The Relative Effect of Public and Private Investment on the Economic Growth in OECD Countries

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Abstract

This paper examines the relative effect of public and private investment on per capita GDP growth in 25 OECD countries. It extends the basic neoclassical model of growth by separating investment into its public and private components following Khan and Kumar (1997) and estimates this model using single equation estimation techniques for the time period 1970-2013. This empirical analysis provides a framework to test several interesting hypotheses: (1) Does total investment have a significant effect on economic activity? (2) Does private investment have a larger impact on growth than public investment, and is the differential impact statistically significant? (3) Does public investment substitute or complement private investment in the economic growth process? The findings from this study are relevant from a theoretical, empirical, and policy points of view. The findings suggest (1) total investment has a positive and significant effect on output; (2) private investment has a markedly larger effect on output than public investment; (3) public investment tends to crowd out private investment.

I. INTRODUCTION

The main concern for OECD countries, has been ensuring a sustained positive economic growth. While economists agree that investment can affect economic activity, they have not produced a consensus on whether public and private investment have different effects on total output and whether there is a link between the two. Public investment may affect economic growth through two different channels. First, it may complement private investment by providing high quality infrastructure and human capital formation and be beneficial for growth. Second, public investment may compete with private investment. For instance, an increase in government borrowing leads to higher interest rates and the private sector which is sensitive to interest rate will likely reduce investment due to the lower rate of return. This crowding out effect may have little, no or even negative effects on total output. Thus, for policymakers in the world concerned with growth, it does matter how to split total investment between its public and private components.

The literature on this topic has been concerned with three questions: Does total investment have a significant effect on economic activity? Does private investment have a larger impact on growth than public investment, and is the differential impact statistically significant? Does public investment substitute or complement private investment in the economic growth process? The findings from this study are relevant from a theoretical, empirical and policy point of view. From the theoretical perspective, total investment has played an important role in the long-run growth in real GDP per capita incomes across countries (Barro, 1991; Mankiw, Romer and Weil, 1992). If the two components of investment and their interaction affect the growth in different ways, it would be important to determine the steady-state growth path. The empirical evidence on the relative effect of

public and private investment on economic growth of the OECD countries has been limited. Number of studies conclude that public investment has a larger positive impact on growth rather than private investment in these countries (Argimon, et al., 1997; Fournier, 2016; Afonso and Aubyn, 2016). However, because these studies suffered from small samples of countries and limited time periods, there is a great doubt about how their results are robust. To the extent that policy is concerned, if the private investment has a larger effect on economic growth, or if public investment complement private investment, it is needed to rationalize public investment as well as provide additional support for the private sector investment.

This paper examines the relative effect of public and private investment on the economic growth of 25 OECD countries over the time period 1970-2013. It extends the basic neoclassical model of growth by separating investment into its public and private components following Khan and Kumar (1997) and estimates this model using single equation estimation techniques. I correct for the existence of heteroskedasticity in the model by utilizing White heteroskedasticity-consistent standard errors and covariance, and I provide two sets of results: with aggregate investment and with two different components of investment. To examine the relationship between public and private investment, I use the panel data. I account for the cross sectional dependence of the variables to avoid biased results for the cointegration analysis.

The results show that total investment has a positive statistically significant impact on economic growth of countries. Moreover, both public and private investment have a positive statistically significant impact on economic growth, with private investment having a much stronger impact than

public sector investment. Interestingly, public and private investment have no long run relationship, but in the short run, public investment crowds out private investment.

Overall, examining how public and private investment affect total output , is one step towards having a sustained positive economic growth. Coupled with the findings that public and private investment have a different impact on economic growth and public investment crowds out private sector investment, my paper suggests that adopting some policies which provide additional support for private sector investment in these countries can contribute to an improved economic growth in OECD countries.

II. LITERATURE

The theoretical framework for modelling the relationship between investment and economic growth has followed the neoclassical growth model and Solow (1956). In the Solow model, economic growth is studied by assuming a standard neoclassical production function with constant returns to scale in its two arguments, capital and effective labor. Solow indicated that the rates of saving and population growth as exogenous variables determine the steady-state level of income per capita. Different countries will be in different steady-state due to the variation of saving and population growth rates across countries. Solow's model gives simple testable predictions about how these variables influence the steady-state level of income (Mankiw et al, 1992).

