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# The Impact of Public Investment on Private Investment in Vietnam's Central Key Economic Region and the Mekong Delta Key Economic Region: A PMG Approach

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## Abstract

The purpose of this study is to find out the impact of public investment on private investment in the localities of the Mekong Delta Key Economic Region and the Central Key Economic Region. Using data on public investment (state sector's investment) and private investment (non-state sector's investment excluding FDI) in the period 2010-2021 with the PMG (Pool Mean Group) method, the research results show that in the long run, public investment creates a crowding-in effect on private investment in two Key Economic Regions. However, in the short term, public investment creates a crowding - out effect or does not affect private investment. Based on empirical research results, some relevant policy implications are suggested.

**Keywords***:* Central Key Economic Region (CKER), Mekong Delta Key Economic Region (MDKER), Key Economic Region (KER), public investment, private investment.
**JEL Classifications**: E22, H54, C51.

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# 1. Introduction

One of the key contents of Vietnam's investment policy innovation is strengthening and promoting public investment, especially in key economic regions that consider it an important driving factor in the post-COVID-19 context. The question is how the key economic sectors need to use public investment capital to promote private investment and thereby economic growth in the provinces themselves and to generate spillover effects on neighboring localities.

Many empirical studies have examined the impact of public investment on private investment from the perspective of countries or from the perspective of 63 provinces in Vietnam. However, to the best of the authors' knowledge, there is still no research applied to Key Economic Regions, especially in the context of the Mekong Delta Key Economic Region (MDKER) and the Central Key Economic Region (CKER). Despite being considered the driving forces of Vietnam, MDKER and CKER's GRPD account for only 5%-6% of Vietnam's GDP. Furthermore, while the scale of public investment tends to increase, the scale and growth rate of private investment tend to decrease gradually in these regions. This proves that MDKER and CKER's public investment might not have a stimulative effect on private investment. Therefore, determining the impact of public investment on private investment in these two KERs, thereby proposing policies to strengthen the crowding-in effect of public investment on private investment has many practical implications.

In addition, previous studies mainly focused on analyzing the impact of public investment on private investment through quantitative methods, but the disadvantage is that they do not assess the dependence between cross-observations in panel data, and the coefficients are assumed to be identical. This may lead to incorrect conclusions. To overcome these limitations, the study uses the PMG estimation method (Pool Mean Group), with the advantage of the method being to assess the dependence of the cross-observations in the panel data and the heterogeneity coefficient. Besides, PMG estimates also provide short-run and long-run estimation coefficients.

The study is organized as follows: Section 2 presents a literature review. Section 3 summarizes the data sources and research methods. Section 4 analyzes the research results and Section 5 provides policy implications.

# 2. Literature Review

Pradhan et al. (1990) examine the impact of public investment on private investment in India in the period 1990-2000 with the general equilibrium (CGE) model. The research shows that public investment crowds out private investment. Research also shows that the degree of the crowding- out effect depends on how the government finances public investment. In particular, the degree of the crowding-out effect is highest when the government borrows in the loanable capital market. Meanwhile, Bilgili (2003), with data for Turkey from 1988 to 2003, found the crowding -out effect of public investment on private investment. Specifically, when public investment increases by 1%, private investment decreases by 0.68%. However, Toshiya (2010) used Japanese data for the period 1953-2004 to analyze the impact of public investment on private investment using Cobb-Douglas production function with ECM model. Accordingly, after the first year, public investment begins to have a crowding -in effect on private investment. The author also tests the additive effect of public investment on private investment through

the Granger causality test. The results show that public investment has a positive impact on private investment. Bahal et al. (2015) analyzed the impact of public investment on private investment in India in the period Q2/1996-Q1/2015 with the SVECM (Structural Vector Error Correction Model) model. The results show that public investment had a complementary effect on private investment in the period 1980-2012 due to the reforms of the Indian economy in the early 1980s. Specifically, if public investment increases by 1 rupee, private investment will increase by 0.3, 1.24, and 1.07 rupees, respectively, after 4, 8, and 12 quarters.

