The Effects of Public and Private Capital Investments on Sectoral Output: A Panel Approach for the Case of Turkey

Meliha ENER, PhD
Professor
Canakkale Onsekiz Mart University
Biga Faculty of Economics And Administrative Sciences
Economics Department
Ağaköy, Biga, Çanakkale, Turkey.

Cüneyt KILIÇ, PhD
Assistant Professor
Canakkale Onsekiz Mart University
Biga Faculty of Economics And Administrative Sciences
Economics Department
Ağaköy, Biga, Çanakkale, Turkey.

Feyza ARICA
Research Assistant
Canakkale Onsekiz Mart University
Biga Faculty of Economics And Administrative Sciences
Economics Department
Ağaköy, Biga, Çanakkale, Turkey.

Abstract

The fixed capital investment is a key macroeconomic indicator and its effects on economic growth have been widely taken place in both the theoretical and empirical literature. Using the framework of an endogenous growth model, this study analyzes the impacts of public and private investments on their gross domestic product composition in Turkey over the period 1998 – 2012. In order to estimate this relationship, panel data estimation techniques were applied. The empirical results show that both public and private capital investments have played important role on the process of growth of Turkey, and that the effect of public capital investment on sectoral output is larger than private capital investment's effect.

Keywords: Public fixed capital investment, private fixed capital investment, sectoral output, panel data analysis.

1. Introduction

Many empirical and theoretical studies have attempted to determine the reasons of differences of the rate of growth across countries. The relationship between fixed capital formation and economic growth has been subjected to by many economists since World War II. Relating to this subject, neoclassical growth theorists discussed the key role of investment on economic growth in 1960s and 1970s. In the Solow's (1956) model, capital accumulation affects growth only during transition to the steady state; contrary, long-run growth is determined only by population growth and the rate of technical change, which is assumed exogenous. Lipsey and Kravis (1987) who studied the issue in early times found that for five-year periods within the longer spans, the rate of growth was more closely related to capital formation rates in succeeding periods than to preceding rates (Blomström et al., 1996). Mankiw, Romer and Weil (1992) expand Solow's model to contain human capital and with the assumption of accumulation is guided by that of physical capital, concluded that investment performance can account for the bulk of the variation in growth performance across countries (Hebbel et al. 1994).

In the Keynesian and post-Keynesian traditions investment plays an important role both as a component of aggregate demand (probably the most volatile) as well as a vehicle of creation of productive capacity on the supply side. In post Keynesian demand-driven models investment still plays a crucial role in determining medium-run growth rates. Keynes suggest that investment depends on the difference between the real cost of capital relevant for firms and the marginal efficiency of capital whereas savings depend upon disposable income and wealth (Gutiérrez and Solimano, 2007).

Many policymakers and economists investigating the determinants of the economic growth have stated foreign direct investment (FDI) and fixed investments as sources in promoting the economic growth. That the researchers such as Solow (1956), Swan (1956) predicts that one of the key determinants of growth is the investment rate have triggered the studies subjected to the impacts of the investments on economic growth.

Following this tradition, this study examines empirically the impact of public and private investments on GDP composition by sector in Turkey. The rest of the study is arranged as follows, section one presents a review of the relevant literature, and section two discusses the methodology. The empirical results are presented in section three and section four concludes summary of finds, recommendation and conclusion.

2. Literature

Empirical studies on the relationship between public and private investments and economic growth are quite extensive. Much of the research was stimulated by Eberts (1986), Aschauer (1989, 1989) and Munnell (1990) empirical studies on the relationship between government investments on economic infrastructure, and economic growth. These studies (Aschauer (1989), Eberts (1986), and Munnell (1990)) all found a statistically significant positive relationship between public investment and economic growth (Kandenge, 2007).

