Does Research and Development Expenditure Co-integrate with Gross National Income of ASEAN Countries?

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Does Research and Development Expenditure Co-integrate with Gross National Income of ASEAN Countries?[1]

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ABSTRACT

In order to successfully transform into a knowledge economy and eradicate poverty, many ASEAN countries have allocated a considerable amount of their yearly expenditures in research and development over the last decade. The objective of this paper is to examine the long-run relationship between research and development expenditure and gross national income of five major ASEAN countries – Thailand, Malaysia, Singapore, Indonesia and Philippines. The results of a cross-country panel data analysis performed in this study suggest that there is a long-run cointegration relationship between these two variables. Findings imply that higher research and development expenditure has a favorable impact on the long-run prosperity of these countries.

Keywords: Research and development expenditure, Gross national income.

1.0 Introduction

The economic theory which only take into account labour, capital, land and entrepreneurship as the inputs to produce goods and services for economic profit have been adjusted many times. Nowadays, most countries have switched from the old production functions to adopt the

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knowledge-economy model. The main ingredient under knowledge-economy is intellectual capital that focuses on technological progress. Specifically, technological progress is defined as innovations, inventions or research and development works which are supported by the allocation set aside as gross expenditure in research and development (Karczewska, 2015).

As one of the most rapidly developing economy entity in the world, ASEAN countries recognize the importance of moving up the value chain to produce higher value added technology intensive products in order to become high-income economies. To achieve this goal, it is imperative for ASEAN countries to allocate a proportion of their GDPs in research and development. In fact, numerous studies contend that improving the innovative capacity of a nation is crucial to ensure the long-run economic growth of a country and one of the avenues to improve innovative capacity is by providing sufficient funding to support academic researches and preparing the necessary platform to facilitate both business and private research and development (Pavitt, 1980 and Piras et al. 2012).

Even though both research and development expenditure and gross national income are on the upward trend in most ASEAN countries, however, it is not known whether the investments in research and development provides the outcome as anticipated to the nations' wealth. Indeed, investing in research and development is not only risky but also could take a long gestation period. With that in mind, the objective of this paper is to assess the long-run relationship between research and development expenditure and the gross national income of five major ASEAN countries, namely, Indonesia, Singapore, Malaysia, Philippines and Thailand.

2.0 Literature Review

The neoclassical theory of economic growth proposed by Solow (1957) asserts that sustainable technological progress is the crucial driving force for productivity and economic advancement. This was supported by Inekwe (2015) who posits that technological progress via research and development is important for the growth of businesses and consequently the improvement of a country. However, the high cost of developing new technology can be improvident for some countries and therefore, the acquisition of technology varies across different countries whereby some countries achieve technological progress via imitation whilst others by means of innovation or both. Among the ASEAN-5 countries included in this study, Indonesia, Malaysia, Philippines and Thailand's are predominantly agricultural economies while Singapore's economy was driven by the manufacturing sector. Nevertheless, in order to foster productivities and eradicate poverty these five ASEAN countries have taken measures to transform their economies into a knowledge-based economy. In their quest to achieve this aspiration, technological progresses via research and development initiatives involving the industries, academics and international collaborations activities have been instigated.

From the economic policy maker's perspective, investment in research and development is a proactive strategy which allows poor countries to achieve higher livings standard and thus, catch up with their developed counterparts. Thirthe et.al (2003) found that research and development activities in Asia and Africa have brought about technological advancements in the agricultural sector and that has contributed to a reduction of twenty-seven millions of people living in poverty each year. A later study conducted by Freire-sern (2001) also found a significant relationship between aggregate research and development spending and economic growth whereby and 1% increase in research and development expenditure results in 0.08% increase in the real GDP. Tiits (2007) highlights the importance for small countries to implement proactive foreign investment strategies in the field of research and development whilst Walde and Woitek (2004) find research and development activity shows pro-cyclical rather than countercyclical behavior on the GDP growth of G7 countries.

Contradict to Walde and Woitek (2004), Saint-Paul (1993) postulates research and development expenditure does not correlate with the cyclical behavior of the economy and this finding was supported by Fatas (2000). Similar studies by Salter and Martin (2001) and Piras et al. (2012) propound that the social-economic benefits of research and development could be hard to measure as they vary across industries and field. Based on the literature review discussed above, the empirical findings on the payoff for research and development expenditure are inconclusive. It is therefore the aim of this paper to investigate whether research and development expenditure has any impact on ASEAN-5's economic wellbeing.