In addition to studies of the effect of public investment on private investment within a country, there are also studies of a group of countries. Everhart & Sumlinski (2001) studied the impact of public investment on private investment with unbalanced panel data for 63 developing countries for the period 1970-2000. The results show that public investment outweighs private investment in most countries with weak institutions. Similarly, Cavallo & Daude (2008) analyzed the effect of public investment on private investment with the GMM (Generalized Method of Moments) moment regression method. The study using data from 116 developing countries for the period 1980 to 2006 shows that the crowding-out effect is quite pronounced. However, the crowding out of public investment is diminishing and may even have the effect of encouraging private investment in countries that have better institutions and greater openness to trade flows and international investment. Meanwhile, Erden & Holcombe (2005) analyzed the impact of public investment on private investment not only within the group of developed countries but also extended to the group of developed countries. The study was carried out with the POLS model, FE model, and RE model with panel data, including 12 developed countries in the period 1980-1996 and 19 developing countries in the period 1980-1997. The results show that for the group of developed countries, public investment has a crowding-out effect. However, research by Oshikoya (1994) for a group of 7 African countries (Cameroon, Mauritius, Morocco, Tunisia, Kenya, Malawi, and Tanzania) in the period 1970-1988 with the OLS method shows that public investment crowds private investment in both middle- and low-income countries. Evidence of the crowding-in effect is more evident in middle-income countries.

Other papers also separate public investment into investment categories and study the impact of those categories on private investment. Pereira (2000) analyzed the impact of public investment on private investment in the United States based on the VAR (Vector Autoregression) vector model and data for the period 1956-1997. In this study, the author not only evaluates the impact of public investment on total private investment but also considers each type of public investment in two directions: (1) analyzing the impact of total public investment on private investment; and (2) analyzing the impact of 5 types of public investment on each type of private investment. The results show that, in terms of results on the impact of each type of public investment on each type of private investment, in about one-third of the cases, public investment crowds out private investment. Rahman et al. (2015) also divided public investment into different categories when analyzing the impact of public investment on private investment in the case of Pakistan in the period 1974-2010. Specifically, the study shows that public investment includes government spending on health, transport, information, community services, and defense. The results show that public investment in public services and defense has an overwhelming effect on private investment. Dada (2013), when analyzing the case of Nigeria, also showed similar results. Specifically, public investment in administration, construction, agriculture, and information creates a crowding- out effect on private investment.

In Vietnam, the crowding-out effect of public investment on private investment is still controversial when analyzing the effect in the short and long term. Nguyen (2018), when researching the impact of public and private investment on economic growth with

the VECM model, found that in the long run, public investment dominates private investment. The general conclusion is that public investment is having a larger dominant effect than the complementary effect of private investment in Vietnam during the study period 1995-2016. Similarly, Nguyen et al. (2021) studied the impact of investment on economic growth in 63 provinces and cities of Vietnam in the period 2000-2020 using the PMG model. Research results show that in the long run, public investment crowds out private investment and thereby adversely affects economic growth, although other factors such as foreign direct investment (FDI), labor, and trade openness have a positive effect on economic growth. Meanwhile, Nguyen (2022) argued that public investment has an overwhelming impact on private investment in the short term when analyzing the case of the Central Key Economic Regions in the period 2000-2021. Similarly, Pham (2020) mentioned the short-term and long-term impacts of public investment on the Vietnamese economy. The author uses the DSGE / RBC model to analyze the effects of public investment on the business cycle in Vietnam after Doi Moi. Research shows that public investment explains up to 40% of the variation in Vietnam's output in both the short and long run. At the same time, the study also shows the crowding-out effect of public investment on private investment in the short run.

Besides, some research in Vietnam shows that the crowding-in effect of public investment on private investment mainly occurs in the long run. Su (2011) used the SVAR model to analyze the impact of public investment on private investment in Vietnam in the period 1990-2010. As a result, the paper finds that public investment does not crowd out private sector investment but on the contrary, creates a long-term boosting effect, especially domestic private investment. Similarly, Nguyen (2022) studied the long-term impact of public investment on domestic private investment in the localities of Vietnam. The study used panel data from 63 provinces and cities in Vietnam from 2000 to 2020, using FMOLS and DOLS methods. The results show that public investment positively promotes private investment using both estimation methods. Research results on the complementary effects of public investment on private investment in the long run are also found in recent research by Nguyen (2021).

It can be concluded that there are very few studies on the impact of public investment on private investment at the economic region level. In particular, there is no study analyzing the impact of public investment on private investment in Vietnam's Key Economic Regions. Meanwhile, one of the key contents of the investment policy innovation in Vietnam is to strengthen public investment, especially in Key Economic Regions and consider this an important driving factor in creating an infrastructure foundation to attract private investment in the country's economic recovery and development in the post-Covid-19 context. However, public investment in Vietnam has always been a bottleneck in the economy, especially in the Mekong Delta Key Economic Region (MDKER) and the Central Key Economic Region (CKER). Therefore, studying the impact of public investment on private investment in these economic regions and proposing solutions to implement public investment to promote private investment in Key Economic Regions is meaningful in practice.

