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Full Length Research

Modelling the nexus between defense spending and economic growth in asean- 5: Evidence from cointegrated panel analysis

Rudra P. Pradhan

Assistant Professor, Vinod Gupta School of Management, Indian Institute of Technology Kharagpur, India. Email: rudrap@vgsom.iitkgp.ernet.in.

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The paper explores the nexus between defense spending and economic growth in the five ASEAN countries namely, namely Indonesia, Malaysia, Philippines, Singapore and Thailand over the period 1988 - 2007. The empirical analysis is based on cointegration and causality test at the individual level and panel level. The findings suggest the presence of unidirectional causality from economic growth to defense spending in Indonesia, Malaysia, Singapore and Thailand. It also finds the feedback between defense spending and economic growth in Philippines at the individual level and at the panel of ASEAN-5. The implication of this research is that neither economic growth nor defense spending can be considered as exogenously determined.

Key words: Economic growth, defense spending, panel cointegration.

INTRODUCTION

The foundation of credible national security is based upon the level of economic prosperity and wellbeing of people in the country. It depends upon, other things remaining same, the provision of government on public goods such as protection, security, peace, etc. The perception is that economic growth is closely related to government's provision on defense. This is, however, debated in the development literature. There are two opinions on the relationship between economic growth and defense spending. First, the massive inflow of resources into the defense sector leads to crowd out resources for the civilian sector and hence, could affect the general welfare. Second, the larger flows of defense spending leads to creation of externalities such as infrastructure, human capital, technological progress, etc. and therefore, could contribute general welfare in the economy.

At a purely economic point of view, defense spending was widely recognized as the quintessential unproductive expenditure (except as insurance against war) and consequently, generated negative impact on economic growth (Dunne et al., 2001; Dunne and Vougas, 1999; Deger, 1986; Deger and Smith, 1983). The relation between defense spending and economic growth has, however, been debated since the seminal work of Benoit (1973, 1978), who suggests that defense spending has a positive impact on economic growth (Reitschuler and Loening, 2005; Halicioglu, 2004; Georgiou et al., 1996; Deger and Sen, 1995; Looney, 1994; Nadir, 1993; Joerding, 1986). There are many ways we can establish the positive impact of defense spending on economic development:

(1) Defense spending promotes growth, if some of the expenditure is used for the creation of socio-economic infrastructure like roads, bridges, airports, hospitals, etc.
(2) Defense spending leads to formation of human capital, if the part of defense spending is used for education, training, discipline, etc.
(3) Defense spending provides protection to the citizens, where internal and external security promotes market exchange.
(4) Defense spending can improve productivity and generate welfare, if the part of spending is used for revamping the economy during crisis times like, earthquakes, floods, terrorist attacks, etc.

(5) Defense spending provides direct technology benefits and spin- offs, where spin- offs applied to the civil sector can promote economic growth.
(6) In the period of unemployment, defense spending provides stimulate effect to economic growth.

The aforementioned benefits of defense spending and its impact on economic growth cannot be generalized across countries and over time (Kollias et al., 2004). There are two broad groups of research on the relation between defense spending and economic growth. First, regression based modelling, where the direction of causality does not matter (Yildirim et al., 2005; Ocal, 2003; Shieh et al., 2002; Stroup and Heckelman, 2001; Alexander, 1990) and second, time series modelling, where the direction of causality does matter (Hirnissa et al., 2008; Yildirim and Ocal, 2006; Atesoglu, 2002; Dakurah et al., 2001; Kollias and Makrydakis, 2000; Chowdhury, 1991). The present study is, however, very keen on time series approach on the nexus between defense spending and economic growth. The debate, in this approach, is whether defense spending responds to increase economic growth or whether enhance in economic growth actually propel increased defense spending. The findings are, however, very inconclusive and sometimes conflicting in nature. That varies with respect to countries and even within a country with different time periods. The foregoing discussion give rise to four possible outcomes: (1) unidirectional causality from economic growth to defense spending; (2) unidirectional causality from defense spends to economic growth; (3) bidirectional causality between defense spending and economic growth and (4) no causality between defense spending and economic growth. The net effect of defense spending on economic growth is, moreover, either positive or negative. There are various policy implications we can derive from the direction of causality between defense spending and economic growth.

The purpose of this study is to empirically investigate the relationship between defense spending and economic growth in the ASEAN-5, namely Indonesia, Malaysia, Philippines, Singapore and Thailand. Though the goal of this study is similar to those of previous studies in this area of research (Hirnissa et al., 2009; Frederiksen and McNab, 2001; Frederiksen, 1991; Looney and Frederiksen, 1990; Frederiksen and LaCivita, 1987), the method of analysis is different at least in one ground. That is the use of panel cointegration and panel causality. The paper first explores the nexus between defense spending and economic growth at the individual country and then compared with panel data setting.

Econometric modelling and database

The relation between defense spending and economic growth has been investigated under three steps: (1) test for order of integration; (2) test for cointegration and (3) test for direction of causality. We conduct these three tests at the individual level as well as panel level. The detail descriptions of these three tests are mentioned below.

