APPENDICES

APPENDIX A

Dynamic Causal Relationships among Macroeconomic Variables in Developing Economies: A Panel Co-Integration/Vector Correction Approach

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Dynamic Causal Relationships among Macroeconomic Variables in Developing Economies: A Panel Co-Integration/Vector Correction Approach

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ABSTRACT

This paper applies "developed-country" empirical tests to a large, geographically-dispersed sample of 95 developing countries for the period 1996-2008. The goal is to identify, measure, sign and directionalize the dynamic casual relationships linking gross domestic product, money, the interest rate, the price level, the exchange rate, population and the savings rate. Panel co-integration with vector correction reveals statistically significant long-term equilibrium relationships among all variables except population and the savings rate, implying that the main sources of determined output come from the demand side. Results from the error correction model suggest that after a fiscal shock, gross domestic product reverts to its equilibrium within 20 quarters. In contrast, the money supply requires only 8 quarters reverting to equilibrium. The evidence implies that the money supply could potentially be used as one indicator of future movements in gross domestic product in a developing economy. Comparisons of the results from the present study with those from OECD economies suggest that macro-economics has reached a point where differences between "developed" and "developing" economies may be less than those within each bloc.

Keywords: Causal relationship; Macroeconomic activity; Developing economies; Panel co-integration

1. Introduction

Development economics has emerged as a field in economics since the independence of 19th century colonies was achieved from the late 1940s through the early 1960s. Nobel prizes have been awarded to at least five economists for their direct analyses of under-development. These include Lewis [44, 45] for dualistic models of labour transfer, Kuznets [38, 39] for the quantification of the structural transformation away from agriculture, Schultz [57, 58] for theories of human capital and farmer rationality, Myrdal [50, 51] for descriptions of underdevelopment in Asia, and Sen [60, 61] for formulating the just rights of the poor. But other Nobel laureates, notably Frisch [21], Leontief [40], North [53], Solow [62] and Tinbergen [63] have also formulated more inclusive theories with strong implications for poor economies.

This body of pioneering development theories clarifies what makes developing economies different from the European and American models upon which modern macroeconomics is based. It has been empirically validated and nuanced by applications to real-world economies by such applied economists as Chenery and Srinivasan [15], Hayami and Ruttan [26], Kanbur et al. [32], Mellor [49] and Ravallion [56]. To the extent that markets are more imperfect, international trade more fettered, information more subject to principal-agent problems, administrators more corrupt, poverty deeper, the safety net more tattered, and the State more over-involved than in industrialized economies, the domain of economic development studies has been justified, and must still be maintained.

However, it must never be forgotten that the goal of economic development theory is eventually to do itself out of a job; i.e., to help the set of low- and middle-income countries to achieve such high levels of income and economic performance that there will someday no longer be a need for development macroeconomists, but simply macroeconomists. The objective of the present paper is to take a mid-term progress reading of how far the developing economies have come in the last 60 years towards achieving that goal. We therefore intentionally subject a large sample of low- and medium-income countries to the same kinds of causal tests among the main macroeconomic aggregates that industrialized countries are subjected to.

This has been done to a modest extent in the past; but each of the handful of studies we cite in this paper has analyzed only one or two countries at a time, and has often used earlier, less incisive forms of econometric models. In the present paper we apply the advanced techniques of vector auto-regression and panel correction to determine how smoothly and integrally a wide range of 95 developing economies are functioning1. We then perform meta-analysis of our results with studies from the recent literature on the G12 economies, which themselves have not done particularly well during the past decade in maintaining high growth rates, eliminating corruption and economic crime, avoiding economic crises, liberalizing trade in agricultural products, or balancing the budget. We test the hypothesis that there is virtually no difference between the two sets of economies; or, more bluntly, that the advanced economies also require a lot of attention to development economics.

2. Review of literature and conceptual framework

Many theoretical and empirical studies in the field of standard macroeconomics have addressed the important question of the exact causal relationship among such macroeconomic variables as gross domestic product, the money supply, technological innovation, the interest rate, the price level, the exchange rate, the wage rate, employment, population and the savings rate. Different schools of thought, such as Classical Economists, the Keynesians, the Monetarists, the new Classicals, the new Keynesians and the New Growth Theorists, have provided different explanations about the relationship among these variables. For example, Keynes believed that effective demand plays a pivotal role in determining output. While acknowledging that a positive monetary shock will increase economic activity and the price level, he emphasized fiscal over monetary policy as being more important to the economy.

The monetarist school provides a different explanation: that the money supply is the primordial factor in determining national income. Friedman and Schwartz [20] studied the relationship between money supply and output, and the implications for effective application of monetary policy in the USA. They advocated a Central Bank policy aimed at keeping the supply and demand for money at equilibrium in order to adjust for differential growth rates of productivity and demand. Their conclusion was that monetary policy was effective and could explain and compensate for fluctuations in output.

Keynesians, Monetarists and the New Classicals agree that fluctuations around the trend are caused by nominal demand events such as monetary shocks, not real supply shocks such as technological breakthroughs. However, Nelson and Plosser's [52] attempt to answer whether fluctuations have a permanent component found that real factors such as the labour supply and technological innovation both determine output in the long run and act as substantial sources of disruption to the economy. It is important to note that the labour supply is a double-edged sword in terms of policy to increase GDP per capita, since the growth in consumption needs of the population and the increase in the workforce to supply those needs are highly correlated.

Since the mid-1980s, "New" or "Endogenous" Growth Theory has emerged to criticize the neo-classical growth model. In the neo-classical view, the long-run growth rate is exogenously determined by either assuming a savings rate (the Harrod-Domar model [17, 24]) or a rate of technical progress net of depreciation and population growth (Solow model [62]). As a result, the Solow model [62] introduces the concepts of "effective" labour, capital "deepening" and capital "widening." However, the savings rate, population growth rate, and rate of technological progress remain exogenous and unexplained. Endogenous growth theory emphasizes that economic growth results from increasing returns due to new knowledge. As a partial correction to these problems, the Hayami-Ruttan model [26] endogenizes technical and institutional change as a response to changes in relative factor prices.

2.1 Determinants of real output

A vast empirical literature, e.g., Ambler [3], Kamas and Joyce [31], Chaudhry et al. [13], Dritsaki and Adamopoulos [18], Husain and Abbas [28], Karras [36, 37], Masih and Masih [47, 48] and Yu et al. [65] has teste the predictions of these theories. Some papers have found that the money supply does not affect output. For example, Ambler [3] studied the impact of the movement in monetary variables upon the changes in real output in Canada and found that increases in the money stock relative to nominal income raise spending and output in the short run. He further concluded that the observed stationarity of Canadian velocity implies that money affects only price in the long run.

For developing economies as well, Kamas and Joyce [31] investigated the impact of changes in monetary variables on the domestic and foreign sectors, the determinants of Central Bank policy, and the response to foreign monetary changes in Mexico and India. Their paper found that domestic monetary policy had no significant effect upon output in either country. Output responded in each country only to changes in foreign, not domestic, money.

Masih and Masih [47, 48] discerned the dynamic causal chain (in the Granger [22] temporal sense rather than in the structural sense) linking real output to money, interest rate, inflation and the exchange rate in the context of a small Asian developing economy (Indonesia). Their findings have clear policy implications for any accommodative and/or excessive monetary expansion since the latter is likely to be dissipated in terms of relatively higher levels of such nominal variables as prices, exchange rates or interest rates rather than real output. Husain and Abbas [28] re-examined the causal relationships among money, income and prices in Pakistan. They showed that unidirectional causality runs from income to money; implying that, in all likelihood, real factors rather than the money supply have played a major role in increasing Pakistan's national income.

On the other hand, Karras [36, 37] found that money supply affects output, which increases its influence upon inflation. Yu et al. [65] applied a monetary function to explain fluctuations in output in Bangladesh. They found that real depreciation, a higher real stock price, a lower real federal funds rate, and increases in aggregate world output all increase real output. However, the ratio of government consumption spending to nominal GDP is insignificant, suggesting that expansionary fiscal policy may not be effective.

2.2 Determinants and effects of macroeconomic fluctuations

Another large branch of macroeconomic research -- e.g., Balcilar and Tuna [4], Canlas [11], Cheng [14] and Yu [64] -- explains both historical patterns of fluctuations in economic activity, and whether or not macroeconomic policy has any significant contribution to those patterns. For example, Cheng [14] found that fluctuations in such policy instruments as the money supply and the budget deficit (but not capital formation) bear a significant relation to real GDP in Malaysia.

In an exploration of short-term output fluctuations in Slovakia, Yu [64] demonstrated that reductions in the expected inflation rate, government deficit, the euro rate, the US federal funds rate; and increases in the real effective exchange rate and aggregate world output would help to raise output. Balcilar and Tuna [4] studied the sources of macroeconomic fluctuations in a typical small open economy (Turkey). They concluded that in the long run, supply-side shocks are the main source of output fluctuations, accounting for almost half the variance of domestic output. In contrast, short-run variability in domestic output is dominated by relative demand shocks. Finally, Canlas [11] explored the effects of changes in the saving rate, population growth and human-capital growth upon real GDP in the Philippines. The results showed that the saving rate has a positive effect, population increase a negative effect, and human-capital improvement no significant effect upon growth.

The present paper proposes to study the interrelationship among money supply and other macroeconomic variables within a conceptual framework similar to those used by Chaudhry et al. [13], Hsieh [27], Dritsaki and Adamopoulos [18], Masih and Masih [47, 48]. Unfortunately, the disparate results of those studies have preclude clear policy recommendations to date. We shall therefore employ recent advances in econometric modeling (vector auto-regression and panel correction) to arrive at a consistent set of conclusions for a much larger sample of 95 countries over the most recent 13 year period for which data are available (1996-2008).

The purpose of this article is to conduct empirical tests to identify, measure, directionalize, and test the significance of the dynamic casual relationships among the macroeconomic variables gross domestic product, money supply, the interest rate, the price level, the exchange rate, population and saving rate in 95 developing economies.

Based upon both the literature cited and this objective, our conceptual framework (Figure 1) is predicated upon the notion that output and price at equilibrium are determined by aggregate supply (real sector) and aggregate demand. On the supply side in the steady state, the levels of population growth and the savings rate ultimately determine aggregate output. Monetary variables influence the savings rate, which, along with foreign direct investment, provides the capital for aggregate investment. On the demand side as well, financial policy plays a pivotal role in determining output and price levels through monetary policy instruments, whose impacts are transmitted through the money and asset markets. Within this broad macroeconomic model of steady-state equilibrium, the present paper targets those variables highlighted in gray type.

The remainder of this paper is organized as follows. Section 2 describes the data sources as well as the limitations of the analysis. Section 3 outlines the methodology to test results for co-integration, unit roots and the need to estimate an error correction model. Section 4 presents and discusses the empirical results. Finally, section 5 summarizes the conclusions within a practical policy perspective.

3.Data and Empirical Methodology

3.1 Data

The empirical analysis is applied to a sample of 95 developing countries drawn from Central and Eastern Europe, Middle East, the Western Hemisphere, the Commonwealth of Independent States, Asia and Sub-Saharan Africa (Table 1).

Table 1 Number of countries by region

Region	Number
Central and Eastern Europe	11
Middle East	8
Western Hemisphere	19
Commonwealth of Independent States	8
Asia	17
Africa	32
Total	**95**

Source: International Monetary Fund [30].

We use annual data for the period 13-year period 1996-2008[1] to investigate the casual relationships the among key macroeconomic variables noted above. Gross Domestic Product at constant prices (GDP), money supply (M1), the interest rate (IR), national currency per US dollar or nominal exchange rate (ER), the inflation rate with base 2000 (CPI), population (POP) and the savings rate as a percent of gross national income (SA) are used as cardinal indicators. All series were obtained from the IMF (2009) and Central Bank of each country and converted into natural logarithms prior to the empirical analysis.

4. Econometric methods

Following established procedures, we conducted tests of the causal relationship among gross domestic product and the other macroeconomic aggregates in three stages:

Stage1:tests for the order of integration in the money supply, gross domestic product, the interest rate, the price level, the exchange rate, population and saving rate series.

Stage2:panel co-integration to examine the long-run relationships among the variables.

Stage3:dynamic panel causality tests to evaluate the short run co-integration and the direction of causality among the variables.

4.1 Panel unit root

The co-integration properties of the variables involved determine the appropriate specification of the real output function. If the series are co-integrated, then the relationship among the target macroeconomic variables should be interpreted as a long-run equilibrium, as deviations are mean-reverting. However, it is well known for small samples that standard unit root and co-integration tests can lose power as compared to stationary alternatives. Panel data circumvent the low power problem of standard unit root tests by increasing the number of observations [5].

[1] The length of the period is dictated by the availability of data.

Six panel unit root tests were used in this paper: Levin and Lin [41, 42], Breitung [10], Choi [16], Hadri [23], Im et al. [29], two Fisher-Type tests using ADF and PP-test, Maddala and Wu [46]. In general, the type of panel unit root tests is based upon the following univariate regression;

$$\Delta y_{it} = \rho_i y_{it-1} + z'_{it}\gamma + u_{it} \qquad (1)$$

where i = 1, 2, ..., N is the country, t = 1, 2, ..., T zit is the deterministic components and uit is iid(0, σ2i) zit could be zero, one, the fixed effects or fixed effect as well as a time trend (t).

