THE IMPACT OF PUBLIC CAPITAL EXPENDITURE ON THE PERFORMANCE OF PRIVATE CAPITAL EXPENDITURE IN THE SELECTED ECONOMIC SECTORS IN MALAYSIA

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Abstract

Economists have argued that public capital is one of the important business stimuli to the performance of private capital expenditure. This argument is considered as the main essence in the theory Public Capital Hypothesis (PCH) that proposed by Aschauer. The PCH postulates that a positive relationship exists between private capital and public capital. However, this hypothesis remains a controversy as there has been no consensus, particularly in terms of empirical evidence. Therefore, the objective of this study is to prove the validity of the PCH by using a panel time series analysis on the four sectors of the Malaysian economy. Panel cointegration analysis is used to prove the hypothesis by using panel data for the period of 1976 – 2006. In this analysis, four sectors were chosen; agriculture, industry and trade, transportation and communication, and construction. Private capital expenditure for each sector is chosen as a dependent variable. Meanwhile independent variables used in the analysis are represented by public capital expenditure, gross domestic product, domestic credit ratio, and fiscal deficit. Findings of the study indicate that public capital expenditure has positive effect on private investment in all sectors, except agriculture.

JEL Classification: E20, H50
Keywords: Public Capital Hypothesis, Private Capital, Panel Cointegration Analysis.

Conference category: Economic and Finance

This paper is submitted to the 2011 SIBR Conference on Interdisciplinary Business & Economic Research, June 16 – 18, 2011 in Bangkok.

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1. INTRODUCTION

Economists have argued that public capital is one of the important business stimuli to the performance of private capital expenditure. The earliest study by Meade (1952), for instance, sees public capital as a critical element in the private production process. According to Aschauer (1989a,b), public capital is argued to induce an increase in the rate of return to private capital and, thereby, to stimulate private capital expenditure. The researchers call the theory proposed by Aschauer as Public Capital Hypothesis (PCH). This hypothesis supports the argument that public capital is a complement to private capital. According to this hypothesis, an increase in public capital will result in an increase in private capital since the availability of economic and social infrastructures may create conducive condition for private sector decisions by offering essential services to the production system both in the short and the long-run. Hence, public and private capital may be linked by a complementary relationship if public capital exerts positive stimulus on the private sector. As Munnell (1992) has argued, “everyone agrees that public capital investment can expand the productive capacity of an area, both by increasing resources and by enhancing the productivity of existing resources”. However, this hypothesis remains a controversy because there has been no consensus and convergence of opinions especially in terms of empirical evidences. Some studies such as by Morrison & Schwartz (1992), Argimón et al. (1997) and Zugasti et al. (2001) support PCH. In contrast, several studies such as by Sundarajan & Thakur (1980), Tatom (1991, 1993), Hulten & Schwab (1991), Evans & Karras (1994), Holtz-Eakin (1994), and Baltagi & Pinnoi (1995) have disputed the complementary findings by showing that public investment has substitute impact on private investment. Therefore, this paper tries to provide evidence on the validity of the hypothesis by using a panel analysis in the context of Malaysia. The contribution of this paper lies in the fact that the application of panel data approach has never been widely used in Malaysia, particularly in public and private capital analysis. Thus, this paper adds to the growing body of literature of the effect of public capital on private capital. The rest of this paper is structured as follows. Section 2 explains the macro fact of capital expenditure. This is followed by brief reviewing of literature in Section 3. Meanwhile, Section 4 deals with methodological issues and the data used in the empirical analysis. Furthermore, Section 5 presents the empirical results. Finally, in Section 6, the policy implications are discussed and the conclusions of the analysis are summarised.

2 MACRO FACT OF CAPITAL EXPENDITURES

The total and composition of public and private capital expenditures in Malaysia have changed significantly due to an impressive economic development during the last three decades. Changes in capital expenditure in both sectors were necessary to expand productive capacity so as to cope with expected increase in demand and modernization of the Malaysian economy. In particular, Figure 1 shows the trend of public capital expenditure for agricultural, industrial, transportation and communication, and construction sectors for the period 1976 – 2005. During this period, public capital expenditures for the transportation and communication sectors have experienced continuous increasing trend with only slight fluctuations. Public capital expenditure for these sectors have exceeded other sectors for almost every year since 1990 and have continuously dominated other sectors until 2005. These expenditures were related to huge government allocations to develop new and expand core public infrastructures such as seaports, highways, roads and airports that are important for the development of the Malaysian economy. This situation reflects the interest and priority of the Malaysian government towards the development of
national productive capacity, in line with the needs and aims of current development activities, particularly for the expansion of new residential and industrial areas.

