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The Role of Research and Development Expenditure on GDP Growth: Selected Cases of ASEAN 5 Plus 4 Asia Major Countries

Nailul Huda[1], Izzudin Al Farras Adha[1], Siti Rizqi Ashfina R. S[1]

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Abstract

Innovation plays an important role in increasing productivity, economic growth, and social welfare. One strategy for fostering innovation is to increase research and development funding. However, the strategy to increase research and development funds is very dependent on the conditions of the country and the surrounding area. One of them is the ASEAN region and the 4 main Asian countries where each country has its own policies in increasing research and development funding. This study intends to examine how the role of research and development funds on economic growth in ASEAN-5 countries (Indonesia, Malaysia, Thailand, Singapore, and Vietnam) and four main Asian countries (China, Japan, South Korea, and India). This study uses a panel data model with 5 regression methods, namely First Difference GMM, GMM System, Polled Least Square, Fix Effect, and Random Effect. The results of this study are The research finds that R&D expenditure statistically significant and positive impact to economic growth in those 9 countries which the majority of that countries are developing countries. We also show that the control variables (investment, FDI, Patent, TFP, Labor) significantly correlated with economic growth. Based on the result of 5 regression method, Government needs to increase R&D expenditure through tax incentives because tax incentives have a positive and significant impact on R&D expenditure.

Keywords : Research and Development Expenditure, GDP Growth, ASEAN 5, FEM, GMM

JEL Classification: C13, C23, O3, O4

INTRODUCTION

Innovation is the main source of increasing productivity, economic growth, and people's welfare in the modern economy. Effectiveness and efficiency in adopting the latest technology is very important in achieving innovation and sustainable economic growth. Research and development (R&D) has a key role to drive economic growth. The relationship between R&D expenditure and economic growth are well-researched in numerous studies with either significant or insignificant results (Meo, *et. al*, 2013; Freimane & Balina, 2016; Akcali & Sismanogly, 2015; Turedi, 2016). Most studies that focused on this variable were undertaken on developed and developing countries. Based on their studies, they performed that R&D shows a significant or positive relationship to economic growth, primarily for developed countries, whereas, the studies suggest that, as for developing countries, the result would be significant in the long-run, but insignificant in the short-run.

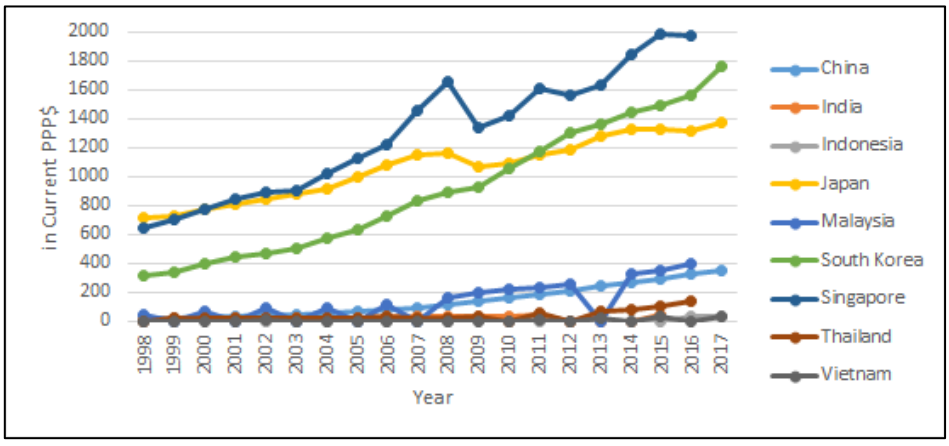
There is two types of R&D source which can impact on economy. First, R&D from public or national institutes. Second, R&D from private or industrial sectors. R&D from national institutes usually have more social impact for community, and the other hand, R&D from private just take the profit (Ishibashi and Matsumura, 2005). Coccia (2011) argumented that productivity growth driven by private R&D rather than public R&D but private R&D depend on public policy tools, such as R&D tax credits and subsidization policies.

In their study on new EU countries, Freimane and Balina (2016) employed Generalized Method of Moments (GMM) and standard growth equation model. They found that R&D expenditure posed a significant impact to economic growth in real GDP per person. Their study suggested that a 10% increase in R&D intensity would generate an increase of 0.2% to their economic growth in the short-run. Furthermore, the constant 10% increase in R&D expenditure would be able to increase 0.9% of economic growth.