Unit root test

The study uses Augmented Dickey Fuller (Dickey and Fuller, 1981) and Ng- Perron (Ng and Perron, 2001) unit root tests to test the stationarity of time series variables. The NG-Perron test is, however, more reliable to the stationarity, because of its good size and power. But the limitation of these two techniques is that they have the problem of low power in rejecting the null hypothesis of stationarity of the time series, particularly for small size of data. The study, therefore, uses panel unit root test to determine the order of integration. The advantage of panel unit root test is that it has good size and power. The panel unit root test has number of test statistics, like IPS, LLC, ADF and PP. The LLC and IPS are, however, very popular and they are based on the lines of ADF principle only (Levin et al., 2002; Im et al., 2003). The LIC assumes homogeneity in the dynamics of autoregressive coefficients for all panel numbers, while IPS assumes for heterogeneity in these dynamics. Hence, IPS is otherwise called as "heterogeneous panel unit root tests".

The LLC proposes a panel-base augmented Dickey-Fuller (ADF) test with a panel setting and restricts γ to keep it identical across cross-sectional regions. The test imposes homogeneity on the autoregressive coefficient, which indicates the presence or absence of a unit root whereas the intercept and trend can vary across individual series. The model only allows for heterogeneity in the intercept and is given by:

$$\Delta Y_{it} = \alpha_i + \gamma Y_{it-i} + \sum_{j=1}^{p_i} \beta_j \Delta Y_{it-j} + \varepsilon_{it} \qquad (1)$$

where Y_{it} is a series for panel member (country i (i = 1, 2, .., N) over period t (t = 1, 2, …, T)); p_i is the number of lags in the ADF regression and the error term ε_{it} are assumed to be IID (0, σ^2) and to be independent across the units of the sample. The model allows for fixed effects, unit specific time trends and common time effects. The coefficient of the lagged dependent variable is restricted to be homogenous across all units of the panel. Consequently, the null hypothesis of non-stationary is as follows:

H_0: $\gamma_i = 0$, is tested against the alternative,
H_A: $\gamma_i = \gamma < 0$ for all i (2)

where, the fixed effect model in Equation 1 is based on the usual t-statistics.

$$t_\gamma = \frac{\hat{\gamma}}{s.e(\hat{\gamma})} \qquad (3)$$

where, γ is restricted by being kept identical across regions under both the null and alternative hypothesis.

The IPS begins by specifying a separate ADF regression for each cross section (country):

$$\Delta Y_{it} = \alpha_i + \gamma_i Y_{it-i} + \sum_{j=1}^{p_i} \beta_{ij} \Delta Y_{it-j} + \varepsilon_{it} \quad \text{.......... (4)}$$

where series y_{it} (i = 1, 2,…, N; t = 1, 2, …, T) is the panel series (that is, country *i* over time period *t*), p_i is the number of lags in the ADF regression and the error term ε_{it} is assumed to be IID $(0, \sigma_i^2)$ for all i and t.

Both γ_i and the lag order β in equation (4) are allowed to vary across sections (countries). IPS relaxes the assumption of homogeneity of the coefficient of the lagged dependent variable. They test the null hypothesis that each series in the panel has a unit root for all cross-section units against the alternative that at least one of the series is stationary:

H_0: $\gamma_i = 0$ for all i, is tested against the alternative,

H_A: $\gamma_i = \gamma_i < 0$ for i = 1, 2, …., N_1, $\gamma_i = 0$,

i = N_1 +1, N_1 + 2, …, N (5)

The alternative hypothesis simply implies that some or all of the individual series are stationary. The IPS developed two test statistics: LM-bar test and the t-bar test. The IPS t-bar statistics is calculated using the average of the individual Dickey-Fuller τ statistics:

$$\bar{t} = \frac{1}{N} \sum_{i=1}^{N} \tau_i \quad (6)$$

$$\tau_i = \frac{\hat{\gamma}_i}{s.e(\hat{\gamma}_i)} \quad (7)$$

Assuming that the cross sections are independent, IPS proposes the use of standardized t-bar statistic. This is as follows:

$$\bar{Z} = \frac{\sqrt{N}(\bar{t} - E(\bar{t}))}{\sqrt{Var(\bar{t})}} \quad (8)$$

The term $E(\bar{t})$ and $Var(\bar{t})$ are the mean and variance of τ statistic. They are generated by simulations and are tabulated in IPS (Im et al., 2003).

Cointegration test

When the series becomes stationary at the first difference level, then there is possibility of linear combinations between the variables. The test to examine the same is known as cointegration (Granger, 1988). If the variables are integrated of order one, the next step is to use cointegartion technique in order to know whether there is any long run relationship among the set of integrated variables. Cointegration tests in this paper are conducted using the method developed by Johansen (1988) and Johansen and Juselius (1990). The method is, moreover, not suited in the panel settings. Hence, Pedroni's (2004) cointegration technique is deployed for the panel data setting. The Pedroni technique is very suitable for the small samples, allowing the heterogeneity in the intercept and slopes in the cointegrating equation. The test starts with the following time series panel regression:

$$GDP_{it} = \alpha_i + \delta_t + \beta_i GED_{it} + \varepsilon_{it} \quad \text{............... (9)}$$

$$\varepsilon_{it} = \rho_i \varepsilon_{i(t-1)} + w_{it} \quad \text{............... (10)}$$

where GDP and GED are the observable variables with dimension of (N* T)) X 1 and (N* T) X m respectively; ε_{it} represents the disturbance term from the panel regression; α_i allows for the possibility of country-specific fixed effects and the coefficients of β_i allows for the variation across individual countries.