![Figure 1: Public Capital Expenditure, 1976 – 2005](image1)

Meanwhile, private capital expenditure represent the expenditures for purchasing residential and non-residential fixed assets, other construction and land; planting and replanting of major perennial crops such as rubber and palm oil; purchasing new transportation and the expansion of plant capacity such as outlays on new plant, machinery and equipment; and conducting exploration activities. The trend of private capital expenditures is shown in Figure 2.

![Figure 2: Private Capital Expenditure, 1976 – 2005](image2)

The figure shows increasing trend particularly after 1980. In the 1970s, private capital expenditure increased consistently in all sectors. However, beginning in 1987, private capital expenditure for the industrial and trade and construction sectors increased considerably compared to the other sectors. The trend also shows that private capital expenditure in industrial and trade had dominated other sectors. In general, private capital
expenditure that contributed to fixed asset investment have increased every year. However, their pattern has changed due to the transformation of the Malaysian economic structure. For instance, the growth of fixed asset capital investment of the agricultural sector is less than the manufacturing sector. This scenario reflects the private sector’s responses that are consistent with the government policies which target the manufacturing sector as the leading economic sector. Furthermore, in consonance with the government efforts to further transform the economy, further rise in private capital expenditures are expected.

3. LITERATURE REVIEW

Our aim in this section is to provide review selected works that shed light on the question of actual relationship between public capital expenditure and private capital expenditure. This question has stimulated a considerable amount of empirical research since the earliest study of Aschauer (1989a,b) on public capital’s impact on the economic performance. As a result, there are large and growing literatures that evaluate the impact of public capital accumulation on private capital expenditure. However, these studies have revealed mixed evidence.

A plethora of empirical research using Keynesian and Neoclassical approach proves the view that there is a positive relationship between public capital accumulation and private capital. Some major findings that emerge after Aschauer’s work appear to provide evidence in support of public capital hypothesis. The study by Shafik (1990) for Egypt, finds strong evidence to support the positive impact of public infrastructural investment on private investment. The rebuilding of Egyptian infrastructure in the late 1970s and early 1980s, which had deteriorated sharply in the late 1960s and early 1970s, provided support for recovery in private investment. Lynde & Richmond (1992) indicated that private and public capital is complements in production and that public capital has a positive marginal product. Meanwhile, by utilizing the major private investment models, Erenburg (1993) found a direct relationship between private investment activity and the government’s provision of nonmilitary public capital. Furthermore, according to findings by DeLong & Summers (1991), a robust statistical relationship exists between productivity and private sector investment in plant and equipment. Odedokun (1997) has showed that in developing countries, public investments in infrastructure facilitate private investment and growth, whereas non-infrastructure public investment has an opposite effect. The same conclusions are also suggested by Boadway (1973), Henderson (1974), Hillman (1978), McMillan (1979), Ratner (1983), Merriman (1990) and Mourmouras & Lee (1999). They strongly support the idea that the public capital condition does matter. The private capital does respond to the change in productive public capital expenditures.