3.0 Methodology

To accomplish our objective in this study, panel unit root tests and panel cointegration tests are adopted in our analysis.

i. Panel unit root tests

The well-established Augmented Dickey-Fuller (ADF) regression with intercept and linear trend specification is as follow:

$$\Delta y_{it} = \alpha_i + \beta_i t + \rho_i y_{i,t-1} + \sum_{j=1}^{p} \theta_j \Delta y_{i,t-j}\, \mu_{it}, \text{ for } i = 1, \ldots, N \text{ and } t = 1, \ldots, T, \quad (1)$$

where y_{it} is the value of the variable of interest for country i at time t. N and T are the total number of cross-section and time series units respectively. μ_{it} denotes the error term, while α_i, β_i, ρ_i and θ_j are unknown parameters to be estimated. The estimator of interest is ρ_i. The null hypothesis of a unit root is specified as:

$$H_o: \rho_i = 0, \text{ for all } i. \quad (2)$$

Panel unit root test of Im et al. (2003) considers the following alternative hypothesis:

$$H_A: \rho_i < 0, \text{ for some } i. \quad (3)$$

The ADF-type *t*-statistics of Im et al. (2003) is given as:

$$\bar{t} = \frac{1}{N}\sum_{i=1}^{N} t_i, \quad (4)$$

where t_i is the individual ADF *t*-statistics for the unit root test.

In another approach, Maddala and Wu (1999) propose to combine the *p*-values of the individual ADF *t*-statistics to obtain:

$$x^2 = -2\sum_{i=1}^{N} \log(\pi_i), \quad (5)$$

where x^2 is a chi-squared test statistic with 2*N* degree of freedom and π_i is the *p*-value of the ADF t-statistics for cross-section unit i.

In the spirit of Maddala and Wu (1999), Choi (2001) suggests the following statistic:

$$Z = \frac{1}{\sqrt{N}}\sum_{i=1}^{N} \emptyset^{-1}(\pi_i), \quad (6)$$

where Z is a statistic with standard normal distribution, and $\emptyset^{-1}$ is the inverse of the standard collective distribution function. Choi (2001) is more practical than Im et al. (1999) for its less restrictive assumptions. Moroever, Choi (2001) improves over Maddala and Wu (1999) in terms of finite sample size and power (Ling et al., 2010)[2].

ii. Panel Cointegration Tests

Engle and Granger's (1987) residuals-based static cointegration regression is given as:

$$y_{it} = \alpha_i + \beta_i t + \beta_{1i}x_{1it} + \cdots + \beta_{Mi}x_{Mit} + \varepsilon_{it}, \quad (7)$$

where *y* is the dependent variable and *x*s are a set of independent variables. If ε_{it} is stationary, it implies that there is cointegration between the *y* and *x*'s variables. The unit root property of ε_{it} can be determined based on ADF regression:

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[2] See also Hlouskova and Wagner (2006), which indicates that Maddala and Wu (1999)'s x^2 statistic is increasingly oversized in short panels with 10-15 years periods of data.

$$\Delta\hat{\varepsilon}_{it} = \alpha_i + \rho_i\hat{\varepsilon}_{i,t-1} + \sum_{j=1}^{p}\theta_j\Delta\hat{\varepsilon}_{i,t-j}\,\mu_{it}, \text{ for } i = 1, \ldots, N \text{ and } t = 1, \ldots, T, \quad (8)$$

where $\hat{\varepsilon}_{it}$ is estimated from Equation (7).

The ADF-type test statistics considered by Pedroni (1997, 1999) are known as the Panel ADF and Group ADF statistics. Referring to Equation (8), Panel or the *within-group* ADF statistic is obtained by pooling the autoregressive coefficients, ρ_i across different cross-section units. Meanwhile the Group or the *between-group* ADF statistic is based on group average approach for each cross-section unit. The null hypothesis for all Pedroni's tests is no cointegration. The alternative hypothesis for the *within-group* estimation is $H_o: \rho_i = \rho < 0$, for all i, while for the *between-group* estimation, the alternative hypothesis is $H_o: \rho_i < 0$, for all i. Before computing the test statistics, one needs to follow the five steps in the Pedroni's procedure (Pedroni, 1999)[3].