# 3. Data, Model and research methodology

### *3.1 Data*

As mentioned in the introduction, the full sample consists of data for 9 localities in 2 Key Economic Regions covering the period 2010-2021. Despite great efforts, the small number of observations is a limitation of the study. However, since the Mekong Delta Key Economic Region was established in April 2009, the data were exploited in

2010. In addition, the data collection for the two Key Economic Regions at a more detailed level, such as the district level, is very difficult due to the lack of statistics at this level.

The data in the model is collected by year, mainly from Statistical Yearbooks of localities in the two Key Economic Regions including Public Investment (PU), Private Investment (PI), Foreign Direct Investment (FDI), Gross Regional Domestic Product (GRDP), Inflation (consumer price index- CPI) and Local Labor Force (L). Real interest rate data (IR) is collected from the World Bank. In more detail, under Public Investment Law of Vietnam in 2019, public investment includes State sector investment, excluding state-owned enterprise (SOE's) investment for production and business. Private investment is a non-State sector investment, including domestic enterprise sector and household sector. Foreign Direct Investment is the annual implemented capital.

Variables including PU, PI, FDI, GRDP, and FDI are expressed in logarithmic form and reported as constant 2010 prices. In addition, these variables will be calculated by being divided by the local labor force. With this calculation, the values will be adjusted to suit the characteristics (population size) of the locality (Tran & Le, 2014).

Table 1: Descriptive Statistics

| Variables | Abb | Mean | Std.Dev | Min | Max |
|---|---|---|---|---|---|
| Ln of public investment over the local labor force | PU | 1.768 | 0.736 | 0.286 | 3.113 |
| Ln of private investment over the local labor force | PI | 2.391 | 0.604 | 1.444 | 3.363 |
| Ln of foreign direct investment over the local labor force | FDI | -2.126 | 2.476 | -9.723 | 0.457 |
| Ln of gross regional domestic over the local labor force | GRDP | 3.872 | 0.322 | 2.990 | 4.311 |
| Ln of Consumer price index (Inflation) | INF | 4.656 | 0.044 | 4.600 | 4.763 |
| Real interest rate | IR | 2.077 | 7.824349 | -20.495 | 8.990 |

Source: Author's calculations

### *3.2 Model*

The model in this study builds on the neoclassical theory of investment proposed by Jogenson (1963). This model was recently studied using panel data by Altin & Agim (2012), Omojolaibi et al. (2016), and Omitogun (2018). Assume that the production function has the following form:

$$\boldsymbol{Y_t}=\mathbf{F}\ (\boldsymbol{K_t}\ ,\boldsymbol{L_t}\ )=\boldsymbol{AK^{\alpha}L^{1-\alpha}} \quad (1)$$

In which, $\boldsymbol{Y_t}$ is the output produced by firms, K is capital, L is labor. The firm's profit is written as:

$$\boldsymbol{\pi_t}=\boldsymbol{P_t}\,\boldsymbol{Y_t}\ -\boldsymbol{s_t}\ \boldsymbol{I_t}\ -\boldsymbol{w_t}\,\boldsymbol{L_t} \quad (2)$$

$\boldsymbol{\pi_t}$ is the profit at time t, $\boldsymbol{P_t}$ is the price of output at time t, $\boldsymbol{s_t}$ is the price of capital at time t, and $\boldsymbol{w_t}$ is the salary at time t. To find the optimal amount of capital (K) and the investment function, the model derivative (1):

$$\boldsymbol{K^{*}}=\boldsymbol{P^{\alpha}}\mathbf{Y/c} \quad (3)$$

where K* -optimal capital is a function of P – price of output and c – cost of capital. Therefore, investment is the change in the optimal amount of capital between two periods. We have:

$$\mathbf{I}=P^{\alpha}\mathbf{Y}/\mathbf{c}-K^{*}(t-\tau) \quad (4)$$

Assume that the price is fixed in the investment function, so:

$$\mathbf{I}=\alpha Y \quad (5)$$

Omojolaibi et al. (2016) transformed the model (3) for the panel data model as follows:

$$K_{it}^{*}=\varphi P_{it}\,Y_{it}\,C_{it}^{-\sigma} \quad (6)$$

$\varphi$ and $\sigma$ are the distribution coefficients and the constant elasticity of substitution between capital and labor. Focusing on the investment factor, researchers have shown that investment equals the change in the expected amount of capital. Assuming that capital and labor have elasticities of 1, the model is rewritten as:

$$I_{it}=\varphi_1\Delta Y_{it}+\varphi_2\Delta P_{it}-\varphi_3\Delta C_{it}+U_{it} \quad (7)$$

