Applying Panel Dynamic OLS and Panel VECM to Estimate the Relationship between Public Investment, Private Investment and Economic Growth in Developing Asian Countries

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ABSTRACT

This study aims to investigate the link between public investment, private sector investment and GDP based on data from 18 Asian developing countries over a 21-year period (1995-2015). We employ Panel Dynamic OLS and Panel VECM to estimate the long-run relationship among the concerned variables. Our findings suggest that there are differences in the relationship between types of investment in each group of countries, and the short-run link between public investment and private investment is less positive in ASEAN countries compared to their non-ASEAN peers. With regard to the long-run relationship, it is clear that the investment from both government and public-private partnership exerts positive impact on private investment, so there is a long-run crowding-in effect of public investment, which supports the growth in private investment. With regard to the impact of types of investment on GDP, it is found that in the short run all three types of investment in ASEAN countries do not perform as positively as in the case of non-ASEAN countries. However at least in the long run, all three types of investment have favorable impact on GDP for both ASEAN and non-ASEAN countries. Based on this result, we suggest some policy implications for ASEAN developing countries.

Keywords: *Public investment, Private investment, Economic growth, ASEAN and Asian developing countries*
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1. INTRODUCTION

Asian developing countries have seen relatively steady growth in recent years. Developing Asian economies are still the main driver of global economic growth since the crisis, according to Asian Development Bank (ADB) experts. The question is what is the role of public investment and private investment for economic growth in these countries?

Most of economists agree that investment has a positive effect on economic growth. However, they have not yet agreed on the impact of public investment on private investment and economic growth.

There has been a change in the views of the economics profession as well as economic policy-makers over the past on the role of the government in the development process.

There is evidence of the steadily declining importance of government activities in the economies of most of the developing world (Khan and Kemal, 1996).

Reality is that public investment still represents a large share of total investment in the majority of developing Asian countries (such as Vietnam, China, Laos… public investment accounts for around 30%-50%), and the question is what role it plays in relation to private investment in stimulating economic growth. This research is to investigate whether there exists a relationship between public investment, private investment and economic growth in the developing Asian countries.

In this study, besides considering the role of public investment and private investment for economic growth in Asian Developing Countries, we also will test the hypothesis that there are significant differences in the differential effects of public and private investment on economic growth for two developing country regions—ASEAN developing and Non-ASEAN developing countries in Asia. This means we examine the relative effects of public and private investment on economic growth across all developing Asian countries and across countries in different regional groups.

In ASEAN countries, besides Singapore, Brunei is a country having a higher income per capita like that of developed countries, other developing countries having a low income per capita, small size of economy and having transition economies like Vietnam, Laos, and Cambodia.

In particular, since 2016, ASEAN countries have been a member of the common economic community, and the implementation of the ASEAN Economic Community (AEC) will turn ASEAN into a single market and production base, which will contribute to enhancing the competitiveness of ASEAN. Thus, examine the relative effects of public and private investment on economic growth for two groups, ASEAN and non-ASEAN developing countries, we can see the difference in impacts in order to provide appropriate policy implications for ASEAN developing countries.

2. LITERATURE REVIEW AND PREVIOUS EMPIRICAL STUDIES

The theory that explains the relationship between inputs and growth in a national product is called the production function. The production function is one of the key concepts of mainstream neoclassical theories, used to define marginal product and to distinguish allocation efficiency, the defining focus of economics. Cobb–Douglas production function (1928) represents the technological relationship between the amounts of two or more inputs, particularly physical capital (K) and labor (L), and the amount of output (Y) that can be produced by those inputs. Solow (1956) tried to explain the origin of growth by a different kind of production function that allows analysis of the different causes or origins of growth called the Solow model. The main assumptions of the Solow model relate to the characteristics of the production function and the evolution of the three inputs of product (capital, labor and knowledge) over time.