In contrast, several studies such as by Sundarajan & Thakur (1980), Tatom (1991, 1993), Hulten & Schwab (1991), Evans & Karras (1994), Holtz-Eakin (1994), and Baltagi & Pinnoi (1995) have disputed the complementary findings by showing that public investment has substitute impact on private investment. Most of the literature that follows Aschauer has been criticized on econometric ground. A time-series study for India and Korea by Sundarajan & Thakur (1980) reported a negative effect of public investment on private investment. Tatom (1991) argued that Aschauer and Munnell use an inappropriate method to detrend the data. Both researchers used a deterministic time trend rather than taking first differences of each data series. The former method is correct only when the data is trend stationary, but Tatom finds evidence of nonstationary in the data. As Tatom notes, failure to correct for nonstationary can result in finding spurious correlation between variables in the regression. A more direct examination of this issue is provided in a paper on Turkey by Chhibber & van Wijnbergen (1988). This study finds strong evidence that
non-infrastructure public investment hurts private investment but no strong evidence to support the positive impact of public infrastructure investment on private investment. Meanwhile Holtz-Eakin (1993) dismisses the conventional arguments for a federal infrastructure program by asserting that a large-scale public infrastructure program has no appreciable effect on productivity growth; in the current fiscal climate of scarce federal resources, a federal infrastructure program is not consistent with the goal of deficit reduction; there are better infrastructure strategies than new spending and massive construction programs; and policies aimed at increasing private rather than public investment will have a more positive impact on U.S. competitiveness. In the following paper, Holtz-Eakin (1994) found that after controlling for state specific characteristics, the public sector capital has no role in influencing private investment. The analysis of investment behavior in Malawi’s private and public goods sector between 1967 and 1988 by Mataya & Veeman (1996) have indicated contrast evidence to PCH. Their econometric results suggest that private investment is negatively related to the level of public investment.

Even though the analytical approach using panel data has many advantages, there are limited studies using this framework for proving PCH.\(^1\) The empirical analyses of PCH have been characterized by a strong focus on time series data. Among the earliest studies using panel data relating to PCH was conducted by Greene & Villanueva (1991) and Evans & Karras (1994). By using panel data series for the OECD countries, Evans & Karras showed that public capital brings negative effect on private capital. Other researchers have also undertaken PCH analysis whether using panel of countries, states, economic sectors, or industries. Ahmed & Miller (2000), Ghura & Goodwin (2000), Bende-Nabende & Slater (2003) and Erden & Holcombe (2005) for developing countries; Ramirez (2000) for Latin American countries, Blejer & Khan (1984); Oshikoya (1994) for African countries and Odedukun (1997) for a panel consisting of 48 developing countries. These studies found that public capital is a stimulus for private capital as the results show that public infrastructure investment has a positive effect on private sector investment, while non-infrastructure investment has an opposite effect. The study by Erden & Holcombe (2005) aimed to look at the effect of public investment in developing countries. A balanced panel consisting of 19 developing countries including Malaysia has been used in analyses using four methods which are pooled OLS, fixed effect, random effect, and two stage least squares (2SLS). Data analysis for the 1980 – 1997 period show that public investment is a complement to private investment. This study found that on average, an increase of 10 percent in public investment has increased private investment by two percent. On the other hand, Bende-Nabende & Slater for instance, used cointegration panel method to study private capital formation in the ASEAN countries for the period of 1965 – 1999. This empirical study intended to evaluate factors which are stimuli to private investment. The effect of public investment is significant but relate negatively with private investment.

Meanwhile, the study by Zugasti et al. (2001) and Martinez-Lopez (2006) used panel for sectors and industries to prove the validity of PCH. The study by Zugasti et al. aimed to look at the effect of public infrastructure on the performance of private businesses in Spain at the industry level. The study sample consist of 14 industries chosen from six selected sectors which are manufacturing, construction, hotels and restaurants.

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\(^1\) The advantages of panel data analysis is discussed extensively by Baltagi (2005) and Hsiao (1996). For instance, Baltagi (2005) has listed a few major advantages of using panel data. Among these advantages are panel analysis allows for heterogeneity in individuals, firms, sectors, regions, and countries. The heterogeneity aspect is usually ignored in analysis using aggregate time series data.
transportation, communication, and financial services. By using a trans-log function and the maximum likelihood method for analysis, the results of their panel analysis show that the effect of public infrastructure are different across industry, where the value of estimated parameter lies in the range of -84.16 – 8.60. The value of parameters show that public infrastructure provide a high benefit for chemical industry and the lowest for non-metallic mineral and synthetic mineral. This study confirmed that the effect of public capital on private investment differs, depending on sectors.

4. METHODOLOGY

Panel cointegration analysis is used to prove the relationship between private capital and public capital. A balanced panel with four units of cross sections \( j \) which represents four selected sectors which are the agriculture (1), trade and industry (2), transportation and communication (services) (3), and construction sector (4) is used to analyze PCH. Data for all variables are industry data. The panel period \( i \) of data is between 1976 and 2006. The sources of data are Central Bank of Malaysia, International Financial Statistics (IFS) and other official government reports.