Omojolaibi et al. (2016) extended the model (7) with the participation of the fiscal policy variable. Based on the model of Malik (2013), Omojolaibi et al. (2016) added a fiscal policy variable (FP) including government investment spending, government recurrent expenditure, taxes, and debt. Accordingly, model (7) is transformed as follows:

$$I_{it}=\varphi_1\Delta Y_{it}+\varphi_2\Delta P_{it}+\varphi_3 C_{it}+\sum k\delta_k\,FP_{itk}+\mu_{it} \quad (8)$$

However, for the purposes of this study, model (8) is modified to show the impact of public investment on private investment. Accordingly, based on the research of Omitogun (2018), the model (8) is transformed as follows:

$$\begin{aligned} PI_{it}&=\alpha+\varphi_1\Delta Y_{it}+\varphi_2\Delta P_{it}+\varphi_3 C_{it}+\delta PU_{it}+\mu_{it}\\ PI_{it}&=\alpha+\delta PU_{it}+\sum\varphi_j\,X_{itj}+\mu_{it}\end{aligned} \quad (9)$$

*Where: PU is public investment, PI is private investment, X are the independent variables including cost of investment (C), price of output (P) and output (Y).*

According to studies by Demilie & Fikr (2015), Cavallo & Daude (2010), and Sofia (2019), cost of investment (C), price of output (P), output (Y) can be measured by the real interest rate (IR), inflation (INF), Gross Domestic Product or Gross Regional Domestic Product (GRDP), respectively. Besides, based on the studies of Nguyen (2018), Dang et al. (2020), and Nguyen (2021), foreign direct investment (FDI) is also a crucial factor that has an impact on private investment in Vietnam. Therefore, our model can be rewritten as follows.

$$PI_{it}=\alpha+\delta PU_{it}+\varphi_1 IR_{it}+\varphi_2 GRDP_{it}+\varphi_3 INF_{it}+\varphi_4\,FDI_{it}+\mu_{it} \quad (10)$$

### *3.3 Research Methodology*

Unlike previous studies when studying the impact of public investment on private investment in Vietnam, this study will not use traditional panel models such as FE (fixed effect), RE (fixed effect random), and GMM (generalized momentary regression). First, these methods will only work if T and N are large enough. However, because of the limitations of data sources and research space, the article will use a sample with T=12 and N=9. With such a sample size, it is not ideal to estimate the coefficients using the models RE or FE. On the other hand, panel data estimators such as FE, RE, and GMM require uniform parameters across panel units. In addition, because cointegration is not considered, the estimation results of the regression coefficients of the above methods may be biased and inconsistent in the long run. The intermediate estimation method (PMG) allows for short-term parameters to differ between groups while constraining long-term parameters to be uniform across panel units. Therefore, the advantage of PMG is that it allows for the distinction between short-term (difference between groups) and long-term (homogeneity between groups).

$$\Delta Y_{it}=\theta_i(Y_{i,t-1} - \gamma_i X_{it}) + \sum_{j=0}^{n} \rho_{ij}\Delta Y_{i,t-j} + \sum_{j=0}^{m} \beta_{ij}\Delta X_{i,t-j} + \tau_i+\varepsilon_{it} \quad (11)$$

Where:

$(Y_{i,t-1} - \gamma_i X_{it}) = EC$ : The error correction factor reflects the adjustment speed

$\gamma_i$ và $\rho_{ij}$ , $\beta_{ij}$ : the long-run and short-run regression coefficients, respectively

$\tau_i$, $\varepsilon_{it}$ : the unobserved and observable errors, respectively

Equation (11) above in PMG method for assessing the impact of public investment on private investment can be specified as follows.

$$\Delta PI_{it}=\theta_i(PI_{i,t-1} - \gamma_{1i}PU_{it} - \gamma_{2i}GRDP_{it} - \gamma_{3i}FDI_{it} - \gamma_{4i}IR_{it} - \gamma_{5i}INF_{it})+ \sum_{j=0}^{n} \rho_{ij}\Delta PI_{i,t-j} + \sum_{j=0}^{m} \beta_{1ij}\Delta GRDP_{i,t-j} + \sum_{j=0}^{m} \beta_{2ij}\Delta FDI_{i,t-j} + \sum_{j=0}^{m} \beta_{3ij}\Delta IR_{i,t-j} + \sum_{j=0}^{m} \beta_{4ij}\Delta INF_{i,t-j} + \tau_i + \varepsilon_{it} \quad (12)$$

# 4. Empirical Findings

### *4.1 Cross-sectional dependence and unit root test*

According to Pesaran (2004), there is a need to perform a cross-sectional dependence (CD) test on a data set to verify whether the panel data cross-sectional analyses are independent in order to ensure the estimated coefficients are consistent. In this study, we adopted the Pesaran (2004) CD test that is suitable for panels with large cross-section (N) and small time series (T).