Public investment which strongly affects economic growth is also reflected by aggregate supply and demand. Public investment directly impacts aggregate demand as a government expenditure and aggregate supply as a production function (capital factor). Public investment has spillover effect and indirectly impacts aggregate demand by stimulating private investment and to aggregate supply through attracting private investment. Public investment may facilitate and stimulate private investment through the provision of infrastructure and this can raise the productivity of capital and finally increase economic growth. However, public investment may crowd out private investment. This is because additional public investment requires raising future tax, public debt and domestic interest rate and it may decrease economic growth.

Some related studies have addressed the effects of public investment on private investment and the crowding-in hypothesis by applying OLS and VAR (Vector Autoregressive model) analysis. For instance, the study on the effect of public investment on private investment in developing economies was done by Erden and Holcombe (2005; 2006) with applying several pooled specifications of a standard investment model and panel data for period (1980 – 1997), whose results suggest that public investment crowds in private investment. Hatano (2010) has a study investigating the effects of public investment on private investment based on Japanese empirical data. Estimating the error correction model, the author affirmed that the crowding-in effect of public investment on private investment. The study of Foye (2014) is the impact of public capital spending on private investment in Nigeria showed that public investment is motivation of private investment growth. Dreger and Reimers (2016) have a study to answer a question "Does public investment stimulate private investment in the euro area?". In this study, the relationship between private and public investment by examining capital stocks as well as gross investment flows is investigated in a panel VAR framework, where the euro area member states constitute the cross section. The result indicated that the lack of public investment may have restricted private investment and thus GDP growth in the euro area.

On the contrary, there are also some studies that show the negative effects of public investment (public investment crowds out private investment). Some studies such as Bruno de Oliveira (Cruz and Teixeira, 1999) and Gjini and Kukeli (2012) find that the private investment is crowded out by public investment in short – term, but in the long term these two variables complement each other. Erden and Holcombe (2005) and Gjini and Kukeli (2012) conclude that public investment has positive affect on private investment in developing economies or in Eastern European Countries, whereas, public investment has a negative affect private investment in developed countries or in Western countries.

A comprehensive study of the effects of public investment on private investment and economic growth has also been carried out in different countries and groups of countries, and results are not quite the same.

Some studies find negligible role of public investment on economic growth. Hsieh and Lai (1994) use endogenous growth model by Barro (1990) and suggest that there is no clear evidence that government spending can increase GDP per capita GDP in G7. Ghani and Din (2006) have studied the impact of public investment on economic growth in Pakistan with using the vector autoregressive approach (VAR). The VAR consists of four variables including public investment, private investment, public consumption and GDP with data from 1973 to 2004. The result of this study showed that economic growth is largely driven by private investment and that no strong inference can be made about the effects of public investment and public consumption on economic growth. The results also showed the presence of long-run causality from public investment, private investment, and public consumption to economic growth. Bukhari *et al.* (2007) examined the casual connection between public investment and economic growth in the Three Little Dragons (Korea, Singapore, and Taiwan) using a variety of econometric techniques with Heterogeneous Dynamic Panel Data in the period (1971 – 2000). The authors also used four variables model that includes public investment, public consumption, private investment and growth rate of GDP.

The results indicated that both public and private investment and public consumption have a long-term dynamic impact on economic growth and the pair-wise analysis showed bidirectional causality between public investment and economic growth in all the countries. Swaby (2007) investigated the relationship between public investment and growth in Jamaica, with using VECM. The Granger causality result suggested that public investment does not cause GDP; however, GDP causes public investment. The VECM showed that in the long-run domestic private investment, FDI, and the REER all have a positive statistically significant direct impact on the level of GDP. Public investment has the effect of crowding – out net private investment. Gregoriou and Ghosh (2009) have a study on the impact of government expenditure on growth for 15 developing countries. Using GMM techniques, the authors showed that countries with substantial government expenditure have strong growth effects.