Although the studies on examining the relationship between R&D and economic growth are robust, few that focus on examining the impacts to emerging economies, such as Southeast and East Asian countries (Yang & Han, 2017; Martynova, 2018). By focusing on historical analysis, Yang (2017) examined whether increasing research activities will increase economic growth in China. To improve its national research and innovation, China established research and innovation-related agencies and it has been conducted since its reform and opening up in the late 1970s. Yang argued that the implementation of research in China might not always benefit economic growth.

Akcali and Sismanogly (2015) also supported the same premise that the increase of R&D expenditure has a significant impact to countries economic growth. Examining 19 countries comprising of both developing and developed countries with panel data analyses, they found the highest impact of R&D expenditure to economic growth to developed countries and lowest impact to developing countries.

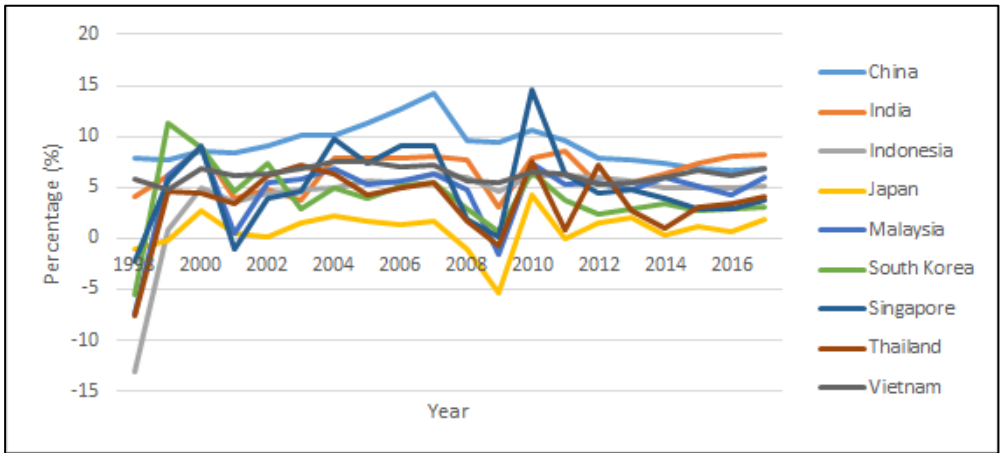
However, the total government R&D expenditure in each gross domestic product in various Southeast Asian and East Asian countries had a varying magnitude. Based on Figure 1, three countries with the largest number of R&D expenditures are 3 developed countries, namely Singapore, South Korea and Japan. Their R&D expenditures had been increased since the 1998. While six countries others compared, namely China, India, Indonesia, Malaysia, Thailand and Vietnam, are far behind to invest in R&D compared to the three developed countries. Nevertheless, Malaysia and China have a tendency to increase R&D expenditure per capita in the last 10 years and the increasing trend has been experienced by Thailand in the last 5 years.



Source: UNESCO Institute for Statistics

Figure 1. Gross Expenditure on R&D per Capita

The growth of R&D expenditure at Figure 1, is not linear with the economic growth of each country where the 9 countries have varied GDP growth rates as illustrated in Figure 2. In Figure 2, 3 countries with the highest R&D expenditure per capita actually have relatively GDP growth low compared to 6 other countries.



Source: World Bank

Figure 2. Gross Domestic Product per Capita

We want to show about the ratio of R&D expenditure to GDP issued by each country from 1998 to 2017. There is an increase of the ratio of R&D expenditure to GDP in the last 20 years with increases varies. South Korea increased from 2.1 percent in 1998 to 4.5 percent in 2017, up to 2.4 percent in 20 years. China had an increase of ratio of R&D expenditure to GDP as big as 1.5 percent, from 0.6 percent in 1998 to 2.1 percent in 2017. Malaysia became the country with the highest increase of the ratio of R&D expenditure to GDP from 0.3 percent in 1998 to 1,4 percent in 2016. While the increase in other countries is below 1 percent in the last 20 years.

Based on Figure 3, Indonesia was a country with low GDP growth and low ratio of R&D expenditure to GDP compared to ASEAN plus 4 (China, India, South Korea, and Japan). China was an example of a country that is able to make R&D expenditure as a driver of GDP growth. China had a high ratio of R&D expenditure to GDP and high GDP growth compared to ASEAN plus 4. Japan, South Korea, and Singapore had relatively low GDP growth, but they had a relatively high ratio of R&D expenditure to GDP. This is because the three countries are advanced countries. Most likely, Malaysia and Thailand will transform like Japan, South Korea, and Singapore in the coming years. India and Vietnam were even better off compared to Indonesia because even though their ratio of R&D expenditure to GDP is relatively low but they had higher growth than Indonesia. Vietnam also has the opportunity to become a country like China in the future.