Table 2: Cross-sectional Dependence Test

| Variable | PU | PI | FDI | IR | INF | GRDP |
|---|---|---|---|---|---|---|
| **CD test** | -0.263 | -1.263 | 1.76 | 8.785 | 8.075 | 7.052 |
| **p-value** | 0.792 | 0.207 | 0.78 | 0.134 | 0.159 | 0.365 |

Source: Author's calculations

The result from Table 2 indicates that the null hypothesis of no cross-sectional dependence is accepted. Therefore, there is no cross-sectional dependence in the data. This suggests that it is necessary to test the stationery of the series by using the first-generation unit root tests. In the study, the author uses Breitung's test (2000) to test the stationarity of the series.

Table 3: Unit Root Test

| Variable | Levels | First Differences | Results |
|---|---|---|---|
| **PU** | 0.828 | -3.547*** | I(1) |
| | (-0.203) | (-0.000) | |
| **PI** | 0.193 | -2.713*** | I(1) |
| | (-0.576) | (-0.003) | |
| **FDI** | -1.113 | -3.324*** | I(1) |
| | (-0.132) | (-0.000) | |
| **GRDP** | -1.801** | 0.184* | I(0) |
| | (-0.035) | (-0.057) | |
| **IR** | -5.265*** | -1.387* | I(0) |
| | (-0.000) | (0.082) | |
| **INF** | -2.107** | 1.070* | I(0) |
| | (0.017) | (-0.085) | |

*Note:***,**,* indicate level of significance at 1%, 5%,10%, respectively*
Source: Author's calculation from Stata

Table 3 reveals the result of Breitung's test (2000) for unit root. Accordingly, PU, PI, and FDI are stationary at first difference while GRDP, IR, and INF are stationary at higher levels.

### *4.2 Co-integration test*

After confirming the mix stationary in the unit root test, this study went further to scrutinize the co-integrating bond among the variables of interest using the Pedroni panel co-integration test (2004). Pedroni (2004) appraised the characteristics of residual-based tests for the null of co-integration in the model, in which both the long-run quantities and the short-run dynamics are tolerable to be diverse across discrete members of the panel. The Pedroni test considers both pooled and group mean between dimension tests with individual intercepts in the test.

Table 4: Panel Cointegration Test

| | Statistic | p-value |
|---|---|---|
| Modified Phillips-Perron t | -4.020*** | 0.000 |
| Phillips-Perron t | -4.055*** | 0.000 |
| Augmented Dickey-Fuller | -2.922*** | 0.001 |

*Note:***, **, * indicate level of significance at 1%, 5%,10%, respectively*
Source: Author's calculation from Stata

The results presented in Table 4 above suggest that the null hypothesis H0 (no cointegration) is rejected at the 1% significance level or that there is a long-term equilibrium between the variables in the model.

### *4.3 PMG estimation*

Table 5: The Long Run Pooled Mean Group (PMG) Results

| | Coef. | Std. Err. | z | P>z | [95% Conf. Interval] | |
|---|---|---|---|---|---|---|
| PU | 0.616*** | 0.052 | 11.7 | 0.000 | 0.513 | 0.720 |
| FDI | -0.103*** | 0.017 | -5.82 | 0.000 | -0.138 | -0.068 |
| GRDP | 0.068*** | 0.019 | 3.52 | 0.000 | 0.030 | 0.107 |
| IR | -0.002 | 0.003 | -0.7 | 0.482 | -0.010 | 0.004 |
| INF | 0.336*** | 0.027 | 12.14 | 0.000 | 0.281 | 0.390 |
| EC | -0.393 | 0.083 | -4.72 | 0.000 | -0.556 | -0.230 |

*Note: ***, **, * indicate level of significance at 1%, 5%,10%, respectively*
Source: Author's calculation from Stata

The error correction vector (EC) is negative and statistically significant at the 1% level, indicating the existence of a co-integration relationship between the variables in the model in at least one of the provinces in the Mekong Delta Key Economic Region (MDKER) and the Central Key Economic Region (CKER).