Some other studies find the positive role of public investment on economic growth. Cullison (1993) applied VAR model to evaluate linkage between public investment and economic growth and found that government consumptions for Education and Labor training have clear positive effects on economic growth. Khan and Kemal (1996) also concluded that the private investment has a much stronger impact than public sector investment in the Developing World. Ramirez and Nazmi (2003) studies on public investment and economic growth in Latin America using OLS and data for the period (1983-1993) showed that the openness of economy, human capital and government consumption/ public health significantly affect private investment. Research results also indicated that both private investment and public investment contribute to economic growth. Zainah (2009) investigated the role of public investment in promoting economic growth in Mauritius, used dynamic econometric framework, and Vector Autoregressive (VAR) model. The link between public capital, as measured by transport and communication infrastructure and economic performance has been analyzed in a multivariate dynamic framework. Results from this analysis revealed that both transport and communication infrastructure is important elements promote the Mauritian economy. Phetsavong and Ichihashi (2012) have a study on the impact of public and private investment on economic growth in developing Asian countries. The author analyze the factors affecting economic growth and the interrelationship of public investment, FDI, and private domestic investment using a panel dataset covering the period 1984 – 2009. The study found that both public investment and private domestic investment positively affect economic growth. Therefore, any increasing in public investment more than 4.9% - 8%, the public investment will reduce the positive effect of FDI on economic growth. Kumo (2012) conducted pairwise Granger causality tests between infrastructure investment and economic growth in South Africa for the period 1960-2009 using bivariate vector autoregression (VAR) model with and without a structural break. The author found that there is a strong causality between infrastructure investment and GDP growth that run in both directions implying that infrastructure investment drives the long term economic growth in South Africa while improved growth feeds back into more public infrastructure investments. Haque (2013) investigated the effect of public and private investment on economic growth in Bangladesh, using the new neo-classical growth model of Cobb Douglas production function utilizing the error correction model (ECM). The findings of the study concluded that there exist a short-run and long-run relationship between public and private investment and economic growth in Bangladesh.

Lee (2007) construct a panel dataset of 9 OECD countries from 1971 – 1999 and uses FMOLS and DOLS to examine the long-run relationship between FDI and productivity of host countries. This author relies mostly on group mean FMOLS as the main estimator, and finds that there is a long run equilibrium relationship between productivity and domestic knowledge base for G7 countries. The author emphasizes the suitability of FMOLS over conventional OLS method in panel data's context due to the Bardi *et al.* (2016) study the link between policies and economic growth, income distribution and poverty. The authors use dynamic panel framework (FMOLS and DOLS) for a sample of 6 countries in the period from 1975-2012. Research findings suggest a positive relation

between structural policy and economic growth for the sampled countries. EU (2014) studies the relationship between transport infrastructure and economic growth in European countries using panel cointegration techniques. The research findings confirm the existence of a long-run positive link between transport and electricity infrastructure and growth. The authors suggest further that public investment in transport and electricity infrastructures can stimulate growth, given that there is no oversupply of infrastructure.

Our research will inherit previous studies but has some differences including (1) the evaluation of the effect of public investment we use General government investment as well as Public-private partnership (PPP) investment; (2) the relationship is investigated using a panel VECM framework. The large sample allows for consideration of the hypothesis that there are significant differences in the differential effects of public and private investment on economic growth for two developing country regions—ASEAN developing and Non-ASEAN developing countries. This means we examine the relative effects of public and private investment on economic growth across all developing Asian countries and across countries in different region groups.

3. RESEARCH METHOD AND DATA

Our study used dynamic panel framework (DOLS) from 1995 to 2015 on 18 Asian developing countries, among which 7 are ASEAN developing countries, constituting 378 observations. To analyze the mutual impact of types of investment and their impact on GDP, we use four variables, namely GDP, general government investment, private investment and public-private partnership (PPP) investment. The public and private investment capital is calculated on average for one year. All data are obtained from IMF source, measured in US dollars. The variables used in this study are described in the following table 1.