According to Barro (1990) investigated the relationship between investment and economic growth. The investigation includes three phases, namely; the crowding-in phase, the efficient crowding-out phase, and the inefficient crowding-out phase. In the case of the crowding-in phase, public investment increases the returns to private investment, the rate of private savings and the growth rate. In the case of efficient crowding-out phase, the effects of higher taxes offset the effects of more public capital on savings rate. In this case, increases in public investment still raise the growth rate, since public investment remains highly productive. In the case of inefficient crowding-out phase, which is the last phase, public investment is less productive, when compared to the former phase. Increases in public investment reduce both the private saving rate and the growth rate.

De Long and Summers (1991) investigated the relationship between the machinery and equipment investment and economic growth. They found that the machinery and equipment investment has important effect on income growth. Similarly, Qin et al. (2006) found that there exists a long-run positive relation between investment and growth for Chinese economy. But, surprisingly growth of investment does not lead to economic growth. That is, the direction of the causality is from economic growth to growth of investment.

De Long and Summers (1993) investigated the relationship between the ratio of equipment investment to GDP and total factor productivity. They found a positive and statistically significant correlation between the variables.
Nazmi and Ramirez (1997) analyzed the impact on economic growth of public and private investment spending. They concluded that public investment expenditures had a positive and significant effect on output growth. At the same time public investment's impact on economic growth was statistically identical to the impact of private capital spending. The contribution of public investment to output expansion however came at the expense of private investment as indicating a significant crowding out effect. On the other hand, Anderson et al. (2006) pointed out that the impact of public investment on economic growth will depend on four things: the kind of public investment; the amount of investment; the initial stock of public capital; and the economic context in which investment occurs.

Khan and Kumar (1997) analyzed the impact of public and private investment on long-run growth of 95 developing countries for the period 1970-1990. Khan and Kumar (1997) exerted that private investment has a higher effect on growth compared to public investment, especially during the 1980's.

Ghali (1998) analyzed the long-run relationship between public investment, private capital formation and output for the case of Tunisia for the period 1963-1993. Using multivariate co-integration techniques, Ghali (1998) concluded that public investment has a negative and significant effect on private investment. Similarly, using a bivariate framework, Norayan (2004) found that public and private investment were cointegrated variables in Fiji for the period 1950-1975. Bazaumana (2004) also found the positive relationship for the case of Senegal.

Ismihan et al. (2002) examined the relationship between Turkey's investment performance and economic growth over the period 1963-1999. They showed that there are significant differences in investment rates during the pre- and post- 1980's. They argued that public investment, especially its infrastructure component, reduced, and the complementariness between public and private investment reversed in the long run in the post-1980 period. Consequently, they find that both private investment and output respond positively to increases in public investment but that the response of private investment is significant and large (Altug and Zenginoubuz, 2009).
Sala-i Martin and Artadi (2003) investigated the determinants of economic growth for the Arab World. According to Sala-i Martin and Artadi (2003) the decline in the investment rate in the region is probably a consequence, not a cause, of the slowdown. They stated that this advantage has not been translated into higher growth rates, whereas there have been high investments by international and historical standards. The underlying reason is that what matters for growth is not the quantity of investment, but its quality (Sala-i Martin, Artadi; 2003). So, they concluded that the low quality of investment projects is the key determinant of growth.

Investigating the relationship among inflation, economic growth, and fixed capital investments over the period 1976-2003 for the Turkish economy, Terzi and Oltulular (2006) found that there was a positive relation between growth-fixed capital investments.

Bilgili et al. (2007) investigated the interaction between growth, foreign direct investments and domestic investments for Turkish economy over the period 1992:01-2004:04. Using VAR analysis, impulse-response functions and variance decomposition, Bilgili et al. (2007) concluded that there was an interaction between the selected variables, and gross investments is more evident than those of other variables.

Kandenge (2007) examined empirically the impact of public and private investment on economic growth in Namibia over the period 1970-2005. Adopting cointegration and error correction modeling approaches, Kandenge (2007) found that in addition to public and private investment, exports, imports, economic freedom, labour and human capital significantly and positively impact on short and long-term economic growth.