In the long run, except for the real interest rate (IR), public investment (PU), foreign investment (FDI), gross domestic product (GRDP), and inflation (INF) all have impacts on private investment where PU, GRDP, and INF have the positive effect and FDI has the opposite effect. More specifically, in the long run, when public investment increases by 1%, then private investment increases by 0.616 %. This result coincides with the research results of Kamps (2004b), António & Miguel (2008), Su (2011), Nguyen (2018), and Nguyen (2022). This result also shows agreement with the general theory about the impact of public investment on private investment. Accordingly, in the long term, public investment in infrastructure will stimulate domestic private investment. And in the two key economic regions, in the structure of public investment capital, investment capital from the state budget for infrastructure accounts for the highest proportion. Therefore, according to the analysis results, in the long term, public investment has a complementary effect on private investment in the MDKER and the CKER. Meanwhile, FDI increased by 1%, while private investment decreased by 0.103%. This result also coincides with some studies, such as Agosin & Mayer (2000), and Borensztein et al. (1998). Accordingly, foreign companies are often technologically superior and can more quickly and effectively take advantage of opportunities that were previously only accessible to domestic investors. FDI inflows may lead to a decrease in market share or withdrawal from the market of some domestic firms, especially in the case of significant technological disparities between foreign and domestic firms (Borensztein et al., 1998). However, the crowding-out impact of FDI on private investment in the two key economic regions is very small because the proportion of FDI capital compared to the total social investment capital in the two key economic regions accounts for a very small proportion. Gross regional domestic product (GRDP) has a positive impact on private investment. Specifically, a 1% increase in GRDP will lead to a 0.068 % increase in private investment. This result also coincides with the studies of Nguyen (2018) and Nguyen (2022). Accordingly, when there is economic growth, the demand for goods and services will increase, thereby promoting private investment. Meanwhile, inflation (INF) increased by 1%, then private investment increased by 0.33%. This is contrary to the author's expectation, but Hall & Hitch (1939) argued that inflation can increase private investment. According to their research, inflation has an effect on government revenue. When inflation is higher, government revenue increases because the government has

higher tax revenue. As a result, spending on infrastructure will improve and have a positive effect on private investment. However, there is no evidence of the impact of the real interest rate factor on private investment in the two key economic regions in the long run. In fact, in the MDKER and CKER, enterprises are mainly small-sized enterprises. Only about 3% of these subjects have access to official capital from banks due to a lack of collateral. They have to access informal capital, much of which comes from black credit. Therefore, it might be the reason that the bank's real lending interest rate has no impact on private investment in the MDKER and CKER.

Table 5: The Short Run Pooled Mean Group (PMG) Results

| | **Cities/ Provinces** | **ΔPU** | **ΔFDI** | **ΔGRDP** | **ΔIR** | **ΔINF** |
|---|---|---|---|---|---|---|
| **The Central Economic Key Region (CKER)** | Da Nang | 0.112 | 0.563*** | 0.419** | -0.018** | 3.256*** |
| | | (0.388) | (0.000) | (0.010) | (0.022) | (0.009) |
| | Hue | 0.570 | 0.516 | -0.983 | -0.079 | -0.079 |
| | | (0.859) | (0.890) | (0.877) | (0.648) | (0.994) |
| | Quang Nam | -0.586* | -0.326*** | 1.711*** | -0.011 | 2.929*** |
| | | (0.085) | (0.001) | (0.001) | (0.131) | (0.000) |
| | Quang Ngai | -1.110*** | 0.960*** | -0.956 | -0.038** | 0.692 |
| | | (0.002) | (0.001) | (0.455) | (0.011) | (0.767) |
| | Binh Dinh | -0.173*** | 0.026** | 1.792*** | -0.010*** | 1.705*** |
| | | (0.000) | (0.016) | (0.000) | (0.000) | (0.000) |
| **The Delta Mekong Economic Key Region (MDKER)** | Kien Giang | -0.793*** | 0.110* | 0.055*** | -0.031*** | -0.995 |
| | | (0.000) | (0.058) | (0.000) | (0.001) | (0.286) |
| | An Giang | 0.044 | 0.087* | 0.750 | -0.001 | -1.362 |
| | | (0.770) | (0.057) | (0.670) | (0.857) | (0.397) |
| | Can Tho | -0.857 | 0.500 | -2.046 | -0.017 | 4.362 |
| | | (0.0250) | (0.202) | (0.562) | (0.447) | (0.223) |
| | Ca Mau | 0.321 | 0.0373 | -1.040 | -0.030** | 1.752 |
| | | (0.241) | (0.204) | (0.103) | (0.014) | (0.237) |