Table-1. Variable description

Variable	Notation	Data Source	Unit
igov	general government investment (gross fixed capital formation)	IMF	billions of constant 2011 international USD
ipriv	private investment (gross fixed capital formation)	IMF	billions of constant 2011 international USD
gdp	gross domestic product	IMF	billions of constant 2011 international USD
ippp	public-private partnership investment (gross fixed capital formation)	IMF	billions of constant 2011 international USD

Source: The author's notation

3.1. Unit Root Test

Panel unit root tests are proven to have better power compared to conventional individual time series unit root tests. There are several approaches to testing panel unit root, including Breitung (2000), Levin *et al.* (2002); Im *et al.* (2003) which are frequently cited in empirical works and are based on different assumptions. A major constraint of Levin *et al.* (2002), Harris and Tzavalis (1999) and Breitung (2000) tests is that they base on the assumption that all panels have the same value of rho, which is relaxed in the Im *et al.* (2003) test. In other words, this test allows for each panel to own its own rho. Besides that, the IPS test does not require strongly balanced data. We employ Im *et al.* (2003) in this paper to test for the existence of the unit root of the series.

3.2. Co-Integration Test

To find the long-run impact, the existence of cointegrating relationship between non-stationary variables should be tested and established using cointegration-related methods. To ensure the robustness of the cointegration

nature of the combination of variables, we employ Pedroni (1999; 2001) and Fisher cointegration test (Johansen, 1988)'s proposal. If the test statistics reject the null hypothesis of unit root for a specific combination of variables, a long run relationship between these variables is to be established. Pedroni develops seven types of statistics that are based on the estimated residuals, among which four are panel statistics and obtained by averaging the residuals within panels, and the other three are attained by averaging the residuals across panels or group mean statistics. Upon performing Pedroni (1999; 2001) short panels can be an obstacle since they can undermine the power of the test. In fact, Benassy-Quere (2005) suggest that in short panels, the parametric panel and group ADF-statistic offer the most reliable results, while the group rho-statistic test is the worst performer. Therefore, we base on this pecking order to decide the cointegration nature of the variables in the paper.

If, according to our tests, there are cointegrating relationships between variables that are non-stationary in their levels, we will proceed to estimate the long-run relationship using appropriate methods. As for the estimation of the cointegrating equation (or long-term relationship), although the OLS method is consistent even for panel data, the standard errors produced are not valid for statistical inferences because of a second order asymptotic bias (Lee, 2007). Therefore, to derive valid statistics for inferences, several methods have been proposed, such as Fully Modified OLS or FMOLS and Dynamic OLS or DOLS.

It is suggested that the fixed effects panel OLS method is not fit for a panel with long T and not large N because this method can produce a size distortion, especially in the presence of endogeneity. Fully Modified OLS method is proposed by Pedroni to tackle this issue thanks to its using the long-run covariance matrices that helps with the removal of nuisance parameters (Eberhardt, 2009). Kao and Chiang (2001) also suggest that OLS estimator generates non-negligible bias with small panel samples. Pedroni (2001) suggests that within-dimension panel estimators (both FMOLS and DOLS) by Kao and Chiang (2001) are bound to distortions in small samples. The simulation performed shows that for within-dimension panel estimator, FMOLS only improves marginally compared to OLS, while DOLS exerts more desirable small sample properties. DOLS is used to estimate the long-run relationship between the variables in models (1) and (2). Furthermore, panel VECM is employed to estimate a system of equations to analyze the simultaneous links between types of investment as well as to find the short-run impacts between the variables.

4. RESEARCH RESULTS

Table 2 provides the results for the panel unit root tests proposed by Im *et al.* (2003) for the sample of ASEAN, non-ASEAN countries and all countries in the sample. The results consistently suggest that all of the series are nonstationary in their levels, namely ipriv, igov, ippp, gdp. The same tests reject the null hypothesis of unit root process at 1 percent for the above variables when they are transformed to their first difference. Therefore, we conclude that ipriv, igov, ippp and gdp follow I(1) process.

Table-2. Panel unit root tests

	ASEAN	NONASEAN	ALL
gdp	0.9995	1.000	1.0000
gov	0.5021	0.3267	0.3641
priv	0.1254	0.232	0.0987
ppp	0.6466	0.6762	0.7231
d.gdp	0.0000	0.0003	0.0000
d.gov	0.0000	0.0000	0.0000
d.priv	0.0000	0.0000	0.0000
d.ppp	0.0087	0.0310	0.0016

Note: p-values are present. Null hypothesis in the test is there is a unit root process.