The null hypothesis of no cointegration of the pooled (within-dimension) estimation is H_0: $\rho_i = 1$ for all i against H_0: $\rho_i = \rho < 1$. But under alternative hypothesis, the within-dimensional estimation assumes a common value for $\rho_i = \rho$. That means it does not allow an additional source of possible heterogeneity across individual country members of the panel. The null hypothesis of no-cointegration of the pooled (between-dimension) estimation is H_0: $\rho_i = 1$ for all i against H_0: $\rho_i < 1$.

Moreover, under alternative hypothesis, the between-dimensional estimation does not assume a common value for $\rho_i = \rho$. That means it allows an additional source of possible heterogeneity across individual country members of the panel.

Pedroni suggested two types of test to know the existence of heterogeneity of cointegration vector. First, test based on within-dimension approach (that is, panel test). It includes four statistics such as panel *v*-statistic, panel ρ- statistic, panel PP- statistic and panel ADF-statistic. These statistics pool the autoregressive coefficients across different members for the unit root tests on the estimated residuals. Second, test based on between- dimensional approaches (group test). It includes three statistics such as group ρ-statistic, group PP-statistic and group ADF-statistic. These statistics are based on estimators that simply average the individually estimated coefficients for each member. The details of heterogeneous panel and heterogeneous group mean panel cointegration statistics are calculated as follows:

Panel *v*- statistic, which is shown is Equation 11:

$$Z_v = \left[\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{\varepsilon}_{it-1}^{2} \right]^{-1} \quad (11)$$

Panel ρ- statistic:

$$Z_\rho = \left[\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{\varepsilon}_{it-1}^{2} \right]^{-1} \sum_{i=1}^{N} \sum_{t=1}^{T} L_{11i}^{-2} \left(\hat{\varepsilon}_{it-1} \Delta \hat{\varepsilon}_{it} - \hat{\lambda}_i \right) \quad (12)$$

Panel PP- statistic:

$$Z_t = \left[\hat{\sigma}^2 \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{\varepsilon}_{it-1}^{2} \right]^{-0.5} \sum_{i=1}^{N} \sum_{t=1}^{T} L_{11i}^{-2} \left(\hat{\varepsilon}_{it-1} \Delta \hat{\varepsilon}_{it} - \hat{\lambda}_i \right) \quad (13)$$

Panel ADF- statistic:

$$Z_t^* = \left[\hat{s}^{*2} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{\varepsilon}_{it-1}^{*2} \right]^{-0.5} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{\varepsilon}_{it-1}^{*} \Delta \hat{\varepsilon}_{it}^{*} \quad (14)$$

Group ρ- statistic:

$$\tilde{Z}_\rho = \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \hat{\varepsilon}_{it-1}^{2} \right)^{-1} \sum_{t=1}^{T} \left(\hat{\varepsilon}_{it-1} \Delta \hat{\varepsilon}_{it} - \hat{\lambda}_i \right) \quad (15)$$

Group PP- statistic:

$$\tilde{Z}_t = \sum_{i=1}^{N} \left(\hat{\sigma}^2 \sum_{t=1}^{T} \hat{\varepsilon}_{it-1}^{2} \right)^{-0.5} \sum_{t=1}^{T} \left(\hat{\varepsilon}_{it-1} \Delta \hat{\varepsilon}_{it} - \hat{\lambda}_i \right) \quad (16)$$

Group ADF- statistic:

$$\tilde{Z}_t^* = \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \hat{s}_i^2 \hat{\varepsilon}_{it-1}^{*2} \right)^{-0.5} \sum_{t=1}^{T} \left(\hat{\varepsilon}_{it-1}^{*} \Delta \hat{\varepsilon}_{it}^{*} \right) \quad (17)$$

where, $\hat{\varepsilon}_{it}$ is the estimated residual from equation (9) and $\hat{L}_{11i}^{-2}$ is the estimated long run covariance matrix for $\Delta\hat{\varepsilon}_{it}$.

Similarly, $\hat{\sigma}_i^2$ and $\hat{s}_i^2 \left(\hat{s}_i^{*2} \right)$ are the long run and contemporaneous variances for individual i. All seven tests are asymptotically standard normal distribution given by the respective panel/ group cointegration statistic. The panel v is a one sided test where large positive values reject the null hypothesis of no cointegration. The other remaining statistics diverge to negative infinite, which means that large negative values reject the null hypothesis. These tests are able to accommodate individual specific short-run dynamics, individual specific fixed effects and deterministic trends as well as individual specific slope coefficients (Pedroni, 2004).

