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Business cycles in the US and five ASEAN countries: are they related?

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Abstract

Given the inter-country linkages arising from technological advances in communication and transportation, this paper examines the interdependent relationships between the output of the world's largest economy, the US, and those of five other ASEAN countries, namely, Indonesia, Malaysia, Philippines, Singapore and Thailand. Based on results of the augmented VAR of the Granger non-causality test, the paper finds a weak interdependence between the US and the five ASEAN countries, but a strong interdependence among the ASEAN countries. The empirical findings also revealed bi-directional causality among ASEAN countries especially Malaysia and Singapore. As such, every ASEAN country has to consider the economic developments and policies of other ASEAN countries as their decisions could affect one another.

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1. Introduction

In this information age, easier access to information, technologically improved communication channels and convenient transportation systems have virtually connected the different countries of the world. Fundamentally, an economy that is closely linked with the rest of the world is said to have greater opportunities for trade, economic development and growth. However, the threat of possible undesirable economic fluctuation is also inevitable. Like a plague, any adverse economic condition or implementation of economic policy by one country could be easily transmitted to another. It is therefore crucial to be aware of the economic condition of other economies, especially among trading partners, so that necessary precautionary measures can be taken to cushion against any negative impact on the economy.

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There have been several studies that examined how macroeconomic variables affect the output of a country. Some of these studies include those conducted by Masih and Masih [1996], Shan and Sun [1998], Doyle [2001], Caporale et al. [2002] and Hamori [2000]. Up till now, there has been a lack of empirical evidence on the interdependent relationship among countries' output, especially among developing countries. Therefore, this paper aims to unearth the interdependent relationships between the business cycles of the world's largest economy, the United States, and those of five Southeast Asian countries, namely, Malaysia, Singapore, Thailand, Indonesia and the Philippines.

Since problems may arise in statistical inference derived from vector autoregression (VAR) or vector error correction (VEC) models should there be errors in the process of unit root and cointegration test, we conduct our estimation through an augmented VAR procedure proposed by Toda and Yamamoto [1995]. This method is used as it guarantees the asymptotic distribution of the MWald statistic and does away with the problem of the coexistence of both a unit root and cointegration.

In the next sections of this paper, we review related literature, discuss the empirical techniques and data used, as well as analyze our empirical findings. Finally, we offer some concluding remarks.

2. Review of related literature

The effect of macroeconomic variables on the output of the country has been studied by Masih and Masih [1996], Shan and Sun [1998], Doyle [2001] and Caporale et al. [2002]. Masih and Masih [1996] investigated the causal relationships between real output, money (M1 and M2), interest rate, inflation rate and exchange rate in Thailand and Malaysia. They found that money supply, particularly M1, played the leading role among policy variables while output, interest rate, exchange rate and prices bore short-run endogenous adjustment in different proportions to re-establish long-run equilibrium. Money supply, M1, was found to be predominantly leading output and the other three endogenous variables, consistent with the Keynesian view (for Thailand) and the monetarist view (for Malaysia); this finding did not support the recent business cycle macroeconomics paradigm. However, Caporale et al. [2002] argued that previous studies had left out important monetary variables in their analysis. Using quarterly data of consumer price index, producer price index, money supply and the GDP of G7 countries, they established that producers' prices dominated over consumer prices, and the causality structure agreed with previous studies that there was a one-sided lag structure from producer to consumer prices.

On the other hand, the low level of savings in Australia was the concern of Shan and Sun [1998]. They feared that the low level of savings in Australia might cause low level of investment, leading to lower level of GDP growth. Shan and

Sun [1998] argued that lower savings would also cause higher current account deficit, resulting in a large inflow of foreign investment, thereby creating an increase in financial risk and higher interest rate premium. Hence, they investigated the nature of the causal relationship between domestic savings and foreign investment in Australia. Using the Granger causality test, Shan and Sun discovered that the direction of causality was from foreign investment to domestic savings in Australia and not the other way around.

In another causality study, the relationship between exports and output was examined by Doyle [2001]. Using the VAR causality approach introduced by Toda and Yamamoto [1995], Doyle found that there was bi-directional causality for Irish exports and output. Doyle found export and economic growth to be positively influencing each other and enhancing the Irish economic development during the sample period 1950-1997.

