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A Panel Cointegration Analysis: An Application to South East Asia Macroeconomic Recessions

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Abstract

This paper sought to find the long-run relationships among of macroeconomic variables such as GDP, interest rate, money supply, exchange rate and consumer price index for the period of *1996 to 2008*. During recessions and a bear stock market the crisis fluctuate from America to Europe, and Asia. This paper used the standard panel unit root tests such as LLC (2002) panel unit root test, Breitung (2000) panel unit root test, IPS (2003) panel unit root test, Maddala and Wu (1999) and Choi (2001) panel unit root test and Handri (1999) panel unit root test. Moreover, the panel cointegration test based on Kao residual cointegration tests was used to test in panel among the variables. The Random-effects ML regression and The Random-effects GLS regression were also used to find better solutions in terms of the long-run relationship among of macroeconomic variables during economic recessions. This paper presents the empirical results regarding long-run results indicated that money supply in selected South East Asia countries (Malaysia, Philippines, Thailand, Vietnam, Cambodia and Lao) have a positive influence on GDP. In addition, the exchange rate of those countries has negative impact on GDP. The findings were consistent with its applications in these areas. Consequently, the theoretical framework of economic theory shows macroeconomic movement consistent with the hypothesis for a set of macroeconomic variables.

Keywords: Macroeconomic variables; South East Asia; Recession; Panel unit root test; Panel cointegration test; Long-run relationship.

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1. Introduction

The Asian Financial Crisis was a period of financial crisis that gripped much of Asia beginning in July 1997. This crisis that stared in Thailand also affected its neighbors such as the Philippines, Indonesia, Singapore and South Korea (Lim and McAleer,2001). Another effect of the economic crisis in 1997 was the decreasing GDP of Thailand from 1997 to 2001. Indonesia, South Korea and Thailand were the countries most affected by the crisis. Hong Kong, Malaysia, Laos and the Philippines were also hurt by the slump. The People's Republic of China, India, Taiwan, Singapore, Brunei and Vietnam were less affected, although all suffered from a loss of demand and confidence throughout the region. Between 1997 and 2006, the price of the typical American house increased by 124% (*United States housing bubble*, *2008)*. During the two decades ending in 2001, the national median home price ranged from 2.9 to 3.1 times median household income. This ratio rose to 4.0 in 2004, and 4.6 in 2006. This housing bubble resulted in quite a few homeowners refinancing their homes at lower interest rates, or financing consumer spending by taking out second mortgages secured by the price appreciation. Consequently, the financial crisis of 2007 has already to present and the United States and world economy have a lot of problem from this case such as collapse of large financial institutions in US, downturns in stock markets around the world, declines in consumer confident around the world, decline in economics activity around the world and significant risks remain for the world economy over the 2010-2011 periods. Moreover, the United Nations Conference on Trade and Development report that the third world or the developing countries were affected from this crisis such as the rise in food prices, the instability of international financial, High fuel costs and they are worrying about global recession will be happened. Uncertainty and instability in international financial, currency and commodity markets, coupled with doubts about the direction of monetary policy in some major developed countries, are contributing to a gloomy outlook for the world economy and could present considerable risks for the developing world (The UN Conference on Trade and Development (UNCTAD)). Based on information above, the aim of this research focus on how many factors affect to GDP of South East Asia countries (Malaysia, Philippines, Thailand, Vietnam, Cambodia and Lao) during period of Global Economic Recession (1996-2008) in the long-run based on panel cointegrationa analysis. And the empirical results from this research were used to suggest the valuable of policy recommendation to these countries during period of future Global Economic Recession.

2. Research Aim and Objective

This research aimed to determine how various factors affect to GDP of South East Asia countries (Malaysia, Philippines, Thailand, Vietnam, Cambodia and Lao) during period of Global Economic Recession (1996-2008) in the long-run and to use these various factors suggest the valuable of policy recommendation to these countries during period of future Global Economic Recession.

