and medium enterprises (SMEs). In addition, the exchange rate drives economic growth by improving trade balances. Policymakers should reinforce trade regulations and remove trade barriers to attract foreign direct investment. To conclude, the interaction between the government and central banks plays a vital role in stimulating economic growth.

The current study has several limitations that cannot be avoided. The sample study only involved five countries and five variables. Future studies can involve developed countries and developing countries to make a comparison. Also, some control variables (i.e., investment, exports, imports, interest rate, exchange rate, and so forth) were not included as well as supply-side variables (i.e., production cost, wages, and so forth). Apart from that, the study did not consider threshold inflation since economic growth varies according to a threshold level. A potential scope for future study would thus adopt appropriate threshold techniques to determine the effect of inflation levels on economic growth. Besides this, further study may expand the analysis of other relevant variables for economic growth.

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Institutional Review Board Statement: The Ethical Committee of the Sultan Idris Education University, Malaysia has granted approval for this study on 13 July 2021 (Ref. No. M20201000911).
Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
Data Availability Statement: Upon a reasonable request, the supporting data of this study can be provided by the corresponding author.
Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: Literature review, data analysis, and results discussion, E.E-L.T.; research design, methodology, conclusions, and the implications of the study, P-T.G.; methodology, F.S.A.H. and Z.Z. All authors have read and agreed to the published version of the manuscript.

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