Public Infrastructure Investment and Development: Evidence from Turkey

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Abstract

This paper investigates the relationship between public infrastructure investment and development. The study follows the human development approach and measures the aspects of development by economic growth rate, gross enrolment rate and infant mortality rate. Public infrastructure investment is disaggregated to energy infrastructure, city infrastructure and security, and transportation and communication. For the purpose of research, a panel dataset for the provinces of Turkey for the years between 1975 and 2001 is used. As the econometric technique, the fixed-effects technique is preferred. Standard errors robust to heteroscedasticity, serial correlation and cross-sectional dependence are reported. To capture the long-run impact of investment in public infrastructure and address the issue of endogeneity of public policy in econometric analysis, dependent variables are calculated as the five-year forward-moving average of the growth rate of real gross domestic product (GDP) per capita, the five-year forward-moving average of the gross enrolment rate and the five-year forward-moving average of the infant mortality rate. The results provide evidence for a positive relationship between public infrastructure investment and development indicators. Findings support those who promote public provision of infrastructure for pro-poor growth, sustainable development or inclusive development. However, multi-collinearity and cross-sectional dependence arise as factors that reduce the robustness of inferential statistics. Additionally, the robustness of the results relies on the assumptions that simultaneity and dynamic endogeneity are not present, and that the impact of public infrastructure investment does not extend beyond the province that receives it.

Keywords: Development public infrastructure; economic growth; gross enrolment rate; infant mortality rate.

1. Introduction

Although economic growth is considered to be an important component of development, it is no longer regarded as the sole objective of development policies. One of the lessons the United Nations Development Programme (UNDP) draws from the "lost decade" of the 1980s is that economic growth is not necessarily accompanied by an improvement in human welfare (UNDP, 1990). International development agencies now promote types of economic growth that are accompanied by a reduction in poverty and progress in human development.

Infrastructure has arisen as an effective policy tool that has economic and social benefits. In 2015, the United Nations announced sustainable development goals that include ensuring access to basic infrastructure services for all. Provision of infrastructure is also an important element of inclusive development (Rauniyar and Kanbur, 2010), according to the Asian Development Bank's definition (Klasen, 2010).

Despite the emerging significance of infrastructure as a positive factor in human welfare, the empirical studies regarding the relationship between public infrastructure investment and development are limited to those that measure development by an increase in output per capita. This paper contributes to the literature by providing an analysis of the statistical relationship between public infrastructure investment and development by taking human welfare indicators into account.

For the empirical analysis, this paper uses a panel dataset of Turkish provinces for the years between 1975 and 2001. Turkish provinces are chosen as the research subject because of their diverse development characteristics and the nature of Turkish public policy to address underdevelopment. In Turkey, Western provinces tend to have higher economic growth and school enrolment rates and lower infant mortality rates than Eastern provinces. Additionally, in Eastern provinces, relatively more urbanised provinces are better off in terms of health, education and economy, compared to those that are rural. Similarly, it is also the Western and relatively urbanised provinces that provide better access to water and sanitation facilities, electricity and transportation networks. Finally, because in Turkey these facilities are provided through public infrastructure investment via the central government budget, the case of Turkish provinces provides a fertile setting for this paper's research topic.

2. Literature review and hypothesis development

2.1. Literature review

In development literature, the relationship between public infrastructure expenditure and development is analysed from the perspective of economic theory. This is primarily due to the fact that up until the 1990s, economic growth had been perceived as the primary indicator of development. Although health and education were considered to be important for development, their significance was attributed to their role as an input in the production process. This understanding was altered after the introduction of the capability approach, which reformulated health and education as factors that improve the quality of life. This shifted the focus of public policies from the sole objective of attaining higher economic growth to meeting a set of economic and social targets that reflect the level of development.

In economic theory, public infrastructure is conceptualised as public capital that may have a positive or a negative impact on the economy. Provision of public infrastructure requires funds to be raised through taxes or borrowing, both of which reduce the funds for the private sector. However, the overall impact of public provision of infrastructure on the economy can be positive because of the market failure in the infrastructure sector and the positive externalities of infrastructure services. Although the effectiveness of public-financed infrastructure services is questioned due to congestion or government's failures such as corruption, empirical evidence in the literature points out that there is a positive relationship between public infrastructure expenditure and economic growth (Aschauer, 1989; Easterly and Rebelo, 1993; Odedokun, 2001; Shioji, 2001; Leon-Gonzalez and Montolio, 2004; Pereira and Andraz, 2005).

However, beyond being an input for economic production, infrastructure arises as a factor that is associated with human welfare in development literature on poverty, health and education (Brenneman and Kerf, 2002). Recent literature provides evidence for correlations between access to water and sanitation and schooling ratios (Adukia, 2017) and child mortality rates (Woldemicael, 2000; Gamper-Rabindran, Khan and Timmins, 2010; Günther and Fink, 2011; Cheng et al., 2012). Results in a few studies also indicate a negative statistical relationship between the percentage of the population with access to electricity and children's survival rates (Wang, 2003; Fay, Leipziger, Wodon and Yepes, 2005; Günther and Fink, 2011).

The significance of infrastructure for various aspects of development appears to be recognised by international institutions. Provision of infrastructure is promoted for pro-poor growth (Organisation for Economic Co-operation and Development, 2007), inclusive development (Klasen, 2010) and sustainable development (United Nations General Assembly, 2015). However, despite the discussions regarding the role of accessibility of infrastructure in achieving higher rates of economic growth and better levels of health and education, development literature lacks empirical analysis regarding the relationship between public infrastructure expenditure and non-income components of development. This paper contributes to the literature by investigating the impact of public infrastructure on development using three indicators: primary and middle school gross enrolment rate, infant mortality rate and the growth rate of real GDP per capita. For the purpose of the paper, firstly, the links between public infrastructure and development are discussed, secondly, a regression model is provided, then the summary statistics are presented, and results are reported. Finally, the implications of the results are discussed and the conclusion is presented.