Equation [1] is the model constructed for panel estimation. It is based on the modification of models developed from the previous studies.

\[
RPE_{jt} = \lambda_1 + \lambda_2 RGE_{jt} + \lambda_3 RGDP_{jt} + \lambda_4 DCR_{jt} + \lambda_5 RFD_{jt} + \epsilon_{jt}
\]

where;

\[
RPE_{jt} = \text{real private capital expenditure for sector } j \text{ at year } t, \\
RGE_{jt} = \text{real public expenditure for sector } j \text{ at year } t, \\
RGDP_{jt} = \text{real gross domestic product for sector } j \text{ at year } t, \\
DCR_{jt} = \text{domestic credit ratio for sector } j \text{ at year } t, \\
RFD_{jt} = \text{real fiscal deficit for sector } j \text{ at year } t, \\
\epsilon_{jt} = \text{error terms for sector } j \text{ at year } t \text{ and } \\
\lambda_i = \text{coefficient (} i = 1, \ldots, 5) .
\]

The domestic credit ratio is defined as credit for each sector/GDP. All variables other than the domestic credit ratio are expressed in real values. The real value of each variable is calculated based on the consumer price index (CPI).

Panel analysis in this study involved three main steps; panel root test, panel cointegration test, and panel estimation. Panel root test was carried out on all variables in equation [1] before panel cointegration analysis and panel estimation were carried out to avoid the incidence of spurious regression when panel data are used. Panel root test was used because the main problem of using unit root using ADF is a very low power of the test. The use of panel root test can overcome this problem because according to Banerjee, Marcellino & Osbat (2001), this test have more power and can provide a reliable prove even though cross section cointegration is bias when using panel test.

Based on several arguments explained in previous studies and its dominant usage specifically in international finance and macroeconomy compared to other tests, this study used Im, Pesaran & Shin or IPS (2003) test as the main panel unit root test. Panel unit root test was performed using autoregressive model of variable \( Y_t \) shown by equation [2].

\[ Y_t = \sum_{i=1}^{p} \alpha_i Y_{t-i} + \epsilon_t \]

\(^2\) For example, see the study by Chou & Chao (2001) relating to the effectiveness of currency devaluation in the Asian economic crisis.
\[ \Delta Y_{it} = \mu_i + \beta_i t + \delta_i Y_{i,t-1} + \sum_{j=1}^{p} \theta_{ij} \Delta Y_{i,t-j} + \alpha X_{i,t} + \varepsilon_{it} \]

where \( Y_{i,t} \) represent all variables in the study, \( \mu_i \) is the fixed effects coefficient, \( \beta_i \) is the specific time effects coefficient, \( t \) is the deterministic trend and \( \delta_i \) is the heterogenous coefficient for cross section unit \( i \). The error terms for the panel are normally and independently distributed, \( \varepsilon_{it} \sim \mathcal{N}(0, \Sigma) \) that is contemporaneous variance-covariance for cross section \( i \) at year \( t \). Next, \( p_i \) is the order for the ADF regression and the value chosen must assure that the residuals do not relate in the analysis period.

Panel unit root test is performed by testing the null hypothesis that every series in the panel contains unit root, that is \( H_0: \delta_i = 0 \) for all \( i \). Because the IPS test allows for heterogeneity among the panel units, the alternative hypothesis is shown by equation [3].

\[ H_1: \begin{cases} \delta_i < 0 & \text{for } i = 1, 2, \ldots, N \\ \delta_i = 0 & \text{for } i = N_1 + 1, \ldots, N \end{cases} \]

This hypothesis allows for a part of the (but not all) individual series have unit root.