For the six tests considered, the null hypothesis is that all series have a unit root, that is, ρi = 0 ∀i. Each specific test has a different alternative hypothesis, depending upon different degrees of heterogeneity under the alternative hypothesis.

In the Levin and Lin (LL) tests [41, 42], one assumes homogeneous autoregressive coefficients between individuals, i.e., ρi = ρ ∀i and tests the null hypothesis Ho : ρi = ρ = 0 against the alternative Ha : ρi = ρ < 0. However, the LL test has some limitations so Im et al. [29] extended the Levin and Lin [41, 42] framework to allow for heterogeneity in the value of the autoregressive coefficient under the alternative hypothesis. Indeed, the alternative hypothesis can be written: ρi < 0 for i = 1, 2, ..., N1 and ρi = 0 for i = N1 + 1, ..., N .

The Breitung [10] panel unit root test is based upon the regression,

$$y_{it} = \eta_{it} + \sum_{k=1}^{\rho+1} \beta_{ik} x_{i,t-k} + \varepsilon_t \qquad (2)$$

The test statistic examines the null hypothesis that the process is difference stationary,

$$\mathrm{H}_0 : \sum_{k=1}^{\rho+1} \beta_{ik} - 1 = 0 .$$

The alternative hypothesis assumes that the panel series is stationary; i.e.,

$$\sum_{k=1}^{\rho+1} \beta_{ik} - 1 < 0 \text{ for all i.}$$

The Choi [16] and Maddala and Wu [46] test is a non-parametric Fisher-type test which is based on the combination of the p-values of test-statistics for a unit root in each cross-sectional unit. Finally, Hadri [23] gives a test similar to the KPSS unit root test that has a null hypothesis of no unit root in any of the series in the panel.

4.2 Panel cointegration test

Like the panel unit root tests, panel cointegration techniques can be motivated by the search for more powerful tests than those obtained by applying individual time series cointegration tests.

Let lngdp, lnm, lnir, lner, lncp, lnpop and lnsa be the natural logarithms of GDP, money supply, interest rate, the exchange rate, the price level, population and the savings rate, respectively. Provided the variable set {lnm, lngdp, lnir, lner, lncp, lnpop, lnsa} contains a panel unit root, the issue arises as to whether there exists a long-run equilibrium relationship among the variables. We employ panel co-integration using both Pedroni's [55] test that allows for heterogeneity in the intercepts and slopes of the co-integrating equation, and the Kao Test [33].

4.2.1 Pedroni's test

Pedroni [55] provided seven statistics for the test of the null hypothesis of no co-integration in heterogeneous panels. One group of such tests are termed "within dimension" (panel tests) and the other "between dimension" (group tests). The "within dimension" tests pool the data across the ''within dimension,'' thereby taking into account common time factors and allowing for heterogeneity across members. The ''between dimension'' tests allow for heterogeneity of parameters across members, and are called ''group mean cointegration statistics.''

Seven of Pedroni's tests [55] are based upon the estimated residuals from the following long-run model:

$$\ln gdp_{i,t} = \alpha_i + \beta_i \ln m_{i,t} + \gamma_i \ln ir_{i,t} + \theta_i \ln er_{i,t} + \eta_i \ln cp_{i,t} + \lambda_i \ln pop_{i,t} + \pi_i \ln sa_{i,t} + \varepsilon_{i,t} \quad (3)$$

where $\varepsilon_{i,t} = \rho_i \varepsilon_{i,(t-1)} + \mu_{i,t}$ are the estimated residuals from the panel regression.

The null hypothesis tested is whether ρi is unity. Pedroni [55] suggests a Phillips-Perron-type test for cointegration. The statistics can be compared to appropriate critical values; if critical values are exceeded then the null hypothesis of no cointegration is rejected, implying that a long-run relationship between the variables does exist.

4.2.2 Kao tests

Kao tests [33] the residuals εˆi,t it of the OLS panel estimation by applying DF- and ADF-type tests:

$$\hat{\varepsilon}_{i,t} = \rho_i \varepsilon_{i,(t-1)} + \mu_{i,t} \quad (4)$$

The null hypothesis of no cointegration, H0: ρ = 1, is tested against the alternative hypothesis of stationary residuals, H1: ρ ≠ 1.

4.3 Panel long run estimators

First, we will estimate the model by using a pooled OLS estimator. However, pooled time series data, much like univariate time series data, tend to exhibit a time trend and are, therefore, non-stationary. In other words, the variables in question have means, variances, and covariances that are not time invariant. Therefore, we are using panel-OLS, panel-DOLS and panel-GMM to estimate our model.

For pooled models, consider the following system of cointegrated regressions,

$$y_{i,t} = \alpha_i + x_{i,t}\beta_i + u_{i,t}$$

Pooled models assume that regressors are exogenous and simply write the error as $u_{i,t}$ rather than using the decomposition $\alpha_i + u_{i,t}$, then

$$y_i = \alpha + x_i \beta_i + u_i \tag{5}$$

Note that x_{it} here does not include a constant, whereas in cross-sectional data x_i , one additionally includes a constant term.

Kao and Chiang [34, 35] consider the following panel regression,

$$y_{it} = x'_{it}\beta + z'_{it}\gamma + u_{it} \tag{6}$$

where $\{x_{it}\}$ are $k \times 1$ integrated processes of order one for all i and $x_{it} = x_{it-1} + \varepsilon_{it}$

The OLS estimator of β is

$$\hat{\beta}_{OLS} = \left[\sum_{i=1}^{N}\sum_{t=1}^{T}\tilde{x}_{it}\tilde{x}'_{it}\right]\left[\sum_{i=1}^{N}\sum_{t=1}^{T}\tilde{x}_{it}\tilde{y}_{it}\right] \tag{7}$$

However, Kao and Chiang [34, 35] show that $\hat{\beta}_{OLS}$ is inconsistent when using this estimator for panel data. As a corrective to OLS for serial correlation and non-exogeneity of the regressors, a panel version of the DOLS estimator can be used, based upon the equation,

$$y_{it} = x'_{it}\beta + \sum_{k=-K_i}^{K_i}\gamma_{ik}\Delta x_{it-k} + \varepsilon_{it}\ , \tag{8}$$

where

$$\hat{\beta}_{DOLS} = \left[N^{-1}\sum_{i=1}^{N}\left(\sum_{t=1}^{T}z_{it}z'_{it}\right)^{-1}\left(\sum_{t=1}^{T}z_{it}\tilde{y}_{it}\right)\right]_1 \tag{9}$$

and where

z_{it} = is the 2(K+1) x 1 vector of regressors $z_{it} = \left(x_{it} - \bar{x}_i, \Delta x_{it-k}, \ldots, \Delta x_{it+k}\right)$

$\tilde{y}_{it}$ = $y_{it} - \bar{y}_{it}$, and the subscript 1 outside the brackets indicates the first elements of the vector used to obtain the pooled slope coefficient.

Another method is GMM. Formally, model (6) may be transformed into the following difference equation:

$$y_{it} - y_{it-1} = \beta'(X_{it} - X_{it-1}) + \gamma'(z_{it} - z_{it-1}) + (u_{it} - u_{it-1}) \quad i=1,\ldots,n \ t=2,\ldots,T_i \tag{10}$$

However, from (10) a bias arises: since $y_{it-1} - y_{it-2}$ is correlated with the transform error term ($u_{it} - u_{it-1}$), an OLS on dynamic panel data will be inconsistent.

But if there are valid instruments, then GMM can be used to estimate the equation with lags of the dependent variable two periods back as an instrumental variable.

4.4 Panel vector error correction model

Once the variables were cointegrated, the causality test was performed. We used a panel-based (VECM) to identify the existence and direction of a long-run equilibrium relationship using the two-step procedure of Engle and Granger [19]. In the first step, we estimated the long-run model using Eq. (3) to obtain the estimated residual ε (the error correction term; eit hereafter). In the second step, we estimated the panel Granger [22] causality model with dynamic error correction. That model can be estimated using instrumental variables to deal with the correction between the error term and the lagged dependent variables.

$$\Delta \ln gdp = \pi_{igdp} + \lambda_{gdp} e_{it-1} + \sum_p \pi_{11ip} \Delta \ln gdp_{it-p} + \sum_p \pi_{12ip} \Delta \ln m_{it-p} + \sum_p \pi_{13ip} \Delta \ln ir_{it-p} + \sum_p \pi_{14ip} \Delta \ln er_{it-p} + \sum_p \pi_{15ip} \Delta \ln cp_{it-p} + \sum_p \pi_{16ip} \Delta \ln pop_{it-p} + \sum_p \pi_{17ip} \Delta \ln sa_{it-p} + \varepsilon_{it} \quad (11a)$$

$$\Delta \ln m = \pi_{im} + \lambda_m e_{it-1} + \sum_p \pi_{21ip} \Delta \ln m_{it-p} + \sum_p \pi_{22ip} \Delta \ln dgp_{it-p} + \sum_p \pi_{23ip} \Delta \ln ir_{it-p} + \sum_p \pi_{24ip} \Delta \ln er_{it-p} + \sum_p \pi_{25ip} \Delta \ln cp_{it-p} + \sum_p \pi_{26ip} \Delta \ln pop_{it-p} + \sum_p \pi_{27ip} \Delta \ln sa_{it-p} + \varepsilon_{it} \quad (11b)$$

$$\Delta \ln ir = \pi_{iir} + \lambda_{ir} e_{it-1} + \sum_p \pi_{31ip} \Delta \ln ir_{it-p} + \sum_p \pi_{32ip} \Delta \ln gdp_{it-p} + \sum_p \pi_{33ip} \Delta \ln m_{it-p} + \sum_p \pi_{34ip} \Delta \ln er_{it-p} + \sum_p \pi_{35ip} \Delta \ln cp_{it-p} + \sum_p \pi_{36ip} \Delta \ln pop_{it-p} + \sum_p \pi_{37ip} \Delta \ln sa_{it-p} + \varepsilon_{it} \quad (11c)$$

$$\Delta \ln er = \pi_{ier} + \lambda_{er} e_{it-1} + \sum_p \pi_{41ip} \Delta \ln er_{it-p} + \sum_p \pi_{42ip} \Delta \ln gdp_{it-p} + \sum_p \pi_{43ip} \Delta \ln m_{it-p} + \sum_p \pi_{44ip} \Delta \ln ir_{it-p} + \sum_p \pi_{45ip} \Delta \ln cp_{it-p} + \sum_p \pi_{46ip} \Delta \ln pop_{it-p} + \sum_p \pi_{47ip} \Delta \ln sa_{it-p} + \varepsilon_{it} \quad (11d)$$

$$\Delta \ln cp = \pi_{icp} + \lambda_{cp} e_{it-1} + \sum_p \pi_{51ip} \Delta \ln cp_{it-p} + \sum_p \pi_{52ip} \Delta \ln gdp_{it-p} + \sum_p \pi_{53ip} \Delta \ln m_{it-p} + \sum_p \pi_{54ip} \Delta \ln ir_{it-p} + \sum_p \pi_{55ip} \Delta \ln er_{it-p} + \sum_p \pi_{56ip} \Delta \ln pop_{it-p} + \sum_p \pi_{57ip} \Delta \ln sa_{it-p} + \varepsilon_{it} \quad (11e)$$

$$\Delta \ln pop = \pi_{ipop} + \lambda_{pop} e_{it-1} + \sum_p \pi_{61ip} \Delta \ln pop_{it-p} + \sum_p \pi_{62ip} \Delta \ln gdp_{it-p} + \sum_p \pi_{63ip} \Delta \ln m_{it-p} + \sum_p \pi_{64ip} \Delta \ln ir_{it-p} + \sum_p \pi_{65ip} \Delta \ln er_{it-p} + \sum_p \pi_{66ip} \Delta \ln cp_{it-p} + \sum_p \pi_{67ip} \Delta \ln sa_{it-p} + \varepsilon_{it}$$

(11f)

$$\Delta \ln sa = \pi_{isa} + \lambda_{ssa} e_{it-1} + \sum_p \pi_{71ip} \Delta \ln sa_{it-p} + \sum_p \pi_{72ip} \Delta \ln gdp_{it-p} + \sum_p \pi_{73ip} \Delta \ln m_{it-p} + \sum_p \pi_{74ip} \Delta \ln ir_{it-p}$$
$$+ \sum_p \pi_{75ip} \Delta \ln er_{it-p} + \sum_p \pi_{76ip} \Delta \ln cp_{it-p} + \sum_p \pi_{77ip} \Delta \ln pop_{it-p} + \varepsilon_{it}$$

(11g)

5. Empirical results

5.1 The empirical results of the panel unit root test

Tables 2 and 3 report in summary fashion the panel unit root tests on the relevant variables given in equation (3) above. As can be readily seen, most of the tests (with the exception of the LLC test in one case) fail to reject the unit root null hypothesis for lngdp, lnm, lnir, lner and lncp in level form in table 2; but the tests do reject the null of a unit root in difference form in table 3. The tables further report the widely used Hadri-Z [23] test statistic, which, as opposed to the aforementioned tests, uses a null hypothesis of no unit root.