2.2. Hypothesis development

For hypothesis development, it is necessary to define development. In this paper, the term development refers to economic growth that is accompanied by improvements in non-income components of human welfare. This study refines the scope of the non-income aspects of development to education and health, which are considered to improve the quality of life and enhance human capital. This aligns the concept of development discussed in this paper to human development as advocated by the United Nations Development Programme.

The literature unearths various links between access to infrastructure services and non-income components of development. For example, accessibility of clean water and sanitation facilities leads to a reduction in prevalence of diseases, which lowers mortality rates among children (Woldemicael, 2000; Gamper-Rabindran, Khan and Timmins, 2010; Cheng et al., 2012) and increases school enrolment rates (Rosenzweig and Wolpin, 1982; Adukia, 2017). Similarly, modern energy sources – such as liquid petroleum, gas, electricity or solar power – help to reduce indoor air pollution, which contributes to protecting children's health (World Health Organization, 2006). Availability of an energy source also increases the quality of public health and education services (Brenneman and Kerf, 2002).

Public investment in transportation and communication increases the school enrolment rates by reducing distance to school (Tansel, 2002). Better transportation facilities increase the accessibility of health services for the poor, as the majority of the poor live in remote areas (Brenneman and Kerf, 2002). Availability of communication technologies is also stated as one of the factors that enhance health services. Healthcare providers require patient information and they operate by exchanging information between health centres, which can be performed through communication facilities (Brenneman and Kerf, 2002).

From the perspective of economic theories, the types of public infrastructure mentioned above constitute complementary input for private sector production. This is firstly due to market failures in infrastructure services which limit private sector activity in these sectors and, secondly, due to the positive impact of public infrastructure on private sector productivity. Nevertheless, the overall impact of public investment can be negative, if the cost of providing the public services exceeds their benefits.

In relation to the impact of public infrastructure expenditure on economic growth, Barro (1990) argues that the positive impact of government expenditure (on infrastructure, health or education) reduces as the size of the government in the overall economy increases. Finally, considering the evidence in the literature regarding the impact of accessibility of infrastructure on school enrolment rates and longevity, Agénor and Moreno-Dodson (2006) argue that public expenditure on infrastructure might contribute to economic growth indirectly by improving the workforce's education and health - which constitute human capital (Schultz, 1961; Lucas, 1988; Romer, 1989; Glomm and Ravikumar, 1992).

Given the above literature, this paper tests the hypothesis that is expressed as follows:

Hypothesis: Public infrastructure investment is associated with at least one aspect of development.

This hypothesis arises from the fact that infrastructure services are predominantly financed through public resources. This is especially the case in Turkey where public investment projects are planned and implemented by the central government. Thus, one can infer that the positive relationship between access to infrastructure, health, education and economic indicators should be observed between public expenditure on infrastructure and these development indicators in principle.

Following the human development approach, this paper uses three key indicators as dependent variables to test the hypothesis provided above. The economic aspect of development is measured by the growth rate of real GDP per capita. The human welfare aspect is measured by primary and middle school enrolment rate, and infant mortality rate. While the primary and middle school enrolment rate reflects the degree of participation in education, infant mortality rate captures longevity among the most vulnerable age group, and is also used as a measure of human poverty. A reduction in the infant mortality rate or an increase in the primary and middle school enrolment rate also represents an improvement in equity.

3. Data and method

3.1. Data and data source

In this article, the data sources are the Turkish State Planning Organisation for public investment, the Ministry of National Education (Milli Egitim Bakanligi - MEB) for the primary and middle school gross enrolment rate, and Annual Death Statistics published by the Turkish Statistical Institute (formerly known as the State Statistics Institution) for the infant mortality rate. Data for public investment consist of public capital spending by the central government, and do not include spending by local authorities (municipalities). Data for gross domestic product, for the years between 1987 and 2001, are provided by the Turkish Statistical Institute. For the years between 1975 and 1986, they are available in Karaca (2004). Data for private capital include gross investments in fixed capital in the manufacturing industry. The data are collected by annual manufacturing industry surveys carried out by the Turkish Statistical Institute. The population growth rate is calculated, using census statistics. Census statistics were collected in 1975, 1980, 1985, 1990 and 2000. Values of public investment, GDP and private capital in the manufacturing sector are deflated for 1987. The time range of the panel dataset used in this paper is limited by the available data.

3.2. Regression specification and estimation method

3.2.1. Regression specification

The regression models for analysing the relationship between public investment infrastructure, economic growth, education and health are constructed according to the implications of the literature provided in the previous section. Three layouts of public infrastructure are used in the regression models. These are public city infrastructure and security investment, which includes types of spending that aim to establish sewage systems and tap-water networks; public energy infrastructure investment, which reflects the amount of investment to provide access to the electricity grid; and public transportation and communication investment, which shows the amount of investment in roads, railways, airports and communication services.

In addition to public investment in infrastructure services, public investment in health and education is also included in the regression models. Public education investment consists of spending that is related to education services, which could have an impact on the gross enrolment rate. Public health investment includes spending on health facilities, which may have a positive impact on the infant mortality rate. Public investment in health and education is also predicted to be positively related to economic growth as it improves the productivity of the workforce (Barro, 1990).

In this paper, the variables for public investment are specified as shares in GDP, G_i/GDP. Traditionally, in empirical studies that use data for a cross section of countries to investigate the relationship between public expenditure and economic growth, the indicators are calculated in per capita terms and converted to a logarithmic scale. However, this technique is not applicable for this paper. This is because for a number of provinces the amount of public investment equals zero, which is not defined in the logarithmic scale. As a result, calculating public investment indicators in per capita terms does not allow one to include the provinces that do not receive a type of public investment. This problem does not affect empirical studies that use data for cross sections of countries because the amount of public investment tends to be greater than zero in a national scale.