The IPS test uses the \( \bar{t} \) statistic which is average statistic for every individual ADF obtained by carrying out regression analysis of equation [2]. The \( \bar{t} \) statistic is defined by equation [4].

\[ \bar{t}_{N,T} = \frac{1}{N} \sum_{i=1}^{N} t_{b_i} (p_i) \]

where \( t_{b_i} (p_i) \) is the individual ADF is \( ADF \) statistic for testing the null hypothesis \( H_0: \delta_i = 0 \) for all \( i \) based on the ADF regression with \( \delta_i 3 \). Further, the IPS test transform the \( \bar{t} \) statistic to \( Z_\bar{t} \) statistic, which is shown by equation [5].

\[ Z_i = \sqrt{N} \left( \frac{ \bar{t}_{N,T} - E(\bar{t}_{N,T}) }{ \sqrt{\text{Var}(\bar{t}_{N,T})} } \right) \sim N(0,1) \]

where the mean is \( E(\bar{t}_{N,T}) = (1/N) \sum_{i=1}^{N} E(t_{b_i} (p_i)) \) and the variance is \( \text{Var}(\bar{t}_{N,T}) = (1/N) \sum_{i=1}^{N} \text{Var}(t_{b_i} (p_i)) \). Both the mean and variance are asymptotes for individual ADF-statistics where both are the product of a simulation process and have been tabled in Im et al. (2003). The \( Z_\bar{t} \) statistic is normally distributed when \( N \) and \( T \rightarrow \infty \) and \( N/T \rightarrow k \) where \( k \) is a positive constant. The results of the \( Z_\bar{t} \) statistics test are compared with the critical value for the IPS test shown in Im et al. (2003).

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\[^3\] Im et al. (1997) explains that this statistic has certain characteristics. If it is assumed that there is no correlation between sectors for errors and \( T \) is the same for all sectors, normalized statistics centre on normal distribution, which is, \( \sqrt{N} \left( \frac{ \bar{t}_{N,T} - E[\bar{t}_{N,T}] }{ \sqrt{\text{Var}[\bar{t}_{N,T}]} } \right) \Rightarrow N(0,1) \), where the focus in distribution \( E[\bar{t}_{N,T}] = \mu \) and \( \text{Var}[\bar{t}_{N,T}] = \sigma^2 \) are arranged according to the Monte-Carlo simulation.
Furthermore, panel cointegration test was carried out to identify whether there exist a long run relationship between private capital expenditure and public capital expenditure and other variables. The method suggested by Pedroni (1995, 1997, 1999) was used to run the panel cointegration test on the model shown by equation [1]. Pedroni (1999) suggested two types of statistical tests, namely panel statistics and group statistics to determine the significance of panel cointegration test. Panel statistic test is based on the within-dimension-approach. This test involved four statistics which are panel v – statistics, panel ρ-statistics, panel PP – statistics and panel ADF – statistics (panel statistics test). All these statistics group autoregressive coefficient across different panel units for unit root test on the estimated residual. Group statistics test, on the other hand, are based on between-dimension–approach. This test involved three statistics namely group ρ-statistics, group PP-statistics and group ADF – statistics (group – mean statistics). All statistics are obtained from the estimators which are the average value of each individual estimated. The hypotheses of panel co-integration test using the Pedroni method are represented by equations [6], [7] dan [8].

\[ H_0 : \rho_i = 1 \quad \forall i \]

\[ H_1 : \rho_i = \rho < 1 \quad \forall i \]

\[ H_1 : \rho_i < 1 \quad \forall i \]

Equation [6] is the null hypothesis for both panel statistics and group average statistics tests. Equations [7] and [8] each represents the alternative hypothesis for panel statistics test and group average statistics test. Equation [7] assumes that \( \rho \) - value is the general value for all panel unit whereas equation [8] allows for heterogeneity across the panel units.

With the assumption that panel cointegration exists, panel estimation was performed to identify the long run relationship between the private capital expenditure variable and public capital expenditure and other independent variables using fully modified ordinary least square (FMOLS). The FMOLS method, first suggested by Phillips & Hansen (1990), is used to overcome the problem of asymptotic bias and nuisance parameter dependency relating to the estimated cointegration vector in single equation. This study has used group-mean FMOLS suggested by Pedroni (1996, 2000, 2001) because this estimation method allows for more flexible alternative hypothesis based on the existence of heterogeneity of cointegration vector and it is less problematic in terms of small sample size disturbance compared to FMOLS pooled panel.