Findings derived from this model shows that there is a positive and significant relationship between the investment rate and the level of output (Solow, 1956). Turning to public investment, theory

suggests that public capital is a determinant of productivity given that infrastructure is an important input in most economic sectors and crowds in private investment by raising the rate of return of private capital (Aschauer, 1989; Alvarez, 2012). Similarly, Romer (1986) shows that in the presence of positive externalities, government intervention can lead to welfare gains. On the contrary, if public and private capital are substitutes, increasing public investment decreases private investment. If the crowding out effect is partial, the aggregate investment still rises. If one unit of public investment crowds out one unit of private investment, the aggregate investment may be unchanged. In the case of inefficient public investment which is less effective than private investment, the growth effect could even turn negative. Several studies have empirically investigated the contributions of public and private investment on economic growth using international data. Most of the studies may fall in one of the three categories of time-series, cross-sectional and panel analysis based on the type of data used in the empirical investigation.

The first group of literature consists of studies based on time-series data (Aschauer, 1989; Ram and Ramsey, 1989; Berndt and Hansson, 1992; Cruz and Teixeira, 1999; Pereira, 2001; Noriega and Fontenla, 2005; Bahal et al., 2015; IMF, 2015; Fonseca et al., 2019). Typically, these studies use a vector error correction model (VECM), vector autoregressive (VAR) model or an auto-regressive distributed lag (ARDL) model to examine the long-run and short-run causality between variables. Three studies relevant to our work (Berndt and Hansson, 1992; Cruz and Teixeira, 1999; Fonseca et al., 2019) have revealed that public investment serves as a substitute for private investment in the short-run. However, in the long-run there is a complementarity between public and private investment. On the other hand, the view that public capital accumulation may have become more

complementary to private investment and the evidence of ''crowding in'' of private investment by public investment is supported by Bahal, et al. (2015). A number of other studies (Aschauer, 1989; Pereira, 2001) have focused on the impact of different types of public investment on different types of private investment and suggest that in about one third of cases, public investment crowds out private sector investment.

The second group of studies has investigated the impact of private and public investment on growth using cross-sectional data (Reinhart and Khan, 1989; Khan and Kumar, 1997; Heitger, 2001; Fournier, 2016). Overall, the findings suggest that private investment has a larger positive effect on economic growth than public investment. As such, these studies suggest that governments should aim at creating conditions which make private investment more attractive in developing countries (Reinhart and Khan, 1989; Khan and Kumar, 1997). Fournier (2016) has reviewed the impact of public and private investment on growth in OECD countries. His empirical results demonstrate that public investment has a large and significant effect on growth in all countries, especially in the case of investments with large externalities such as health, development and research. Research by Heitgar (2001) has revealed that in OECD countries, total government expenditure as well as different types of government expenditure do have a negative impact on economic efficiency. The findings also suggest that government investment crowds out private investment.

The third group of studies based on panel data utilizes generalized least square (GLS) model, weighted least square (WLS) model or dynamic ordinary least square (DOLS) (Coutinho et al., 1991; Evans and Karras, 1994; Argimon et al., 1997; Everhart and Sumlinski, 2000; Erden and Holcombe, 2006; Bose et

al., 2007; Hunt, 2008; GJini and Kukeli, 2012; Afonso and Aubyn, 2016). Panel studies benefit from higher degrees of freedom and lower multicollinearity than cross-sectional studies, thereby results are more robust relative to time series or cross sectional analysis (Yoo, 2005). Some studies (Evans and Karras, 1994; Everhart and Sumlinski, 2000) analyzing the productivity of public sector activities find strong evidence that only government educational services are productive but not the same for other government activities. They also find evidence of crowding out of private investment by public investment with the crowding out stronger in the presence of corruption. Coutinho, et al. (1991) note that in countries where private investment and public investment are interdependent, private investment tends to be superior. On the other hand, the view of complementary relationships between public and private investment and their positive effect on economic growth is supported by Afonso and Aubyn (2016) and Hunt (2011).