From the perspective of economic theory, using public investment indicators as the shares of GDP in the analysis means that public infrastructure, health and education are assumed to be non-rival, and so one is interested in the amount of total investment instead of public investment per capita. However, it should be noted that although public infrastructure services (for example, roads and highways) could be considered non-rival, most of the education and health services have rival characteristics (Barro, 1990).

The dependent variables are calculated as the five-year forward-moving average of the growth rate of real GDP per capita, the five-year forward-moving average of primary and middle school gross enrolment rate, and the five-year forward-moving average of the infant mortality rate. This addresses the issue of endogeneity of public policies in econometric analyses regarding the relationship between public investment and development, which is discussed in further detail in the following sub-section. Calculating the dependent variable as a forward-moving average also allows for a lag in the effect of public investment on outcome variables.

Regression models used in this paper are provided in equations (1), (2) and (3), where Y_1 is the five-year forward-moving average of the growth rate of real GDP per capita, Y_2 is the five-year forward-moving average of the primary and middle school gross enrolment rate, and Y_3 is the five-year forward-moving average of the infant mortality rate. G_{En}/GDP is the ratio of public energy infrastructure investment to GDP, $G_{T\&C}/GDP$ is the ratio of public transportation and communication investment to GDP, $G_{C.I.\&S.}/GDP$ is the ratio of public city infrastructure and security investment to GDP, $G_{Ed.}/GDP$ is the ratio of public education investment to GDP, and G_H/GDP is the ratio of public health investment to GDP.

$$Y_1 = \alpha + \beta_1 \frac{G_{En.}}{GDP} + \beta_2 \frac{G_{T\&C}}{GDP} + \beta_3 \frac{G_{C.I.\&S.}}{GDP} + \beta_4 \frac{G_{Ed.}}{GDP} + \\ + \beta_5 \frac{G_H}{GDP} + \beta_6 \frac{K}{GDP} + \beta_7 n + \sum_1^m \beta_m \mathcal{T}_m + u \qquad (1)$$

$$Y_2 = \alpha + \beta_1 \frac{G_{En.}}{GDP} + \beta_2 \frac{G_{T\&C}}{GDP} + \beta_3 \frac{G_{C.I.\&S.}}{GDP} + \beta_4 \frac{G_{Ed.}}{GDP} + \\ \beta_5 \frac{G_H}{GDP} + \beta_6 \ell n\left(\frac{GDP}{N}\right) + \beta_7 n + \sum_1^m \beta_m \mathcal{T}_m + u \qquad (2)$$

$$Y_3 = \alpha + \beta_1 \frac{G_{En.}}{GDP} + \beta_2 \frac{G_{T\&C}}{GDP} + \beta_3 \frac{G_{C.I.\&S.}}{GDP} + \beta_4 \frac{G_{Ed.}}{GDP} \cdot$$

$$\beta_5 \frac{G_H}{GDP} + \beta_6 \ell n\left(\frac{GDP}{N}\right) + \beta_7 n + \sum_{1}^{m} \beta_m \mathcal{T}_m + u \qquad (3)$$

In equation (1), the control variables for the regression model to estimate the relationship between public investment and economic growth are chosen according to economic theory. Output, thus economic growth, is considered to be a function of capital and labour. Correspondingly, in the regression model, the share of private capital in GDP, *K/GDP*, and population growth rate, *n*, which determines the increase in the pool of labour, are included.

In equations (2) and (3), the control variables are the logarithm of GDP per capita, *ln(GDP/N)*, and population growth rate, *n.* Population growth rate controls for the change in the number of infants and school-aged children. The logarithm of GDP per capita is expected to capture the impact of income on the infant mortality rate and the primary and middle school gross enrolment rate. In relation to the primary and middle school gross enrolment rate, the logarithm GDP per capita additionally substitutes for the real wage rate. Expected returns to education depend on the existing employment opportunities and the composition of the local economy, too, as wage rates vary across sectors such as agriculture, manufacture and services (Tansel, 2002). Accordingly, in Turkey, output and output per capita tend to be higher in the industrialised provinces compared to those that are rural. Rural areas also suffer from higher unemployment rates (Devlet Planlama Teşkilatı, 1995). Thus, although wage rates for 1975-2001 are not available for the provinces in Turkey, the logarithm of GDP per capita could capture their effect on the primary and middle school gross enrolment rate.

In equations (1), (2) and (3), to account for the time effect, dummy variables for the years, T, are included. α is the constant term that captures the fixed effect, and *u* is the error term. β represents the estimated coefficients for the variables.

It must be noted that there are other factors that impact on the primary and middle school gross enrolment rate and infant mortality rate. Indicators such as fertility rate, mother's education, child's nutrition, birth weight, vaccination rates and urbanisation rates are strong predictors of children's education and health. The quality of education acts as a factor that increases the incentives for education. Schools that lack qualified teachers and equipment, have a poor curriculum, or provide education in an unfamiliar language can be perceived by households as inadequate to provide skills to their children. In addition to these factors, there may be social pressures against education in some communities depending on their religious, traditional, or political values, and their perception of the education provided in schools (Mani, Hoddinott and Strauss, 2013).

Data for these indicators are not available for the provinces for the years between 1975 and 2001. The analysis in this paper relies on the assumption that the effect of these indicators is fixed over time. This is due to the regional differences in the level of development across the provinces, as shown in the section reporting the data. For example, the provinces in the West tend to have higher population growth rates due to migration from the provinces in the East. These provinces are also more urbanised and industrialised. For these reasons, provinces in the West are expected to be better off in terms of female literacy, fertility, vaccination rates and child nutrition. The fixed-effects technique is expected to account for the effect of those indicators that are province-specific.