\[
\hat{\beta}_{GFM}^* = \frac{1}{N} \sum_i \left[ \frac{\sum_{t=1}^T (SR_{i,t} - \bar{SR}_i)JR_{i,t}^* - T\hat{\gamma}_i}{\sum_{t=1}^T (SR_{i,t} - \bar{SR}_i)^2} \right]
\]

where,

\[
JR_{i,t}^* = (IR_{i,t} - \bar{IR}_i) - \frac{\hat{\Omega}_{21,i}}{\hat{\Omega}_{22,i}} \Delta SR_{i,t}
\]

\(^4\) The formula for all statistics tests are shown by Table 1 in Pedroni (1999).
\[ \hat{\gamma}_i = \hat{\Gamma}_{2i}^2 + \hat{\Omega}_{21i}^0 - \frac{\hat{\Omega}_{21i}^2}{\hat{\Omega}_{22i}} \left( \hat{\Gamma}_{22i} + \hat{\Omega}_{22i}^0 \right) \]

Here, \( \hat{\Omega}_i = \hat{\Omega}_i^0 + \hat{\Gamma}_i^0 + \hat{\Gamma}_i^1 \) is the estimated long run covariance matrix for stationary vector, \( \hat{\Omega}_{21i}^0 \) is the long run covariance between the stationary error term and autoregressive error unit root.

FMOLS estimator is constructed by correcting the endogeneity problem and serial correlation on OLS estimator. The estimator is shown by equation [10].

\[ \hat{\beta}_{FM} = \left[ \sum_{i=1}^{n} \sum_{t=1}^{T} \left( X_i - \bar{X}_i \right) (X_t - \bar{X}_t) \right]^{-1} \left[ \sum_{i=1}^{n} \sum_{t=1}^{T} \left( X_i - \bar{X}_i \right) \hat{\epsilon}_{it}^+ - T \hat{\epsilon}_{it}^+ \right] \]

where \( \Delta_{it}^+ \) is the serial correlation correction term and \( Y_{it}^+ \) is the endogeneity correction.\(^5\) The FMOLS group average hypothesis allows for the null hypothesis \( H_0 : \beta_i = \beta_0 \) and alternative hypothesis, \( H_1 : \beta_i \neq \beta_0 \) for all \( i \). This means that homogeneity is not required across panel unit under the alternative hypothesis.

5. EMPIRICAL RESULTS

The panel unit root tests results using the IPS test at the level and first differentiation are shown in Table 1.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Level</th>
<th>First Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range</td>
<td>W-stat</td>
</tr>
<tr>
<td>Intercept</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RPS</td>
<td>0 – 4</td>
<td>2.938</td>
</tr>
<tr>
<td>RPA</td>
<td>0 – 1</td>
<td>0.071</td>
</tr>
<tr>
<td>RGDP</td>
<td>0 – 1</td>
<td>4.235</td>
</tr>
<tr>
<td>NKD</td>
<td>0 – 4</td>
<td>1.330</td>
</tr>
<tr>
<td>RDF</td>
<td>0</td>
<td>1.201</td>
</tr>
<tr>
<td>Intercept and trend</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RPS</td>
<td>0 – 4</td>
<td>-0.589</td>
</tr>
<tr>
<td>RPA</td>
<td>0 – 2</td>
<td>0.636</td>
</tr>
<tr>
<td>RGDP</td>
<td>0 – 1</td>
<td>0.809</td>
</tr>
<tr>
<td>NKD</td>
<td>0 – 1</td>
<td>-0.893</td>
</tr>
<tr>
<td>RDF</td>
<td>0</td>
<td>2.069</td>
</tr>
</tbody>
</table>

Note: * Significant at the five percent confidence level

For the level, the IPS test results show that the null hypothesis is not rejected at the five percent confidence level. Therefore, all variables in the series are not stationary. After

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\(^5\) Cripolti & Maarconi (2005) provide detailed review relating to the methods for the derivation of the FMOLS estimator.
first differencing of all variables, the IPS test gives homogeneous results, which is reject the null hypothesis. This confirms that all variables are stationary at first differencing. The results verify that all variables are integrated of order one, I(1). Based on the panel unit root test, it clearly shows that cointegration analysis is needed to get the long run equilibrium equation. The panel cointegration results using the Pedroni (1997) method are shown in Table 2.