Bayraktutan and Arslan (2008) investigated the long-run relation between fixed capital investment and economic growth in Turkey over the period 1980-2006. Using Johansen-Juselius cointegration technique, Bayraktutan and Arslan (2008) found that economic growth is positively affected by fixed capital investment in the long-run.
Altug and Zenginobuz (2009) investigated the role of investment in Turkey's growth performance for the period 1950-2007. Altug and Zenginoubuz (2009) emphasized the role and importance of taxation and regulatory policy, the existence of large informal sector, and corruption on Turkey's investment and growth performance.

Boopen and Khadaroo (2009) analyzed the dynamic relationship between public (particularly transportation) and private investment for the case of Mauritius over the period 1950-2000 using dynamic time series techniques. Employing a neoclassical investment model in an error correction framework, Boopen and Khadaroo (2009) concluded that transport capital is complementary to private investment and hence consistent with the crowding in hypothesis in both short and long run. According to Gutiérrez and Solimano (2007), investment plays a greater role in explaining growth transitions (that last around a decade or so) than in accounting for medium-term and long-run growth paths (that last several decades).

Arısoy (2011) examined the relationship between physical investment and economic growth from the perspective of AK type endogenous growth model in Turkey for the period 1968-2006. Using VAR method, Arısoy (2011) found that physical capital investments do not trigger output growth in the long-run, hence AK type endogenous growth model is not valid for Turkey.

Çetin (2012) tested empirically short-run and long-run relationships between fixed capital investments and economic growth for eight upper-middle income countries over the period 1980-2009.

Using Johansen-Juselius cointegration and Vector Error Correcton models, Çetin (2012) concluded that there is a co-integration relationship in only Malaysian economy, but there is no evidence for short-run causality relationship in Malaysian economy.

Fujii et al. (2013) investigated the dynamic response of sectoral capital investment to public investment by estimating the factor-augmented VAR model. Fujii et al. (2013) concluded that public investment crowds out aggregate investment.

3. Data and Methodology

The present study is intended to examine whether fixed capital investments have an impact on Turkey's GDP. With this aim, equation 1 is estimated using the panel data as following:

$$DGDP_{it} = \gamma_0 + \gamma_1 DPFCI_{it} + \gamma_2 .DPRFCI_{it} \quad (1)$$

Furthermore, equation 2 is estimated in order to investigate the aggregate effect of fixed capital investments on Turkey's GDP, Equation 2 is following as:

$$DGDP_{it} = \lambda_0 + \lambda_1 .DTFCI_{it} \quad (2)$$

The basic data in this study are annual observations for the period 1998 to 2012. Table 1 shows data sources and construction used in the study.

Table 1: Data Sources and Construction

Series	Sources and Construction
Gross Domestic Product in Constant Prices (GDP)	By kind of economic activity at basic prices at 1998 Ministry of Development
Public Fixed Capital Investment (PFCI)	By kind of sectors[1] at basic prices at 1998 Ministry of Development
Private Fixed Capital Investment (PRFCI)	By kind of sectors at basic prices at 1998 Ministry of Development
Total (Public + Private) Fixed Capital Investment (TFCI)	By kind of sectors at basic prices at 1998 Ministry of Development

According to Baltagi (2005), panel data technique or longitudinal data technique that is used in empirical section of the study has some the advantages. These advantages are summarized as: i) Panel data are able to control the heterogeneity that occurs among individuals, firms, states or countries whereas time-series and cross-section studies do not control the heterogeneity for these units. ii) Panel data give more informative data, more variability, less co-linearity among the variables, more degrees of freedom and so, more efficiency. iii) Panel data are relatively more suitable about the dynamics of adjustment than other techniques. iiii) Panel data model is better able to study more complicated behavioral models that pure time-series or pure cross-section models cannot study.

Pesaran and Yamagata (2008)'s Homogeneity Test

An homogenous panel data model (or pooled model) is a model in which all coefficients are common while an heterogenous panel data model is defined as a model in which all parameters (constant and slope coefficient) vary across individuals (Hurlin, 2010).