In summary, previous studies provide a mixed picture of the impact of private versus public investment on economic growth, as well as the substitutability versus complementary relationship between the two types of investments. As such, the literature will benefit from further investigation of the subject. This study will empirically reexamine the contribution of private and public capital on economic growth using a cross-sectional data on 25 OECD countries over 1970-2013. Two distinguishing features of this study are (1) the use of an extended and more recent annual data set on OECD countries, and (2) the inclusion of a larger number of OECD countries.

III. THEORETICAL FRAMEWORK

The long-run rate of economic growth of a nation has played a crucial role in order to provide improving standards of living for its people. The theoretical framework for modelling the relationship between investment and economic growth follows the neoclassical growth model by Solow (1956). An economy's output of goods and services depends on the quantities of available inputs, such as capital and labor, and on the productivity of those inputs. In the Solow model, the relationship between output and inputs is described by the production function with a constant returns to scale as the form:

$$Y(t) = F(K(t),\ A(t)L(t)) \qquad \textbf{(1)}$$

Where t denotes time.

The Solow model examines an economy as it evolves over time. Equation (1) relates total output, Y, to the economy's use of capital, K, and labor, L, and to productivity, A. Saving and investment decisions play a central role in the analysis. Along with changes in productivity, the rates at which a nation saves and invests and thus the rate at which it accumulates capital goods are important factors in determining the standard of living that the nation's people can attain.

In order to focus on the role of private and public capital, only these two forms of capital are considered in the following theoretical model which also considers the role of population growth, as determinants of growth of real per capita income. Assume a Cobb-Douglas production function, with production at time t given by:

$$Y(t) = K_g(t)^{\alpha} K_p(t)^{\beta} (A(t)L(t))^{1-\alpha-\beta} \qquad \alpha + \beta < 1 \qquad \textbf{(2)}$$

Where Y, L and A denote the levels of output, labor, and productivity respectively; K_g and K_p denote public and private sector capital stock respectively; α and β are the elasticities of output with respect to public and private capital. The elasticities α and β both are numbers between 0 and 1. L and A are assumed to grow exogenously at constant rates n and γ;

$$\dot{L}(t) = nL(t) \qquad \textbf{(3)}$$

$$\dot{A}(t) = \gamma A(t) \qquad \textbf{(4)}$$

Where a dot over a variable denotes a derivative with respect to time. Equation (3) and (4) imply that L and A grow exponentially. That is, if $L(0)$ and $A(0)$ denote their values at time 0, (3) and (4) imply $L(t) = L(0)e^{nt}$, $A(t) = A(0)e^{\gamma t}$.

Let S_g and S_p be the share of income invested in public and private capital respectively. Following Blejer and Khan (1984), I assume that both types of capital stock depreciate at the same rate δ [1]:

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$$\dot{k}_g = I_g - \delta k_g \qquad (5)$$
$$\dot{k}_p = I_p - \delta k_p \qquad (6)$$

[1] It might be discussed that public capital stock, especially in infrastructure, depreciates at a different rate compared with private capital stock. While such an extension complicates the analysis, it does not change the conclusion significantly. For simplicity, therefore, the restriction of equality of depreciation rates is maintained.

Where I_g and I_p denote public and private sector investments, respectively. In equilibrium, aggregate savings equal aggregate investments. Define k_g and k_p as the stock of public and private capital per effective units of labor (i.e., $k_g = \frac{K_g}{AL}$ and $k_p = \frac{K_p}{AL}$) and let y be the level of output per effective unit of labor ($y = \frac{Y}{AL}$) (Khan and Kumar, 1997). The evolution of k_g and k_p is given by following:

$$\dot{k_g} = S_g Y - (n + \gamma + \delta)k_g \qquad (7)$$
$$\dot{k_p} = S_p Y - (n + \gamma + \delta)k_p \qquad (8)$$

Where the saving (investment) and population growth affect output per worker through their impact on capital per worker. A country that saves more of its output has more capital per worker, and hence more output per worker; a country with higher population growth devotes more of its saving to maintaining its capital labor ratio, and so has less capital and output per worker. The implication of this model shows that while population growth has a negative and significant relationship with the level of output, there is a positive and significant relationship between the investment (saving) rate and the level of output. In the next sections it will be analysed whether there is empirical evidence in favour of this hypothetical relationship between public and private investment and economic growth.