Table 2: Pedroni Residual Cointegration Test

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Statistics Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative hypothesis : general AR coefficient (internal-dimension)</td>
<td></td>
</tr>
<tr>
<td>Statistics – ν Panel</td>
<td>1.127</td>
</tr>
<tr>
<td>Statistics – ρ Panel</td>
<td>-0.314</td>
</tr>
<tr>
<td>Statistics – PP Panel</td>
<td>-5.244*</td>
</tr>
<tr>
<td>Statistics – ADF Panel</td>
<td>-5.315*</td>
</tr>
<tr>
<td>Alternative hypothesis : general AR coefficient (inter-dimension)</td>
<td></td>
</tr>
<tr>
<td>Statistics – group ρ</td>
<td>0.165</td>
</tr>
<tr>
<td>Statistics – group PP</td>
<td>-6.233*</td>
</tr>
<tr>
<td>Statistics – group ADF</td>
<td>-6.657*</td>
</tr>
</tbody>
</table>

Note: * significant to reject H₀ at the 5 percent confidence level.

With the exception panel ν, panel ρ, and group ρ statistics, all the PP and ADF statistics show that the statistics values are higher than the critical value which is -1.64. This shows that the null hypothesis that there is no cointegration between private capital expenditure and public capital expenditure in every sector is rejected. Thus, all specifications form long run co-integration vector.

The panel long run estimation results were obtained by using the FMOLS group-mean method shown in Table 3. These results do not include the constant value because panel data analysis normally eliminates the individual effect by rejecting the individual mean. The results in Table 3 show that the RGE gives significant effect on RPE for all sectors under study.

Table 3: FMOLS Individual Panel Estimation Results

<table>
<thead>
<tr>
<th>Dependent Variable: RPE</th>
<th>RGE</th>
<th>RGDP</th>
<th>DCR</th>
<th>RFD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural Sector</td>
<td>-0.11</td>
<td>0.54</td>
<td>451.38</td>
<td>-0.04</td>
</tr>
<tr>
<td>Industrial &amp; Trade Sector</td>
<td>0.78</td>
<td>0.84</td>
<td>754.48</td>
<td>0.13</td>
</tr>
<tr>
<td>Transportation and Communication Sector</td>
<td>1.50</td>
<td>0.38</td>
<td>778.37</td>
<td>-0.14</td>
</tr>
<tr>
<td>Construction Sector</td>
<td>2.01</td>
<td>1.91</td>
<td>531.48</td>
<td>0.02</td>
</tr>
<tr>
<td>Group</td>
<td>0.30</td>
<td>-0.44</td>
<td>972.33</td>
<td>0.12</td>
</tr>
</tbody>
</table>

Note: Statistic-t in parenthesis
(*): Significant at the five percent confidence level.
With the exception of the agricultural sector, the $RGE$ variables for the trade and industry sector, the construction sector, and the transportation and communication sector give a highly significant positive effect on the $RPE$. This means that there exists a complementary relationship between public and private capital expenditure for the latter three sectors which corresponds with the expected relationship. An increase in public capital expenditure in the three sectors will result in an increase in private capital expenditure in these sectors. As shown in Table 3, an increase of RM1 million in $RGE$ will result in an increase of RM0.78 million in $RPE$ for the industrial and trade sector, RM1.50 million for the transportation and communication sector, and RM2.01 million for the construction sector. As a group, an increase of RM1 million in $RGE$ causes an increase of RM0.30 million in $RPE$. In this context, according to Aschauer (1989a), public capital expenditure in each sector will result in an increase in the rate of return of private capital and consequently will encourage private capital expenditure in these sectors.

Based on the significant positive effect of $RGE$ on $RPE$ for all the three sectors, the biggest change in private capital expenditure is shown in the construction sector followed by the transportation and communication sector (services) sector. These results verify that the construction sector is regarded as having a higher degree of interdependence compared to the industry and trade sector and services sector. This sector gets higher benefits compared to the other sectors. Even though using the VAR approach, Pereira & Roca-Sagales (2001) have shown the same scenario as proven by the results of this study. However, their results showed that the positive effect of public capital is the highest in transportation and communication sector followed by manufacturing sector. On the other hand, construction sector receive the minimum positive effect. This scenario is consistent with Aschauer (1989b) who explained that public expenditure which is a complement to private sector production input is expected to have a large impact on the output of the private sector.