3.2.2. Estimation method

In this paper, as the econometric method, the fixed-effects technique is used. A major challenge in econometric analyses regarding the relationship between public expenditure and economic growth is the simultaneity and dynamic endogeneity. This is due to the fact that as well as policy interventions having an impact on development, the state of development has an influence on the choice of public policies. When this is the case, the ordinary least square estimates become biased and inconsistent. In the literature, to address this problem, either the dependent variable is specified as a forward-moving average, or the dynamic regression models that include lagged values of public expenditure are used. This paper prefers the former method as the forward-moving average of the dependent variable allows one to account for the lagged impact of public expenditure.

To reduce the possibility that public policy is endogenous, the dependent variables are calculated as the five-year forward-moving averages of the growth rate of real GDP per capita, the gross enrolment rate for primary and middle school, and the infant mortality rate. Although it is possible to increase the time horizon of the dependent variables to be able to rule out the possibility of endogeneity of public policy, this reduces the size of the available data for empirical analyses, which affects the robustness of the results.

The second potential issue in this paper's estimations is the cross-sectional dependence between the panels. This can arise if the impact of public intervention in a region is not restricted by the geographical boundaries. This is more likely to be the case in intra-country studies such as this paper. If the cross-sectional dependence between the panels (in this paper's case, provinces) is a factor that is correlated with the dependent variable or explanatory variables, the ordinary least square estimates become biased. If this is not the case, the cross-sectional dependence between panels reduces the reliability of the inferential statistics due to the correlation between the residuals.

In this paper, post-estimation diagnostics provide evidence that results are robust to omitted variable bias. To ensure the robustness of the inferential statistics, two types of standard errors are reported in the next section. In Tables 3, 5 and 6, standard errors that are robust to heteroscedasticity and serial correlation are presented, and in Table 6 those that are robust to heteroscedasticity, serial correlation and cross-sectional dependence are displayed. Additionally, in Table 5, the robustness of the results is controlled for outliers. Finally, as diagnostics for multi-collinearity, pairwise correlation coefficient matrix is provided in Table 2 and variance inflation factors are reported in Table 4. Summary statistics can be found in Table 1.

4. Results and discussion

4.1. Descriptive statistics

Table 1 shows the summary statistics for the dependent variables in the dataset. Although the number of observations is 1809, computing the dependent variable as the five-year forward-moving average of the growth rate of

GDP per capita reduces the dataset to 1474. The number of observations for the five-year forward-moving average of the primary and middle school gross enrolment rate and infant mortality rate is 1541. There are 67 panels in the dataset, and each panel consists of a province containing the values of the variables for the years between 1975 and 2001.

In Table 1, "overall" sample statistics are provided for the pooled data, "between" sample statistics for the panels of provinces, and "within" sample statistics for within a panel of province. There are two types of mean, the sample and panel mean, and there are three types of standard deviation, overall, between and within standard deviations. Overall standard deviation shows the average deviation from the sample mean. Between standard deviation treats each panel as an entity, and shows the average deviation of panel means from the sample mean. Within standard deviation shows the average deviation from the panel mean. Maximum and minimum values for the overall statistics show the highest and lowest values for a province. They indicate the highest and lowest values of the panel means for the "between" statistics, and show the maximum and minimum deviations from the panel mean for the "within" statistics.

In this sense, the maximum and minimum values and the standard deviation for the overall sample are a general measure of the variation of the values across the provinces. Between and within statistics show how much of the variation stems from the change in the values between provinces and how much, within time. For example, for the growth rate of capita, the size of within standard deviation (8.7%) is higher than the size of between standard deviation (1%), which indicates that the variation in the value of this variable is higher within time compared to its variation between the provinces, which is likely to be a result of the frequent economic crises experienced between 1975 and 2001. On the other hand, the statistics show that the variation between the provinces is higher for the gross enrolment rate compared to the variation within time. Nevertheless, in general, for almost all indicators, summary statistics in Table 1 indicate a high variation both between the provinces and within time.

The summary statistics show that the level of output per capita for a province is 1.1 million Turkish Lira (TL), which is approximately $4000 (TÜİK, 2016). For the years between 1975 and 2001, GDP per capita on average was $2,950.01 for the world, $8,296.73 for the European Union and $13,326.33 for the United States (World Bank, 2015).

GDP per capita grows at 1.3% annually, on average. The mean of the five-year forward-moving arithmetic average of the growth rate of GDP per capita is 1.8%. The summary statistics show that maximum values of the annual growth rate and the five-year forward-moving average of the growth rate are extremely high. To establish the accuracy of the dataset, the growth rate of GDP per capita for Turkey is computed by using the data for the provinces, and this is compared with the data provided by the World Bank (2015). Figure 1 shows that the data in this paper and the data provided by the World Bank are in accordance with each other. It also shows that the Turkish economy experienced expansion and contraction periods between 1975 and 2001, which is the likely reason behind the high values of the growth rate of real GDP per capita in Table 1. There are 198 observations that have an annual growth rate higher than 10%. Given the summary statistics, in the next section, for the robustness of the analyses, the results are controlled for outliers.

The rest of the statistics can be summarised briefly as follows. In the manufacturing sector, 1.4% of the output is invested in fixed capital. In rural areas, the share of private capital in GDP in the manufacturing sector is approximately zero. Its value is negative for some years because of economic crises. The share of gross fixed capital in GDP is 20% on average, according to the World Bank (2015). In this paper, the share of private capital in GDP reflects the amount of private investment only in the manufacturing sector; thus its value is considerably lower than the world average.

The population growth rate for the years between 1975 and 2001 is 1.5%, which is close to the world average, at 1.6%, for the same years. Its minimum value is -3.4%, which is below zero. This is due to domestic migration between provinces, from the rural areas in the East to the industrialised provinces in the West.