3. Scope of this research

This research focuses on during period of 1996 to 2008. Most of the data was used in this research as secondary data and also the countries under analysis are South East Asia countries (Malaysia, Philippines, Thailand, Vietnam, Cambodia and Lao). The variables were used in this research such as the GDP of them, the interest rate of them, the money supply of them, the exchange rate of them and the consumer price index of them.

4. The research framework and methodology analysis

4.1 The framework of macroeconomics model

In framework of Gordon and King (1982), Masih(1995, 1996) and Hondroyannis (2000) have examined the causal relationship among macroeconomic variables for various countries and time periods. Moreover, Dritsaki and Adamopoulos (2005) also have examined the causal relationship among macroeconomics variables for European Union such as output, money supply, inflation, interests rate and exchange rates. However, based on above of literature this research focus on the causal relationships among GDP and other macroeconomics variables of South East Asia countries (Malaysia, Philippines, Thailand, Vietnam, Cambodia and Lao) during period of Global Economic Recession (1996-2008). (See equation 1A and 2A).

$$GDP_t = f(Ir_t, M1_t, Er_t, CPI_t) \quad \text{---------- (1A)}$$

Definitions:

GDP_t = is a GDP at time t;
Ir_t = is a interest rate at time t;
$M1_t$ = is a money supply at time t;
Er_t = is a exchange rate at time t ;
CPI_t = is a consumer price index at time t;

Based on panel cointegrariong analysis this research needs to modify equation (1A) to be equation (2A) for estimation.

$$\ln GDP1_{it} = \square + \square \ln(Ir_{it}) + \square\square \ln(M1_{it}) + \square\square\square \ln(Er_{it}) + \sigma \ln(CPI_{it}) + u_{it} \quad \text{---(3A)}$$

where

i = cross-section-data (the number of country in South East Asia countries)
t = time series data
$\ln(GDP1_{it})$ = logarithm of GDP of South East Asia countries (the number i at time t);

$\ln(Ir_{it})$ = logarithm of interest rate of South East Asia countries (the number i at time t);
$\ln(M1_{it})$ = logarithm of money supply of South East Asia countries (the number i at time t);
$\ln(Er_{it})$ = logarithm of exchange rate of South East Asia countries (the number i at time t) ;
$\ln(CPI_{it})$ = logarithm of consumer price index of South East Asia countries (the number i at time t) ;
u_{it} = independently distributed random error term, with zero mean and constant variance (the number i at time t) ;

4.2 Panel Unit-Root Tests

Recent literature suggests that panel-based unit root tests have higher power than unit root tests based on individual time series. See Levin, Lin and Chu (2002), Im, Persaran and Shin (2003), and Breitung (2000) which mention test purchasing power parity (PPP) and growth convergence in macro panels using country data over time. This research focused on five types of panel unit root tests such as Levin, Lin and Chu (2002), Breitung (2000), Im, Pesaran and Shin (2003), Fisher-Type test using ADF and PP-test (Maddala and Wu (1999) and Choi (2001), Hadri (1999). These method also see more detail in Chukiat, Prasert, N. Rangaswamy. (2008) and Songsak(2010).

4.3 Panel Cointegration Test

Kao (1999) uses both DF and ADF to test for cointegation in panel as well as this test similar to the standard approach adopted in the EG-step procedures. Also this test starts with the panel regression model as set out in equation 20I.

$$Y_{it} = X_{it}ß_{it} + Z_{it}□_0 + □_{it} \quad \text{---------- (20I)}$$

where Y and X are presumed to be non-stationary and :(see equation 21I)

$$e^{\wedge}_{it} = \rho e^{\wedge}_{it} + □□□_{it} \quad \text{---------- (21I)}$$

where $e^{\wedge}_{it} = (Y_{it} - X_{it}ß^{\wedge}_{it} - Z_{it}□^{\wedge})$ are the residuals from estimating equation 20I. To test the null hypothesis of no cointegrarion amounts to test $H_0 : \rho = 1$ in equation 21I against the alternative that Y and X are conitegrated(i, e., $H_1 : \rho < 1$). Kao(1999) developed both DF-Type test statistics and ADF test statistics were used to test cointegration in panel also both DF-Type(4 Type) test statistics and ADF test statistics can present below that:

$$DF_\rho = \frac{\sqrt{N}T(\hat{\rho}-1)+3\sqrt{N}}{\sqrt{51/5}},$$

$$DF_t = \sqrt{\frac{5t_\rho}{4}}+\sqrt{\frac{15N}{8}}.$$

$$DF_\rho^* = \frac{\sqrt{N}T(\hat{\rho}-1)+\frac{3\sqrt{N}\hat{\sigma}_v^2}{\hat{\sigma}_{0v}^2}}{\sqrt{3+\frac{36\hat{\sigma}_v^4}{5\hat{\sigma}_{0v}^4}}},$$

$$DF_t^* = \frac{t_\rho+\frac{\sqrt{6N}\hat{\sigma}_v}{2\hat{\sigma}_{0v}}}{\sqrt{\frac{\hat{\sigma}_{0v}^2}{2\hat{\sigma}_v^2}+\frac{3\hat{\sigma}_v^2}{10\hat{\sigma}_{0v}^2}}},$$

$$ADF = \frac{t_{ADF}+\sqrt{6N}\hat{\sigma}_v/2\hat{\sigma}_{0u}}{\sqrt{\hat{\sigma}_{0v}^2/2\hat{\sigma}_v^2+3\hat{\sigma}_v^2/10\hat{\sigma}_{0v}^2}}$$

where

N	=	cross-section data
T	=	time series data
$\rho^{\wedge}$	=	co-efficiencies of 21I
t_ρ	=	$[(\rho^{\wedge}-1)\sqrt{(\square^{N}_{i=1}\square^{T}_{t=2}e^{\wedge *2}_{i\,t-1})}]/Se$
Se	=	$(1/NT)\square\square^{N}_{i=1}\square^{T}_{t=2}(e^{\wedge *}_{i\,t}-\rho^{\wedge}e^{\wedge *}_{i\,t-1})^2$
$\sigma_u^{\wedge 2}$	=	variance of u
$\sigma_v^{\wedge 2}$	=	variance of v
$\sigma_u^{\wedge}$	=	standard deviation of u
$\sigma_v^{\wedge}$	=	standard deviation of v
t_{ADF}	=	$[(\rho^{\wedge}-1)(\square^{N}_{i=1}(e/Q_i e_i))^{1/2}]/S_v$

4.4 Model selection for panel data analysis

4.4.1 The Breusch–Pagan Test (LM-Test)

This method test has first proposed by Breusch and Pagan (1980) and they have derived a Lagrange multiplier (LM) test to test by define hypothesis testing is shown in equation (22 I1).

$$\text{Ho: } \sigma_{\mu}^2 = \sigma_{\lambda}^2 = 0 \qquad \text{---------- (22I1)}$$

The loglikelihood function under normality of the disturbances is given by equation (22I2) as

$$L(\delta,\theta) = const - \tfrac{1}{2}\log|\Omega| - \tfrac{1}{2}\mu'\Omega^{-1}\mu \qquad \text{---------- (22I2)}$$

where

$$\theta' = (\sigma_{\mu}^2 = \sigma_{\lambda}^2 = \sigma_{v}^2)$$

$$\Omega = \sigma_{\mu}^2(I_N \otimes J_T) + \sigma_{\lambda}^2(J_N \otimes I_T) + \sigma_{v}^2 I_{NT}$$

The information matrix is block-diagonal between δ and θ as well as H_0 involves only θ, the part of the information matrix due to δ is ignored. And Breusch and Pagan (1980) have already used LM –Test to test the random effect model based on concept of time specific do not exist.