Granger causality test

According to Granger (1988), if two variables are cointegrated, then there is possibility of causality between the two at least in one direction. The Granger causality test is applied here to examine the nature of the relationship between defense spending and economic growth. It applies at the individual country and the panel setting. The causality test follows two step processes (Engle and Granger, 1987): First, estimation of residuals from the long run cointegrating equation and second, fitting the estimated residuals as right variable in a dynamic error correction model. The dynamic error correction model can be specified as follows:

$$\Delta GDP_{it} = \eta_j + \sum_{k=1}^{p} \alpha_{ik} \Delta GDP_{it-k} + \sum_{k=1}^{q} \beta_{ik} \Delta GED_{it-k} + \lambda_i EC_{1it-k} + \Delta\varepsilon_{1it}$$

….. (18)

$$\Delta GED_{it} = \mu_j + \sum_{k=1}^{p} \gamma_{ik} \Delta GED_{it-k} + \sum_{k=1}^{q} \partial_{ik} \Delta GDP_{it-k} + \tau_i EC_{2it-k} + \Delta\varepsilon_{2it} \quad (19)$$

where Δ is the difference operator; EC is lagged error correction term obtained from the cointegrating equation; λ and τ are adjustment coefficients; and $\varepsilon_1$and ε_2 are disturbance terms.

We can identify the sources of causation by testing for the significance of the coefficients on the lagged dependent variables in equations (18) and (19). To evaluate the weak Granger causality, we first test H_A: $\beta_{ik} = 0$ for all i in equation (18), or δ_{ik} = o for all i in equation (19). The weak Granger causality is treated as short run shocks to the stochastic environment. The long run causality can be tested by looking at the significance of the coefficient of the error term in equations (18) and (19). That means the change in the endogenous variable is caused not only by their lags, but also by the previous period's disequilibrium.

To examine the long run causality relationship, we test H_A: $\lambda_i = 0$ for all i in equation (18) or H_A: $\tau_i = 0$ for all i in equation (19). For example, if $\lambda_i = 0$ then economic growth does not respond to deviations from the long run equilibrium in the previous period. Similarly if $\tau_i = 0$, then defense spending does not respond to deviations from the long run equilibrium in the previous period. If both $\lambda_i =$

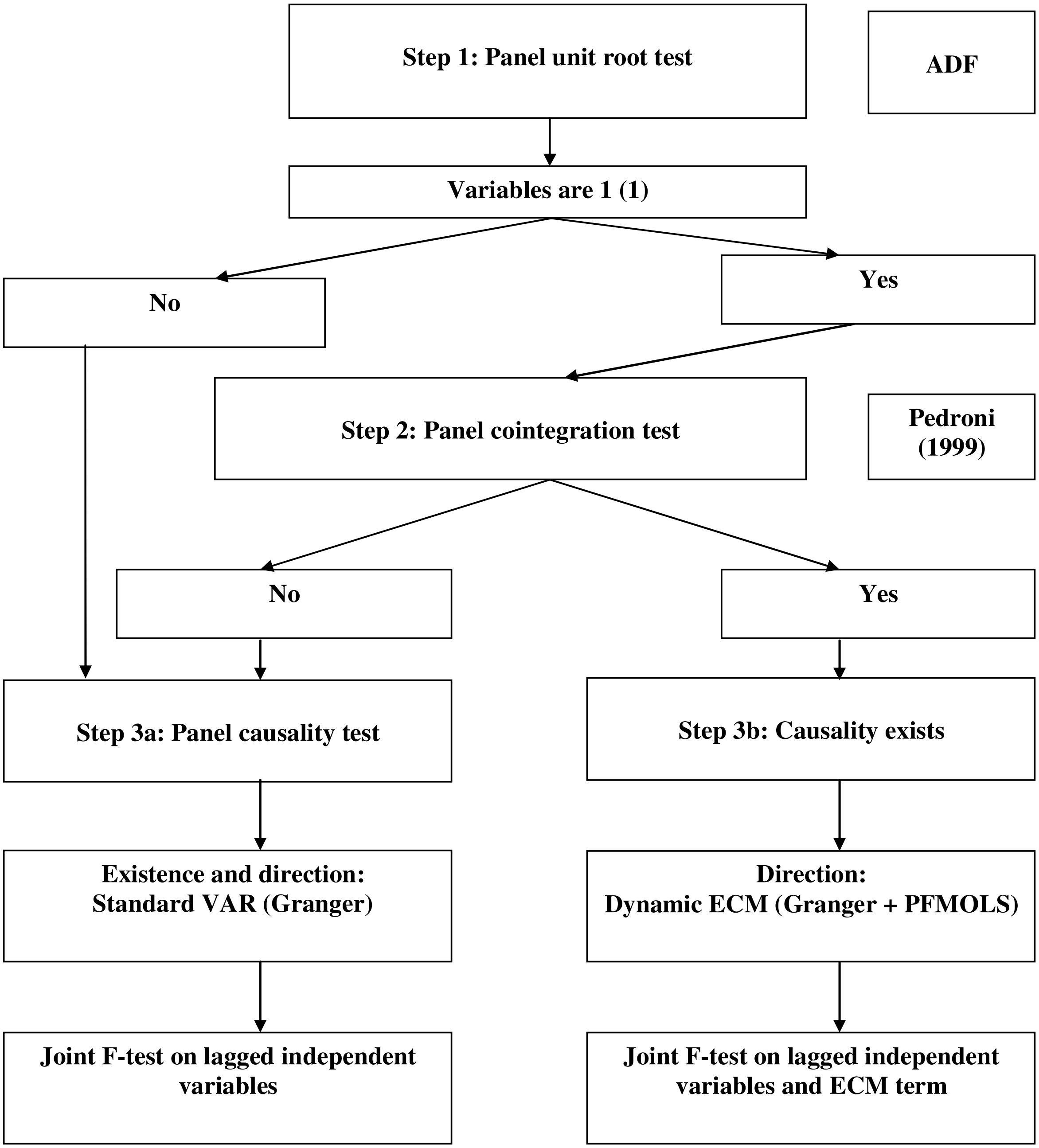

Figure 1. Panel causality testing framework.