On average, 69% of school-aged children are enrolled at school. The mean of the five-year average of the primary and middle school gross enrolment rate is 68%. Turkey achieved 100% primary school enrolment rates in the mid of 1990s. However, the average of the gross enrolment rates is low due to the middle school enrolment rates.

Between the years 1975 and 2001, the infant mortality rate is 15‰ infants on average, which is lower than the world average (67‰) for the same period (World Bank, 2015). The infant mortality rate is as high as 97 per thousand in some provinces, and as low as (approximately) zero in some others. The five-year forward-moving average of the infant mortality rate has similar statistics.

For the years between 1975 and 2001, on average, the share of public energy investment in GDP is 2%, the share of public city infrastructure and security investment in GDP is 0.8%, the share of public education investment in GDP is 0.5%, the share of transportation and communication investment in GDP is 0.4%, and the share of public health investment in GDP is 0.2%. It can be seen that the minimum values for the share of public investment in GDP are zero. This is because not all the provinces receive all types of investment. Due to the size of projects with respect to the output of the province, the share of public energy investment in GDP can be as high as 91%.

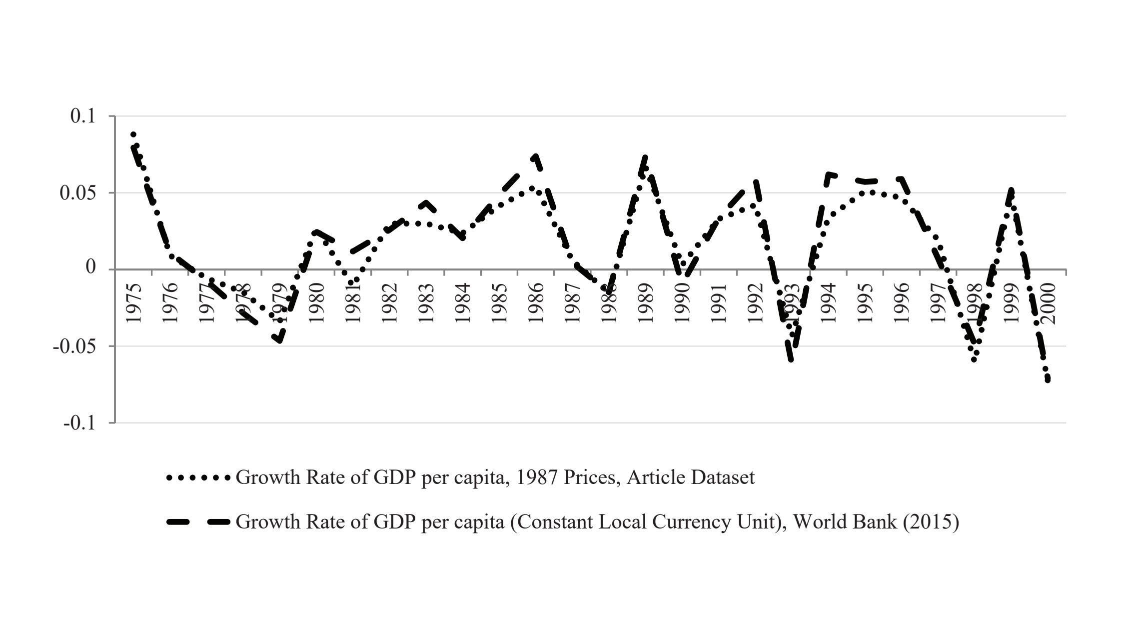
The correlation matrix for the variables in the regressions is presented in Table 2. Pairwise correlation coefficients are indicative of association between two variables. Although it is a common practice to report t-test statistics for the coefficients, inferential statistics for the correlation matrix in Table 2 are not reported. This is because the robustness of the t-test for pairwise correlation coefficients requires the data for the variables to be normally distributed. However, the distribution of data for the variables in this paper (especially the public investment indicators) is skewed. Pairwise correlation coefficients also neglect the effect of control variables, which also reduces their reliability. Despite its shortcomings, the correlation matrix provides a useful tool for pre-de-

Table 1: Summary statistics

Variable		Mean	Std. Dev.	Min.	Max	Obs.
Growth Rate of real GDP per capita	overall	0.013+	0.086	-0.474	0.519	N=1742
	between		0.010	-0.016	0.037	n=67
	within		0.086	-0.457	0.536	T=26
Y_1	overall	0.018	0.032	-0.081	0.193	N=1474
	between		0.012	-0.011	0.045	n=67
	within		0.030	-0.086	0.172	T=22
Gross Enrolment Rate	overall	0.686	0.106	0.256	0.961	N=1809
	between		0.090	0.452	0.837	n=67
	within		0.057	0.463	1.027	T=27
Y_2	overall	0.681	0.097	0.305	0.898	N=1541
	between		0.090	0.450	0.832	n=67
	within		0.038	0.516	0.895	T=23
Infant Mortality Rate	overall	0.015	0.013	0.000	0.097	N=1809
	between		0.011	0.003	0.050	n=67
	within		0.007	-0.014	0.062	T=27
Y_3	overall	0.015	0.012	0.001	0.080	N=1541
	between		0.011	0.003	0.051	n=67
	within		0.006	-0.013	0.045	T=23
$\ell n(GDP/N)$	overall	13.801	0.533	12.429	15.358	N=1809
	between		0.504	12.693	15.166	n=67
	within		0.184	13.198	14.341	T=27
GDP/N	overall	1 135 436.000	642 109.400	250 042.400	4 674 362.000	N=1809
	between		597 368.600	328 788.400	3 887 794.000	n=67
	within		246 144.200	150 912.000	2 301 788.000	T=27
n	overall	0.015	0.015	-0.035	0.101	N=1541
	between		0.012	-0.022	0.041	n=67
	within		0.008	-0.029	0.075	T=27
K/GDP	overall	0.014	0.027	-0.005	0.377	N=1809
	between		0.019	0.000	0.088	n=67
	within		0.019	-0.073	0.375	T=27
$G_{C.I.\&S.}/GDP$	overall	0.008	0.009	0.000	0.193	N=1809
	between		0.005	0.002	0.026	n=67
	within		0.008	-0.013	0.178	T=27
$G_{T\&C}/GDP$	overall	0.004	0.008	0.000	0.116	N=1809
	between		0.004	0.000	0.024	n=67
	within		0.006	-0.020	0.114	T=27
$G_{En.}/GDP$	overall	0.020	0.068	0.000	0.918	N=1809
	between		0.039	0.000	0.189	n=67
	within		0.056	-0.169	0.751	T=27
$G_{Ed.}/GDP$	overall	0.005	0.006	0.000	0.095	N=1809
	between		0.004	0.002	0.026	n=67
	within		0.004	-0.020	0.090	T=27
$G_{H.}/GDP$	overall	0.002	0.003	0.000	0.074	N=1809
	between		0.001	0.000	0.006	n=67
	within		0.003	-0.004	0.073	T=27