4.4.2 The Hausman Test for correlated random effects model

The Hausman Test for correlated random effects has already first proposed by Hausman in 1978 and this method test has the assumption that random effects are uncorrelated with the explanatory variables. And also this method to test between the fixed effect model and random effect model. Hausman test statistics is given by equation (22I3) and also it can be explained by this equation below that:-

$$M_1 = \hat{q}_1' [\text{var}(\hat{q}_1)]^{-1} \hat{q}_1 \qquad \text{---------- (22I3)}$$

where

$$\hat{q}_1 = \hat{\beta}_{GLS} - \hat{\beta}_{Within}$$

$$\text{var}(\hat{q}_1) = \text{var}(\hat{\beta}_{Within}) - \text{var}(\hat{\beta}_{GLS})$$

And under H_0 is asymptotically distributed as χ_K^2 where K denotes the dimension of slope vector β.

4.5 Estimating panel cointegration model

The various (casually single equation) approach for estimating a cointegration vector using panel data such as the Pedroni (2000,2001) approach, the Chiang and Kao (2000,2002) approach and the Breitung (2002) approach. The various estimators available include with-and between-group such as OLS estimators, fully modified OLS (FMOLS) estimators and dynamic OLS estimators. FMOLS is a non-parametric approach to dealing with corrections for serial correlation while OLS and DOLS are a parametric approach which DOLS estimators include lagged first-differenced term are explicitly estimated. These method also see more detail in Chukiat, Prasert, N. Rangaswamy. (2008) and Songsak(2010).

4.5.1 The Random-effects GLS regression with panel data analysis

The Generalized Least Squares (GLS) regression with panel data analysis will be started from equation (22I4)

$$y_{it} = x_{it}\beta + \alpha_i + u_{it}, \quad \text{---------- (22I4)}$$

where

y_{it} is the dependent variable,

x_{it} is the vector of regressors,

β is the vector coefficients,

α_i are the random effects, then α_i should have a normal distribution with

mean zero and a constant variance.

u_{it} is the error term,

The coefficients of GLS estimator can be estimated via (see equation 22I5)

$$\begin{aligned} \widehat{\beta} &= (X'\Omega^{-1}X)^{-1}(X'\Omega^{-1}Y), \quad \text{---------- (22I5)} \\ \widehat{\Omega} &= \mathrm{I} \otimes \Sigma, \end{aligned}$$

where X and Y are the matrix version of the independent variable and the dependent variable, respectively, I as an identity matrix, Σ as the variance of u_{it} and α,[*clarification needed*] $\otimes$ is the Kronecker product, and Ω is the variance-covariance matrix.

4.5.2 The Random-effects ML(Maximum likelihood) regression with panel data analysis

Under normality of the disturbances, it can be written the likelihood function as equation (22I6)

$$L(\alpha, \beta, \phi^2, \sigma_v^2) = const - \frac{NT}{2}\log\sigma_v^2 + \frac{N}{2}\log\phi^2 - \frac{1}{2\sigma_v^2}\mu'\sum^{-1}\mu \text{ ----- (22I6)}$$

where

$$\hat{\alpha}_{mle} = \bar{y}_{..} - \bar{x}_{..}^{/} \hat{\beta}_{mle}$$

$$\hat{\sigma}^2_{v,mls} = (1/NT)\hat{\mu}^{/} \sum^{\wedge -1} \hat{\mu}$$

$$\hat{\alpha}_{mle} = \bar{y}_{..} - \bar{x}_{..}^{/} \hat{\beta}_{mle}$$

$$\hat{\phi}^2 = \frac{\sum\sum\left(d_{it} - \bar{d}_i\right)^2}{T(T-1)\sum(\bar{d}_{i.} - \bar{d}_{..})^2}, d = y - x\hat{\beta}_{mle}$$

$$\hat{\beta}_{mle} = \left[x^{/}(Q + \phi^2(p - \overline{J_{NT}}))x\right]^{-1} x'[Q + \phi^2(p = \bar{J}_{NT})]y$$

This research focused on the Random-effects GLS regression analysis, The Random-effects ML(Maximum likelihood) regression and FMOLS regression analysis to estimating panel cointegration for the causal relationships among GDP and other macroeconomics variables of South East Asia countries (Malaysia, Philippines, Thailand, Vietnam, Cambodia and Lao) during period of Global Economic Recession (1996-2008).