0 and τ_i = 0 for all i is equivalent to both Granger non-causality in the long run and the weak exogeneity. The sources of causation will be done by testing the joint hypothesis of H_A: $\beta_{ik} = \lambda_i = 0$ for all i in equation (18) or H_A: $\partial_{ik} = \tau_i = 0$ for all i in equation (19). This is referred to as a strong Granger causality test. The joint test indicates which variables bear the burden of short run adjustment to reestablish the long run equilibrium, following a shock to the system. If there is no causality in either direction, the neutrality hypothesis holds true. The details of the econometric methodology adopted in this paper are summarized in Figure 1.

The empirical analysis is based on a panel of five emerging countries, namely Indonesia, Malaysia, Philippines, Singapore and Thailand, over the period 1988-2007. The data used in the study are GDP (as a proxy to economic growth), PCGDP (per capita GDP) and military expenditure as a percentage of GDP (as a proxy to defense spending). The data on GDP has been obtained from World Development Indicators, World Bank; data on per capita GDP has been obtained from World Resources Institute, Washington; and data on

Table 1. Descriptive statistics of defense spending and economic growth.

Countries	Variable	Mean	Med	Max	Min	Std	Skew	Kur
	GED	0.138	0.146	0.301	-0.046	0.100	-0.209	1.873
Indonesia	GDP	5.239	5.218	5.636	4.948	0.186	0.414	2.549
	PCGDP	3.436	3.452	3.640	3.166	0.129	-0.469	2.510
	GED	0.371	0.371	0.505	0.204	0.081	-0.469	2.857
Malaysia	GDP	4.911	4.945	5.271	4.547	0.193	-0.192	2.495
	PCGDP	3.864	3.891	4.090	3.572	0.149	-0.422	2.238
	GED	0.067	0.079	0.176	-0.046	0.079	-0.233	1.524
Philippines	GDP	4.843	4.875	5.159	4.578	0.149	0.049	2.643
	PCGDP	3.577	3.571	3.760	3.429	0.097	0.367	2.086
	GED	0.670	0.672	0.732	0.602	0.035	-0.001	2.553
Singapore	GDP	4.865	4.926	5.208	4.401	0.214	-0.698	2.745
	PCGDP	4.289	4.304	4.540	4.005	0.154	-0.210	2.109
	GED	0.261	0.300	0.447	0.041	0.142	-0.228	1.481
Thailand	GDP	5.112	5.099	5.389	4.790	0.148	-0.332	2.871
	PCGDP	3.766	3.789	3.990	3.458	0.145	-0.46	2.555

GED: Government Expenditure on Defense; GDP: Economic Growth; PCGDP: Per capita GDP; Med: Median; max: Maximum; Min: Minimum; Std: Standard Deviation; Skew: Skewness; Kur: Kurtosis. Note 2: The descriptive statistics are reported at the log of original variables.

defense spending has been obtained from Stockholm International Peace Research Institute, Stockholm. The natural logs of the variables are taken for the econometric analysis. The summary of descriptive statistics of the variables is reported in Table 1.

RESULTS AND DISCUSSION

In what follows we discuss the results based on the econometric setting on the nexus between defense spending and economic growth in the ASEAN-5 countries, namely Indonesia, Malaysia, Philippines, Singapore and Thailand. We first analyse the dynamics between defense spending and economic growth at the individual country, and then examine the dynamic implications at the panel of ASEAN-5. The econometric analysis starts with the stationarity of the time series data, which is, in fact, the prime requirement for cointegration and causality test. The estimated results of unit root tests are reported in Table 2 for the individual country. The computed test statistics (ADF and Ng-Perron) could not reject the null hypothesis of stationarity at any level of significance (1 to 10%). This confirms that the time series variables (economic growth (measured by GDP and PCGDP) and defense spending) are having unit root problems at the level. But once the first differences of the variables are considered, the null hypothesis of unit root is rejected at 5% significance level. This is exclusively true for all the five individual countries, namely Indonesia, Malaysia, Philippines, Singapore and Thailand.

The Table 3 provides the unit root test results at the panel of ASEAN-5 countries, namely Indonesia, Malaysia, Philippines, Singapore and Thailand. The results confirmed that the time series variables are having unit roots problem at the level data. But they attain stationarity at the first difference level, as the null hypothesis of non-stationarity is rejected at 5% level of significance. Overwhelmingly, all the testing procedures suggest the existence of unit root or non-stationarity in the level but found stationary at the first difference for all the variables. This confirms that the variables are integrated of order one (or I (1)).