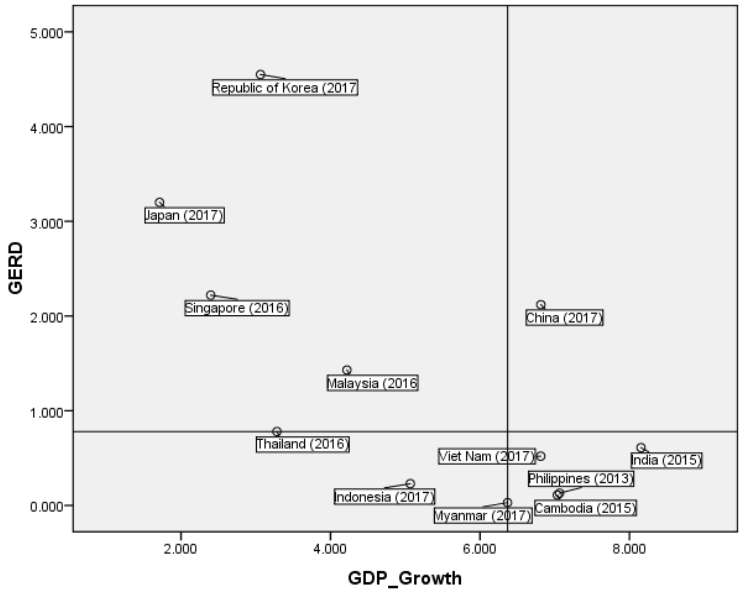


Figure 3. GERD and GDP Growth Scatter Plot

Based on the previous studies, this study aims to contribute to further explore the relationship between the degree of R&D expenditure and its impact to economic growth using difference and system Generalized Method of Moments (GMM) models in some developed and developing countries in East Asia and Southeast Asia. Through this study, it produces key takeaways for emerging economies for better policy prescriptions to drive economic growth.

RESEARCH METHODOLOGY

This paper uses quantitative research for main method. The quantitative approach use the Generalized Method of Moments (GMM) Models model and 3 panel model. The GMM model which used in this paper is the First Difference GMM, and the System GMM. This study will also compare with the polled least square, fix effect, and random effect model. Then we choose a robust model to elaborate.

The initial model which built in this paper was the production model of Cobb Douglas. Cobb Douglas production model explains the existence of capital and labor factors to create an economic production. This model was refined by Schumpeter by adding innovation factors in economic growth and places the factor of innovation as a separate factor besides the factors of capital and labor. Mathematically, the Cobb Douglas function which has added endogenous innovation factors as explained by Inekewe (2015) is

$$Y = A\, L^{\alpha} C^{\beta} [K]^{\gamma} [K^{0}]^{\theta} \varepsilon^{\mu} \quad \text{..... (i)}$$

Where, Y is economic output, L measures labor, C is capital seen, K refers to capital not visible (internal), and K0 is capital is not visible (external). Through the logarithmic model, equation (i) can be changed to

$$Y_{it} = \delta + \mu_i + \alpha\, L_{it} + \beta\, C_{it} + \gamma\, K_{it} + \theta K_{it}^{0} + \varepsilon_{it} \quad \text{.....}$$

(ii)

Capital not visible has be proxied by innovation (Schumpeterian model). In addition, external capital can be proxied by Foreign Investment (FDI). From this equation, this paper has model as follows:

$$lnY_{it} = \alpha_0 + \alpha_1 R\&DExpen\_to\_GDP_{it} + \alpha_2 I\_to\_GDP_{it} + \alpha_3 FDI\_to\_GDP_{it} + \alpha_4 Patent\_Residence_{it} + \alpha_5 Patent\_nonResidence_{it} + \alpha_6 TFP_{it} + \alpha_7 LaborQuantity\_to\_GDP_{it} + \alpha_8 LaborQuality\_to\_GDP_{it} + \varepsilon_{it}$$

Where,
Y_{it} = Country Nominal GDP i year t
$I\_to\_GDP_{it}$ = Proportion of Investment to GDP of the State i year t
$R\&Dexpen\_to\_GDP_{it}$ = Proportion of R & D Expenditures to GDP of the State i year t
$FDI\_to\_GDP_{it}$ = Proportion of Capital Value from Overseas to the GDP of the Country i year t
$Patent\_Residence_{it}$ = Number of patent by resident of the State i year t
$Patent\_Residence_{it}$ = Number of patent by resident of the State i year t
TFP_{it} = Total Factor Production of the State i year t
LaborQuantity_to_GDP = Contributition of Labor Quantity to GDP Growth of the State i year t
LaborQuality_to_GDP = Contributition of Labor Quality to GDP Growth of the State i year t

RESULT AND DISCUSSION

Empirical Result

In this section, the empirical result about the impact of R&D fund to economic growth is presented. Table 1 shows the descriptive statistics of all variable used in the analysis. The mean value of R&D expenditure to GDP ratio is 1,69 percent. The minimum ratio is 0,05 percent and the maximum ratio is 4,55 percent. Other than that, the average sample country has not applied super deduction tax incentives in that period.