As the variables are order 1 integrated (I (1)), we proceed with the Pedroni (2001; 1999) test for the panel cointegration test, where we conduct the tests for several combinations of the variables. We test the cointegrating relationship of the different types of investment (ipriv, igov and ippp) and of the different types of investment and output (ipriv, igov, ippp and gdp). Among the seven test statistics, we are inclined to rely on the panel and group ADF statistics to conclude about the cointegration of the variables. We employ Fisher cointegration tests to consolidate the decision as to whether there exists any cointegration between the variables. Based on the objectives of the paper, we perform cointegration tests on the following specifications:

$$ipriv_{it} = \beta_0 + \beta_1 igov_{it} + \beta_2 ippp_{it} + \varepsilon_{it} \quad (1)$$

$$gdp_{it} = \alpha_0 + \alpha_1 ipriv_t + \alpha_2 igov_{it} + \alpha_3 ippp_{it} + \varepsilon_{it} \quad (2)$$

Table-3. Pedroni's co-integration tests for model 1

	ASEAN		**NON-ASEAN**		**ALL**	
	Prob.	Weighted Prob.	Prob.	Weighted Prob.	Prob.	Weighted Prob.
Panel v-Statistic	0.2638	0.1089	0.0002	0.8494	0.0000	0.7547
Panel rho-Statistic	0.0633	0.0660	0.0918	0.4806	0.0416	0.3037
Panel PP-Statistic	0.0082	0.0116	0.2128	0.1312	0.1336	0.0283
Panel ADF-Statistic	0.0049	0.0039	0.0000	0.1750	0.0000	0.0308
Group rho-Statistic	0.2741		0.7146		0.5274	
Group PP-Statistic	0.0041		0.0402		0.0013	
Group ADF-Statistic	0.0021		0.0021		0.0000	

Source: The author's calculations

From Table 3, there is strong evidence of the existence of long-run relationship among ipriv, igov and ippp for the three groups of countries (model 1). Especially, panel and group statistics are almost always significant at 1%, except for the case of weighted probability of panel ADF statistics of non-ASEAN and all countries. Table 4 provides the results of Johansen Fisher's panel cointegration which again confirms strong statistical evidence of the cointegrating relationship of the variables in model (1).

Table-4. Johansen Fisher's panel co-integration tests for model 1

ASEAN				
Hypothesized	Fisher Stat.*		Fisher Stat.*	
No. of CE(s)	(from trace test)	Prob.	(from max-eigen test)	Prob.
None	46.36	0.0000	33.88	0.0022
At most 1	26.12	0.0250	22.54	0.0682
At most 2	17.51	0.2299	17.51	0.2299
Non-ASEAN				
None	65.80	0.0000	58.62	0.0000
At most 1	28.75	0.1522	25.38	0.2793
At most 2	23.91	0.3522	23.91	0.3522
All				
None	112.2	0.0000	92.50	0.0000
At most 1	54.87	0.0228	47.92	0.0884
At most 2	41.42	0.2461	41.42	0.2461

* Probabilities are computed using asymptotic Chi-square distribution.

Table 5 provides results of Pedroni residual cointegration test for model (2). The evidence of the cointegrating relationship of the variables are weaker than those in model (1). However, the evidence for the long-run relationship is rather strong for the case of non-ASEAN and all countries (panel and group ADF statistics are all significant at 1% level). Table 6 provides results of Johansen Fisher panel cointegration. The p-values are all smaller than 1% for

the hypothesis of no cointegration for the three groups of countries, which significantly confirms that there is cointegrating relationship of the variables in model (2).