Note: +The values of the variables are expressed in decimal numbers; thus, for example, the average growth rate of real GDP per capita should be read as 1.3 %.

Figure 1: The growth rate of GDP per capita according to the dataset in this paper and the World Bank (2015)



tecting potential multi-collinearity between the variables. A correlation coefficient between two explanatory variables that exceeds 30% is considered to be a cause of concern. In Table 2, only the share of public education investment appears to be problematic as it is highly correlated with the share of public transportation and communication investment (0.3053) and the logarithm of GDP per capita (0.4986). Additionally, the logarithm of GDP per capita appears to be slightly correlated with all the explanatory variables in health and education regressions. Given the initial diagnostics, potential multi-collinearity between the explanatory variables is further examined in the next section using variance inflation factors.

4.2. Regression analysis

4.2.1. Results

Results in Table 3 show a positive statistical relationship between public energy investment, public education investment, public city infrastructure and security investment and the five-year forward-moving arithmetic average of the growth rate of real GDP per capita.

Public city infrastructure and security investment appears to be positively related to the five-year forward-moving average of the primary and middle school gross enrolment rate, and negatively with the five-year forward-moving average of the infant mortality rate. The results also show that public energy investment is statistically negatively related to the five-year forward-moving average of the infant mortality rate.

The logarithm of GDP per capita is not statistically significant in the second and third columns of Table 3. The results in the fourth and fifth columns indicate that the statistical signif-

Table 2: Pairwise correlation matrix for the variables

	Y_1	Y_2	Y_3	$\frac{G_{En.}}{GDP}$	$\frac{G_{T\&C}}{GDP}$	$\frac{G_{Ed.}}{GDP}$	$\frac{G_{He.}}{GDP}$	$\frac{G_{C.I.\&S.}}{GDP}$	n	$\frac{K}{GDP}$	$ln(\frac{GDP}{N})$
Y_1	1.0000										
Y_2	0.2240	1.0000									
Y_3	-0.0465	0.2923	1.0000								
$G_{En.}/GDP$	0.1420	-0.1199	-0.0266	1.0000							
$G_{T\&C}/GDP$	-0.1694	-0.2365	0.0235	0.0091	1.0000						
$G_{Ed.}/GDP$	-0.1794	-0.4182	-0.0938	0.1541	0.3053	1.0000					
$G_{He.}/GDP$	-0.0575	-0.1001	0.0416	0.0229	0.0550	0.1437	1.0000				
$G_{C.I.\&S.}/GDP$	-0.0481	-0.2189	-0.0301	0.0167	0.1349	0.2303	0.1026	1.0000			
n	0.0068	-0.1398	0.3473	-0.0225	-0.0689	-0.1228	0.0000	0.0443	1.0000		
K/GDP	0.0909	0.3375	0.1774	-0.1125	-0.1058	-0.1854	-0.0767	-0.0504	0.1612	1.0000	
$ln(GDP/N)$	0.0509	0.7234	0.3211	-0.1592	-0.2379	-0.4986	-0.1341	-0.1437	0.1528	0.4804	1.0000

icance of the coefficients of public city infrastructure and security investment and public energy investment disappears when the logarithm of GDP is excluded from the regressions.

Table 4 presents the variance inflation factors for the regressions in Table 3. Although the values of the variance inflation factors are at acceptable levels for the first regression, the logarithm of GDP per capita in the second and third regressions arises as a cause of multi-collinearity. This variable is also not statistically significant in the fourth and fifth columns of Table 3.

Table 5 shows that results remain similar to those in Table 3 when controlled for outliers . The noticeable changes are that the coefficients for the share of private capital in GDP in the first column, the logarithm of GDP per capita in the second column, and the share of public city infrastructure and security investment in GDP in the fourth column become statistically significant. Additionally, according to the results in Table 5, the share of public transportation and communication investment also has a statistically significant coefficient with a negative sign. This is likely to be a result of cross-sectional dependence between the error terms that leads to biased inferential statistics.