Having confirmed the existence of unit roots for all the data series, the next step is to check possibility of long run equilibrium relationship between defense spending and economic growth. The cointegration test is applied for the same at the individual data series and panel level. The Johansen's maximum likelihood test has been applied for each country in the panel and Pedroni's panel cointegration test has been applied to the five countries in the panel. The estimated results are reported in Tables 4 and 5. The null hypothesis of no cointegrating vector in favour of at least one cointegrating vector is rejected at 5% significance level for all ASEAN-5 counties at the individual (Table 4) and the panel (Table 5). The rejection of null hypothesis of no cointegration implies that two variables do not drift apart and share at least a common stochastic trend in the long run. This confirms that there

Table 2. Univriate unit root test results.

Variable	Indonesia	Malaysia	Philippines	Singapore	Thailand	Conclusion
			ADF test			
GED	-1.6 (-3.1*)	-1.9 (-6.2*)	-0.6 (-5.2*)	-1.7 (-3.95*)	-0.8 (-2.5**)	1 (1)
GDP	-0.8 (-4.9*)	-0.6 (-3.1**)	-0.1 (-3.5*)	-1.2 (-2.4**)	-1.2 (-2.4**)	1 (1)
PCGDP	-1.8 (-2.8*)	-2.0 (-3.3*)	1.3 (-4.2*)	-1.2 (-4.2*)	-1.1 (-2.5**)	1 (1)
			Ng- Perron test			
GED						
MZa	-3.8 (-8.1*)	-1.1 (-7.6*)	0.3 (-8.3*)	-5.6 (-9.0*)	-1.6 (-8.4*)	1 (1)
MZt	-1.3 (-2.0)	-2.9 (-1.95)	0.2 (-2.0)	-1.49 (-2.1)	-0.73 (-1.6)	
MSB	0.3 (0.3)	0.2 (0.3)	0.7 (0.2)	0.3 (6.2)	0.4 (0.2)	
MPT	6.5 (3.1)	1.5 (3.2)	30.4 (3.1)	4.8 (2.9)	12.5 (4.4)	
GDP						
MZa	-0.6 (-8.9*)	1.5 (-8.5*)	1.9 (-8.0*)	-3.6 (-6.2*)	-6.1 (-6.6*)	1 (1)
MZt	-0.2 (-2.1)	1.0 (-2.0)	1.1 (-2.0)	-1.1 (-1.7)	-1.4 (-1.8)	
MSB	0.3 (0.2)	0.7 (6.2)	0.6 (0.2)	0.3 (6.2)	0.2 (0.3)	
MPT	11.7 (2.8)	36.5 (3.0)	29.9 (3.0)	6.8 (4.0)	4.8 (3.8)	
PCGDP						
MZa	-1.4 (-7.4*)	-1.0 (-8.3*)	0.3 (-6.9*)	-3.3 (-8.7*)	-1.5 (-5.7*)	1 (1)
MZt	-0.5 (-1.9)	-0.4 (-2.0)	0.12 (-1.9)	-1.0 (-2.08)	-0.6 (-1.7)	
MSB	0.4 (0.3)	0.4 (0.24)	0.5 (0.27)	0.31 (0.24)	0.39 (0.29)	
MPT	11.2 (3.3)	12.9 (2.98)	17.6 (3.6)	7.08 (2.85)	10.9 (4.41)	

The parentheses indicate the test statistics at the first difference level; * (**): Statistically significant at 1% (10%) level; and other notations are defined earlier.

Table 3. Panel unit root test results.

Variable	IPS	LLC	ADF	PP	Conclusion
GED	0.059 (0.52)	0.869 (0.81)	6.786 (0.74)	5.15 (0.88)	-----
GDP	1.813 (0.97)	0.252 (0.60)	2.511 (0.99)	4.00 (0.95)	-----
PCGDP	2.22 (0.99)	0.037 (0.52)	3.24 (0.96)	7.54 (0.67)	-----
ΔGED	-2.286* (0.01)	-1.52* (0.05)	20.93* (0.02)	51.47* (0.00)	1 (1)
ΔGDP	-2.135* (0.02)	-3.05* (0.00)	19.73* (0.03)	32.17* (0.00)	1 (1)
ΔPCGDP	-2.9* (0.00)	-4.17* (0.00)	25.29* (0.00)	32.14* (0.00)	1 (1)

IPS: IM, Pesaran and Shin W-stat; LLC: Levin, Lin and Chu t-stat; ADF: ADF- Fisher Chi-square; PP: PP- Fisher Chi-square; the parenthesis indicate the probability of significance; and *: indicates the test statistic is statistically significant.

is cointegration between defense spending and economic growth, measured by GDP and per capita GDP, in the ASEAN-5 countries at the individual and panel level after allowing for a country specific effect. The results, in overall, indicate that the variables share a long run co-movement that is bounded by their long run equilibrium relationship.