All the empirical studies cited above have examined how macroeconomic variables affected the output of a country but not the interdependency of the output between two countries. In a related study, Hamori [2000] explored the interdependent relationship of business cycles among four countries, namely Germany, Japan, the UK and the USA. The empirical findings obtained suggested that the economies of the individual countries under study moved independently and the interdependence among economies was weak. Nevertheless, causality from the US to Japan, and from Japan to Germany, was evident for the total sampling period.

3. Methodology

Our analysis requires data on the gross domestic product (GDP) of five ASEAN countries, namely, Malaysia, Singapore, Thailand, Indonesia and the Philippines, as well as the US for the sampling period 1966–1999. Annual data on GDP for US, Japan and all five ASEAN countries are sourced from the *International Financial Statistics*.

It has been well documented that macroeconomic time series are non-stationary in nature. Since a non-stationary time series does not have a long-run mean and the variance and covariance will exhibit time dependency, it is important for the series to be stationary to determine how the trend component of output could be removed and its cyclical component derived. In order to de-trend the series to obtain meaningful statistics, we apply the stochastic de-trending Hodrick and Prescott [1980] procedure (also known as HP filters) which involves solving the following inter-temporal optimization problem:

$$\text{Min}\sum_{t-1}^{T}\left\{\left(y_t-\tau_t\right)^2+\lambda\left[\left(1-L\right)^2\tau_t\right]^2\right\} \qquad (1)$$

where τ_t is the trend series to be de-trended, L is the usual lag-operator and lambda (λ) is a "smoothness" parameter whose value is set to 100 for annual data.

The empirical technique employed in this paper is the augmented VAR procedure introduced by Toda and Yamamoto [1995] and extended by Rambaldi and Doran [1996]. The advantage of this technique lies in its simplicity since it does not require the knowledge of the cointegration properties of the system (Zapata and Rambaldi [1997]). Moreover, this technique utilizes a modified WALD test for restrictions on the parameters of a VAR(r) or MWald procedure, where k is the lag length in the system, and can be computed by using Seemingly Unrelated Regression (SUR) form, as is shown by Rambaldi and Doran [1996]. Therefore, to perform the Granger non-causality test, we need to determine a lag length (k), and to estimate $(k + d_{\max})$ order of VAR formulated in levels where $d_{\max}$ is the maximum order of integration suspected to occur in the system.

In order to begin our analysis, we test for Granger non-causality analysis as proposed by Toda and Yamamoto [1995], in two stages: 1) among the five ASEAN countries to determine whether the countries have a common business cycle; and 2) to determine the effect of the US business cycle on the five ASEAN countries.

3.1. Five ASEAN countries

Our first set of estimation of the system of SUR is a VAR(3) where $k = 2$ and $d_{\max} = 1$ as follows :

$$\begin{bmatrix} YI_t \\ YM_t \\ YP_t \\ YS_t \\ YT_t \end{bmatrix} = A_0 + A_1 \begin{bmatrix} YI_{t-1} \\ YM_{t-1} \\ YP_{t-1} \\ YS_{t-1} \\ YT_{t-1} \end{bmatrix} + A_2 \begin{bmatrix} YI_{t-2} \\ YM_{t-2} \\ YP_{t-2} \\ YS_{t-2} \\ YT_{t-2} \end{bmatrix} + A_3 \begin{bmatrix} YI_{t-3} \\ YM_{t-3} \\ YP_{t-3} \\ YS_{t-3} \\ YT_{t-3} \end{bmatrix} + A_4 \begin{bmatrix} \varepsilon_{YI_t} \\ \varepsilon_{YM_t} \\ \varepsilon_{YP_t} \\ \varepsilon_{YS_t} \\ \varepsilon_{YT_t} \end{bmatrix} \qquad (2)$$

where: YI_t is the gross domestic product of Indonesia at time t; YM_t is the gross domestic product of Malaysia at time t; YP_t is the gross domestic product of the Philippines at time t; YS_t is the gross domestic product of Singapore at time t; YT_t is the gross domestic product of Thailand at time t; ε_t is the error term; A_1, A_2, A_3 are five times five matrices of coefficient and A_0 is an identity matrix.