5. The empirical results of the research

5.1 The empirical results of the panel unit root test

This research used the panel unit root test of the variables by five standard method tests for panel data including Levin, Lin and Chu (2002), Breitung (2000), Im, Pesaran and Shin (2003), Fisher-Type test using ADF and PP-test (Maddala and Wu (1999) and Choi (2001)) and Hadri (1999). Table 1 present the results of the panel unit root tests based on the five methods test for all variables were used in Macroeconomics Model of the selected South East Asia countries. The Levin, Lin and Chu (2002) method test indicate that $lnGDP_{it}$ and $lnCPI_{it}$ are at the level of insignificance and all of them have unit root. The Breitung (2000) method test indicate that $lnGDP_{it}$, $lnM1_{it}$, $lnIr_{it}$ and $lnEr_{it}$ are at the level of insignificance and all of them have unit root. The Im, Pesaran and Shin (2003) method test indicate that $lnGDP_{it}$, $lnM1_{it,}$ $lnCPI_{it}$ and

$lnEr_{it}$ have a unit root. Maddala and Wu (1999) and Choi (2001) method based on ADF-Fisher Chi-square test indicate that $lnGDP_{it}$, $lnM1_{it}$ $lnCPI_{it}$ and $lnEr_{it}$ have a unit root. And also Maddala and Wu (1999) and Choi (2001) method based on PP-Fisher Chi-square test indicate that $lnGDP_{it}$, $lnM1_{it}$, $lnIr_{it}$ and $lnEr_{it}$ have unit root. The Hadri (1999) method test indicates that $lnGDP_{it}$, $lnM1_{it}$, $lnIr_{it}$, $lnCPI_{it}$ and $lnEr_{it}$ have a unit root because this method has a null hypothesis of no unit root. From the results of the panel unit root test, it can be concluded that most variables were used in this model have unit root. So all variables should be take first differing as well as after first differing in all variables then the results of the panel unit root test based on five methods are presented in table 2. The Levin, Lin and Chu (2002) method test indicate that lnGDPit, $lnM1_{it}$, $lnIr_{it}$ and $lnEr_{it}$ are at the level of significance for rejecting the null hypothesis of a unit root. The Breitung (2000) method test indicates that $lnIr_{it}$ is at the level of significance for reject the null hypothesis of a unit root. The Im, Pesaran and Shin (2003) method test indicate that $lnGDP_{it}$, $lnM1_{it}$, $lnIr_{it}$ and $lnEr_{it}$ are at the level of significance for rejecting the null hypothesis of a unit root. The Maddala and Wu (1999) and Choi (2001) method based on both ADF-Fisher Chi-square test and PP-Fisher Chi-square test indicated that $lnGDP_{it}$, $lnM1_{it}$, $lnIr_{it}$ and $lnEr_{it}$ are at the level of significance for rejecting the null hypothesis of a unit root. The Hadri (1999) method test indicated that $lnGDP_{it}$, $lnM1_{it}$, $lnIr_{it}$, lnCPI, and $lnEr_{it}$ have a unit root because this method has a null hypothesis of no unit root (see more detail in table 2).

5.2 The empirical results of panel cointegration test

Table 3 present the results of the panel cointegration test in among macroeconomic variables of South East Asia countries (Malaysia, Philippines, Thailand, Vietnam, Cambodia and Lao) during period of Global Economics Recession (1996-2008) based on Kao Residual Cointegration Tests. And this method was used to test for those macroeconomic variables indicate that all variables were used to test are level of significant for rejecting the null hypothesis (no cointegration). The empirical results imply that all variables were used to test have cointegration with each other.