*Note: ***, **, * indicate level of significance at 1%, 5%,10%, respectively*
Source: Author's calculation from Stata

In the short run, regarding the CKER, public investment has a crowding-out effect on private investment in Quang Nam, Quang Ngai, and Binh Dinh. This result can be found in the studies of Kollamparambil & Nicolaou (2011) and Bui & Le (2017). Accordingly, it comes from the fact that, in the short term, public investment in infrastructure cannot immediately create a complementary effect on private investment. Even an increase in unproductive infrastructure investment, which is financed by taxing income, reduces public investment and per capita GDP growth (Agenor & Moreno-Dodson, 2006). Accordingly, public spending on infrastructure causes crowding-out effect that, in the short run, an increase in public spending on infrastructure would decrease finance opportunities in the private sector. On the other hand, when the government increases investment, it will lead to an increase in the demand for money, thereby creating pressure to increase interest rates and reduce private investment. Similar results are found in the MDKER, where public investment has a crowding-out effect on private investment in Kien Giang and Can Tho. In the remaining cities and provinces of the two key economic regions, there is no evidence of the impact of public investment on private investment in the short term. This result can be found in the studies of Phetsavong & Ichihashi (2012), Tran & Le (2014), and Dreger & Reimers (2016). Especially in the two cities and provinces that are considered the centers of the two key economic regions, Can Tho and Da Nang, the impact of public investment on private investment in the short

term is not statistically significant. This result can be explained because, after achieving a high growth rate in the period 2010-2016, the growth rate of public investment decreased sharply and continuously reached negative values in the period 2017-2021. Therefore, it might be the reason why the overall effect of public investment on private investment in the period 2010-2021 is not clear in the case of Can Tho and Da Nang. In the remaining localities, the reason is that the scale of public investment is very small, so in the short term, the impact of public investment on private investment is uncertain.

Regarding FDI, in the short term, the impact of FDI on private investment varies by cities and provinces. Specifically, in the CKER, FDI creates a positive impact on private investment in Da Nang, Quang Ngai, and Binh Dinh but creates a negative impact in Quang Nam. For the Mekong Delta key economic region, FDI creates a positive impact in Kien Giang and An Giang. This result can be found in the study by Tran & Le (2014) and Nguyen (2014). Furthermore, it can be seen that the impact of FDI on cities and provinces in the CKER is stronger than in the MDKER. This is due to the policies of almost all provinces in CKER that focus on attracting FDI into the local strong industry in order to attract domestic enterprises to participate in the global value chain. At that time, domestic enterprises will be one of the links in the value chain created by FDI capital instead of being competitors in the market and being overwhelmed by FDI enterprises. In addition, the gross regional domestic product (GRDP) creates a positive impact on private investment in Da Nang, Quang Nam, Quang Ngai, Binh Dinh in the CKER, and Kien Giang in MDKER.

Regarding IR, in the CKER, IR creates a negative impact on private investment in Da Nang, Quang Ngai, and Binh Dinh. Similarly, IR also negatively affects private investment in Kien Giang and Ca Mau. This evidence is in accordance with standard neoclassical theory: real interest rates are negatively related to private investment rates. This result also coincides with the studies of Demilie (2015), Nguyen (2018), and Nguyen (2022). Especially, IR has an impact on the majority of localities in the CKER instead of the MDKER. The reason may stem from the fact that in this region, the contribution of the business sector to private investment is nearly twice as large as that of the household sector. And the business sector may be affected by the interest rate more than the household sector.

Regarding INF, a special feature is that INF affects private investment in Da Nang, Quang Nam, and Binh Dinh in the CKER. Although the impact of INF on private investment is contrary to the expectations of the author and some other studies, such as Sofia (2019), and Nguyen (2021), this result can be found in the study of Hall & Hitch (1939). Accordingly, the author shows that inflation has an effect on government revenue. When inflation is higher, government revenue increases because the government has higher tax revenue. As a result, spending on infrastructure will improve and have a positive effect on private investment. Furthermore, the high inflation rates may be related to strong private investment activity (Joshua & Delano, 1991). That might explain why there is no sign of INF's impact on private investment in the MDKER, where the scale and growth rate of private investment are relatively smaller than those of the CKER.