Before estimating the regressions, it should be control whether the coefficients are common in the model. The estimation method will differentiate depending on whether the coefficients are common or varying coefficients the across individuals. With this aim, it is followed the homogeneity test of Pesaran and Yamagata (2008).

The results for the homogeneity test of Pesaran and Yamagata (2008) are illustrated in Table 2. According to Pesaran and Yamagata (2008), the problem of the small sample can be overcome under the normally distributed errors by considering mean and variance bias adjusted version, delta_tilde_adjusted.

[1] In this study, agriculturing, mining and quarrying, manufacturing, energy, construction, transport, education, health, and other service activities are examined as sectors.

Thus, we rely on the result regarding delta_tilde_adjusted statistic in Table 2. Because the p-value of delta_tilde_adjusted is larger than 0.05 significance level, we cannot reject that slope coefficients don't vary across individuals. That is, it is clear that the null of hypothesis Pesaran and Yamagata (2008)'s homogeneous test isn't rejected at 95%.

Table 2: Pesaran and Yamagata (2008)'s Homogeneity Test

	Test statistic	P-value
delta_tilde	-1.981	0.976
delta_tilde_adjusted	-2.287	0.989

Unit root characteristics

According to Yule (1926), who introduced spurious regression problem that is further analysed by Granger and Newbold (1974), using non-stationary time series steadily diverging from long-run mean will produce biased standard errors, which causes to unreliable correlations and unbiased estimations within the regression analysis leading to unbounded variance process (Korap, 2007).

For the second step of the study, we have examined stationary properties of the data. Firstly, we have applied the cross-section dependence LM (CDLM) tests developed by Pesaran (2004) to verify the consideration of cross-section dependence in the analysis. Three LM tests have been applied to check cross sectional dependency. One of them, CDLM1 was developed by Breusch Pagan (1980). Other LM tests are CLM2 and CDLM tests that were developed by Pesaran (2004). CDLM1 test is useful when N is fixed and T goes to infinity. CDLM is better to use when N is larger and T is smaller. CDLM2 test is useful when T and N are larger enough (Guloglu and Ivrendi, 2010: 383-384). All CDLM tests with the null hypothesis of no cross section dependency across units are illustrated in Table 3. The results of CDLM1 test have been taken into account because of large T relatively to N.

Table 3: ***Cross Section Dependence Test Results***

Variable	CD LM1	p-value
GDP	50.621	0.053*
PFCI	70.431	0.000*
PRFCI	34.708	0.53
TFCI	39.302	0.32

Note:* indicate rejection of null hypothesis at 10 percent level of significance.

According to the results of cross dependency tests, the null of hypothesis of cross-section independence can be clearly rejected by a value 50.621 for GDP and 70.431 for PFCI at 10 percent level of significance. However, the null of hypothesis of cross-section independence cannot be clearly rejected for PRFCI and TFCI at 10 percent level of significance. Thus, the results of the CDLM1test indicate that gross domestic product and public fixed capital investment are highly dependent across countries. Thus, the series with the cross-section dependence will be included to the analysis by subtracting from their time-mean values (Y_{it}^{*})[2]. So, we can rely on the first-generation test results. We have used the approach of Levin, Lin and Chu (LLC, 2002), which assume homogeneous autoregressive coefficients between individual accordance with the result of Pesaran and Yamagata (2008)'s homogeneity test.

In general, panel unit root tests are based on the following regression:

$$\Delta Y_{i,t} = \beta_i . Y_{i,t-1} + Z_{i,t} . \gamma + u_{i,t} \qquad (3)$$

where i = 1,2,…,N is individual, for each individual t=1,2,…,T time series observations are available, $Z_{i,t}$ is deterministic component and $u_{i,t}$ is error term. The null hypothesis of this type is ρ_i=0 for $\forall_i$.