5.3 The empirical results of model selection for panel cointegration analysis

Table 4 present the results test of model selection for panel cointegration analysis of the selected South East Asia countries (Malaysia, Philippines, Thailand, Vietnam, Cambodia and Lao). Panel data model analyzes one amongst fixed effect, random effect or common effect models. The Breusch and Pagan Lagrangian multiplier test and Hausman test have determined which of these models to be used. In this

research fixed effects analysis, random effects analysis and common effects analysis are separately applied. Through LM test, the result from table 4 has already confirmed that Random effect model to be used. In addition, through Hausman test the results from same table also has already confirmed that Random effect model to be used too.

5.4 The empirical results of estimating panel cointegration model

Table 5 and Table 6 present the results of the long-run relationship between $lnGDP_{it,}$ and other
Macroeconomic variables ($lnIr_{it}$, $lnM1_{it}$, and $lnEr_{it}$) of the selected South East Asia countries (Malaysia, Philippines, Thailand, Vietnam, Cambodia and Lao) based on Random-effects ML regression estimator, Random-effects GLS regression estimator and FMOLS-estimator. The empirical results of the long-run relationship between $lnGDP_{it,}$ and other Macroeconomic variables ($lnIr_{it}$, $lnM1_{it}$, and $lnEr_{it}$) of the selected South East Asia countries are presented in table 5. All exogenous variables appear with the correct sign in model to estimate. Clearly, Money Supply ($lnM1_{it}$) of the selected South East Asia countries and exchange rate of the selected South East Asia countries have relationship with the Gross Domestics Product of them based on the Random-effects ML regression analysis, Random-effects GLS regression analysis and FMOLS-analysis.

In six countries(Malaysia, Philippines, Thailand, Vietnam, Cambodia and Lao) as in long-run base on Random-effects ML regression analysis, Random-effects GLS regression analysis and FMOLS-analysis to estimating panel cointegration model suggested that Money Supply ($lnM1_{it}$) has positive impact on the Gross Domestics Product of these country at both 1 and 2 percent significance level. Moreover, in six countries (Malaysia, Philippines, Thailand, Vietnam, Cambodia and Lao) as in long-run base on Random-effects ML regression analysis, Random-effects GLS regression analysis and FMOLS-analysis to estimating panel cointegration model suggested that Exchange Rate ($lnEr_{it}$) has negative impact on the Gross Domestics Product of these country at 1 percent significance level. Interns of individual FMOLS-analysis to estimating panel cointegration model suggested that all exogenous variables appear with both the correct sign and incorrect sign in model to estimate.

6. The conclusions of research and policy recommendations

This paper also has two important conclusions and recommendations that emerge from the empirical analysis of this research. Firstly, if Money Supply (lnM1) of the selected South East Asia countries (Malaysia, Philippines and Vietnam) increases then it leads to an increase the Gross Domestics Product of them as well. This result is consistent with economics theory (is more consistent with Keynesian and monetaristic theory) and it was similar to the results of previous empirical studies about a casual relationship and macroeconomics activity of European Union (Dritsaki and Adamopoulos, 2005). If these results can be generalized for future years (especially during period of future Global Economics Recession), then it argues well to use monetary policy for recovering the economy of those country to move forward and growth up again.

And secondly, if the Exchange Rate (lnEr) of the selected South East Asia countries (Malaysia, Philippines, Thailand and Cambodia) has a strong value more than foreign currency then it leads to decrease the Gross Domestics Product of them as well. This result was similar to the results of previous empirical studies about a casual relationship and macroeconomic activity of European Union (Dritsaki and Adamopoulos, 2005). And also at the time of the mid-1990s, Thailand, Indonesia and South Korea had large private current account deficits and the maintenance of fixed exchange rates (the exchange rate has a strong value more than real exchange rate) encouraged external borrowing and led to excessive exposure to foreign exchange risk in both the financial and corporate sectors. If these results can be generalized for future years (especially during period of future Global Economics Recession), then it argues well to use international monetary policy for recovering the economy of those country to move forward and growth up again.