In a separate endeavor, Kao (1999) derives a different ADF-type statistic. See Kao (1999) for procedure to compute the statistic[4]. Guitierrez (2003) shows via a Monte Carlo study that Kao's tests have higher power than Pedroni's tests when a small number of time series observations (T) are included in the panel. Compare to the former, the latter allows for a more flexible alternative hypothesis and suffers less from small sample size distortion (Pedroni, 2001 and Kim et al., 2005). Furthermore, the latter can address problem of omitted variables and simultaneity bias in a non-stationary static panel setting (Cavalcanti et al., 2011). To provide a more robust analysis, all the methods discussed above are utilized in this study.

4.0 Empirical Results

This study includes a sample of five ASEAN countries namely, Indonesia, Malaysia, Philippines, Singapore and Thailand. Annual data from 2000 to 2010 on gross national income (GNI) and research and development expenditure (RDE) are obtained from IMD and World Bank database. All data are logarithmic transformed before applied. The results of Im et al. (2003), Maddala and Wu (1999) and Choi (2001) panel unit root tests are summarized in Table 1. The results as shown in Table 1 suggest that LGNI and LRDE are not stationary at 5% significance level. It can be said so because the marginal significance value of all test statistics are bigger than 0.05, and hence the null hypothesis of stationary series could not be rejected. Nonetheless, ÄLGNI and ÄLRDE are stationary since the null hypothesis of all the tests can be rejected at 5% significance level. With that, it can be concluded that LGNI and LRDE variables are integrated of order 1 as they become stationary after first-differencing.

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[3] Together with the two ADF-type tests, Pedroni also proposed five other statistics.

[4] Kao (1999) also introduces four other Dickey-Fuller statistics, which assume no serial correlations in the residuals.

Table 1. Results of Panel Unit Root Tests

	Panel unit root tests		
Variable	Im et.al (2003)	Maddala and Wu (1999)	Choi (2001)
LGNI	-0.523 [0.301]	10.540 [0.395]	-1.627 [0.052]
$\Delta LGNI$	-2.029 [0.021]	23.189 [0.010]	-2.813 [0.003]
LRDE	-0.198 [0.422]	13.388 [0.203]	-0.762 [0.223]
$\Delta LRDE$	-2.349 [0.009]	26.941 [0.003]	-2.726 [0.007]

Notes: LGNI and LRDE represent the logarithms of GNI and R&D expenditure. The first differenced variable is given by a symbol Δ in front of the variable name. The values in brackets are the *p*-values of the test statistics.

Since all the variables are integrated of order 1 there is a possibility that they are cointegrated. As such, the cointegration tests of Pedroni (1997, 1999 and 2001) and Kao (1999) are employed and the results are presented in Table 2. Similar to the unit root tests, the results of cointegration tests are sensitive to the lag used in the estimation. Cavalcanti et al. (2011), consider lag 0,1,2,3 separately in their study. This study fixes the maximum lag as 3 and let AIC decides on the optimal lag length. The results depicted in Table 2 show that there are some evidences of cointegration between R&D expenditure and GNI.

Table 2: Panel Cointegration Tests Results

	Pedroni (1999,2001)		Kao (1999)
Variable	Panel ADF	Group ADF	ADF
LGNI	0.045 [0.519]	-4.413 [0.000]	-1.514 [0.065]
LRDE	-4.672 [0.000]	-12.117 [0.000]	-0.749 [0.227]

Notes: LGNI and LRDE represent the logarithms of GNI and R&D. The values in brackets are the *p*-values of the test statistics.

5.0 Conclusion

This study examines the relationship between gross national income and research and development expenditure of Indonesia, Malaysia, Philippines, Singapore and Thailand. Panel unit root test and panel cointegration test are used to examine the data. Empirical evidence suggests that there is a long-run cointegration relationship between these two variables in the panel countries examined. Consistent with Inekwe (2015), result implies that research and development investment is crucial to the longrun prosperity of developing countries and in this study, the ASEAN-5.

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