TABLE 2 :Results of Panel Unit root test base on 6 method test for all variables

	lngdp	**lnm**	**lnir**	**lner**	**lncp**	**lnpop**	**lnsa**
Series in level							
Null Hypothesis: Unit root (assumes common unit root process)							
Levin,Lim and Chu	-1.61 (0.05)	-8.59 (0.00)	-38.24 (0.00)	-6.17 (0.00)	6.28 (1.00)	-21.41 (0.00)	-13.53 (0.00)
Breitung	11.48 (1.00)	9.55 (1.00)	3.046 (0.99)	4.88 (1.008)	5.13 (1.01)	1.15 (0.87)	6.04 (1.00)
Null Hypothesis: Unit root (assumes individual unit root process)							
Im,Pesaran and Shin	8.70 (1.00)	2.19 (0.99)	-4.22 (0.00)	1.67 (0.95)	15.42 (1.00)	-12.45 (0.00)	-4.57 (0.00)
Fisher-ADF	92.24 (1.00)	171.91 (0.82)	231.49 (0.01)	177.83 (0.29)	118.50 (1.00)	494.68 (0.00)	303.69 (0.00)
Fisher-PP	110.75 (1.00)	208.01 (0.18)	212.77 (0.048)	180.08 (0.25)	132.80 (0.99)	457.33 (0.00)	277.61 (0.00)
Null Hypothesis: Stationary							
Hadri	18.79 (0.00)	18.68 (0.00)	15.91 (0.00)	21.93 (0.00)	21.04 (0.00)	18.86 (0.00)	22.26 (0.00)

Note: An intercept and trend are included in the test equation. P-values are provided in parentheses. The lag length was selected by using the Akaike Information Criteria.

However, for lnpop and lnsa, most of the tests do reject the null of a unit root in level form, which implies that these two are variables are stationary at level. Thus, the evidence suggests that the variables which are lngdp, lnm, lnir, lner and lncp do evolve as non-stationary processes and the application of OLS to equations (3) above will result in biased and inconsistent estimates. It is, therefore, necessary to turn to panel cointegration techniques in order to determine whether a long-run equilibrium relationship exists among the non-stationary variables in level form.

TABLE 3 :Results of Panel Unit root test base on the 6 method tests at first differences

	lngdp	lnm	lnir	lner	lncp
Series in first differences					
Null Hypothesis: Unit root (assumes common unit root process)					
Levin,Lim and Chu	-27.37 (0.00)	-19.85 (0.00)	-30.03 (0.00)	-20.21 (0.00)	-17.91 (0.00)
Breitung	-4.80 (0.00)	-0.51 (0.30)	-4.73 (0.00)	-2.27 (0.01)	12.37 (1.00)
Null Hypothesis: Unit root (assumes individual unit root process)					
Im,Pesaran and Shin	-12.80 (0.00)	-9.79 (0.00)	-15.58 (0.00)	-7.24 (0.00)	-2.15 (0.02)
Fisher-ADF	467.03 (0.00)	415.09 (0.00)	517.52 (0.00)	323.49 (0.00)	286.35 (0.00)
Fisher-PP	550.09 (0.00)	600.17 (0.00)	756.72 (0.00)	380.97 (0.00)	297.60 (0.00)
Null Hypothesis: Stationarity					
Hadri	21.75 (0.00)	16.85 (0.00)	26.86 (0.00)	16.82 (0.00)	25.88 (0.00)

Note: An intercept and trend are included in the test equation. P-values are provided in parentheses. The lag length was selected by using the Akaike Information Criteria.

5.2 The empirical results of panel cointegration test

Having established that money, gross domestic product, interest rate, price level and exchange rate are I(1), we next proceed to test whether a long-run relationship exists between them using Pedroni's [55] heterogeneous panel cointegration test and the Kao test [33]. The results for the seven different panel test statistics suggested by Pedroni [55] are reported in Table 4. The statistical significance of these test statistics is provided in parenthesis in the form of P-values. Four of the seven-test statistics suggest that money, gross domestic product, interest rate, level of price and exchange rate are cointegrated at the 5 percent level or better. However, simulations made by Pedroni [54] show that, in small samples ($T \approx 20$), the group mean parametric t-test is more powerful than the other tests, followed by the panel v test. The Kao test [33] also suggests that money, gross domestic product, the interest rate, the price level and the exchange rate are cointegrated at the 10 percent level.

TABLE 4 Pedroni's (2004) and Kao(1999) and panel cointegration test

Test Statistic	T-Ratio	P-Value
Pedroni's [55]		
Panel υ -statistic	3.79***	0.00
Panel Phillip-Perron ρ -statistic	11.85	1.000
Panel Phillip-Perron t -statistic	-9.85***	0.000
Panel ADF t -statistic	-0.77	0.221
Group Phillip-Perron ρ -statistic	15.52	1.000
Group Phillip-Perron t -statistic	-23.47***	0.000
Group ADF t -statistic	-5.66***	0.000
Kao [33] Test	-1.46*	0.072

Note: Probability values are in parenthesis;*, ** and *** denote statistical significance at the 10 percent, 5 percent and 1 percent levels, respectively.

5.3 The empirical results of estimating panel cointegration model

Tables 5 and 6 report the results of the long- and short-run relationships for money, gross domestic product, the interest rate, the price level, and the exchange rate based on the pool-OLS-,OLS-, DOLS- and GMM-estimators with $lngdp_{it}$ as the dependent variable. The long-run results show that all variables have the expected sign and are statistically significant at the 10% level or better. Given that the variables are expressed in natural logarithms, the coefficients can be conveniently interpreted as elasticities.

The pool-OLS estimate implies a strong positive association among money supply, the interest rate, the exchange rate and gross domestic product in developing countries. Inflation now has a negative sign and is significant with respect to gross domestic product.

The long run panel cointegration model based on an OLS-estimator shows that money and price level have positive impacts on gross domestic product while the interest rate and the exchange rate have negative impacts at the 1 percent level of statistical significance. The elasticity of GDP with respect to the money supply is greater in absolute terms than that with respect to either the interest rate, the price level or the exchange rate. A 1% increase in the money supply will increase gross domestic product by 0.45%.

The long run panel cointegration model based on the DOLS-estimator shows that money and price level exert positive impacts upon gross domestic product while the interest rate and the exchange rate have negative at the 1 percent level of statistical significance. The results indicate that the elasticity of money is greater than the elasticity of either the interest rate, the price level or the exchange rate; and that and a 1% increase in money leads to a gain in gross domestic product of 0.38%.

TABLE 5 Pool-OLS, Panel OLS and DOLS estimates

	Pool-OLS	**Panel-OLS**	**Panel-DOLS**
Constant	-3.09*** (0.00)	-1.17*** (0.00)	-1.22*** (0.00)
$\ln m_{it}$	0.83*** (0.00)	0.45*** (0.00)	0.38*** (0.00)
$\ln ir_{it}$	0.13*** (0.00)	-0.05*** (0.00)	-0.05** (0.02)
$\ln cp_{it}$	-0.21*** (0.00)	0.22*** (0.00)	0.34*** (0.00)
$\ln er_{it}$	0.02*** (0.01)	-0.13*** (0.00)	-0.14*** (0.00)
$\Delta(\ln m_{it}(-1))$			0.20*** (0.00)
$\Delta(\ln ir_{it}(-1))$			0.07*** (0.00)
$\Delta(\ln cp_{it}(-1))$			0.01 (0.67)
$\Delta(\ln er_{it}(-1))$			0.04 (0.39)
AIC	2.20	-0.04	-0.12
SIC	2.22	0.37	0.38

Note:*** denote statistical significant at the 1 percent level.p-value in parenthesis.

Moreover, the DOLS also portrays the effects of change in the short run. The results indicate that in the short run, the elasticity of money is greater than the elasticity of the interest rate, the price level or the exchange rate; and that a 1% increase in money supply increases gross domestic product by 0.20%. However, the DOLS-estimator suggests that the interest rate has a significant impact upon gross domestic product but not with the expected signs.

Comparing AIC and SIC, we can see that AIC suggests DOLS as the better model, while SIC suggests OLS. However, BIC generally penalizes free parameters more strongly than does the Akaike information criterion. Therefore, following a traditional time-series approach to model selection based on the minimization of Schwartz's Bayesian information criterion, the OLS-estimator is preferred to either the pooled-OLS or the DOLS estimator.

Table 6 presents regression results when the dependent variable is lngdp_{it}. The results show that there is a statistically significant negative relationship between the exchange rate and gross domestic product; but a statistically significant positive relationship among money supply, the interest rate and gross domestic product. However, the GMM-estimator yields an unexpected sign for the significant impact of the interest rate on gross domestic product. The Dynamic-GMM-estimator suggests that only the money supply and interest rate bear a significant impact upon gross domestic product.

TABLE 6 Result from GMM-estimate

	Panel-GMM	**Panel-Dynamic GMM**
Constant	-3.21*** (0.00)	-5.59*** (0.00)
$\ln m_{it}$	0.71*** (0.00)	1.02*** (0.00)
$\ln ir_{it}$	0.15*** (0.00)	0.41*** (0.00)
$\ln cp_{it}$	0.21*** (0.00)	-0.04 (0.77)
$\ln er_{it}$	- 0.22*** (0.00)	-0.01 (0.90)
$\Delta(\ln m_{it}(-1))$		-1.41*** (0.00)
$\Delta(\ln ir_{it}(-1))$		-0.49*** (0.00)
$\Delta(\ln cp_{it}(-1))$		-0.95*** (0.00)
$\Delta(\ln er_{it}(-1))$		-0.78** (0.03)

Note: Probability values are in parenthesis;*,** and *** denote statistical significance at the 10 percent ,5 percent and 1 percent levels, respectively.

5.4 The empirical results of the panel vector error correction model

The empirical results of the panel error correction model are reported in Table 7. Equation 11a shows that the variables money supply and interest rate lagged one period have a positive and significant impact on gross domestic product. The one period lagged error correction term is statistically significant at the 10% level. This result implies that after a shock to the system, GDP reverts to its equilibrium. The speed of adjustment equals -0.196, which implies that in the presence of one unit deviation from the long run in period t-1, the gap from equilibrium in gross domestic product will close by 19.6 percent in each period or will take 5 years to revert to long-run equilibrium at 10% significantly.

TABLE 7 Panel vector error correction model

Independent Variable	Dependent Variable				
	D(LNGDP)	**D(LNM)**	**D(LNIR)**	**D(LNER)**	**D(LNCP)**
Error correction term	-0.20* (-1.83)	-0.49*** (-2.61)	-0.85* (-1.66)	-0.72*** (-2.72)	0.13 (0.64)
D(LNGDP(-1))	0.07 (0.57)	-0.35 (-1.57)	-0.23 (-0.65)	-0.76* (-1.71)	-0.02 (-0.04)
D(LNM(-1))	0.12* (1.79)	-0.03 (-0.23)	0.43 (1.49)	0.94*** (3.04)	0.11 (0.41)
D(LNIR(-1))	0.09** (2.16)	0.24*** (2.73)	0.47** (2.08)	-0.17 (-1.17)	-0.15* (-1.85)
D(LNER(-1))	0.03 (0.46)	-0.09 (-0.67)	-0.30* (-1.93)	0.73*** (4.69)	0.16 (1.37)
D(LNCP(-1))	0.03 (0.47)	0.05 (0.34)	-0.59** (-2.10)	0.02 (0.15)	-0.23 (-0.40)

Note: The t-statistics are shown in parenthesis;*,** and *** denote statistical significance at the 10 percent ,5 percent and 1 percent levels, respectively.

It further appears (Eq. 11b) that the one-period lagged interest rate has positive and statistically significant impacts upon the money supply. Moreover, the error correction term is statistically significant at the 10% level. The speed of adjustment is equal to -0.49, implying that the presence of a one unit deviation from the long run in period t-1 induces the money supply in each period to return 49 percent of the distance back to long-run equilibrium at 10% significantly. Both one-period lagged gross levels of price and exchange rates have a positive impact on the interest rate while the once-lagged interest rate has negative impacts (Eq. 11c). The error correction term is significant at the 10% level. This result implies that after a shock to the system, the interest rate reverts to its equilibrium. The speed of adjustment is equal -0.85, in other words in the presence of a one unit deviation from the long run in period t-1, the interest rate will correct itself by 85 percent in each period toward long-run equilibrium at the 10% level of significance.

Eq. 11d further indicates that one-period lagged gross domestic product, money supply and exchange rate have positive and significant impacts on the exchange rate, even though the error correction term is statistically significant and the speed of adjustment is -0.72. This implies that the exchange rate will tend back to long-run equilibrium by covering 72 percent of the distance from equilibrium in each period.

In terms of Eq. 11e, interest rate lagged one period has a negative and statistically significant impact upon the level of price. However, the error correction term is not statistically significant.