Accordingly, Table 6 reports the standard errors that are robust to heteroscedasticity, serial correlation and cross-sectional dependence. The results in columns (1), (2) and (3) are similar to those in Table 3. However, in Table 6, the coefficients for the share of private capital in GDP in the first column and the logarithm of GDP in the second column are statistically significant. Also, in columns (4) and (5), the coefficients for the share of public city infra-

Table 3: Statistical relationship between public infrastructure investment and development

	(1)	(2)	(3)	(4)	(5)
	Y_1 †	Y_2	Y_3	Y_2	Y_3
$G_{En.}/GDP$	0.093††	0.008	-0.008	0.001	-0.007
	(0.020)**	(0.028)	(0.004)*	(0.027)	(0.004)
$G_{T\&C}/GDP$	-0.195	-0.419	-0.027	-0.387	-0.032
	(0.125)	(0.352)	(0.035)	(0.363)	(0.036)
$G_{Ed.}/GDP$	0.635	-0.376	0.083	-0.430	0.091
	(0.204)**	(0.517)	(0.053)	(0.563)	(0.052)
$G_{H.}/GDP$	0.004	-0.075	-0.001	-0.131	0.008
	(0.345)	(0.356)	(0.052)	(0.365)	(0.054)
$G_{C.I.\&S.}/GDP$	0.713	0.663	-0.168	0.605	-0.159
	(0.346)*	(0.316)*	(0.078)*	(0.324)	(0.079)*
n	-0.048	-1.141	-0.052	-1.127	-0.054
	(0.277)	(0.334)**	(0.037)	(0.329)**	(0.038)
K/GDP	0.044				
	(0.030)				
$\ell n(GDP/N)$		0.014	-0.002		
		(0.017)	(0.003)		
Year Dummies†††					
Constant	-0.009	0.562	0.040	0.756	0.010
	(0.007)	(0.239)*	(0.036)	(0.007)**	(0.001)**
Observations	1474	1541	1541	1541	1541
Number of Groups	67	67	67	67	67
F	28.33	69.87	9.69	64.45	9.39
Prob> F	0.0000	0.0000	0.0000	0.0000	0.0000
Within R-Squared	0.19	0.44	0.48	0.44	0.48

Notes:

†Y_1 = Five-Year Forward-Moving Average of the growth rate of real GDP per capita, Y_2 = Five-Year Forward-Moving Average of the Gross Enrolment Rate, Y_3 = Five-Year Forward-Moving Average of the Infant Mortality Rate.

† † The values of the variables are expressed in decimal numbers in Table 1. Thus, for example, the coefficient for public energy infrastructure in column 1 reflects that an increase of 1% in the share of public energy infrastructure investment in GDP is associated with an increase of 0.093% in the five-year forward-moving average of the growth rate of real GDP per capita. The coefficients in Tables 3 and 4 should be interpreted in the same manner.

† † † The results for year dummies are not reported in the table for conciseness.

** Significant at 5%; ** significant at 1%*

structure and security investment in GDP and the share of public energy investment become statistically significant when the standard errors are corrected for heteroscedasticity, serial correlation and cross-sectional dependence.

4.2.2. Discussion

The findings are in accordance with the literature provided in the paper. However, multi-collinearity and cross-sectional dependence between the standard errors appear to be

Table 4: Variance inflation factors for the regressions in Table 3

	(1)		(2)		(3)		(4)		(5)	
	VIF	1/VIF	VIF	1/VIF	VIF	1/VIF	VIF	1/VIF	VIF	1/VIF
$G_{En.}/GDP$	1.1300	0.8850	1.1200	0.8950	1.1200	0.8950	1.1200	0.8950	1.1200	0.8950
$G_{T\&C}/GDP$	1.7600	0.5683	1.7300	0.5786	1.7300	0.5786	1.7200	0.5799	1.7200	0.5799
$G_{Ed.}/GDP$	2.4700	0.4041	2.3600	0.4233	2.3600	0.4233	2.3300	0.4297	2.3300	0.4297
$G_{H.}/GDP$	1.3500	0.7412	1.3700	0.7308	1.3700	0.7308	1.3600	0.7357	1.3600	0.7357
$G_{C.I.\&S.}/GDP$	3.0100	0.3319	2.9400	0.3400	2.9400	0.3400	2.8600	0.3502	2.8600	0.3502
n	2.3200	0.4306	2.2900	0.4369	2.2900	0.4369	2.2100	0.4533	2.2100	0.4533
K/GDP	1.3300	0.7509								
$\ell n(GDP/N)$			24.5500	0.0407	24.5500	0.0407				
Mean VIF	1.3500		2.7500		2.7500		1.3000		1.3000	

factors that reduce the reliability of the inferential statistics. Public infrastructure investment appears to be related to both economic growth and non-income aspects of development. The results are consistent within the context of this paper in the sense that the types of public investment statistically related to economic growth rate are associated with the gross enrolment rate and/or infant mortality rate, too. Similarly, the types of public investment that are not related to economic growth seem to be unrelated to other development indicators as well.

The results firstly point out that public infrastructure investment might have an economic impact through its positive effect on education and health, as suggested in Agénor and Moreno-Dodson (2006). Although the dependent variables used in this paper are not statistically related to each other, public infrastructure indicators are likely to be associated with other education and health indicators, which could have a positive effect on economic growth. Secondly, as primary and middle school gross enrolment rate and infant mortality rate are indicators of minimum living standards, the findings imply that public infrastructure investment has poverty-reducing and equity-improving effects. Thus, results lend support to those who promote the provision of infrastructure for pro-poor growth (Organisation for Economic Co-operation and Development, 2007), inclusive development (Klasen, 2010; Rauniyar and Kanbur, 2010) and sustainable development (United Nations General Assembly, 2015).