The subsequent aim of this paper is to know the direction of causality between economic growth and defense spending. The cointegrating test already provides an indication of causality between defense spending (DS) and economic growth (GDP/ PCGDP). But it does not ensure any direction of causality. We therefore, deploy the Error Correction Model (ECM) to detect the direction of causality between defense spending and economic growth, both in the short run and long run. The long run causality can be revealed through the significance of the lagged error correction terms(ECM) by t- statistic, while F-statistic (or Wald test) is used to detect the short run causality through the significance of joint test with an application of sum of lag explanatory variables in the model. The Table 6 presents the results of causality test, both at the individual country and panel of ASEAN-5. It shows the presence of unidirectional causality from economic growth to defense spending (GDP => DS and PCGDP=> DS) in Indonesia, Malaysia,

Table 4. Results of Johansen's cointegration test.

Countries	Null hypothesis	Trace statistics	MEV statistics
Indonesia	None	16.6*(16.94*)	17.2*(14.07*)
	At most 1	3.58(2.86)	3.84 (2.86)
Malaysia	None	28.3*(13.91*)	28.1*(13.43*)
	At most 1	0.21(0.475)	0.21 (0.475)
Philippines	None	15.8*(12.57*)	15.4*(12.12*)
	At most 1	0.44(0.442)	0.44 (0.442)
Singapore	None	23.6* (20.8*)	16.1*(17.4*)
	At most 1	7.56(3.479)	7.56 (3.479)
Thailand	None	23.2*(20.95*)	17.34*(14.76*)
	At most 1	6.189(5.858)	5.900(6.189)
Johansen's fisher panel cointegration			
Test	None	24.47*(31.86*)	24.22*(32.37*)
	At most 1	10.26(9.382)	10.26(9.382)

The parentheses indicate the cointegration between defense expenditure and per capita GDP; and *: Indicates the probability of significance at 1%.

Table 5. Results of Pedroni's panel cointegration test.

Test statistics		
Panel v- statistic	1.628*	(1.017)
Panel ρ- statistic	-0.359	(-0.79)
Panel PP- statistic	-1.323	(-0.94)
Panel ADF- statistic	-1.638*	(-0.859)
Group ρ- statistic	0.420	(0.337)
Group PP- statistic	-1.123	(-0.211)
Group ADF- statistic	-1.875*	(-0.397)

The parentheses indicate the cointegration between defense expenditure and per capita GDP; and *: Indicates the probability of significance at 1%.

Singapore and Thailand. The estimated F-statistics rejected the null hypothesis of non-causality at 5% level of significance. The findings also show the presence of bidirectional causality between defense spending and economic growth (GDP< = > DS and PCGDP < = > DS) in Philippines and at the panel of ASEAN-5 countries. This suggests that economic growth and defense spending are very interdependent in the Philippines and ASEAN- 5 at the panel level. The Table 6 also displays the results of error correction term, for all equations and for all countries. In most of the cases, they are significant and negative and so, confirm the sign of stable relationship between defense spending and economic growth. To complement this study, it is important to investigate whether the aforementioned long run relationship that we found are stable over the period of study. We conduct the diagnostic tests for serial correlation (LM test), autoregressive conditional heteroskedasticity (ARCH test), heteroskedasticity (White test) and stability test (Ramsey test). The estimated results are reported in Table 7. The results confirm the stability of the model on the nexus between economic growth and defense spending in the ASEAN- 5 countries.

It can be noted that the findings of the present study is very similar and somewhat contradicts with some of the earlier studies. For instance, in the case of Malaysia, the findings of the present study is very similar to the study by Frederiksen (1991) and Looney and Frederiksen (1990) but contradicts with the study by Frederiksen and McNab (2001), who found the unidirectional causality from defense spending to economic growth and Hirnissa et al. (2009), who found no causality between defense spending to economic growth. For Philippines, the findings of present study contradict with the findings of Frederiksen (1991) and Hirnissa et al. (2009), who found no causality between defense spending and economic growth, Benoit (1978), who found the unidirectional causality from defense spending to economic growth, and Frederiksen and LaCivita (1987), who found the unidirectional causality from economic growth to defense spending. For Singapore, the findings of present study contradict with the findings of Frederiksen (1991), who found unidirectional causality from defense spending to economic growth, and Hirnissa et al. (2009), who found the feedback between defense spending and economic growth. For Indonesia and Thailand, the findings of present study contradict with the findings of Frederiksen (1991) and Hirnissa et al. (2009), who found the unidirectional causality from defense spending to economic growth. Overall, the nexus between defense spending and economic growth is very inconclusive. This is particularly due to different time periods of the study. For instance, while the present study analyzed the nexus between defense spending and economic growth over the period 1988 to 2007, Frederiksen and LaCivita (1987) analyzed the same over the period 1956 - 1982 and Hirnissa et al. (2009) analyzed the same for 1965 - 2006.

In short, there are at least three possible reasons for these inconclusive findings in the literature: different spans of data; use of different techniques; and the omitted variable bias. Different studies have different problems. For instance, a common view is that studies which focus on the two variable models may be biased due to the omission of relevant variables (Narayan, 2009; Clarke, 2005; Hendry and Richard, 1982). Similarly for two cointegrated variables of I (1), if VAR is used against VECM, then the result may be spurious (Granger, 1988; Engle and Granger, 1987).

Conclusion

The work explores the relationship between defense

Table 6. Granger causality test based on ECM.