# 5. Conclusion and policy implications

This study was conducted to analyze the impact of public investment on private investment in the Central Key Economic Region (CKER) and the Mekong Delta Key Economic Region (MDKER) in the period 2010 - 2021 employing the PMG method.

Research results show that in the long term, public investment has a complementary effect on private investment in the CKER and the. However, in the short term, public investment creates a crowding effect or does not impact private investment in the cities and provinces of the two key economic regions. Especially, evidence of the crowding-out effect of public investment on private investment is more obvious in CKER compared to MDKER. Moreover, in localities that are considered the centers of the two key economic regions, there is no evidence of a crowding-out effect in the short run. This might explain the reason why these two economic regions experience a decreasing scale and growth rate of private investment. This is due to the fact that public investment insufficiently promotes investment in the short run in almost all provinces, especially in the leading cities of the Key Regions. Based on empirical research, some policy implications can be drawn as follows*:*

*Firstly, the government's public investment policy in the CKER and the MDKER should aim at long-term goals.* Research results show that instead of causing a crowding-out effect on private investment in the short run, in the long run, public investment in the two key economic regions creates a –crowding-in effect on private investment. Therefore, it is essential that long-term goals of public investment, which are mainly aimed at increasing investment in infrastructure, be prioritized. In the context that the budget is shrinking due to the Covid-19 pandemic and therefore it is impossible to invest in all projects related to infrastructure in the cities and provinces, the government needs to support public investment capital focusing on intra-regional linkages. Besides, regarding overloaded road transport and the implementation of Vietnam's commitment to reducing CO2 emissions, public investment in key economic regions should prioritize the development of waterway transport infrastructure.

*Secondly, in the short term, in order to limit the overwhelming impact of public investment, the provinces in the CKER and the MDKER need to strengthen the attraction of foreign direct investment (FDI) as well as improve the allocation of public investment.* Research results show that FDI has an impact on promoting private investment in most localities in the CKER. For the CKER, tourism is the key economic sector of the region, so it is crucial to find solutions to restore and develop the –tourism-service economy. For the MDKER, agriculture is the region's strength. Therefore, it needs to focus on attracting FDI in the high-tech agricultural sector through forms such as subsidies for investors and supporting research and development. At the same time, it should improve basic infrastructure in agriculture by continuing to deploy and enhance power systems, information technology systems, and irrigation systems. Besides, the decrease in private investment in these regions might be due to the misallocation of public investment in the short-run, which leads to a decrease in the financial opportunities of the private sector. Therefore, it is crucial to improve the allocation of public investment by jointly considering both the overall priorities for the development of the region and the appropriate division of responsibility between public and private activities.

*Thirdly, develop green credit for private investment in the context that credit sources from commercial banks for the private sector are affected by the impact of the Covid-19 pandemic and Vietnam is moving towards sustainable growth*. Research results show that the real interest rate has a negative impact on private investment in some cities

and provinces in two Key Economic Regions. This might be due to the lack of credit, so the private sector has to pay a high cost to borrow money from banks. Furthermore, access to credit for the private sector in the CKER and the MDKER is relatively difficult because the private sector in these two KERs includes mainly small and medium enterprises and small business households that lack collateral. Therefore, developing the green bond market as an alternative to the credit sources of banks and financial institutions to facilitate the private sector's approaching credit.

*Fourthly, for the leading cities of the two KERs (Da Nang, and Can Tho), in the short term, it is necessary to promote effective public investment activities to create complementary effects on private investment as well as spillover effects on private investment in neighboring cities and provinces*. The study results show that –short-term public investment in these two cities does not create an effect on public investment while creating a complementary effect in the long run. With their position as the central cities of the two key economic regions, Da Nang and Can Tho need to step up public investment disbursement, focus on investing in key projects, and attract more investment resources from the private sector for public investment activities in the short run.

Regarding the cases of CKER and MDKER, other Key Economic Regions including Southern Key Economic Region and Northern Key Economic Region should increase public investment in infrastructure with the aim of promoting private investment in the long term. Furthermore, strengthen the attraction and selection of FDI projects in the areas of strength of the localities in the region to reduce the crowding-out effect of public investment in the short run. Though the above-recommended policies are expected to help CKER, MDKER, and other Key Economic Regions allocate public investment efficiently to promote private investment, it should also be remembered that the policy framework needs to consider the spatial effects that might happen among localities in Key Economic Regions. Further research in this aspect can be carried out by employing spatial regression models to represent the possible spill-over effect of public investment on private investment in Key Economic Regions.

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