Table 1. Descriptive Statistics

Variable	Mean	Std.Dev.	Min	Max
gdp_growth	4.90	3.67	-13.13	14.53
rnd_to_gdp	1.69	1.19	0.05	4.55
investasi_~p	28.50	5.92	19.43	45.69
fdi_to_gdp	4.17	5.75	-2.76	28.02
patent_res~t	90681.70	194330.40	25.00	1245709.00
patent_non~t	25240.62	30408.48	723.00	135885.00
tfp	0.49	3.18	-20.05	9.00
laborquant~p	0.51	1.02	-5.07	3.87
laborquali~p	0.36	0.33	-0.54	2.20
dummy_taxi~e	0.41	0.49	0.00	1.00

Before we discuss the impact of R&D fund to economic growth, we can see the effect of tax incentives on R&D performance. From all models tested, tax incentives has a positive and significant effect on the portion of R&D expenditure on GDP. These results indicate that the government's policy to provide tax incentives on R&D activities, such as super deducative tax, is effective to increase the portion of R&D expenditure to GDP. Countries such as China, India, Malaysia, Singapore, and Thailand, has been provided super deduction tax incentives to increase the ratio of R&D expenditure to GDP. This result is in accordance with the findings of Huda (2020) which states that there is a positive and significant impact between tax incentive policies in the R&D sector on the ratio of R&D funds to GDP.

Table 2. Estimation Result on Tax Incentives to R&D Expenditure

rnd_to_gdp_new	-1 PLS	-2 FEM	-3 REM	-4 FDGMM	-5 SYSGMM
dummy_taxincentive_inRnD	0.260***	0.179**	0.260***	0.268***	0.749
	-0.069	-0.0635	-0.069	-0.0702	-0.628
investasi_to_gdp	0.0131**	-0.00952	0.0131**	0.0136***	0.00554
	-0.00527	-0.00933	0.00527	-0.00519	-0.0181
fdi_to_gdp	-0.00279	0.0126	0.00279	-0.000486	-0.016
	-0.00409	-0.00774	0.00409	-0.00445	-0.0241
dummy_asean	0.468***	.	0.468***	0.437***	413.8**
	-0.0879	.	-0.0879	-0.0912	-161.4
tfp	0.0125*	-0.00271	0.0125*	0.0160**	0.126*
	-0.00664	-0.00599	0.00664	0.00712	-0.0667
dummy_china	-0.204**	.	0.204**	-0.200*	0
	-0.0996	.	-0.0996	-0.104	0
ln_patent_resident	0.0111	0.210***	0.0111	0.0223	-3.431*
	-0.0372	-0.0623	-0.0372	-0.029	-1.871
ln_patetnt_non_resident	0.0979	0.103	0.0979	0.0559	5.410*
	-0.0752	-0.0964	-0.0752	-0.0625	-3.12
Lag (-1).rnd_to_gdp_new					0.976***
					-0.17
_cons	-0.0078	-0.886*	-0.0078	0.281	-247.8**
	-0.498	-0.475	-0.498	-0.462	-98.82
N	179	179	179	179	170
R^2	0.251	0.471			

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 3. Comparison of Tax Incentives (before 2019)

Type of Incentives	China	India	Japan	South Korea	Indonesia	Malaysia	Singapore	Thailand	Vietnam
Super Tax Deducations	v	v				v	v		
Tax Deducations								v	
Reduced Tax Rates	v								v
Tax Credits		v	v	v					
Tax Allowance	v				v	v			v

Source : Ernst & Young, 2018

Based on the five models we have examined, the ratio of R&D fund to GDP has an effect on four models. In the PLS and REM models, the ratio of R&D expenditure to GDP has a positive and significant at alpha 1 percent. While in FEM model, the ratio of R&D expenditure to GDP has a positive and significant at alpha 5 percent. Whereas in the FDGMM model, the ratio of R&D expenditure to GDP has a positive but not significant effect to GDP Growth. In SYSGMM model, the ratio of R&D expenditure to GDP has a negative but not significant effect to GDP Growth.