IV. EMPIRICAL FRAMEWORK

I empirically investigate the relative effects of public and private investment on economic growth using a log-linear approximation of the production function:

$$ln(y_{i,t}) - ln(y_{i,0}) = \alpha_0 + \alpha_1 ln(Ig_i) + \alpha_2 ln(Ip_i) - \alpha_3 ln(1 + n_i) + \alpha_4 ln(HC_i) + \alpha_5 ln(FDI_i) - \alpha_6 ln(y_{i,0}) + e_i \qquad (9)$$

Where the left hand side of the equation provides the growth of per capita income for country i which depends on public investment (Ig_i), private investment (Ip_i), population growth (n_i), human capital secondary enrollment ratio (HC_i) and foreign direct investment (FDI_i). For real GDP per capita, I consider $y(0)$ as the real GDP per capita for some initial date and $y(t)$ as the real GDP per capita for the last year of the time-period. I use the ordinary least square (OLS) estimation method in order to get the estimated coefficients of the relative variables. The logarithm of (1+n) is approximately equal to the growth rate of population. In order to make the interpretation of the estimated coefficient simple, I include the logarithm of (1+n) instead of including the logarithm of the population growth (n) itself.

The coefficients of interests are α_1 *and* α_2. The estimated coefficients will show us how public and private investment affect per capita GDP growth in 25 OECD countries. These two coefficients might have different magnitudes and different signs. In general, some components of public investment may crowd in private investment and so would have a positive effect on economic growth, while others might crowd out private investment and have a less positive, or even negative effect on economic growth. For instance, if public investment complements private investment by providing high quality of infrastructure, this would increase the marginal product of private capital. However, public investment in infrastructure may not always have a positive effect on private investment and economic growth. There is evidence of low quality public investment in infrastructure which had a negative effect on economic growth in many countries in Latin America, Asia and Africa (Khan and Kumar, 1997).

The results suggest that private investment has a much stronger effect than public investment on economic growth. Also, population growth adversely affects the growth of per capita income. The effects of human capital and foreign direct investment as a productivity of factor production and macroeconomic stability respectively, should be positive on economic growth of countries and they may improve the explanatory power of the equation. The next step is to examine the relationship between public and private investment. Since traditional estimation methods have become inconsistent or inefficient in the presence of cross-sectional dependence, new techniques have been developed in panel data econometrics for stationarity and cointegration analysis and estimation procedures which take account of cross-sectional dependence.

A. COINTEGRATION ANALYSIS

The cross-sectional dependence is due to common unobserved components which might provide bias results. To resolve this potential problem, I employed Bias-Adjusted CD test developed by Pesaran et al. (2008), cross-sectionally augmented Im-Pesaran-Shin (CIPS) panel unit root test proposed by Pesaran (2007), Common Correlated Effects Mean Group (CCEMG) estimator proposed by Pesaran (2006), and Augmented Mean Group (AMG) estimator proposed by Eberhardt and Bond (2009) which allow for cross-sectional dependence arising from multiple unobserved common factors.

In order to investigate the possibility of panel cointegration, it is first necessary to determine the existence of unit roots in the data series. IPS use separate unit root tests for the N cross-section units.

Their test is based on the Augmented Dickey Fuller (ADF) statistics averaged across groups. The null and alternative hypothesis for this test are as follow:

H0: all panels contain unit roots

Ha: some panels are stationary

The next step is to test for the existence of the long-run cointegration between public and private investment. I employed the Common Correlated Effects Mean Group (CCEMG) and Augmented Mean Group (AMG). The advantage of using CCEMG method is that it induces cross-section dependence, time-variant unobservables with heterogeneous impact across panel members. CCEMG provides some indications of a long run relationship between public and private investment. In order to examine the short run relationship between public and private investment I employed the Granger-Causality test.

V. DATA

The data come from the International Monetary Fund (IMF), the World Bank's World Development Indicators and OECD National Accounts (see Table (1) for details). The sample of cross sectional data consists of 25 OECD countries during the period 1970 to 2013. The countries included are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.