To test the hypothesis that there is non-Granger causality from YM_t to YI_t, we test $H_0 : a_{12}^1 = a_{12}^2 = 0$, where a_{12}^i are coefficients of YM_{t-1} and YM_{t-2} in the first equation of the system stated above. A causality from YM_t to YI_t can be established by rejecting the above null hypothesis, which requires finding the significance of the MWald statistic for the group of the lagged independent variables identified above. Alternatively, the testing procedure can be applied to the alternative hypothesis that there is non-Granger causality from YI_t to YM_t by testing

$H_0 : a_{21}^1 = a_{21}^2 = 0$, where a_{21}^i are the coefficients of YI_{t-1} and YI_{t-2} in the second equation of the system. A similar testing procedure is repeated to test Granger non-causality for the remaining variables.

3.2. US *and five* ASEAN *countries*

Our second set of SUR system of equations is a VAR(2) as follows :

$$\begin{bmatrix} YI_t \\ YM_t \\ YP_t \\ YS_t \\ YT_t \\ YU_t \end{bmatrix} = A_0 + A_1 \begin{bmatrix} YI_{t-1} \\ YM_{t-1} \\ YP_{t-1} \\ YS_{t-1} \\ YT_{t-1} \\ YU_{t-1} \end{bmatrix} + A_2 \begin{bmatrix} YI_{t-2} \\ YM_{t-2} \\ YP_{t-2} \\ YS_{t-2} \\ YT_{t-2} \\ YU_{t-2} \end{bmatrix} + A_3 \begin{bmatrix} YI_{t-3} \\ YM_{t-3} \\ YP_{t-3} \\ YS_{t-3} \\ YT_{t-3} \\ YU_{t-3} \end{bmatrix} + A_4 \begin{bmatrix} \varepsilon_{YI_t} \\ \varepsilon_{YM_t} \\ \varepsilon_{YP_t} \\ \varepsilon_{YS_t} \\ \varepsilon_{YT_t} \\ \varepsilon_{YU_t} \end{bmatrix} \quad (3)$$

where YU_t is the gross domestic product of the US at time t.

In the same way, the non-Granger causality test for YU_t to YI_t is conducted for $H_0 : a_{16}^1 = a_{16}^2 = 0$, where a_{16}^1 is the coefficient of YU_{t-1} in the first equation of the system stated above. A causality from YU_t to YI_t can be established if the null hypothesis is rejected, which requires finding the significance of the MWald statistic for the lagged independent variable identified above. Alternatively, the testing procedure can be applied to the alternative hypothesis that there is non-Granger causality from YI_t to YU_t by testing $H_0 : a_{61}^1 = a_{61}^2 = 0$, where a_{61}^1 is the coefficient of YI_{t-1} in the sixth equation of the system. The testing procedure is repeated to test Granger non-causality for the remaining variables.

4. Empirical findings

In our Granger non-causality test, the true lag length (k) is chosen using the Schwart Bayesian Criterion (SBC) presented in Table 1. For our ASEAN five analysis, although the optimal lag length k=1, we have estimated the model using different lag structures, namely, lag 1, lag 2 and lag 3, to ensure that the results are robust or sturdy. The results from our estimation of the system of $VAR(\rho = d_{\max} + k = 2, \rho = d_{\max} + k = 3, \rho = d_{\max} + k = 4)$ and the computation of the MWald test statistics are presented in Table 2.

The results indicate that for VAR(2), the null hypothesis of Granger non-causality—from GDP of Malaysia to GDP of Indonesia and Singapore; GDP of the Philippines to GDP of Malaysia; GDP of Singapore to GDP of Indonesia and Malaysia; and GDP of Thailand to GDP of Singapore—can all be rejected at the 1% level. The GDPs of the Philippines, Singapore and Thailand are found to be influenced by their own GDPs for lag length 1 at the 1% level.

Table 1. The choice of true lag length (k) based on the SBC

*Nlag**	*SBC : ASEAN-5*
0	237.7743
1	243.3876**
2	230.3284
3	230.5485
*Nlag**	*SBC : ASEAN-5 and US*
0	318.4246
1	330.6198**
2	323.8247
3	325.0468

*Nlag is the number of lags used in VAR.

**largest value of SBC.

For VAR(3), at the 5% level, the null hypothesis of Granger non-causality—from GDP of Indonesia to GDP of Singapore; GDP of Malaysia to GDP of Indonesia and Singapore; GDP of Philippines to GDP of Indonesia and Malaysia; GDP of Singapore to GDP of Indonesia and Malaysia, as well as GDP of Thailand to GDP of Indonesia and Singapore—are all rejected. The GDPs of Indonesia, Philippines, Singapore and Thailand are affected by their own GDPs for lag 2 at the 1% level.