[2] $\overline{Y}_t = \frac{1}{N} . \sum_{i=1}^{N} Y_{it}$, $Y_{it}^{*} = Y_{it} - \overline{Y}_t$

The first of first generation panel unit root tests is LLC that allow for heterogeneity of individual deterministic effects and heterogeneous serial correlation structure of the error terms assuming homogeneous first order autoregressive parameters. They assume that both N and T tend to infinity but T increase at a faster rate, so N/T $\rightarrow 0$. They assume that each individual time series contains a unit root against the alternative hypothesis that each time series stationary. Thus, referring to the model (3), LLC assume homogeneous autoregressive coefficients between individual, i.e. $\beta_i = \beta$ for all i, and test the null hypothesis $H_o : \beta_i = \beta = 0$ against the alternative $H_A : \beta_i = \beta \prec 0$ for all i. The structure of the LLC analysis may be specified as follows:

$$\Delta Y_{i,t} = \alpha_i + \beta_i . Y_{i,t-1} + \delta_i . \tau + \sum_{j=1}^{p_j} \phi_{ij} . \Delta Y_{i,t-j} + u_{it} \qquad (4)$$

i = 1,…, N t= 1,…,T where τ is trend, α_i is individual effects, u_{it} is assumed to be independently distributed across individuals. LLC estimate to this regression using pooled OLS. In this regression deterministic components are an important source of heterogeneity since the coefficient of the lagged dependent variable is restricted to be homogeneous across all members in the panel (Barbieri, 2006).

Results for the panel unit root tests are showed in Table 4. According to LLC, all variables are not level-stationary for constant model. As can be readily seen from Table 4, for the first differences of all variables, we are able to strongly reject the unit root null hypothesis at 1 percent significance. In other words, the empirical results of Table 4 show that the panel series are I(1).

Table 4: Panel Unit Root Tests

Variable	LLC	Constant
GDP	2.95	[0.99]
PRFCI	0.50	[0.69]
PFCI	0.37	[0.64]
TFCI	1.11	[0.86]
DGDP	-8.63*	[0.00]
DPRFCI	-6.05*	[0.00]
DPFCI	-13.12*	[0.00]
DTFCI	-7.37*	[0.00]

Note: Numbers in brackets are p-values. D is first difference operator. The max lag lengths were set to 6 and Schwarz Bayesian Criterion was used to determine the optimal lag length. * indicate rejection of null hypothesis at 1 percent level of significance.

4. Estimation and Empirical Results

We use a specific country (Turkey) in the study, so fixed effect panel data analysis is useful (Baltagi, 2008: 14). Panel data may have group effects, time effects, or both. These effects are either fixed effect or random effect. A fixed effect model assumes differences in intercepts across groups or time periods. Fixed effects model explores the relationship between the predictor and outcome variables within an entity. This entity may be households, countries, firms. The model assumes all other time invariant variables across entities that can influence the predictor variables to be constant (Torres-Reyna, 2007).

$$u_{it} = \mu_i + \lambda_t + v_{it} \qquad \text{i= 1,…,N t=1,…,T}$$

where μ_i denotes the unobservable individual effect, λ_t denotes the unobservable time effect, and v_{it} is the stochastic disturbance term. λ_t is individual-invariant and it accounts for any time-specific effect that is not included in the regression (Baltagi, 2005).

If the μ_i and λ_t are assumed to be fixed parameters to be estimated and $v_{it} \sqcup$ IID $(0, \sigma_v^2)$, then the above regression represents a two-way fixed effects error component model (Baltagi, 2005).
Fixed effects model can be formulated as:

$$y_{it} = x'_{it}.\beta + \alpha_i + \varepsilon_{it} \quad (5)$$

Where α_i denotes all the observable effects and it is group-specific constant term in the regression model. α_i equals $z_i'.\alpha$ in the regression (5). If z_i is unobserved, but correlated with x_{it}, then the coefficient of β is biased and inconsistent under assumptions of $E(u_{it}) = 0$; $E(u^2_{it}) = \sigma^2$ all i; $E(u_{it}.u_{jt-s}) = 0$ for $s \neq 0$ and $i \neq j$

$$y_{it} = \alpha_0 + X_{it}.\beta + \alpha_i + \gamma_t + \varepsilon_{it} \quad (6)$$

Equation (6) can be formulated as a Two-Way Fixed Effects Model controlling for unmeasured time-invariant differences between units and unit-invariant differences between time periods. α_i denotes individual-specific effects and γ_t denotes period-specific effects (Worrall and Pratt, 2004).