	Dependent variable	Short run causality		Long run causality	Joint causality
		ΔGDP	ΔGED	ECT (-1)	F
Indonesia	ΔGDP	--------	1.978	-0.61	0.807
	ΔGED	11.59*	---------	-3.31*	-6.31*
	ΔPCGDP	--------	1.279	0.195	1.272
	ΔGED	7.668*	------	-3.366*	5.48*
Malaysia	ΔGDP	--------	1.294	0.927	0.759
	ΔGED	6.243**	--------	-2.83**	6.66*
	ΔPCGDP	--------	0.727	1.795	1.369
	ΔGED	8.577*	---------	-2.444*	6.00*
Philippines	ΔGDP	--------	5.699**	-1.64	2.363**
	ΔGED	4.849*	---------	1.54	2.412**
	ΔPCGDP	--------	6.934*	-3.36*	4.098*
	ΔGED	2.246*	---------	-0.764	0.621
Singapore	ΔGDP	--------	0.092	0.181	1.825
	ΔGED	3.00**	---------	-2.33	1.821
	ΔPCGDP	--------	0.182	0.041	0.063
	ΔGED	0.991	---------	-1.926	1.242
Thailand	ΔGDP	--------	1.522	-2.32**	3.957*
	ΔGED	3.71**	--------	-0.255	1.400
	ΔPCGDP	--------	0.266	-2.35*	4.556*
	ΔGED	3.23**	---------	-0.187	1.434
Panel granger Causality Test	ΔGDP	--------	4.343*	-1.25	2.32**
	ΔGED	4.386*	--------	-1.40	2.28**
	ΔPCGDP	--------	4.51*	1.585	7.440*
	ΔGED	0.462	---------	-0.976*	0.750

* (**): Indicates statistically significant at 1% (5%) level.

Table 7. Short run diagnostic tests.

Countries	LM	ARCH	Ramsey	White
Indonesia	17.357* (17.68*)	7.095* (7.89*)	2.049 (15.87*)	10.65 (7.97)
Malaysia	9.672* (9.88*)	0.415 (0.462)	6.969* (10.97*)	0.974 (0.585)
Philippines	34.9* (35.1*)	10.59* (18.02*)	15.02* (75.66*)	1.329 (2.60)
Singapore	7.142* (6.357*)	2.318 (2.263)	11.077 (11.48*)	0.016 (1.085)
Thailand	44.74* (44.96*)	16.23* (27.33*)	14.06* (76.69*)	0.003 (0.001)

LM: Serial Correlation LM Test; ARCH: ARCH Test; Ramsey: Ramsey test; White: White heteroskedasticity test; the parentheses represent the diagnostic test between defense expenditure and per capita GDP.

spending and economic growth in the ASEAN-5, namely Indonesia, Malaysia, Philippines, Singapore and Thailand, over the period 1988 to 2007. The empirical investigation has been carried out at the individual country and the panel of ASEAN-5. The main contribution of the paper is to check the reliability of the results (the nexus between defense spending and economic growth) between individual countries and the panel of ASEAN-5. The panel data setting seems to be more powerful, as it raises the degree of freedom compared to the cross-section approach and also allows different individual effect cross-sectional interdependency. It also improves the efficiency of cointegration and Granger causality test. The main findings of this study are summarized as follows:

(1) Economic growth (measured by GDP and per capita GDP) and defense spending is integrated of order one for the ASEAN-5, namely Indonesia, Malaysia, Philippines, Singapore and Thailand, at the individual level and at the group.
(2) Johansen's multivariate cointegration and Pedroni's panel cointegration test confirmed the presence of cointegration between economic growth and defense spending. This suggests the existence of long run relationship between defense spending and economic growth in the ASEAN- 5 at the individual and panel.
(3) The error correction model confirms the presence of unidirectional causality from economic growth to defense spending in Indonesia, Malaysia, Singapore and Thailand. This suggests that economic growth is very responsive to defense spending in the ASEAN-5. Philippines shows the feedback between defense spending and economic growth. The bidirectional causality is also found at the panel of ASEAN-5. This represents that economic growth affects defense spending and defense spending can affect economic growth. That means defense spending is a limiting factor to economic growth and economic growth is also a limiting factor to defense spending.

The policy recommendation of this paper is that the respective government should take some policy initiative to increase defense spending in order to enhance economic growth in the country. The lack of same not only affects defense in particular but also affects economic growth in general. The reverse is also true. That means the lack of economic growth also affects economic growth in particular and defense pending in general. Though the study adds some important findings to existing literature, it cannot be free from limitation. The major limitation of this paper is that it is bounded with defense spending, economic growth and per capita economic growth only. But in reality, defense spending may be affected by some other variables like gross capital formation, spending towards infrastructure, governmental stability, etc. Over all, the obtained results are very consistent with some earlier findings and contradict with some other earlier studies. This suggests that the nexus between defense spending and economic growth is very inconclusive and can vary with respect to different time periods in a particular country. It gives an indication that how economic growth can affect defense spending (and vice versa) on a country-by- country and year-by-year basis. The policy implication of this research is that neither economic growth nor defense spending can be considered as exogenously determined.

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