Based upon these empirical results, we rewrite the conceptual framework (Figure 1) as Figure 2. There are major forward impacts upon GDP exerted by the money supply, the interest rate (passing through the domestic sector), the exchange rate and the price level. However, the only significant backward linkage is from GDP to the exchange rate (passing through the external sector). Since the money supply, the interest rate structure and the exchange rate are all policy operable, macroeconomic planners in low income countries may be able to better maintain, and hasten the return to, equilibrium through a judicious mix of open-economy policies.

6. Conclusion

The main purpose of this study was to conduct empirical tests to identify, measure, sign and directionalize the dynamic casual relationships linking the macroeconomic variables money, gross domestic product, the interest rate, the price level, the exchange rate, population and the savings rate in a large, geographically-dispersed sample of 95 developing countries. In the framework of this empirical analysis, we applied panel co-integration with vector correction to investigate the existence of causal relationships among the target variables.

The main finding from the panel results establishes a statistically significant long-term equilibrium relationship among all variables (except population and the saving rate), implying that the main sources of determined output come from the demand side. These results are consistent with those from Blanchard and Quah [8], Blanchard and Watson [9], and Hartley and Whitt [25] for the US, UK and European countries. They differ, however, from the findings of Ahmed and Park [1] and Bergman [6], which found that shocks on the supply side are the main source of output variance. Thus, although long-term equilibrium exists in all studies, demand is more important in developing economies and the NATO (the North Atlantic Treaty Organization) economies, while supply is more important in other developed

economies.

The long-term equilibrium results of our study further imply that when a deviation from long-run equilibrium does occur, error correction will make it return to equilibrium, as in the predictions of standard Western macroeconomics. Consistent with the Chicago Monetarist School, the empirical evidence shows that the money supply has greater impacts on gross domestic product than the other variables under study. The error correction model suggests that after a shock to the system, gross domestic product reverts to its equilibrium but that the speed of adjustment is only 19.6 percent per year, so that it will take 5 years for GDP to revert. In contrast, the money supply requires only 2 years to revert to equilibrium. This finding has strong policy implications for any monetary expansion, since it is found that money supply has greater impacts on gross domestic product than the other nominal variables, such as prices or exchange rates or interest rates in developing country.

These results are in fact even more clear-cut than in the case of most studies on OECD economies. For example, Aksoy and Piskorski [2] used Granger [22] causality tests to prove the existence of a significant correlation between monetary aggregates and such macroeconomic fundamentals as real output and inflation in the US economy. However, given growing globalization, they had to adjust the measurement of monetary aggregates for US dollar outflows abroad. In so doing, they discovered that domestic money (currency corrected for foreign holdings) may help to predict future real output and inflation. Their innovation of the "standard" theory even for the US economy was necessary to re-establish the Friedman-Schwartz [20] relationships among the money supply, inflation and output, a relationship that had virtually apart in the early 1980s.

Similarly for the United Kingdom, Bhattarai and Jones [7] found persistent unemployment and inflation consistent with the hysteresis hypothesis; and a trade-off between unemployment and inflation in the period 1975-99. Modeling deviations of output from equilibrium, growth rate of national income, inflation, terms of trade, and exchange rates against key currencies; they determined that shocks on either the demand or the supply side tend to prolong up to 10 quarters in the future before returning to equilibrium. These lags in return to equilibrium are similar to those calculated above (5 to 20 quarters) for underdeveloped economies.

Finally, Caporale et al. [12] employed tests of unit roots in the presence of co-integration to draw conclusions about long-run causality among output, money and interest rates in industrialized economies. Although narrow M1 is the best predictor of GDP movements in the bivariate model, interest rates are the most useful in the trivariate model in all industrialized economies except Germany. The authors warn advanced-country policy makers to give greater weight to interest rates than to monetary aggregates in predicting GDP.

Taken together, the results from the present study and from those cited for the OECD economies suggest that macro-economics has reached a point where differences between “developed” and “developing” economies may be less than those within each bloc. It will be up to further research to test for significant differences in either intercept or slope for the macroeconomic indicators analyzed in this paper by sub-category of developing economies (for example, South Asia vs. Latin America or Coastal Africa). Once those differences, if any, are clearly established, it would be desirable to perform the same exercise for the developed macro-economies in order to identify paired subtypes of macro-economy across the two blocs. This would help to harmonize understanding of the strengths and weaknesses of broad categories of economies, and to clarify the implications for improved macroeconomic management at the global level.

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APPENDIX B

Copula-VAR Analysis of the Relation between GDP, Imports, Exports: ASEAN Case

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Chapter 3

Copula-VAR Analysis of the Relation between GDP, Imports, Exports: ASEAN Case

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This study concentrates on the causal relationship among output, imports, and exports in ASEAN economies for the period 1980–2010. The investigation is conducted in a time series framework using a vector autoregressive model with copula approach, and impulse response function to test the trade variables of exports and imports for exogenous or endogenous induced growth. Moreover, results suggest there is no causal relation among imports, exports, and output in Malaysia, Thailand, and Brunei. In contrast, the study found empirical evidence in support of bi-directional causal relationship between exports and GDP growth for Laos and The Philippines. Furthermore, the results of Indonesia, Singapore, and Vietnam support only ELG hypothesis, not GLE hypothesis. Empirical results also suggest that there is evidence in support of ILG hypothesis for The Philippines, Indonesia, Singapore, and Vietnam. Thus, it is reasonable to conclude that for several ASEAN countries, both exports and imports play a very important role in stimulating economic growth.

1. Introduction

International trade is often considered to be a main determinant of economic growth in several countries, especially the Association of Southeast Asian Nations, or ASEAN, countries, for which their growth rate of exports and imports have been grown faster and higher than their GDP growth during the past thirty years. Table 1 shows evidence that export growth and import growth are more than GDP growth from 1990 to 2010 in the ASEAN countries (except Vietnam, Laos, Thailand, and Cambodia in 1990), which implies that exports and imports could be main factors to determine output in the ASEAN economies. Table 1 also shows the trend of export growth and import growth. Export growth in ASEAN has continually increased since 1990 in most countries, which arises from export-oriented market-based policies and free trade area agreements. Moreover, import growths also increased from 1990 to 2010, and were mainly due to imports of raw materials, capital goods, and machinery to produce for domestic and exports sector. Furthermore, in 2015, ASEAN aims to integrate ten countries to be one regional economic community called the ASEAN Economic Community (AEC), and AEC considers the following key characteristics: (a) a single market and production base, (b) a highly competitive economic region, (c) a region of equitable economic development, and (d) a region fully integrated into the global economy (ASEAN (2012)). This mean the economic integration will encourage trade in the ASEAN countries and could be lead to increases in GDP in the future.

Therefore, the primary purpose of this study is to investigate the relationship between trade and economic growth in the ASEAN countries which is important for policymakers and governments in the ASEAN countries to decide direction or appropriate policy for trade in their countries, and to decide whether the policies should be the same or different in each country after economic integration.

TABLE 1. GDP growth, Exports growth, and Imports growth of 10 ASEAN countries from 1990-2010.

Country	1990			2000			2010		
	GDP growth	**Exports growth**	**Imports growth**	**GDP growth**	**Exports growth**	**Imports growth**	**GDP growth**	**Exports growth**	**Imports growth**
Brunei	20.95	17.51	16.50	0.54	23.90	7.49	17.26	28.06	22.86
Vietnam	2.84	2.12	-6.27	8.62	25.49	33.16	11.17	22.07	19.18
Malaysia	13.34	17.44	29.15	16.73	16.09	25.50	23.25	26.45	33.13
Indonesia	12.79	17.07	33.61	17.87	27.67	39.63	31.49	35.43	39.93
The Philippines	3.82	5.69	16.33	-2.38	7.70	12.12	18.46	30.64	19.27
Singapore	23.66	17.96	22.67	11.11	20.37	21.21	22.49	30.50	26.37
Thailand	18.53	14.28	31.69	0.08	17.90	22.99	20.93	28.55	36.91
Laos	19.30	-32.44	15.43	15.33	-15.40	-14.72	15.42	44.37	23.61
Cambodia	159.83	101.25	8.00	4.13	7.95	14.61	8.08	11.84	25.55
Myanmar	N/A	N/A	N/A	4.93	42.13	20.26	28.83	9.96	40.60

Source: IMF (2012)

Note: N/A = data are not available

Moreover, in recent years, many research projects have studied the relationship between trade and economic growth, and a large volume of empirical research has confirmed that trade is crucial and necessary for growth and development (Kababie (2010)). However, most studies are interested only in exports factor and attempt to test two hypotheses, which are Exports Lead Growth and Growth Lead Exports, but ignore the imports factor. Reizman, Summers, and Whiteman (1996) argued that exports are not only one factor to determine growth, but imports are also important, and the result will be incomplete and spurious if analyzing a system without including imports. In addition, Awokuse (2008) states that exports in some countries are not an important engine or condition to drive the economy, and Kababie (2010) has established that imports are valuable to economic growth for three primary reasons: (1) they are a source of technology transfers; (2) they promote innovation through imports competition; and (3) they provide factors of production, which are used in both domestic and export sectors.

Therefore, this study investigates the causal relationship among exports, imports, and economic growth for the ASEAN economies within an integrated concept that investigates the role of both exports and imports. The contributions of this paper are the following: 1) export growth and import growth are included in the model as endogenous variables which previous empirical studies specify as exogenous variables. 2) We employ copula-VAR model (suggested by Bianchi, et. al (2010)). The advantage of copula approach is to build flexible multivariate distributions and to consist in representing the joint probability distribution by separating the impact of the marginals from the association structure, explained by the copula functional form. Moreover, there are no empirical studies using copula-VAR model to investigate causality among exports, imports, and GDP.

The rest of this article is organized as follows: Section 2 provides a brief empirical overview of the exports, imports, and output growth relationship. Section 3 discusses the analytical framework and some methodological issues. Section 4 presents empirical findings, and Section 5 contains the concluding remarks.

2. Literature review

The role of exports and imports in promoting growth is perhaps the most discussed topic as far as the role of trade in the economy is concerned. Although there are vast empirical studies that emphasize the positive relationship between trade and economics, Rodriguez and Rodrik (1999) highlight that the controversy between the relationship of trade and economic growth has yet to be resolved. They mention the problem of endogenous relations between income and trade. For example, recent studies have observed that countries with high incomes tends to trade more, and when the trade (especially exports) rises, the income also increases. Therefore, to consider only one direction from trade to economic growth will lead to incomplete results.

According to Awokuse (2008), there are three dominant hypotheses proposed to the economic literature: 1) Export-Led Growth (ELG), 2) Growth-Led Export (GLE), and 3) Imports-Led Growth (ILG). Of the three hypotheses, most empirical testing has been carried out on the ELG and GLE. However, the empirical evidence on the relationship among exports growth, imports growth, and GDP growth is rather mixed, and the results of different regions or countries in different periods of time provide different conclusions.

Several pieces of empirical evidence on the ELG hypothesis have shown that there is a link between economic growth and export growth. But debates still surround the direction of causality. While some researchers have found evidence in support of the ELG hypothesis (Ramos (2001), Sato and Fukushige (2011)), others (Reppas and Christopoulos (2005)) either found reverse causal flow from economic growth to exports growth, or support the alternative GLE hypothesis. Moreover, in some cases, the empirical evidence indicated a bi-directional causal relationship (Khan, et al. (1995), Zang and Balmbridge (2012)).

Moreover, on the context of ILG, endogenous growth models show that imports can be a channel for long-run economic growth because it provides domestic firms with access to needed intermediate factors and foreign technology (Coe and Helpman, 1995). Thangavelu and Rajaguru (2004) found that there is no export-led productivity growth for Hong Kong, Indonesia, Japan, Taiwan, or Thailand. However, significant causal effects were found from imports to productivity growth in India, Indonesia, Malaysia, The Philippines, Singapore, and Taiwan, which similarly result as Marwah and Tavakoli (2004) who consider the effect of foreign direct investment (FDI) and imports on economic growth in four Asian countries (Indonesia, Malaysia, The Philippines, and Thailand) and the result shows FDI and imports are important factors to determine economic growth. In Awokuse (2008), they suggest that economic growth could be driven primarily by growth in imports, and Çetinkaya and Erdoğan (2010) also found imports influenced GDP in Turkey. Pistoresi and Rinaldi (2012) found exports were not the only or the main driver of economic growth in Italy from1863 to 2004.

3. Methodology

This article attempts to capture the causality among exports, imports and GDP via the vector autoregressive (VAR) framework of Sims (1980). Moreover, traditional approach assumed the joint distribution of error term is normality. However, Bianchi et.al (2010) proposes to use of copula to construct the joint distribution and their result show that the copula-Vector Autoregression (VAR) model outperforms or at worst compares similarly to normal VAR models, keeping the same computational tractability of the latter approach. Therefore, in our paper, we employ copula approach to construct VAR model and compare with normal VAR model. This section provides a brief discussion of the copula-VAR model adopted in this study. Since the vector autoregressive (VAR) is fairly commonplace and well-document elsewhere, only a brief overview is provided here.