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Table 1: Results of panel unit root tests based on 5 method tests for all variables

Method test	Test statistic	Significance level for rejection
Null : unit root (assumes common unit root process)		
Levin,Lin and Chu (2002) t*- Statistics		
1. $lnGDP_{it}$	-0.72979	0.2328
2. $lnM1_{it}$	-1.76026	0.0392
3. $ln\ Ir_{it}$	-4.39338	0.0000
4. $lnCPI_{it}$	8.53747	1.0000
5. $lnEr_{it}$	-2.12265	0.0169
Breitung(2000) t*-Statistics		
1. $lnGDP_{it}$	2.57679	0.9950
2. $lnM1_{it}$	3.77915	0.9999
3. $ln\ Ir_{it}$	-0.13958	0.4445
4. $lnCPI_{it}$	-2.32919	0.0099
5. $lnEr_{it}$	0.02062	0.5082
Null : unit root (assumes individual unit root process)		
Im, Pesaran and Shin (2003) W-Statistics		
1. $lnGDP_{it}$	2.16466	0.9848
2. $lnM1_{it}$	1.38853	0.9175
3. $ln\ Ir_{it}$	-1.22976	0.1094
4. $lnCPI_{it}$	8.48155	1.0000

5. $lnEr_{it}$	0.40155	0.6560
Maddala and Wu (1999) and Choi (2001)		
ADF-Fisher Chi-square		
1. $lnGDP_{it}$	4.42266	0.9745
2. $lnM1_{it}$	6.31958	0.8991
3. $ln\ Ir_{it}$	18.6988	0.0961
4. $lnCPI_{it}$	7.38454	0.8312
5. $lnEr_{it}$	4.06799	0.6675
PP-Fisher Chi-square		
1. $lnGDP_{it}$	1.28359	0.9999
2. $lnM1_{it}$	4.35633	0.9761
3. $ln\ Ir_{it}$	15.8134	0.1999
4. $lnCPI_{it}$	22.8125	0.0294
5. $lnEr_{it}$	1.42464	0.9643
Null : No unit root		
Hadri (1999) Z-Statistics		
1. $lnGDP_{it}$	5.02947	0.0000
2. $lnM1_{it}$	4.63802	0.0000
3. $ln\ Ir_{it}$	4.75662	0.0000
4. $lnCPI_{it}$	4.22955	0.0000
5. $lnEr_{it}$	4.88080	0.0000

From: computed

Table 2: Results of panel unit root tests based on 5 method tests for all variables after first differencing into these variables.

Method test	Test statistic	Significance level for rejection
Null : unit root (assumes common unit root process)		
Levin,Lin and Chu (2002) t*- Statistics		
1. $lnGDP_{it}$	-4.66315	0.0000
2. $lnM1_{it}$	-5.46918	0.0000
3. $ln\ Ir_{it}$	-5.64420	0.0000
4. $lnCPI_{it}$	0.33249	0.6302
5. $lnEr_{it}$	-1.52225	0.0640
Breitung(2000) t*-Statistics		
1. $lnGDP_{it}$	0.25040	0.5989
2. $lnM1_{it}$	-0.72879	0.2331
3. $ln\ Ir_{it}$	-3.28419	0.0005
4. $lnCPI_{it}$	5.82133	1.0000
5. $lnEr_{it}$	-0.75769	0.2243
Null : unit root (assumes individual unit root process)		

Im, Pesaran and Shin (2003) W-Statistics		
1. $lnGDP_{it}$	-2.59683	0.0047
2. $lnM1_{it}$	-3.01644	0.0013
3. $ln\ Ir_{it}$	-2.84429	0.0022
4. $lnCPI_{it}$	2.87288	0.9980
5. $lnEr_{it}$	-1.95889	0.0251
Maddala and Wu (1999) and Choi (2001)		
ADF-Fisher Chi-square		
1. $lnGDP_{it}$	26.3973	0.0094
2. $lnM1_{it}$	31.6928	0.0015
3. $ln\ Ir_{it}$	28.8680	0.0041
4. $lnCPI_{it}$	5.83617	0.9241
5. $lnEr_{it}$	14.2986	0.0265
PP-Fisher Chi-square		
1. $lnGDP_{it}$	37.4874	0.0002
2. $lnM1_{it}$	65.4948	0.0000
3. $ln\ Ir_{it}$	63.9845	0.0000
4. $lnCPI_{it}$	10.5290	0.5697
5. $lnEr_{it}$	18.5180	0.0051
Null : No unit root		
Hadri (1999) Z-Statistics		
1. $lnGDP_{it}$	6.42166	0.0000
2. $lnM1_{it}$	6.25362	0.0000
3. $ln\ Ir_{it}$	7.93402	0.0000
4. $lnCPI_{it}$	10.2805	0.0000
5. $lnEr_{it}$	3.64518	0.0001