Table-5. Pedroni Residual Cointegration Test for model 2

	ASEAN		NONASEAN	Weighted	ALL	Weighted
	Prob.	W. Prob.	Prob.	W. Prob.	Prob.	W. Prob.
Panel v-Statistic	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Panel rho-Statistic	0.8737	0.9795	0.9854	0.9925	0.9972	0.9992
Panel PP-Statistic	0.0651	0.8932	0.8587	0.4302	0.9052	0.6763
Panel ADF-Statistic	0.9805	0.9363	0.7750	0.0004	0.8409	0.0088
Group rho-Statistic	0.9866		0.9997		1.0000	
Group PP-Statistic	0.0000		0.1227		0.0000	
Group ADF-Statistic	0.1546		0.0002		0.0004	

Source: The author's calculations

In summary, both the cointegration tests show evidence of the long-run relationship between the ipriv, igov, ippp in model (1) and gdp, ipriv, igov, ippp in model (2).

Table-6. Johansen Fisher Panel Cointegration Test

ASEAN				
Hypothesized	Fisher Stat.*		Fisher Stat.*	
No. of CE(s)	(trace test)	Prob.	(max-eigen test)	Prob.
None	131.5	0.0000	88.68	0.0000
At most 1	58.85	0.0000	43.50	0.0001
At most 2	27.25	0.0178	20.49	0.1153
At most 3	17.95	0.2090	17.95	0.2090
NONASEAN				
None	134.7	0.0000	96.13	0.0000
At most 1	63.08	0.0000	50.66	0.0005
At most 2	33.50	0.0552	33.62	0.0537
At most 3	17.85	0.7151	17.85	0.7151
ALL				
None	254.4	0.0000	178.6	0.0000
At most 1	120.8	0.0000	82.80	0.0000
At most 2	74.77	0.0002	68.32	0.0009
At most 3	42.99	0.1968	42.99	0.1968

* Probabilities are computed using asymptotic Chi-square distribution.

Having established the co-integrating relationship among the variables, we proceed to estimate the long-run and short-run relationship based on the 2 specifications. Long-run relationship is estimated using DOLS, and we save the residuals of the equations for each group as the ECT (error correction term). Table 7 shows the panel VECM estimates for model (1) for the three groups of countries. With regard to the long-run relationship, it is clear that the investment from both government and public-private partnership exerts positive impact on private investment. Therefore in the long run, there is a crowding in effect of public investment, which supports the growth in private investment.

In the short run, the private investment in the previous period has positive impact on the current private investment. Public investment tends to have positive impact on private investment in the short run, but only for the sample of non-ASEAN and all countries. Besides, public-private partnership investment has negative short-run impact on private investment, only for the sample of ASEAN countries. In summary, it can be concluded that ASEAN countries are less efficient in terms of the role of public and public-private partnership investment in supporting the growth of private investment in the short run.

Table-7. short-run and long-run relationships among types of investment for the three groups of countries

	ASEAN		NONASEAN		ALL	
SHORT RUN						
D.ipriv	Coef.	P>z	Coef.	P>z	Coef.	P>z
LD.ipriv	0.043	0.78	0.395	0	0.190	0.071
LD.igov	-0.175	0.615	0.250	0	0.212	0
LD.ippp	-3.282	0	3.347	0.327	0.483	0.789
L1.ect	-0.186	0.005	0.017	0.451	0.009	0.826
_cons	3.589	0.201	15.563	0.16	15.013	0.101
D.igov						
LD.igov	-0.209	0	0.227	0	0.195	0.001
LD.ipriv	-0.071	0	-0.249	0.116	-0.277	0.207
LD.ippp	-0.044	0.713	-7.383	0.027	-3.268	0.115
L1.ect	0.153	0	0.074	0	0.075	0
_cons	1.520	0.032	17.684	0.25	11.431	0.323
D.ippp						
LD.ippp	0.300	0.001	0.471	0	0.281	0.037
LD.ipriv	0.027	0.148	0.015	0.565	0.019	0.188
LD.igov	0.154	0.004	0.000	0.954	0.011	0.363
L1.ect	0.025	0.014	0.004	0.388	0.011	0.142
_cons	-0.259	0.276	-0.196	0.69	-0.232	0.184
LONG RUN						
ipriv	Coef.	P>z	Coef.	P>z	Coef.	P>z
igov	4.499	0	1.608	0	1.550	0
ippp	5.817	0	4.589	0.02	9.748	0