Meanwhile, the $RGE$ variable provides the opposite significant effect on $RPE$ in the agricultural sector with the smallest coefficient magnitude. The same relationship was also shown by Pereira & Roca-Sagales (2001). Our result provides evidence that public capital expenditure for the agricultural sector has a negative effect on the development of private capital expenditure in this sector. The result of this study has proven the statement by Ramirez (2000) who noted that a negative relationship probably exist for agricultural sector because this sector receives high government subsidy and investment activities are partly carried out by inefficient state-owned enterprises. In addition to Ramirez’s statement, this situation is also because of agro-climatic factors which worsen agricultural investment asymmetry. For example, agricultural land is only suitable for certain crops. Moreover, other forms of investment such as tractors and agricultural equipment can only be used solely for agricultural sector and they are regarded as having limited alternative uses. In addition, human and social capital in agriculture cannot be well adapted in other sectors and the adjustment process of agricultural input for use in other sectors involves high costs. Due to this problem, FAO for example, explains that there is a decline in investment in education and training in developing countries which becomes a hindrance towards the growth of the agricultural sector (Beal, 1978). This situation is one of the root causes of the existence of substitute relationship between public and private capital expenditure where an increase in public capital expenditure will reduce private capital expenditure.

The effect of economic growth has a comprehensive effect on private capital expenditure because the results show a positive significant effect between the $RGDP$ and $RPE$ for all four selected sectors at five percent confidence level. This situation shows that a high economic growth will increase private capital expenditure in all sectors with the highest increase in the construction sector. An increase of RM1 million in $RGDP$ will
increase $RPE$ by RM1.91 in the construction sector, compared to RM0.84 million, RM0.38 million and RM0.54 million for the industry and trade sector, construction sector, and agricultural sector, respectively. In general, the results of this study confirm that a high economic growth is very important in influencing an increase in private capital expenditure. Meanwhile, control variables such as $DCR$ and $RFD$ only give significant effect on the $RPE$ for the services sector at the five percent confidence level.

6. **POLICY IMPLICATIONS AND CONCLUSION**

Results of the study indicate that public capital expenditure in industrial and trade, transportation and communication, and construction sectors have positive effect on private capital expenditure in all the four sectors. Public capital expenditure in construction sector has contributed the largest effect on private capital expenditure followed by services sector. One percent increase in public capital expenditure in construction sector cause a 2.01 percent increase in private capital expenditure. Our results are consistent with the PCH and other studies such as by Barth & Cordes (1980) and Blejer & Khan (1984). Barth & Cordes (1980) suggested that capital financed by the public sector must be a catalyst to the private sector investment and output. Policy and incentives designed by the government geared towards a change in the economic structure result in a change in the government expenditure composition. The government encourage more private investment if focus is given towards productive expenditure. A productive and large scale government expenditure will have an impact on an increase in private investment activities. Blejer & Khan (1984) have explained that public and private capital expenditure are related with one another even though there exist an uncertainty on whether public capital expenditure increases or decreases private capital expenditure.

Consequently, the level and composition of government expenditure must be harmonized with the policy framework of an adjustment program, specifically for programs that influence private investment. Government expenditure analysis must be undertaken as part of the economic sector performance analysis. Specifically, the analysis will be able to evaluate and identify the disparity and imbalance in allocation between and within sectors. Private investors will associate their investment decisions with the public expenditure allocation by sectors. Sectors which receive a high allocation normally will be the focal point of current economic change framework.

Finally, the step to reorientate public capital expenditure is very important in influencing the development of economic sectors. Consistent with the change in focus of economic sectors or sector shift, public capital expenditure in sectors which are very sensitive to private capital expenditure change are very important. Sector shift may cause a fluctuation in aggregate demand and consequently cause a shift in investment.

This study has achieved its objective to prove the PCH perspective in the context of Malaysia based on a panel analysis approach. The findings of this study show that the PCH can still be challenged based on the response of private capital expenditure towards different public capital expenditure in certain sectors. Sectors which show a high degree of interdependence with public capital expenditure show a complementary relationship private capital expenditure and public capital expenditure.