At the 5% level for the VAR(4) system, Granger non-causality is rejected for GDP of Indonesia to GDP of Philippines and Thailand; GDP of Malaysia to GDP of Indonesia, Singapore and Thailand; GDP of Philippines to GDP of Indonesia, Malaysia and Thailand; and GDP of Thailand to GDP of all the other four ASEAN countries. The GDP of Indonesia, the Philippines, Singapore and Thailand are affected by their own GDPs for lag length 3 at the 1% level.

Bi-directional causality is also evident for the GDP of Malaysia to Singapore for all lag lengths 1 and 2. In addition, bi-directional relationship is also found in the GDP of Singapore and Thailand for lag 1 at the 10% level; the GDP of Indonesia and Malaysia, and the GDP of Singapore and Indonesia for lag 2 at the 10% level; as well as the GDP for Indonesia and Philippines, and the GDP of Indonesia and Thailand for lag 3 at the 5% level.

As for the US and ASEAN five countries, our optimum lag length was $k = 1$. We have also estimated the model using lags 1 and 2 to ensure that the results are sturdy. Our estimation results of our system of $VAR(\rho = d_{\max} + k = 2,\ \rho = d_{\max} + k = 3)$ and the MWald test statistics are presented in Table 3.

Table 2. Granger non-causality tests for ASEAN-5

Explanatory variables (VAR(2))					
	Indonesia	*Malaysia*	*Philippines*	*Singapore*	*Thailand*
Indonesia	0.5044	9.3229	0.1583	5.7026	0.5811
	(0.4776)	(0.0022)	(0.6906)	(0.0169)	(0.4459)
Malaysia	1.0488	0.859	10.5993	7.6228	1.7933
	(0.3058)	(0.354)	(0.0011)	(0.0058)	(0.1805)
Philippines	0.3216	0.487	13.6387	0.1304	0.1612
	(0.5706)	(0.485)	(0.0002)	(0.7181)	(0.6880)
Singapore	0.6638	4.543	0.3882	64.7796	6.7555
	(0.4152)	(0.033)	(0.5329)	(0.0000)	(0.0093)
Thailand	0.0496	3.375	1.2674	2.7568	28.8362
	(0.8237)	(0.066)	(0.2603)	(0.0968)	(0.0000)
Explanatory variables (VAR(3))					
	Indonesia	*Malaysia*	*Philippines*	*Singapore*	*Thailand*
Indonesia	10.6903	26.4664	17.8902	15.8403	11.8465
	(0.0048)	(0.0000)	(0.0001)	(0.0004)	(0.0027)
Malaysia	5.4748	1.3718	16.0008	8.4605	5.5690
	(0.0647)	(0.5037)	(0.0003)	(0.0146)	(0.0618)
Philippines	1.9062	0.9520	11.8324	1.5327	0.9973
	(0.3855)	(0.6213)	(0.0027)	(0.4647)	(0.6073)
Singapore	6.9886	14.4972	1.7016	41.5803	37.4135
	(0.0304)	(0.0071)	(0.4271)	(0.0000)	(0.0000)
Thailand	0.5294	2.3294	3.3270	0.0520	21.7564
	(0.7674)	(0.3120)	(0.1895)	(0.9743)	(0.0000)
Explanatory variables (VAR(4))					
	Indonesia	*Malaysia*	*Philippines*	*Singapore*	*Thailand*
Indonesia	22.1574	11.4902	17.7874	5.1675	10.9062
	(0.0001)	(0.0094)	(0.0005)	(0.1599)	(0.0122)
Malaysia	3.7083	2.9539	17.1597	1.6263	12.8831
	(0.2947)	(0.3988)	(0.0007)	(0.6534)	(0.0049)
Philippines	17.8715	5.9635	29.5488	4.1436	9.8942
	(0.0005)	(0.11334)	(0.0000)	(0.2464)	(0.0195)
Singapore	4.5444	27.0427	5.2893	42.8189	24.7869
	(0.2084)	(0.0000)	(0.1518)	(0.0000)	(0.0000)
Thailand	26.9438	12.2199	11.8822	5.6607	34.2918
	(0.0000)	(0.0067)	(0.0078)	(0.1293)	(0.0000)

Notes :

1) Numbers in parentheses show the *p*-value associated with the MWald-test.

2) Column headers refer to explained variables while row headers refer to explanatory variables.