The results, which is obtained from the panel least squares method are shown in Table 5. According to Table 5, both the public and private fixed investments have statistically and economically significant and positive effect on GDP as expected from the literature. Furthermore, the effect of the public fixed investment on GDP is larger than the private fixed investment's effect. Also, Table 5 shows the effect of total fixed investments on GDP. According to the empirical results from panel least squares method, total fixed investment has statistically and economically significant and positive effect on GDP as the public and private fixed investment.

Table 5: The Results for Panel Least Squares Method

Dependent Variable: DGDP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DPRFCI	2.291455	0.336861	6.802379	0.0000
DPFC	10.02489	1.721394	5.823703	0.0000
C	-4090339.	957240.5	-4.273052	0.0000
Dependent Variable: DGDP				
DTFCI	2.558775	0.351740	7.274626	0.0000
C	-5665618.	1116825.	-5.072969	0.0000

*Note: D is first difference operator and *indicates the statistical significance at 1% level.*

Table 6 indicates the results of the test of cross-section and period fixed effects. We estimate the relationship among the panel series using two-way fixed effects estimator as well as panel least squares method. Employing the two-way fixed effects model will give reliable results since the estimated probability values of both cross section F and period F statistic at 0.00 are smaller than significance level at 0.05 significance level.

Table 6: Test of Cross-Section and Period Fixed Effects

Redundant Fixed Effects Tests			
Effects Test	**Statistic**	**d.f.**	**Prob.**
Cross-section F	292.349160	(8,102)	0.0000
Cross-section Chi-square	400.063301	8	0.0000
Period F	0.738209	(13,102)	0.7217
Period Chi-square	11.329769	13	0.5832
Cross-Section/Period F	**114.731106**	**(21,102)**	**0.0000**
Cross-Section/Period Chi-square	403.654130	21	0.0000

The results obtained from the two-way fixed effects are shown in Table 7. As is seen from Table 7, the coefficients of all independent variables are significant and positive as expected. According to the empirical evidences, Turkey's GDP has increased depending on the private and especially public fixed investment. Also, Table 7 shows the effect of total fixed investments on GDP for two-way fixed effects model. According to the empirical results, total fixed investment has statistically and economically significant and positive effect on GDP as the effect of public and private fixed investment. Consequently, we can say that the fixed capital investment is important determinant in improving the quality of the country's economy.

Table 7: The Results for Two-way Fixed Effects Model

Dependent Variable: GDP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DPFCI	5.560078	1.111114	5.004057	0.0000
DPRFCI	1.017215	0.166876	6.095648	0.0000
C	-1815769	340443.6	-5.333538	0.0000

Dependent Variable: GDP

DTFCI	1.140410	0.175709	6.490343	0.0000
C	-2525085.	427240.4	-5.910220	0.0000

5. Conclusions

The impact of public and private fixed capital investments on economic growth is a long standing issue in macroeconomics and development economics. In this study, the relationship among public, private investments and their gross domestic product composition in Turkey was surveyed over the period 1998 – 2012. In order to estimate this relationship, panel data estimation techniques were applied.

The emphasis and position of this paper is that both public and private investment plays an important role in increasing GDP. Specially, the study pointed out that the public investments have larger effect when compared to the size of the effect of the private investment. Indeed, public investment will increase economic growth simply by increasing the rate of national savings. A government can raise the share of national income that is saved by taxing consumption and investigating the revenues. In order to arise this effect, the rate of private saving mustn't fall noticeably in the event that public investment decreases the returns to private investment. Thus, it is obvious that the public investments have more important role in improving GDP for Turkish economy. Consequently, the government must encourage stronger investment by the private and public sectors.

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