Let $Y_t = (y_{1t}, y_{2t}, ..., y_{nt})'$ denote an $(n \times 1)$ vector of n endogenous variables. The general p-lag vector autoregressive $(VAR(p))$ model has the form

$$Y_t = c + \mathrm{B}_1 Y_{t-1} + \mathrm{B}_2 Y_{t-2} + ... + \mathrm{B}_p Y_{t-p} + \sqrt{h}\eta_t, t = 1, ..., T \qquad (1)$$

where B_i are $(n \times n)$ coefficient matrices and η_t is standard innovation which has an $(n \times 1)$ unobservable zero mean and variance one.

Moreover, their conditional joint distribution is $H_t(\eta_{1,t}, ..., \eta_{n,t}; \theta)$ with the correlation parameters vector θ. From the Sklar Theorem (1959), the joint distribution can be written in the copula as

$$H_t(\eta_{1,t}, ..., \eta_{n,t}; \theta) = C\left(F_1(\eta_{1,t} : \alpha_1), ..., F_n(\eta_{n,t} : \alpha_n) : \gamma\right) \qquad (2)$$

where $F_i(\eta_{i,t} : \alpha_i)$ is marginal distribution functions of $\eta_{i,t}$ with marginal parameter α_i and $C(:\gamma)$ is the copula function which copula parameter γ. A copula is a function that links together univariate distribution functions to form a multivariate distribution function. Joe (1997) and Nelsen (2006) provide a complete monograph of an introduction to the theory of copulas and a large selection of related models. Another reviews such as Frees and Valdez (1998) and Cherubini et al. (2004) provide more detail about the application in actuarial and financial settings.

From (2) the expression of the corresponding densities can be derived. By taking derivatives to equation (2) we have:

$$f(\eta_1, ..., \eta_n) = \frac{\partial^n [H(\eta_1, \ldots, \eta_n)]}{\partial \eta_1 \ldots \partial \eta_n} = \frac{\partial^n C(F_1(\eta_1), \ldots, F_n(\eta_n))}{\partial \eta_1 \ldots \partial \eta_n}$$

$$= \frac{\partial^n C(F_1(\eta_1), \ldots, F_n(\eta_n))}{\partial F_1(\eta_1) \ldots \partial F_n(\eta_n)} \prod_{i=1}^{n} \frac{dF_i(\eta_i)}{d\eta_i}$$

$$= c(F_1(\eta_1), \ldots, F_n(\eta_n)) \prod_{i=1}^{n} f_i(\eta_i) \qquad (3)$$

From inverse Sklar's theorem which provide

$$C(u_1, \ldots, u_n) = F\left(F_1^{-1}(u_1), \ldots, F_n^{-1}(u_n)\right) \qquad (4)$$

where $u_i = F_i(\eta_i) \Leftrightarrow \eta_i = F_i^{-1}(u_i), i = 1,2,...,n$.

Therefore, equation (4) becomes:

$$c(u_1,\ldots,u_n) = \frac{f\left(F_1^{-1}(u_1),\ldots,F_n^{-1}(u_n)\right)}{\prod_{i=1}^{n} f_i\left(F_i^{-1}(u_i)\right)} \tag{5}$$

where $c(u_1,\ldots,u_n)$ is the multivariate copula density.

By using equation (5), we can derive the Normal-copula, whose probability distribution and density function is:

$$C^G(u_1,\ldots,u_n) = \Phi_\Sigma\left(\Phi^{-1}(u_1),\ldots,\Phi^{-1}(u_n):\Sigma\right) \tag{6}$$

and

$$c^G(u_1,\ldots,u_n) = \frac{\phi_\Sigma\left(\Phi^{-1}(u_1),\ldots,\Phi^{-1}(u_n)\right)}{\prod_{i=1}^{n} \phi_i\left(\Phi^{-1}(u_i)\right)} \tag{7}$$

where Φ^{-1} is the univariate Gaussian inverse distribution function ($u_i = \Phi_i(\eta_i)$),while Σ is the correlation matrix.

Moreover, there are alternative copula families which are called Archimedean copulas (such as Clayton's copula ,Rotated Clayton copula, Plackett copula, Frank copula, Gumbel copula, Rotated Gumbel copula and Symmetries Joe-Clayton copula) are provided to model the joint distribution. However, these copulas can become inflexible in high-dimensions and do not allow for different dependency structure between pairs of variables.

Moreover, Aas et.al(2009) presented a method to build high dimension copulas using pair-copulas as building blocks and they show that the pair-copula decomposition treated in their studies are more flexible to build higher dimension copula. This decompositions are called vine copulas. Initially proposed by Joe (1996) and developed in more detail in Bedford and Cooke (2001, 2002) ,Kurowicka and Cooke(2006) and Brechmann ans Schepsmeirer (2011), vines are a flexible graphical model for describing multivariate copulas built up using a cascade of bivariate copulas, so-called pair-copulas. According to Aas, et.al(2009) ,they described statistical inference techniques for the two classes of canonical (C-) and D-vines. Moreover, in this study, we provide C-vines copula in 3-dimensions and the tree of C-vine show as Figure 1

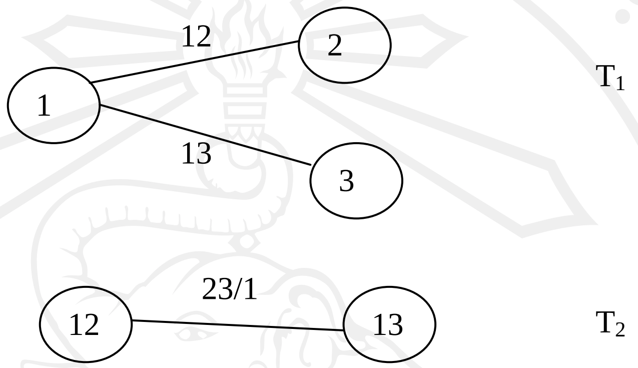

Figure 1. A canonical vine with 3 variables ,2 trees and 3 edges.

The general expression for the canonical structure in the 3-dimensions case is

$$f(\eta_1,\eta_2,\eta_3) = f(\eta_1)f(\eta_2)f(\eta_3)c_{12}(F(\eta_1),F(\eta_2))c_{23}(F(\eta_2),F(\eta_3))$$
$$c_{23|1}(F(\eta_2|\eta_1),F(\eta_3|\eta_1)) \tag{8}$$

or in the n-dimensions case we can write the general expression as follow:

$$f(\eta)=\prod_{i=1}^{n} f_i(\eta_i)\times\prod_{i=1}^{n-1}\prod_{j=1}^{n-i} c_{i,i+j|1:(i-1)}\Big(F(\eta_i|\eta_1,\ldots,\eta_{i-1}),\big(F(\eta_{i+j}|\eta_1,\ldots,\eta_{i-1}\big)\big|\gamma_{i,i+j|1:(i-1)}\Big) \tag{9}$$

where $f_i, i=1,...,n$ denote the marginal densities and $c_{i,i+j|1:(i-1)}$ bivariate copula densities with parameter(s) $\gamma_{i,i+j|1:(i-1)}$.

The crucial question for inference is how to obtain the conditional distribution functions $F(\eta|\nu)$ for an m-dimensional vector ν. For a pair-copula term in tree m+1, this can easily be established using the pair-copulas by sequentially applying the relationship

$$h(\eta|\nu,\gamma) = F(\eta|\nu) = \frac{\partial C_{\eta\nu_j|\nu_{-j}}\left(F(\eta|\nu_{-j}), F(\nu_j|\nu_{-j})|\gamma\right)}{\partial F(\nu_j|\nu_{-j})} \tag{10}$$

where ν_j is an arbitrary component of ν and ν_{-j} denotes the $(m-1)$-dimensional vector ν excluding ν_j (Joe 1996). Further $C_{\eta\nu_j|\nu_{-j}}$ is a bivariate copula distribution function with parameter(s) γ specified in tree m. The notation of the h-function is introduced for convenience (cp. Aas et al. 2009).

Copula and marginal estimation

The estimate the mariginal and copula parameter, Bianchi (2010) provided multi-step procedure is known as the method of Inference Functions for Margins (IFM). According to the IFM method, the parameters of marginal distributions are estimated separately from the parameters of the copula. The estimation following two steps:

(1) Estimate the parameters $\alpha_i, i = 1,...,n$ of the marginal distributions F_i using the Maximum Likelihood (ML) method:

$$\hat{\alpha}_i = \arg\max l^i(\alpha_i) = \arg\max \sum_{t=1}^{T} \log f_i(\eta_{i,t};\alpha_i) \tag{11}$$

where l^i is the log-likelihood function of the marginal distribution F_i;

(2) Estimate the copula parameters γ, given the estimations performed in Step 1:

$$\hat{\gamma} = \arg\max l^c(\gamma) = \arg\max \sum_{t=1}^{T} \log\left(c\left(F_1(\eta_{1,t};\hat{\alpha}_1),..., F_n(\eta_{n,t};\hat{\alpha}_n);\gamma\right)\right) \tag{12}$$

where l^c is the log-likelihood function of the copula.

4. Empirical Analysis and Results

4.1 Data and unit root properties

Data was obtained for eight ASEAN countries[2]: Brunei, Vietnam, Malaysia, Indonesia, Philippines, Singapore, Thailand and Laos. The data set consists of observations for GDP growth (GDP), exports growth (EXPORT), imports growth (IMPORT). Our estimates are based on annual data for the sample period 1980-2010. Data are drawn from two main sources: (a) the International Monetary Fund (IMF, various issues) and the World Development Indicator (World Bank, various issues).

TABLE 2. Trends in GDP growth, exports and imports from 1990 to 2010

Country	GDP Growth (%)			Exports (% of GDP)			Imports (% of GDP)		
	1990	2000	2010	1990	2000	2010	1990	2000	2010
Brunei	20.95	0.54	17.26	59.14	73.51	63.12	26.74	33.19	23.96
Vietnam	2.84	8.62	11.17	39.01	46.46	67.41	43.91	50.16	80.49
Malaysia	13.34	16.73	23.25	66.83	104.66	83.66	66.27	87.66	69.33
Indonesia	12.79	17.87	31.49	22.58	37.66	22.28	19.34	20.31	19.16
Philippines	3.82	-2.38	18.46	16.74	47.18	25.87	26.54	42.57	27.42
Singapore	23.66	11.11	22.49	136.10	146.50	155.53	156.98	142.76	136.72
Thailand	18.53	0.08	20.93	26.94	56.19	61.26	39.03	50.46	57.89
Laos	19.30	15.33	15.42	7.04	23.86	33.99	16.24	42.06	55.34

Source: IMF and World Bank

The trends in GDP growth, share of exports to GDP and share of imports of GDP are shown in Table 2. Across ASEAN countries, the trends in GDP growth do not show any similarly trends. GDP growth in Brunei, Philippines, Singapore, Thailand and Laos decrease from 1990 to 2000 and increase from 2000 to 2010 while GDP growth in Vietnam, Malaysia and Indonesia continuously increase from 1990 to 2010. The data clearly show the highly share of exports and imports on these countries GDP. Compare to GDP growth, there are upward trend for exports and imports from 1990 to 2010 across all the ASEAN countries under study.

Before estimate the VAR model, we have to check whether each time series variable is stationary in levels or stationary after first differencing. Two univariate unit root tests (the augmented Dickey–Fuller (ADF) and Phillips–Perron (PP)) were examined for each of the variables and were shown in Table 3.

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2 We cut Cambodia and Myanmar out of sample data because data are unavailable.

TABLE 3. Tests for unit root

	ADF	PP	Jarque-Bera	Prob	Skewness	Kurtosis
Brunei						
GDP	-4.811***	-4.811***	2.345	0.310	0.148	4.572
Exports	-6.647***	-6.647***	0.377	0.828	0.812	3.588
Imports	-4.338***	-4.338***	106.020***	0.000	-0.787	4.662
Vietnam						
GDP	-5.088***	-6.330***	6.608**	0.037	0.105	5.290
Exports	-5.505***	-11.965***	122.658***	0.000	2.849	11.104
Imports	-4.781***	-7.386***	463.091***	0.000	4.010	20.497
Indonesia						
GDP	-6.014***	-6.242***	47.954***	0.000	-1.491	8.428
Exports	-5.143***	-5.146***	0.648	0.723	-0.338	2.752
Imports	-5.280***	-5.295***	0.749	0.688	0.320	3.436
Malaysia						
GDP	-4.707***	-4.652***	3.227	0.199	-0.795	2.767
Exports	-4.977***	-4.989***	1.076	0.584	-0.421	2.609
Imports	-3.898**	-3.774**	17.529***	0.000	-1.524	5.176
Philippines						
GDP	-4.342***	-4.346***	1.828	0.401	-0.603	2.915
Exports	-3.636**	-3.611**	1.034	0.596	-0.439	2.760
Imports	-3.700**	-3.684**	1.332	0.514	-0.483	2.636
Singapore						
GDP	-3.241**	-3.289**	2.806	0.246	-0.745	2.846
Exports	-4.234**	-4.116**	0.464	0.793	-0.240	2.626
Imports	-4.520***	-4.515***	2.279	0.320	-0.674	2.932
Thailand						
GDP	-3.190**	-3.251**	14.856***	0.001	-1.444	4.883
Exports	-3.999***	-3.886**	1.220	0.543	-0.214	2.110
Imports	-4.173***	-3.913**	0.121	0.941	-0.104	2.767

TABLE 3 (Cont)

	ADF	PP	Jarque-Bera	Prob	Skewness	Kurtosis
Loas						
GDP	-3.959***	-3.758**	3.200	0.202	0.148	4.572
Exports	-5.017***	-7.741***	3.730	0.155	0.812	3.588
Imports	-5.365***	-5.286***	6.547**	0.038	-0.787	4.662

Source: Computation

Notes: ** and *** denotes rejection of the null hypothesis of unit roots for the ADF tests and PP tests at the 5% and 10% significance levels.