My analysis is based on three main variables: Real GDP per capita (y), Public Investment (I_g), Private Investment (I_p). Real GDP per capita (y) based on purchasing power parity (PPP) is gross domestic product converted to international dollars using purchasing power parity rates. The dependent variable is growth of real GDP per capita and it is constructed in the logarithm form as $ln(\frac{y(t)}{y(0)})$ where $y(t)$ is the real GDP per capita at time t and $y(0)$ is the real GDP per capita at some initial date.

The main explanatory variables are public and private investment which are obtained from the IMF. The public sector includes general government, nonfinancial state enterprises, and principal autonomous agencies. The data for public investment is constructed based on the government fixed capital formation which includes land improvements, plant, machinery and equipment purchases and construction of infrastructure such as roads, railways and including schools, offices, hospitals, private residential dwellings and commercial and industrial buildings. Private investment covers gross outlays by the private sector which includes private nonprofit agencies on additions to its fixed domestic assets.

To assess the strength of the linkage between investment components and the real GDP per capita growth, I control for other potential determinants of growth. I use three control variables widely employed in the related literature. First, I included the human capital (HC) which is proxied by total gross enrollment ratio for secondary education[2] which has an important role in the productivity of all other factors of production, or in generating new products or ideas that underpin technological

[2] Human capital can be proxied by three different measures identified by Barro and Lee (1994): total gross enrollment ratio for three categories of education (primary, secondary and higher education); the percentage of schooling completed in the total population for the three categories; and average schooling years in the total population. However, since I am trying to reexamine the work by Khan and Kumar (1997) for OECD countries, I have chosen the total gross enrollment ratio for secondary education as a proxy for human capital.

progress. Second, the foreign direct investment (FDI) which is the net inflow (new investment inflow less disinvestment) in the reporting economy from foreign investors is used as a measure of macroeconomic stability that may positively affect economic growth. Finally, the population growth (n) which counts for all residents regardless of legal status or citizenship. Data on human capital (HC), foreign direct investment (FDI) and population growth (n) are from the World Bank's World Development Indicators.

All of the variables are in the logarithm form as $ln(\frac{y(t)}{y(0)})$, $ln(I)$, $ln(I_g)$, $ln(I_p)$, $ln(n+1)$, $ln(HC)$, $ln(FDI)$, and $ln(y(0))$. Besides examining the effect of different components of investment on economic growth, I aim to consider the overall effect of investment on economic growth. I construct data for total investment, I, by adding public and private investments, I_g and I_p.

Since the use of annual data would be inappropriate for analysing the growth process, and in any case exhibit excessive noise, the procedure adopted was to average growth and the explanatory variables over a period of ten years as follow: 1970-1979, 1980-1989, 1990-1999, and 2000-2013. This type of data also provides an opportunity to avoid missing values in variables. I aim to examine the relationship between economic growth and all explanatory variables in four different decades. Since data was available until 2013, I see it practical to consider four more years for the last decade .

Table (2) presents the descriptive statistics for the variables used in our empirical analysis. There are not considerable variations in our variables across countries. The value for standard deviation of all variables is small which indicates that the data points tend to be close to the mean of the dataset. The most variated variable is log of FDI ranges from a low -2.39 to 3.76.

VI. RESULTS

A. BASIC RESULTS

Before examining the differential impact of public and private investment obtained by estimating equation (9), consider as a test the empirical results for the model with total investment as the main explanatory variable across countries. These results have been provided in table (3) for five different periods__ 1970-2013, 1970-1979, 1980-1989, 1990-1999, and 2000-2013. Column (1) indicates that for the 1970-2013 period as a whole, the fit of this equation is quite good; nearly 80 percent of the cross-country variation in per capita GDP growth is explained by the variation in total investment, initial per capita income, population growth, and human capital (proxied by secondary school enrollment ratio). All the variables have the expected signs. The interesting variable is the investment ratio and it is statistically significant. The estimated coefficient shows that a one percentage point increase in investment ratio is associated with 0.85 of a percentage point increase in per capita GDP across countries.