From: computed

Table 3: Results from panel cointegration test of the selected South East Asia countries

Test Name	Test statistic	Significance level for rejection of the null hypothesis (no cointegration)
(1) Kao Residual Cointegration Tests		
• ADF-Statistic	-2.308884	0.0105

From: computed

Table 4: Results test of model selection for panel cointegration analysis of the selected South East Asia countries (Malaysia, Philippines, Thailand, Vietnam, Cambodia and Lao)

Testing approach	Chi-Sq. Statistic	Prob.
1.Breusch and Pagan Lagrangian multiplier test for random effects (LM-test)	289.08	0.000
2.Hausman Test (Cross-section Random effect)	5.610616	0.1322

From: computed

Table 5: Both Random-effects ML regression and Random-effects GLS regression of long-run relationship between $lnGDP_{it,}$ and other macroeconomics variables ($lnIr_{it}$, $lnM1_{it}$, and $lnEr_{it}$) of the selected South East Asia countries (Malaysia, Philippines, Thailand, Vietnam, Cambodia and Lao)

Variables	Random-effect ML regression	Random-effects GLS regression
Constant	-2.515602*** (-6.30)	-2.543798*** (-6.63)
$lnIr_{it}$	-0.021876 (-0.63)	-0.0213008 (-0.59)
$lnM1_{it}$	0.6965369*** (22.10)	0.6983223*** (21.87)
$lnEr_{it}$	-0.1286244*** (-2.28)	-0.1226354*** (-2.34)

From: computed

Note : Z-statistics are in parenthesis and a * denotes at the 10 percent level of significance and a ** denotes at the 5 percent level of significance and a *** denotes at the 1 percent level of significance.

Table 6: FMOLS-estimate of long-run relationship between $lnGDP_{it,}$ and other Macroeconomics variables ($lnIr_{it}$, $lnM1_{it}$, and $lnEr_{it}$) of the selected South East Asia countries (Malaysia, Philippines, Thailand, Vietnam, Cambodia and Lao)

INDIVIDUAL FMOLS RESULTS
(t-stats in parentheses)

Member	Variable	Coefficient	t-statistic
Malaysia	lnIr	0.17***	(2.52)
	lnM1	0.24***	(2.27)
	lnEr	-0.85***	(-2.83)
Philippine	lnIr	-0.08***	(-3.33)
	lnM1	0.46***	(2.64)
	lnEr	-0.72***	(-3.85)
Thailand	lnIr	-0.01	(-0.55)

	lnM1	-0.41***	(-5.35)
	lnEr	-0.50***	(-6.25)
**********			
Vietnam	lnIr	0.04	(0.23)
	lnM1	1.45**	(4.75)
	lnEr	0.25	(0.67)
**********			
Cambodia	lnIr	0.07*	(1.25)
	lnM1	-0.03	(-0.16)
	lnEr	-0.92***	(-8.48)
**********			
Lao	lnIr	-0.11*	(-1.61)
	lnM1	0.02	(0.06)
	lnEr	-0.15	(-0.61)
**********			

PANEL GROUP FMOLS RESULTS

	Coefficient	t-statistic
$lnIr_{it}$	0.01	(0.61)
$lnM1_{it}$	0.29**	(1.72)
$lnEr_{it}$	-0.48***	(-8.71)

Nsecs = 6 , Tperiods = 13 , no. regressors = 3

****