** and *** denotes rejection of the null hypothesis of normality for the Jarque-Bera tests at the 5% and 10% significance levels.

The combination of the unit root tests results (see Table 3) suggest that the GDP growth, imports growth and exports growth are integrated of order zero (i.e., I(0)) or stationary at level and so we can construct VAR model without take the differentiate. Table 3 also provides the normality test for all of variables and the Jarque-Bera on some of variables reject normality implied that not all marginal of the variables are normal distribution. Therefore, we can not assume the joint distribution of them is multivariate normality.

4.2 Estimation of copula-VAR model

The next step is to formulate the appropriate VAR model. The variables in the VAR models are used on their stationary level. The initial task in estimating the VAR model is to determine the optimum order of lag length. Moreover, in the real world economy, GDP, exports and imports always will delay for recognized the external and internal impact including the impact of changing in value of GDP, exports and imports on other side of economy were not immediately exist. In order to select the lag length of VAR model, sequential modified LR test statistic (LR), Akaike information criterion (AIC), Schwarz information criterion (SIC) and Hannan-Quinn information criterion (HQ) are used. Table 4 presents selected lag length of each country VAR model.

TABLE 4 Selected Lag Lengths

Country	selected lag lengths
Brunei	0
Indonesia	2
Laos	1
Malaysia	0
Philippines	6
Singapore	6
Thailand	0
Vietnam	6

Source: Computation

Table 4 shows that there is no causality among exports, imports and GDP in three countries (Brunei, Malaysia and Thailand). In the case of Laos, there is 1 lag length while 2 lag lengths exist in Indonesia. In addition, the proper lag order for Philippines, Singapore and Vietnam are 6.

After chose the appropriate lag length for each country, we estimate the parameters in VAR model and copula parameter and results of each country are separately presented.

1) Long-run relationship among exports, imports and GDP via copula-VAR model for Indonesia

Table 5 shows that imports and exports are important factors to determined economic growth in Indonesia at 5 percent significant level or better. The coefficient of EXPORT(t-1) on GDP growth shows that increase in 1 percent of exports growth will lead GDP growth increase 0.301 percent. Moreover, the coefficient of IMPORT(t-1) on GDP growth is 0.758 means the 1 percent increase of imports growth will increase GDP growth 0.758 percent. This result indicates the impact of imports on GDP is larger than impact of exports on GDP in the case of Indonesia.

Furthermore, there is relationship between exports growth and imports growth and Table 5 shows that exports led imports in Indonesia (at 10 percent significant level) but there is no causal relationship from imports to exports and there is also no causality from GDP to imports or exports. This result implies that imports and exports policy can encourage growth in Indonesia and imports are relatively more important than exports to GDP growth. We can write the relation in the functional form as follow:

GDP growth = f(EXPORT(t-1), IMPORT(t-1))

Imports growth = f (EXPORT(t-2))

TABLE 5 Causality relationship between Exports, imports and GDP in Indonesia

Variables	EXPORT		IMPORT		GDP	
	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat
Constant	5.085*	1.919	7.208	1.563	7.785**	2.111
EXPORT(t-1)	0.036	0.138	-0.103	-0.706	0.301**	2.012
IMPORT(t-1)	-0.451	-0.996	-0.117	-0.463	0.758***	2.915
GDP(t-1)	0.242	0.668	-0.082	-0.406	-0.104	-0.499
EXPORT(t-2)	-0.104	-0.378	0.247*	1.840	-0.130	-0.774
IMPORT(t-2)	0.378	0.788	-0.177	-0.755	0.154	0.527
GDP(t-2)	0.273	0.712	0.184	0.983	-0.329	-1.405
Log-Likelihood	-351.280					
AIC	756.559					
BIC	794.392					

Source: Computation

Notes: *,** and *** denote 10%, 5% and 1% levels of significance respectively.

Since the joint copula model requires the correct specification of the marginal models and their probability transforms will be iid uniform(0,1), so we provide the KS Test for if the probability transforms are uniform(0,1) and Box-Ljung Test for Autocorrelation. The null hypothesis of KS Test is variable has uniform distribution and the result from Table 6 rejects the null hypothesis for all 3 margins which implied that GDP growth, exports growth and imports growth have uniform distribution in the case of Indonesia. The Ljung–Box tests on the standardized residuals in levels reported in Table 6 highlight no autocorrelation. These results provide significant evidence that our marginal models are correctly specified.

TABLE 6 testing the assumptions of i.i.d and Test for Autocorrelation

KS test for uniform distribution			
Null Hypothesis: Variable has uniform distribution			
	statistic	**pValue**	**Hypothesis**
Margins of GDP growth	0.0936	0.9448	0 (acceptance)
Margins of exports growth	0.0827	0.9823	0 (acceptance)
Margins of imports growth	0.1351	0.6124	0 (acceptance)
Box-Ljung Test for Autocorrelation			
Null Hypothesis: No autocorrelation			
	Q-Stat	**pValue**	**Hypothesis**
Margins of GDP growth	5.9429	0.9990	0 (acceptance)
Margins of exports growth	9.0467	0.9824	0 (acceptance)
Margins of imports growth	10.9125	0.9485	0 (acceptance)

Source: computation

Next, we estimate the copula parameter and we consider pairwise dependence, so we model bivariate distributions of returns for computational tractability. To each pair of variables, we fit the following copulas: Normal copula, Clayton's copula, Rotated Clayton copula, Placket copula, Frank copula, Gumbel copula,and Rotated Gumbel copula . We fit the copulas to the pairs of standardized residuals, obtained after fitting VAR models to each returns series, transformed to uniform distribution by their empirical distribution functions. The copula selection is done on the basis of AIC and BIC perspective. Table 7 shows the optimal copulas and their estimated parameters.

TABLE 7 Copula correlation matrix

	Family	**Copula parameter**	**Kendall's tau**
GDP and Export	Frank	4.817	0.45
GDP and Import	rotated Gumbel copula (180 degrees; "survival Gumbel")	1.676	0.4
Export and Import condition on GDP	Frank	8.002	0.6

Source: Computation

Table 7 shows that, in the case of GDP-export pair and Export-Import pair, the Frank copula are the most appropriate to model the dependence structure. In the case of GDP-Import pair is given to the rotated Gumbel copula. The Kendall's tau shows the positive dependence of each pair.

2) Long-run relationship among exports, imports and GDP via copula-VAR model for Laos

The result of Table 8 indicates that lag of exports and GDP are important factors to determined GDP growth in Laos. In addition, there is bidirectional relation between exports and GDP which support ELG and GLE hypotheses. The result also shows that exports led imports in Laos. However, all coefficients of imports are insignificant which can imply unimportant of imports policy. We can write this relation in the functional form as follow:

GDP growth = f(EXPORT(t-1), GDP(t-1))

Imports growth = f (EXPORT(t-2))

Exports growth = f (GDP(t-1))

Table 8 Causality Relationship between Exports, Imports and GDP in Laos

	EXPORT		IMPORT		GDP	
Variables	**Coefficient**	**t-stat**	**Coefficient**	**t-stat**	**Coefficient**	**t-stat**
Constant	31.461***	3.588	15.906**	2.422	1.653	0.319
EXPORT(t-1)	-0.223	-1.288	0.450**	1.649	0.947***	3.391
IMPORT(t-1)	0.006	0.044	0.019	0.092	0.205	0.981
GDP(t-1)	0.194**	1.898	-0.057	-0.351	0.453***	2.740
Log-Likelihood	880.028					
AIC	917.860					
BIC	-413.014					

Source: Computation

Notes: ** and *** denote 5% and 1% levels of significance respectively.

Next, we provide the KS Test for if the probability transforms are uniform(0,1) and the null hypothesis of KS Test is variable has uniform distribution and the result from Table 9 rejects the null hypothesis for all 3 margins which implied that GDP growth, exports growth and imports growth ,in the case Laos, have uniform distribution. We also employ the Ljung–Box tests on the standardized residuals in levels reported in Table 9 and the result highlights no autocorrelation. These results provide significant evidence that our marginal models are correctly specified and hence copula model will not be mispecified.

Table 9 testing the assumptions of i.i.d and Test for Autocorrelation

KS test for uniform distribution			
Null Hypothesis: Variable has uniform distribution			
	statistic	**pValue**	**Hypothesis**
Margins of GDP growth	0.112	0.826	0 (acceptance)
Margins of exports growth	0.082	0.984	0 (acceptance)
Margins of imports growth	0.094	0.945	0 (acceptance)
Box-Ljung Test for Autocorrelation			
Null Hypothesis: No autocorrelation			
	Q-Stat	**pValue**	**Hypothesis**
Margins of GDP growth	0.729	15.803	0 (acceptance)
Margins of exports growth	0.717	15.990	0 (acceptance)
Margins of imports growth	0.963	10.292	0 (acceptance)

Source: Computation

Table 10 shows the optimal copulas and their estimated parameters.

Table 10 Copula correlation matrix

	Family	**Copula parameter**	**Kendall's tau**
GDP and Export	Clayton	0.141	0.066
GDP and Import	Independence	0.000	0.000
Export and Import condition on GDP	Frank	9.021	0.637

Source: Computation

Table 10 shows that, in the case of GDP-export pair is given to the Clayton copula and the Export-Import pair is given to the Frank copula while there is no relation between GDP and Import which support our VAR model. Moreover, the Kendall's tau of GDP-export pair and Export-Import pair are positive indicate positive dependence of each pair.

3) Long-run relationship among exports, imports and GDP via copula-VAR model for Philippines

In the case of Philippines, the result indicates that exports and imports led economic growth. Table 11 shows that the elasticity of IMPORT(t-5) is greater than the elasticity of other variables that and a 1% increase in IMPORT(t-5) leads to a gain in GDP growth of 2.575%. For imports growth equation (second column), Table 11 shows exports growth, GDP growth and its own lag are important factors to determine imports growth. The results indicate that the elasticity of IMPORT(t-2) is greater than the elasticity of other variables; and that a 1% increase in IMPORT(t-2) leads to a gain in imports growth of 1.458%. The exports growth is also determined by imports, GDP and its past values. The result indicates that the elasticity of IMPORT(t-2) is greater than the elasticity of other variables; and that a 1% increase in IMPORT(t-2) increases exports growth by 1.230%. Therefore, our result supports the ELG, GLE and ILG in Philippines.

Table 11 Causality Relationship between Exports, Imports and GDP in Philippines

Variables	EXPORT		IMPORT		GDP	
	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat
Constant	5.681**	2.249	2.972	1.096	4.009*	1.915
EXPORT(t-1)	-0.035	-0.149	0.698***	2.687	-0.616**	-2.184
IMPORT(t-1)	0.087	0.343	0.224	0.802	0.826***	2.728
GDP(t-1)	0.323*	1.655	-0.367*	-1.707	0.791***	3.382
EXPORT(t-2)	-0.583**	-2.012	0.579*	1.859	-0.498	-1.405
IMPORT(t-2)	-1.230***	-3.954	1.458***	4.365	-1.030***	-2.708
GDP(t-2)	-0.769***	-3.202	0.859***	3.328	-0.232	-0.791
EXPORT(t-3)	-0.571*	-1.842	0.496*	1.626	0.163	0.425
IMPORT(t-3)	-0.477	-1.432	0.268	0.819	-0.694*	-1.681
GDP(t-3)	-0.121	-0.469	-0.039	-0.156	-0.422	-1.324
EXPORT(t-4)	0.419*	1.942	-0.360	-1.441	-0.057	-0.149
IMPORT(t-4)	0.650***	2.804	-0.508*	-1.896	-0.241	-0.583
GDP(t-4)	0.362**	2.022	-0.438**	-2.114	0.089	0.278
EXPORT(t-5)	-0.218	-0.990	-0.624**	-2.399	1.823***	4.269
IMPORT(t-5)	-0.318	-1.346	-0.740***	-2.653	2.575***	5.618
GDP(t-5)	-0.407**	-2.230	0.309	1.433	0.580	1.640
EXPORT(t-6)	-0.242	-1.131	0.408	1.486	0.557	1.029
IMPORT(t-6)	0.195	0.848	-0.153	-0.518	1.218**	2.100
GDP(t-6)	0.154	0.865	-0.123	-0.541	0.146	0.325
Log-Likelihood	-285.905					
AIC	625.810					
BIC	663.643					

Source: Computation

Notes: *,** and *** denote 10%, 5% and 1% levels of significance respectively.