Now consider the differential impact of public and private sector investment on per capita growth. As indicated in column (6) of table 3, both public and private investment have a positive statistically significant impact in the estimates for the full time period 1970-2013; however, their magnitudes are

markedly different, with private investment having a much stronger impact than public sector investment. This result is consistent with previous studies.

The results for sub-periods considerably diverge: while private investment has a positive and statistically significant effect on per capita growth for three respective time periods (1970's; 1980's; 1990's), public investment became insignificant but still it has a positive sign. For the last period 2000-2013, although private investment became statistically insignificant, it still has the positive sign. However, public sector investment turns into a negative sign. One explanation for this difference could be that during the 2000's all countries had faced a great recession. One of the legacy of the recession is debt. Governments try to borrow as much as they can during the crises to stimulate activity and keep financial institutions afloat. While this action was necessary, it caused the transferring of the financial crises from the private sector to the public sector. Financial institutions could not cover their debt. In order to rescue them, the problem shifted to governments, leaving them with high levels of debts.

An attempt was made next to investigate whether the variables of special interest provide different results before and after the great recession. I tested the model for two different sub periods 2000-2007 and 2008-2013. The estimated coefficients are still statistically insignificant for both periods; however, the sign of the coefficient of the public investment became positive during 2000-2007 and then turned into negative during 2008-2013. This result can be a confirmation of the above explanation.

The above results also indicate the importance of the other explanatory variables such as human capital and foreign direct investment. Both these variables enter the regression with the expected signs, and

generally improve the explanatory power of the equation. Human capital turns to be statistically significant during the 1970's. However it became negative in the period when the great recession happened. Foreign direct investment has a positive and statistically significant impact on per capita growth. During the whole period, 1970-2013, one percentage point increase in inflow will increase per capita growth by 0.08 percentage point. One extension was made to the above analysis: I did the test of heteroskedasticity for all periods. For the period 1970-1979 and 1980-1989, the model was heteroskedastic, so I just corrected for this error by using the White heteroskedasticity-consistent standard errors and covariance method.

B. PUBLIC AND PRIVATE INVESTMENT

a. Cross-Sectional Dependence and Panel Unit Root Test

In order to analyse the relationship between public and private investment in 25 OECD countries, I made a panel data. I first examine if our panel variables contain cross-sectional dependence (CSD) using the CSD test proposed by Pesaran (2004) which follows an $N(0,1)$ distribution. The results of this test, which are presented in Table (4), indicate the null hypothesis of CSD is rejected at the 1% level of significance. Hence, each of our series contains CSD. As all the variables are affected by CSD, we implemented the IPS panel unit root test, it is robust to the presence of CSD. The results, which are reported in Table (5), indicate that both variables have a unit root in their levels and are stationary in their first differences. Thus far, the unit root test results indicate the presence of CSD and non-stationarity of the variables.

b. Panel Cointegration Test

Based on the results from the previous section, both public and private investment follow $I(1)$ process and proceed to examine whether a long-run cointegrating relationship exists. First, I used Pedroni's cointegration test. The results indicate a cointegrating relationship between the log of the public investment and the log of the private investment. All the tests are significant at least at the 10% level. However, the downside of the Pedroni's cointegration test is that it does not account for cross sectional dependence (CSD) and is inappropriate in the presence of structural breaks. So the results might be biased. As a result, I utilise the cointegration test proposed by Pesaran(2006), Common Correlated Effects Mean Group (CCEMG) and Augmented Mean Group (AMG) estimator proposed by Eberhardt and Bond (2009), which test the long-run relationship between public and private investment and accommodates CSD in all panels. The CCEMG estimator is robust to slope heterogeneity, endogeneity as well. The results, based on the full model, are represented in Table (6).

The CCEMG estimator indicates that public and private investment have no long run relationship. The coefficient for public investment is negative and statistically insignificant. Similar to CCEMG, AMG estimates suggested a statistically insignificant but positive long run relation between private and public investment. In order to test the short-run relationship between public and private investment, I utilised the Granger causality test. The empirical results of the Granger causality test is provided in Table (7). The null hypothesis is strongly rejected and it is concluded that the public investment does Granger-cause the private investment. We cannot say anything about the direction of causality, however, it might be guessed that the direction of causality is negative due to the dynamic OLS (DOLS) estimation between public and private investment. The results of DOLS (Table 8)

provide support for the crowding out effect of public investment on private investment. Increasing one percentage point of public investment will decrease private investment by 0.082 percentage point.