Table 3. Granger non-causality tests for ASEAN-5 and the US

Explanatory variables (VAR(2))						
	Indonesia	*Malaysia*	*Philippines*	*Singapore*	*Thailand*	*US*
Indonesia	6.706	13.331	0.234	17.822	5.363	0.497
	(0.001)	(0.000)	(0.628)	(0.000)	(0.021)	(0.481)
Malaysia	0.142	0.629	7.834	4.170	3.738	2.034
	(0.706)	(0.428)	(0.005)	(0.041)	(0.053)	(0.154)
Philippines	0.730	0.373	14.895	0.000	0.644	0.500
	(0.393)	(0.541)	(0.000)	(0.997)	(0.422)	(0.479)
Singapore	1.383	4.435	0.497	43.719	6.375	1.767
	(0.240)	(0.035)	(0.481)	(0.000)	(0.012)	(0.184)
Thailand	0.254	3.233	1.328	1.214	23.780	0.759
	(0.614)	(0.072)	(0.249)	(0.271)	(0.000)	(0.384)
US	4.276	14.967	0.049	1.381	6.524	8.010
	(0.039)	(0.000)	(0.944)	(0.240)	(0.011)	(0.005)
Explanatory variables (VAR(3))						
	Indonesia	*Malaysia*	*Philippines*	*Singapore*	*Thailand*	*US*
Indonesia	9.351	26.087	17.525	20.426	14.570	2.863
	(0.009)	(0.000)	(0.000)	(0.000)	(0.001)	(0.239)
Malaysia	3.274	1.624	19.331	3.642	3.888	4.241
	(0.194)	(0.444)	(0.000)	(0.162)	(0.143)	(0.120)
Philippines	2.710	0.776	15.343	1.162	2.101	3.960
	(0.258)	(0.678)	(0.000)	(0.559)	(0.350)	(0.138)
Singapore	2.971	12.930	0.946	34.619	19.887	0.357
	(0.226)	(0.002)	(0.623)	(0.000)	(0.000)	(0.836)
Thailand	0.431	2.938	2.727	0.029	14.393	0.919
	(0.806)	(0.230)	(0.256)	(0.986)	(0.001)	(0.632)
US	32.718	32.704	10.232	8.670	13.548	5.283
	(0.000)	(0.000)	(0.001)	(0.013)	(0.001)	(0.071)

Notes:

1) Numbers in parentheses show the *p*-value associated with the MWald-test.

2) Column headers refer to explained variables while row headers refer to explanatory variables.

For VAR(2) and VAR(3), the null hypothesis is rejected at the 5% level for Granger non-causality from GDP of Indonesia to GDP of the US; GDP of Malaysia to GDP of Indonesia, Singapore, and the US; GDP of Philippines to GDP of Malaysia; GDP of Singapore to GDP of Indonesia; GDP of Thailand to GDP of Indonesia, Singapore and the US. At the 5% level, the GDP of Malaysia is influenced by the GDP of Singapore at lag 1, while the GDP of the Philippines affects the GDP of Indonesia, and the GDP of the US is affected by the GDP of the Philippines and Singapore at lag 2.

The GDP of Indonesia, Philippines, Singapore and Thailand are discovered to be affected by their own GDPs at lags 1 and 2 at the 5% level, while the GDP of the US is affected by its own GDP at lag 1 at the 5% level. However, there is bi-directional causality for lag 1 only for GDP of Malaysia and Singapore at 5% level, as well as GDP of Malaysia and Thailand at the 10% level.

5. Concluding remarks

This paper investigated the interdependent relationship of business cycles among five ASEAN countries and the US using the augmented VAR of the Granger non-causality test developed by Toda and Yamamoto [1995]. The results suggested that there was strong interdependence among the economies of ASEAN countries and this was further strengthened by the evidence of bi-directional causality among trading and neighboring countries like Malaysia and Singapore.

Analyzing the GDPs of US and ASEAN countries, the results revealed a weak interdependency between US and ASEAN output at lag 1 and no bi-directional causality at lag 2. However, the output of all five ASEAN countries did have a significant impact on the output of the US at lag 2 at the 5% level.

The empirical findings also indicated strong evidence of interdependency among the five ASEAN countries studied, revealing a common business cycle. An important implication of this result is that having similar business cycles would accommodate an optimal response to a common monetary policy. In short, the findings point to the possibility of a common currency area in the ASEAN region.

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