Source: The author's calculations

Public and private investment in prior period has a significantly negative impact on current public investment for ASEAN countries. For the sample of non-ASEAN countries and all countries, prior public investment has positive impact on current public investment. Public-private partnership in prior period can have negative impact on current government investment. Public-private partnership investment in prior period has positive impact on the current investment in this sector for three groups of countries. Public investment in prior period has positive influence on current public-private partnership investment only for ASEAN countries. In summary, we see that there are differences in the relationship between types of investment in each group of countries, and the short-run link between public investment and private investment is less positive in ASEAN countries compared to their non-ASEAN peers.

Table 8 provides estimates of the short-run and long-run association between different types of investment and GDP for the three groups of countries. In short term, private investment tends to exert negative influence on GDP for ASEAN countries, while public investment and public-private partnership investment do not have significant impact on GDP. For non-ASEAN countries, public investment and public-private partnership investment are more efficient when both of these types of investment have positive effect on GDP. Therefore, in the short-run, we can see that all three types of investment in ASEAN countries do not perform positively as in the case of non-ASEAN countries. However at least in the long run, all three types of investment have favorable impact on GDP.

5. CONCLUSIONS AND POLICY IMPLICATIONS

This paper examines the simultaneous link between public, private and public-private partnership investment as well as the impact of these types of investment on GDP in Asian developing countries, classified as ASEAN and non-ASEAN countries in the period 1995-2015. Our findings suggest that there are differences in the relationship between types of investment in each group of countries, and the short-run link between public investment and private investment is less positive in ASEAN countries compared to their non-ASEAN peers.

Table-8. Short-run and long-run relationships among types of investment and GDP for the three groups of countries

	ASEAN		NONASEAN		ALL	
SHORT RUN						
D.gdp	Coef.	P>z	Coef.	P>z	Coef.	P>z
LD.gdp	0.307	0	0.218	0.255	0.234	0.245
LD.ipriv	-0.257	0.07	0.652	0.118	0.451	0.346
LD.igov	0.256	0.325	0.220	0.094	0.183	0.07
LD.ippp	1.965	0.139	1.238	0.07	1.088	0.178
L1.ect	0.220	0.038	-0.064	0	-0.079	0
_cons	15.939	0.006	62.653	0.125	47.209	0.097
LONG RUN						
gdp	Coef.	P>z	Coef.	P>z	Coef.	P>z
ipriv	2.978	0	2.133	0	2.208	0
igov	5.824	0	3.370	0	3.288	0
ippp	5.512	0.005	54.735	0	39.756	0

Source: The author's calculations

With regard to the long-run relationship, it is clear that the investment from both government and public-private partnership exerts positive impact on private investment. In the long run, there is a crowding in effect of public investment, which supports the growth in private investment. In the short-run, we can see that all three types of investment in ASEAN countries do not perform positively as in the case of non-ASEAN countries. However at least in the long run, all three types of investment have favorable impact on GDP.

The results of this study provide some policy implications for ASEAN developing countries, including Vietnam as follows:

First, ASEAN developing countries need to promote actively and effectively forms of PPP investment. Government should create the legal framework and favorable conditions for this type of investment to develop; help to increase investment efficiency, to reduce pressure on state budget spending. However, it should be noted that public-private partnership investment must be transferred to the private sector, and the government is only creating a good legal corridor to attract private investors to invest jointly with government in infrastructure development.

Second, public investment policy needs to be open and transparent. The lack of information in public investment leads to inefficient investment attraction.

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APPENDIX: List of ASEAN and Non ASEAN developing countries in Asia

ASEAN Developing Countries			
Cambodia	Indonesia	Lao P.D.R.	
Malaysia	Philippines	Thailand	Vietnam

NON-ASEAN Developing Countries in Asia			
Bangladesh	China	Egypt	India
Iran	Iraq	Mongolia	Nepal
Pakistan	Sri Lanka	Yemen	