By doing Hausman and Chow test, we find the conclusions of the most fit model in this paper is the FEM model. In FEM model, the variable ratio of R&D expenditure to GDP has a positive impact

and significant effect on GDP growth. This estimation result shows us that R&D expenditure R&D is a factor influencing GDP growth, especially in ASEAN 5 plus 4 ASIAN Major Countries at 1998-2017.

The results we find are in line with the findings of Hunady and Orviska (2014) and Freimane and Balina (2016) which states that the effect of R&D expenditure on GDP growth is significant in the European Union member states. The same results were also expressed by Gumus and Celikay (2015) which showed that government spending on R&D has significant effect on GDP growth. Szrowska (2017) also found the same results using GMM approach.

From two result we can say about governments that provide tax incentives to R&D expenditure can increase GDP growth. China, Singapore, Malaysia and India provide super deducation tax in R&D activities. Their government are aware of the importance of R&D so they make policies to increase the role of R&D to GDP. Indonesia needs to emulate their policies to increase the role of R&D on GDP so Indonesia's GDP growth can be accelerated faster. Therefore, the results we found were that the control variables (investment, FDI, Patent, TFP, Labor) has a significant effect on economic growth.

Table 4. Estimation Result on R&D Expenditure to GDP Growth

ln_gdp_growth	(1) PLS	(2) FEM	(3) REM	(4) FDGMM	(5) SYSGMM
rnd_to_gdp_new	0.518***	0.169**	0.518***	0.233	-0.231
	(0.184)	(0.0688)	(0.184)	(0.158)	(0.357)
investasi_to_gdp	0.0660***	0.0256***	0.0660***	0.0698***	0.0579**
	(0.00893)	(0.00594)	(0.00893)	(0.0110)	(0.0242)
fdi_to_gdp	-0.00243	0.0269*	-0.00243	-0.00888	0.0291
	(0.00668)	(0.0128)	(0.00668)	(0.0106)	(0.0197)
tfp	0.232***	0.239***	0.232***	0.232***	0.351***
	(0.0331)	(0.0284)	(0.0331)	(0.0263)	(0.112)
laborquantity_to_gdp	0.303***	0.329***	0.303***	0.368***	0.330***
	(0.0488)	(0.0480)	(0.0488)	(0.0562)	(0.0948)
laborquality_to_gdp	0.137	0.302**	0.137	-0.829	2.757
	(0.146)	(0.112)	(0.146)	(0.738)	(2.696)
ln_patent_resident	-0.228***	-0.0210	-0.228***	-0.104	0
	(0.0796)	(0.0663)	(0.0796)	(0.0910)	(0)
ln_patetnt_non_resident	-0.248*	-0.0853	-0.248*	-0.173	-0.218
	(0.140)	(0.115)	(0.140)	(0.143)	(0.136)
dummy_asean	-1.022***	.	-1.022***	-0.0340	0
	(0.339)	.	(0.339)	(0.567)	(0)
dummy_china	-0.172	.	-0.172	-0.139	0
	(0.169)	.	(0.169)	(0.245)	(0)
dummy_jepang	-0.568**	.	-0.568**	0.245	3.490
	(0.267)	.	(0.267)	(0.549)	(7.462)
dummy_koreaselatan	-0.220*	.	-0.220*	0.132	0
	(0.128)	.	(0.128)	(0.310)	(0)
Lag(-1).ln_gdp_growth					0.159
					(0.308)
_cons	3.222***	0.830	3.222***	1.500	0
	(0.887)	(0.795)	(0.887)	(1.344)	(0)
N	166	166	166	166	152
R^2	0.702	0.615			

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

CONCLUSION

Peper examines the effect of the ratio of R&D expenditure to GDP growth with panel data. This paper takes 9 countries, namely Indonesia, Malaysia, Singapore, Thailand, Vietnam, Japan, China, South Korea, and India. The data series we used are data from 1998-2017. The econometric model that we use is the fixed effect model. This paper produces findings that the ratio of R&D expenditure to GDP has a positive and significant effect on GDP growth. GDP growth is influenced by investment, FDI and TFP too. Based on this paper, one percent of increase in R&D expenditure is significantly correlated with 16 percent of GDP growth in the country being studies.

Based on the result, the government still needs to increase R&D expenditure to support GDP of Indonesia. The government has issued super deductive incentives and this is a positive step. This policy have been applied in Singapore, China, India, dan Malaysia. Vietnam also need this policy for increase R&D fund. Other countries can replicate super deduction tax policy with their custom policy such as lower tariff on subsidies.

The weakness of this paper is that this paper does not use the difference in difference (DiD) method in analyzing the role of R&D funds on economic growth. The reason is that the economic growth that occurs may not be due to R&D funds but other variables outside the model. Therefore, for research on R&D funds it is better to use the DiD method.

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