From Table 11 above, we can write this relation in the functional form as follow:

GDP growth = f(EXPORT(t-1), IMPORT(t-1), GDP(t-1), IMPORT(t-2), IMPORT(t-3), EXPORT(t-5), IMPORT(t-5), IMPORT(t-6))

Imports growth = f (EXPORT(t-1), GDP(t-1), EXPORT(t-2), IMPORT(t-2), GDP(t-2), EXPORT(t-3), IMPORT(t-4), GDP(t-4), EXPORT(t-5), IMPORT(t-5))

Exports growth = f(GDP(t-1), EXPORT(t-2), IMPORT(t-2), GDP(t-2),EXPORT(t-3),EXPORT(t-4), IMPORT(t-4), GDP(t-4), GDP(t-5))

Next, we provide the KS Test for whether the probability transforms are uniform(0,1) and the null hypothesis of KS Test is variable has uniform distribution. The result rejects the null hypothesis for all 3 margins which implied that GDP growth, exports growth and imports growth, in the case Philippines, have uniform distribution. We also employ the Ljung–Box tests on the standardized residuals in levels reported in Table 12 and the result highlights no autocorrelation. These results provide significant evidence that our marginal models are correctly specified and hence copula model will not be mispecified.

Table 12 Testing the assumptions of i.i.d and Test for Autocorrelation

KS test for uniform distribution			
Null Hypothesis: Variable has uniform distribution			
	statistic	**pValue**	**Hypothesis**
Margins of GDP growth	0.1343	0.6198	0 (acceptance)
Margins of exports growth	0.0642	0.9995	0 (acceptance)
Margins of imports growth	0.0826	0.9825	0 (acceptance)
Box-Ljung Test for Autocorrelation			
Null Hypothesis: No autocorrelation			
	Q-Stat	**pValue**	**Hypothesis**
Margins of GDP growth	11.9896	0.9164	0 (acceptance)
Margins of exports growth	22.4147	0.3184	0 (acceptance)
Margins of imports growth	13.6220	0.8491	0 (acceptance)

Source: Computation

Table 13 shows the optimal copulas and their estimated parameters. The Gaussian copula is appropriate family to capture the dependence structure of GDP-export pair and GDP-Import pair while Export-Import pair is given to the Clayton copula. Moreover, the Kendall’s taus of all pairs are positive represent that the ranks of both variables in each pair increase together.

Table 13 Copula correlation matrix

	Family	Copula parameter	Kendall's tau
GDP and Export	Gaussian copula	0.607	0.39
GDP and Import	Gaussian copula	0.780	0.54
Export and Import condition on GDP	Clayton copula	1.176	0.39

Source: Computation

4) Long-run relationship among exports, imports and GDP via copula-VAR model for Singapore

Table 14 Causality Relationship between Exports, Imports and GDP in Singapore

Variables	EXPORT		IMPORT		GDP	
	Coefficient	**t-stat**	**Coefficient**	**t-stat**	**Coefficient**	**t-stat**
Constant	4.087	0.653	4.312	0.651	7.694*	1.667
EXPORT(t-1)	1.273*	1.879	-1.689	-1.517	1.321	1.361
IMPORT(t-1)	1.247*	1.740	-1.758	-1.493	1.387	1.351
GDP(t-1)	0.179	0.359	-0.238	-0.290	0.590	0.824
EXPORT(t-2)	0.390	0.356	0.009	0.006	1.354*	1.690
IMPORT(t-2)	0.262	0.226	0.568	0.377	1.941**	2.291
GDP(t-2)	-0.295	-0.365	1.068	1.017	-1.245**	-2.108
EXPORT(t-3)	0.061	0.072	-0.329	-0.262	0.518	0.625
IMPORT(t-3)	0.196	0.220	0.074	0.056	-0.180	-0.206
GDP(t-3)	-0.626	-1.005	0.577	0.624	0.234	0.383
EXPORT(t-4)	1.189	0.925	-1.310	-1.331	0.462	0.351
IMPORT(t-4)	0.595	0.438	-1.317	-1.265	1.361	0.980
GDP(t-4)	0.223	0.235	-0.616	-0.848	0.803	0.829
EXPORT(t-5)	0.594	0.878	-1.419*	-1.724	0.608	0.730
IMPORT(t-5)	0.953	1.332	-1.596*	-1.834	0.862	0.978
GDP(t-5)	0.123	0.247	-0.940	-1.549	0.958	1.560
EXPORT(t-6)	1.170	1.411	-0.059	-0.096	-1.273*	-1.759
IMPORT(t-6)	1.377	1.571	-0.456	-0.698	-1.586**	-2.072
GDP(t-6)	0.860	1.406	-0.282	-0.618	-1.181**	-2.212
Log-Likelihood	-243.356					
AIC	540.712					
BIC	578.544					

Source: Computation

Notes: *,** and *** denote 10%, 5% and 1% levels of significance respectively.

In the case of Singapore, the result indicates that exports and imports led economic growth. In contrast, GDP does determine neither imports nor exports. This result implies that ELG and ILG but not GLE in Singapore and highlights imports on GDP growth and exports policy to encourage economic growth.

Moreover, Table 14 shows that the elasticity of imports is greater than the elasticity of the exports and a 1% increase in imports leads to a gain in GDP growth of 1.941% at 5 percent significant level. We can write this relation in the functional form as follow:

GDP growth = f(EXPORT(t-2), IMPORT(t-2), GDP(t-2),

EXPORT(t-6), IMPORT(t-6), GDP(t-6))

Imports growth = f (EXPORT(t-5), IMPORT(t-5))

Exports growth = f (EXPORT(t-1), IMPORT(t-1))

Table 15 Testing the assumptions of i.i.d and Test for Autocorrelation

KS test for uniform distribution			
Null Hypothesis: Variable has uniform distribution			
	statistic	**pValue**	**Hypothesis**
Margins of GDP growth	0.1343	0.6198	0 (acceptance)
Margins of exports growth	0.0642	0.9995	0 (acceptance)
Margins of imports growth	0.0826	0.9825	0 (acceptance)
Box-Ljung Test for Autocorrelation			
Null Hypothesis: No autocorrelation			
	Q-Stat	**pValue**	**Hypothesis**
Margins of GDP growth	11.9896	0.9164	0 (acceptance)
Margins of exports growth	22.4147	0.3184	0 (acceptance)
Margins of imports growth	13.6220	0.8491	0 (acceptance)

Source: Computation

Table 15 presents the KS Test for if the probability transforms are uniform(0,1) and the null hypothesis of KS Test is variable has uniform distribution and the result from Table 15 rejects the null hypothesis for all 3 margins which implied that GDP growth, exports growth and imports growth ,in the case Singapore, have uniform distribution. We also employ the Ljung–Box tests on the standardized residuals in levels reported in Table 15 and the result highlights no autocorrelation. These results provide significant evidence that our marginal models are correctly specified.

Next we estimate the copula correlation and from the AIC and BIC perspective, the Rotated Gumbel copula was the best among parameter copula to capture the dependence structure of EXPORT –GDP pair, IMPORT- GDP pair and EXPORT –IMPORT pair (Table 16). Moreover, the Kendall's taus of all pairs are positive suggests that the ranks of both variables in each pair increase together.

Table 16 Copula correlation matrix

	Family	**Copula parameter**	**Kendall's tau**
GDP and Export	rotated Gumbel copula (180 degrees; "survival Gumbel")	3.124	0.68
GDP and Import	rotated Gumbel copula (180 degrees; "survival Gumbel")	5.283	0.81
Export and Import condition on GDP	rotated Gumbel copula (180 degrees; "survival Gumbel")	3.336	0.7

Source: Computation

5) Long-run relationship among exports, imports and GDP via copula-VAR model for Vietnam

The result of Table 17 indicates that exports and imports are important factors to determined GDP growth in Vietnam. Moreover, there is bidirectional relation between imports and GDP which support ILG. In contrast, there is no evidence suggests the causal direction from GDP to exports. The result also shows that exports led imports and imports led exports in Vietnam. We can write this relation in the functional form as follow:

GDP growth = f(IMPORT(t-1),EXPORT(t-2),IMPORT(t-2), EXPORT(t-3), IMPORT(t-3),GDP(t-3), EXPORT(t-4), GDP(t-4) ,EXPORT(t-6), IMPORT(t-6))

Imports growth = f (EXPORT(t-2), IMPORT(t-2), GDP(t-5) , EXPORT(t-6))

Exports growth = f (EXPORT(t-2), EXPORT(t-3), IMPORT(t-3), IMPORT(t-6))

Table 18 presents the KS Test for if the probability transforms are uniform(0,1) and the null hypothesis of KS Test is variable has uniform distribution and the result from Table 18 rejects the null hypothesis for all 3 margins which implied that GDP growth, exports growth and imports growth ,in the case Vietnam, have uniform distribution. We also employ the Ljung–Box tests on the standardized residuals in levels reported in Table 18 and the result highlights no autocorrelation. These results provide significant evidence that our marginal models are correctly specified.

Table 17 Causality Relationship between Exports, Imports and GDP in Vietnam

Variables	EXPORT		IMPORT		GDP	
	Coefficient	**t-stat**	**Coefficient**	**t-stat**	**Coefficient**	**t-stat**
Constant	14.389**	2.189	4.728	0.563	17.589**	2.068
EXPORT(t-1)	0.505	1.554	-0.483	-1.565	0.050	0.281
IMPORT(t-1)	0.469	1.131	-0.558	-1.417	0.657***	2.894
GDP(t-1)	0.247	0.588	0.132	0.332	-0.105	-0.456
EXPORT(t-2)	0.814**	2.485	-0.918***	-2.963	0.391*	1.648
IMPORT(t-2)	0.682	1.631	-1.035***	-2.614	0.794***	2.620
GDP(t-2)	0.295	0.695	-0.003	-0.007	-0.183	-0.597
EXPORT(t-3)	0.889***	3.331	-0.378	-1.313	1.044***	4.027
IMPORT(t-3)	1.176***	3.450	-0.551	-1.496	1.421***	4.293
GDP(t-3)	-0.043	-0.124	-0.597	-1.603	-0.793**	-2.366
EXPORT(t-4)	-0.245	-0.995	-0.187	-0.621	-0.627**	-2.069
IMPORT(t-4)	-0.169	-0.537	-0.627	-1.626	-0.452	-1.168
GDP(t-4)	0.393	1.233	0.227	0.582	0.879**	2.244
EXPORT(t-5)	0.270	1.090	0.105	0.345	0.524	1.458
IMPORT(t-5)	-0.030	-0.094	0.387	0.998	0.190	0.413
GDP(t-5)	-0.188	-0.585	-0.679*	-1.728	-0.565	-1.216
EXPORT(t-6)	-0.225	-1.126	-0.482*	-1.692	-0.468**	-1.791
IMPORT(t-6)	-0.449*	-1.758	0.087	0.240	-0.563**	-1.688
GDP(t-6)	0.289	1.116	-0.214	-0.582	0.194	0.573
Log-Likelihood	-354.725					
AIC	763.451					
BIC	801.283					

Source: Computation

Notes: *,** and *** denote 10%, 5% and 1% levels of significance respectively.

Table 18 Testing the assumptions of i.i.d and Test for Autocorrelation

KS test for uniform distribution			
Null Hypothesis: Variable has uniform distribution			
	statistic	**pValue**	**Hypothesis**
Margins of GDP growth	0.0946	0.9404	0 (acceptance)
Margins of exports growth	0.0757	0.9936	0 (acceptance)
Margins of imports growth	0.0950	0.9384	0 (acceptance)
Box-Ljung Test for Autocorrelation			
Null Hypothesis: No autocorrelation			
	Q-Stat	**pValue**	**Hypothesis**
Margins of GDP growth	9.6459	0.9741	0 (acceptance)
Margins of exports growth	17.5550	0.6167	0 (acceptance)
Margins of imports growth	9.5472	0.9757	0 (acceptance)

Source: Computation

Next we estimate the copula correlation and from the AIC and BIC perspective, the Frank copula was the best among parameter copula to capture the dependence structure of EXPORT-GDP and IMPORT-GDP while the Gumbel copula was the best among parameter copula to capture the dependence structure of EXPORT- IMPORT (Table 19).

Table 19 Copula correlation matrix

	Family	**Copula parameter**	**Kendall's tau**
GDP and Export	Frank Copula	3.767	0.37
GDP and Import	Frank Copula	4.977	0.46
Export and Import condition on GDP	Gumbel Copula	3.232	0.69

Source: Computation

4.3 Impulse response function

Next, we will present impulse response function (IRFs) which is tool to analyze dynamic effects of the system when the model received the impulse. IRFs could provide more insight into how shocks to exports and imports affect economic growth (and vice versa). Figure 2-6 provide results for the IRFs for Indonesia, Laos, Philippines, Singapore and Vietnam, respectively.