VII. CONCLUSION

Utilizing a large sample of 25 OECD countries over the period 1970-2013, multiple empirical analyses were undertaken. The main results are as follows:

- Total investment has a positive and statistically significant impact on economic growth.
- Private investment has played a more important role in the economic growth of OECD countries. There is a substantial difference in the impact of private and public sector investment on economic growth, with private investment having a much larger impact than public investment during the whole period 1970-2013. However in all subperiods, public investment was statistically insignificant while private investment has a positive and statistically significant effect on economic growth. This relationship holds up even when other determinants of per capita growth are taken into account.
- Public investment crowds out private investment in the short run, however they do not have long run correlation.

These results are useful from the economic theory and policy points of view. The basic neoclassical framework which emphasizes savings and population growth for the long term economic growth has

been supported by the results. However, it is suggested that we need to make a distinction between the respective roles played by public and private investment. The main policy implication comes with the role of public and private investment in economic growth in OECD countries. There is an obvious need to improve the productivity of public investment. Since private investment has a much stronger impact on economic growth rather than public investment, results suggest that policy makers should identify the type of public investment to be complementary to the private sector. The governments can improve the financial sector to facilitate the mobilization of savings and prepare funds for productive private sector investment which leads to a more stable macroeconomic condition and thus more economic growth. For further study, it would be recommended to take the different types of public and private investment into account and examine how they affect economic growth.

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TABLE 1
DATA DESCRIPTION

Variable	**Definition**	**Source**
Real GDP per capita (y)	Real GDP per capita (USD, constant 2015, PPPs)	OECD National Account
Total Investment (I)	Ratio of total investment to GDP	IMF
Public Investment (I_g)	Ratio of public sector fixed investment to GDP (public sector includes general government, nonfinancial state enterprises, and principal autonomous agencies)	IMF
Private Investment (I_p)	Ratio of private sector fixed investment to GDP	IMF
Population Growth (n)	Population Growth (% annual)	World Bank's World Development Indicators
Human Capital (HC)	Ratio of secondary education enrollment to total gross education enrollment	World Bank's World Development Indicators
Foreign Direct Investment (FDI)	Ration of net inflow to GDP	World Bank's World Development Indicators

TABLE 2
SUMMARY STATISTICS
1970-2013

Variable	Obs	Mean	Std. Dev.	Min	Max
$ln(y1970)$	25	9.77	.52	7.89	10.61
$ln(y2013)$	25	10.66	.32	9.78	11.50
$ln(I)$	25	2.97	.19	2.61	3.42
$ln(I_g)$	25	1.20	.30	0.73	1.98
$ln(I_p)$	25	2.77	.21	2.26	3.23
$ln(n+1)$	25	.53	.26	.07	1.08
$ln(HC)$	25	4.55	.18	4.06	4.87
$ln(FDI)$	25	.71	1.16	-2.39	3.76

TABLE 3 (I)

DETERMINANTS OF PER CAPITA GROWTH

AVERAGE PER CAPITA GROWTH DURING

	1970-2013	**1970-79**	**1980-89**	**1990-99**	**2000-13**
constant	3.04^{a}	1.60^{a}	1.33^{a}	0.13	1.48
	(1.41)	(0.31)	(0.59)	(0.65)	(1.13)
Initial Per Capita GDP	-0.57^{a}	-0.23^{a}	-0.20^{a}	−0.09	-0.15^{b}
	(0.09)	(0.02)	(0.07)	(0.06)	(0.07)
Investment (Total)	0.85^{a}	0.23^{a}	0.33^{a}	0.20^{a}	0.12
	(0.23)	(0.05)	(0.11)	(0.07)	(0.17)
Population Growth	−0.002	−0.06	-0.12^{b}	0.08	0.07
	(0.18)	(0.04)	(0.06)	(0.05)	(0.08)
Human Capital Enrollment Ratio (Secondary)	0.19	0.07^{b}	−0.003	0.08	−0.01
	(0.29)	(0.04)	(0.13)	(0.07)	(0.10)
Foreign Direct Investment					
R^2	0.78	0.83	0.65	0.29	0.29
S.E.E	0.20	0.06	0.08	0.10	0.10

Notes: Standard errors of coefficients are in the parenthesis. a and b denote statistically significant at the 5 and %10 levels respectively. Coefficients without superscripts are not statistically significant.