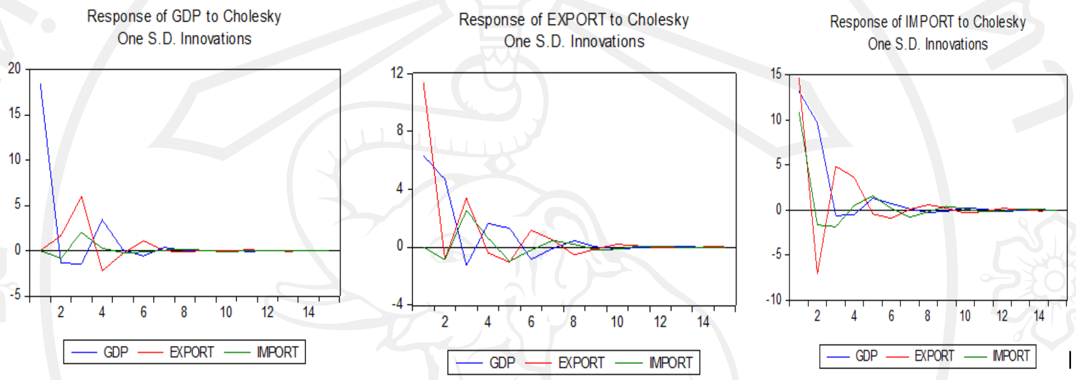

Figure 2 the Impulse Response Analysis for Indonesia

According to Figure 2, the first panel shows the impulse response of GDP growth to exports growth and imports growth for Indonesia. The IRFs shows the response of GDP to shock on exports and the response of GDP on imports are positive in the second to seventh period and then the effect gets weaker and become zero after eight years.

In order to check for reverse causality from GDP to exports and imports the responses of exports and imports are reported. When the impulse is GDP growth, the response of exports growth rate is positive and decrease to zero line after ten years. However, the response of imports growth to GDP shock is insignificantly different from zero.

Finally, the IRFs shows the response of imports to shock of exports is negative in the first and second year and then become a positive after four years and the effect gets weaker after seven years. In contrast, the response of exports to imports is small negative (around 0-4%) and become zero after eight years.

This finding reinforces the result from VAR analysis which provided support for the ELG and ILG argument.

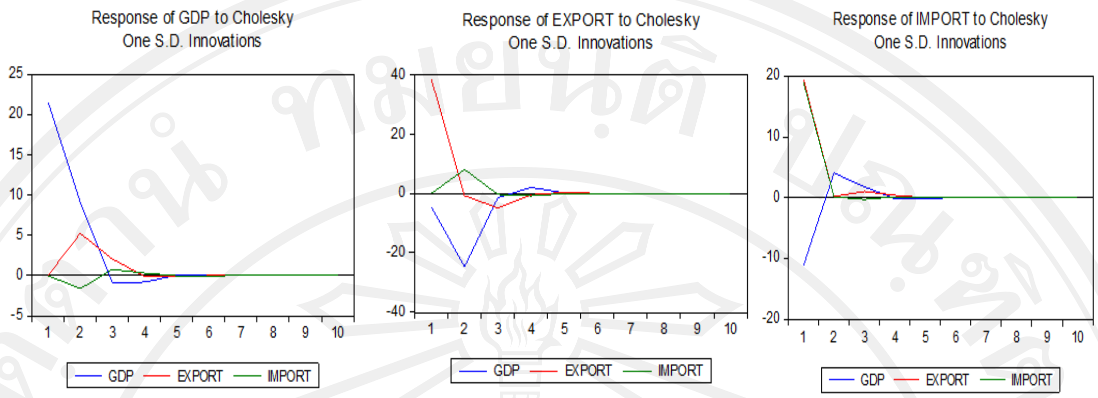

Figure 3 the Impulse Response Analysis for Laos

Figure 3 presents the results from IRFs analysis for Laos. First, there is no evidence in support of ILG as the response of GDP growth due to shocks of imports growth is not significantly different from zero at all horizons. However, IRFs supports ELG as a shock of exports has a positive and significant effect on output growth. Figure 3 also shows output growth has a negative impact on exports while there is positive impact of GDP on imports and the response of exports and imports become fluctuate around zero line after three years. Finally, there is no evidence appear to confirm relationship between imports and exports

Therefore, it supports our VAR findings that exports growth causes GDP and further highlights the significant role of exports in Laos's economic growth.

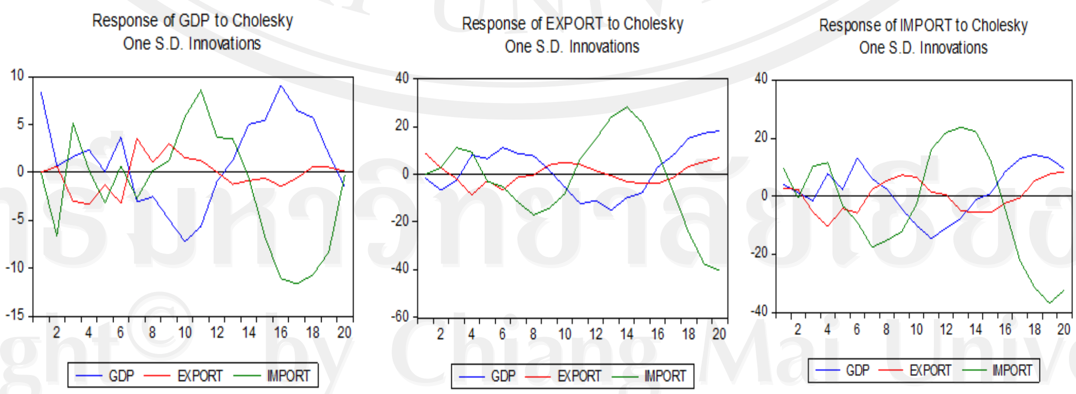

Figure 4 the Impulse Response Analysis for Philippines

According to the Figure 4, first panel presents the impact of GDP growth (GDP) shock, exports growth (EXPORT) shock and imports growth (IMPORT) shock on GDP. Response of GDP to IMPORT obvious fluctuation whiles the response of GDP to EXPORT smooth fluctuation and reach to initial equilibrium. The result also shows that the imports growth (IMPORT) has large effect on GDP growth than exports growth (EXPORT).

The second panel of Figure 4 shows the impact of GDP growth (GDP) shock, exports growth (EXPORT) shock and imports growth (IMPORT) shock on exports growth. Response of EXPORT to IMPORT and GDP obvious fluctuation and the affect move out from initial equilibrium in the long-run. The result suggests that the IMPORT has large effect on exports growth than effect of GDP on EXPORT.

The third panel presents the impact of GDP growth (GDP) shock, exports growth (EXPORT) shock and imports growth (IMPORT) shock on imports growth. Response of IMPORT to GDP and the response of IMPORT to EXPORT obvious fluctuation around the zero line and the impact of imports itself have large effect than GDP growth and exports growth.

Thus, IRFs suggests imports in Philippines have large effect on other variables than exports growth and GDP growth which highlight important of imports policy to driving economic growth.

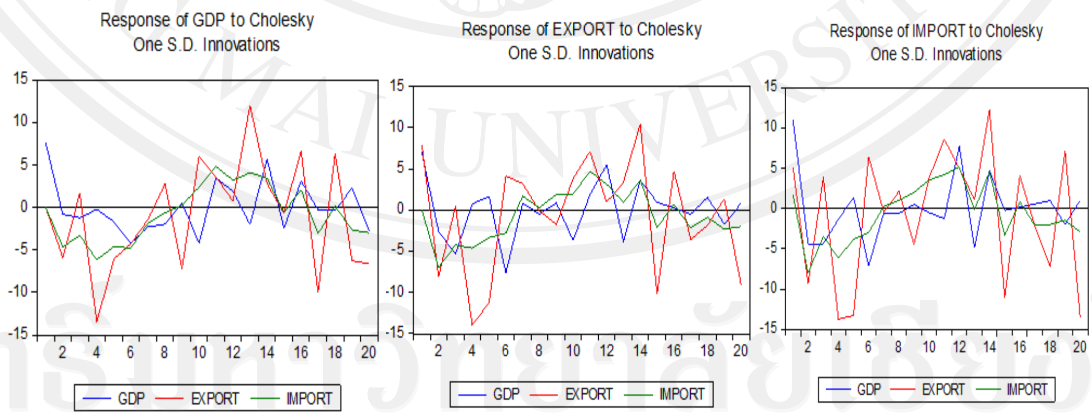

Figure 5 the Impulse Response Analysis for Singapore

To investigate further the impact of exports growth on GDP growth as compared to imports growth, we then have used impulse response function to trace the time paths of GDP in response to a one-unit shock to the variables such as exports growth and imports growth. The first panel of Figure 5 shows the response of GDP to shock of exports obvious fluctuation. The effect is negative and the response reach minimum when the period of response is 4, then the response extent increase. The response of GDP to shock of imports also fluctuation but the imports growth has less effect than exports growth.

The second panel of Figure 5 shows the response of exports growth to shock of GDP and imports growth which obvious fluctuate. Moreover, the response of exports growth to shock of GDP has larger effect than imports growth.

Finally, Figure 5 shows the response of imports to shock of GDP and exports which varies all time horizons. Moreover, the response of imports growth to shock of exports has larger effect than GDP growth.

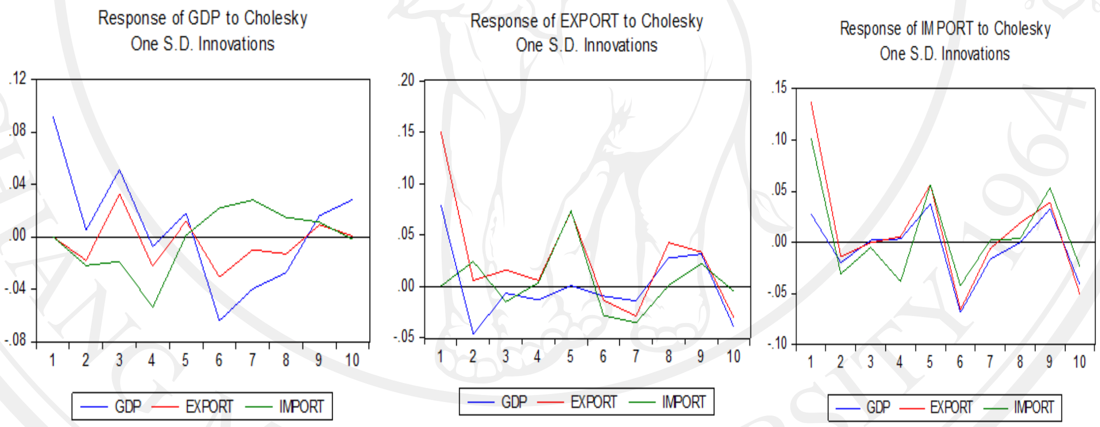

Figure 6 the Impulse Response Analysis for Vietnam

According to the Figure 6, the first panel shows the impact of GDP growth (GDP) shock, exports growth (EXPORT) shock and imports growth (IMPORT) shock on GDP. The response of GDP to one S.D. innovations of imports growth is negative from the first period, then the response reach minimum when the period of response is 4, after that, the response extent increases and reaches to initial equilibrium after ten years. The response of GDP to exports growth fluctuates around zero line and reaches to initial equilibrium after ten years. The result shows that the imports growth has large effect on GDP growth than exports growth.

The second panel of Figure 6 shows the impact of GDP growth (GDP) shock, exports growth (EXPORT) shock and imports growth (IMPORT) shock on exports growth. Response of EXPORT to GDP is negative and the response extent increases when the period of response is 7. The response of EXPORT to IMPORT obvious fluctuates but moves around zero line. The result shows that the imports growth (IMPORT) has large effect on exports growth than GDP growth (GDP).

Finally, Figure 6 shows the impact of shock GDP growth (GDP), exports growth (EXPORT) and imports growth (IMPORT) on IMPORT. Response of IMPORT to GDP and the response of IMPORT to EXPORT obvious fluctuate and move in the same direction.

5. Concluding remarks

In this study, Copula-VAR analysis was applied to investigate the causal relationship among the variables of annual GDP growth, import growth, and export growth belonging to the period 1980–2010 of ASEAN countries (Brunei, Vietnam, Malaysia, Indonesia, The Philippines, Singapore, Thailand, and Laos). The contributions of this paper are the following: 1) export growth and import growth are included in the model as endogenous variables which previous empirical studies specify as exogenous variables. 2) We employ copula-VAR model (suggested by Bianchi, et. al (2010)) and the result suggests that the copula approach are fit to construct the VAR model in ASEAN case.

In particular, these results indicate that relationship among imports, exports, and output have different qualitative relationships in each country. Moreover, results suggest there is a causal relation among imports, exports, and output in Malaysia, Thailand, and Brunei. In contrast, the study found empirical evidence in support of bi-directional causal relationship between exports and GDP growth for Laos and The Philippines. Furthermore, the results of Indonesia, Singapore, and Vietnam support only ELG hypothesis, not GLE hypothesis. Empirical results also suggest that there is evidence in support of ILG hypothesis for The Philippines, Indonesia, Singapore, and Vietnam.

This study's results confirm that the exclusion of imports and the singular focus of many past studies on merely the role of exports as the engine of growth may be misleading or lead to incomplete results. Current empirical evidence from selected ASEAN countries provides empirical support for both ELG and ILG hypothesis, and in some cases there is also evidence to suggest the impact of import growth as larger than export growth on GDP growth, which implies the importance of import policy. Thus, it is reasonable to conclude that for several ASEAN countries, both exports and imports play a very important role in stimulating economic growth.

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