TABLE 3 (II)

DETERMINANTS OF PER CAPITA GROWTH

AVERAGE PER CAPITA GROWTH DURING

	1970-2013	**1970-79**	**1980-89**	**1990-99**	**2000-13**
Constant	4.33[a]	1.74[a]	2.05[a]	0.94[a]	1.57
	(1.37)	(0.26)	(0.63)	(0.49)	(1.28)
Initial Per Capita GDP	− 0.63[a]	− 0.24[a]	− 0.26[a]	− 0.12[a]	− 0.15
	(0.09)	(0.01)	(0.04)	(0.05)	(0.09)
Investment (Public)	0.31[b]	0.01	0.02	0.03	− 0.004
	(0.17)	(0.03)	(0.04)	(0.59)	(0.04)
Investment (Private)	0.53[a]	0.20[a]	0.25[a]	0.25[a]	0.11
	(0.23)	(0.04)	(0.07)	(0.07)	(0.15)
Population Growth	− 0.17	− 0.04	− 0.09	− 0.01	0.08
	(0.19)	(0.04)	(0.02)	(0.05)	(0.10)
Human Capital Enrollment Ratio (Secondary)	0.21	0.08	0.03	− 0.04	− 0.03
	(0.28)	(0.05)	(0.10)	(0.07)	(0.11)
Foreign Direct Investment	0.08[a]	0.003	0.01[a]	0.05[a]	− 0.001
	(0.03)	(0.007)	(0.004)	(0.01)	(0.01)
R^2	0.83	0.85	0.74	0.53	0.29

S.E.E	0.19	0.05	0.08	0.08	0.11

Notes: Standard errors of coefficients are in the parenthesis. a and b denote statistically significant at the 5 and %10 levels respectively. Coefficients without superscripts are not statistically significant.

Table 4
Cross-Sectional Dependence (CSD) Tests Results

Model with Intercept		
Variable	CD-test	p-value
$ln(I_{p_{i,t}})$	19.86	0.000
$ln(I_{g_{i,t}})$	12.09	0.000

Notes: Under the null hypothesis of cross-section independence $CD \sim N(0,1)$

Table 5
Cross-Sectional Dependence Tests Results

Cross-Sectionally Augmented Im-Pesaran-Shin (CIPS) Panel Unit Root Test Results.

Lag numbers:	[0]		[1]	
Variable	Statistic	p-value	Statistic	p-value
$ln(I_{p_{i,t}})$	-0.87	0.19	-4.003	0.0000
$ln(I_{g_{i,t}})$	-1.29	0.09	-2.684	0.0036

Note: The null hypothesis of the test is the presence of unit root in panel data with cross-sectional dependence in the form of common factor dependence.

Table 6

Mean Group Type Estimations (Private and Public Investment)

Dependent variable: $ln(I_{p_{i,t}})$		
Variable	CCEMG	AMG
$ln(I_{g_{i,t}})$	− 0.05 (0.04)	0.001 (0.07)
$ln(I_{g_{i,t}})$ _AVG	0.08 (0.27)	———
$ln(I_{p_{i,t}})$ _AVG	0.94^{a} (0.16)	———

Note: The superscripts a and b denote the statistical significance at 5% and 10% levels, respectively. Asymptotic standard errors are in parentheses.

TABLE 7

Granger Non-Causality Test Results

Optimal number of lags (AIC): 12 (lags tested: 1 to 12)	
Z-bar	4.65
p-value	0.0000

Note: The null hypothesis of the test is public investment does not Granger-cause private investment.

Table 8

Dynamic Ordinary Least Square (DOLS) Estimation Results

Dependent variable: $ln(I_{p_{i,t}})$		
variable	Beta	t-stat
$ln(I_{g_{i,t}})$	− 0.082	− 2.61