An increase of 1% in the share of public energy infrastructure investment, which includes types of spending that aim to provide electricity grids for rural areas, is associated with a 0.09% increase in the five-year forward-moving average of the growth rate of real GDP per capita and a 0.008% increase in the five-year forward-moving average of the infant mortality rate. There does not appear to be a statistical relationship between public energy infrastructure investment and the five-year forward-moving average of the gross enrolment rate. This could be due to the nature of the relationship between access to electricity and education. The results in the case studies in Brenneman and Kerf (2002) show that providing electricity for households is associated with children's achievement rates, as this allows them to study after the sun sets. Access to electricity also contributes to children's attendance rates (such as

Table 5: Results that are robust to outliers

	(1)	(2)	(3)	(4)	(5)
	Y_1†	Y_2	Y_3	Y_2	Y_3
$G_{En.}/GDP$	0.100	-0.001	-0.008	-0.015	-0.005
	(0.015)**	(0.022)	(0.004)*	(0.024)	(0.003)
$G_{T\&C}/GDP$	-0.236	-0.317	-0.022	-0.223	-0.019
	(0.109)*	(0.255)	(0.035)	(0.236)	(0.029)
$G_{Ed.}/GDP$	0.487	-0.345	0.078	-0.449	0.061
	(0.170)**	(0.245)	(0.054)	(0.234)	(0.039)
$G_{H.}/GDP$	0.083	-0.087	0.005	-0.216	-0.003
	(0.256)	(0.339)	(0.052)	(0.337)	(0.038)
$G_{C.I.\&S.}/GDP$	0.464	1.070	-0.164	0.959	-0.067
	(0.239)	(0.228)**	(0.083)	(0.235)**	(0.040)
n	-0.164	-1.122	-0.053	-1.076	-0.045
	(0.183)	(0.270)**	(0.040)	(0.263)**	(0.026)
K/GDP	0.047				
	(0.026)				
$\ell n(GDP/N)$		0.025	-0.001		
		(0.010)*	(0.003)		
Year Dummies††					
Constant	-0.006	0.405	0.027	0.761	0.009
	(0.004)	(0.145)**	(0.039)	(0.006)**	(0.001)**
Observations	1402	1463	1463	1463	1459
Number of Groups	67	67	67	67	67
F	27.77	50.86	9.99	54.55	10.60
Prob>F	0.0000	0.0000	0.0000	0.0000	0.0000
Within R-Squared	0.25	0.53	0.49	0.54	0.60

Notes:
†Y_1 = Five-Year Forward-Moving Average of the growth rate of real GDP per capita, Y_2 = Five-Year Forward-Moving Average of the Gross Enrolment Rate, Y_3 = Five-Year Forward-Moving Average of the Infant Mortality Rate
†† The results for year dummies are not reported in the table for conciseness.
** Significant at 5%; ** significant at 1%*

drop-out and persistence rates), by improving the quality of schools. However, there appears to be a weaker link between access to electricity in schools and children's participation rates. Hence, in this paper, public energy infrastructure might not be picking up the effect of access to a modern energy source in schools on children's enrolment rate, which is a measure of participation.

Similarly, public city infrastructure and security investment which includes spending on water and sanitation systems is statistically pos-

Table 6: Standard errors corrected for heteroscedasticity, serial correlation and cross-sectional dependence

	(1)	(2)	(3)	(4)	(5)
	Y_1 †	Y_2	Y_3	Y_2	Y_3
$G_{En.}/GDP$	0.093	0.008	-0.008	0.001	-0.007
	(0.009)**	(0.012)	(0.002)**	(0.017)	(0.002)**
$G_{T\&C}/GDP$	-0.195	-0.419	-0.027	-0.387	-0.032
	(0.112)	(0.215)	(0.024)	(0.218)	(0.024)
$G_{Ed.}/GDP$	0.635	-0.376	0.083	-0.430	0.091
	(0.217)**	(0.447)	(0.045)	(0.381)	(0.046)
$G_{H.}/GDP$	0.004	-0.075	-0.001	-0.131	0.008
	(0.182)	(0.174)	(0.030)	(0.259)	(0.031)
$G_{C.I.\&S.}/GDP$	0.713	0.663	-0.168	0.605	-0.159
	(0.370)	(0.289)*	(0.078)*	(0.253)*	(0.079)*
n	-0.048	-1.141	-0.052	-1.127	-0.054
	(0.268)	(0.305)**	(0.028)	(0.296)**	(0.029)
K/GDP	0.044				
	(0.014)**				
$\ell n(GDP/N)$		0.014	-0.002		
		(0.019)	(0.001)**		
Year Dummies††					
Constant	-0.009	0.562	0.040	0.756	0.010
	(0.005)	(0.274)*	(0.011)**	(0.006)**	(0.001)**
Observations	1474	1541	1541	1541	1541
Number of Groups	67	67	67	67	67
F	46.97	36.25	28.34	39.80	27.17
Prob>F	0.0000	0.0000	0.0000	0.0000	0.0000
Within R-Squared	0.19	0.44	0.48	0.44	0.48

Notes:

†Y_1 = Five-Year Forward-Moving Average of the growth rate of real GDP per capita, Y_2 = Five-Year Forward-Moving Average of the Gross Enrolment Rate, Y_3 = Five-Year Forward-Moving Average of the Infant Mortality Rate

††The results for year dummies are not reported in the table for conciseness.

** Significant at 5%; ** significant at 1%*

itively related to the five-year forward-moving average of the growth rate of real GDP per capita and the five-year forward-moving average of the gross enrolment rate, and negatively associated with the five-year forward-moving average of the infant mortality rate. However, the statistical relationship between public city infrastructure and security investment, economic growth and infant mortality rate is not robust to outliers. Nevertheless, the results provide evidence that public investment in city infrastructure and security benefits the economy, contributes to human capital and reduces poverty. A 1% increase in the share of public city infrastructure and security is associated with a 0.7% increase in the five-year forward-moving average of the growth rate of real GDP per capita, a 0.6% increase in the five-year forward-moving average of the gross enrolment rate and a 0.2% reduction in the five-year forward-moving average of the infant mortality rate.

It should also be noted that the coefficients for public city infrastructure and security investment are considerably higher than those of public energy infrastructure investment. This is likely because of the importance of access to water and sanitation facilities compared to access to a modern energy source. The size of the impact of the former on development indicators might be larger than that of the latter because of the significance of water and sanitation for human survival.

Public transportation and communication investment does not appear to be statistically related to any of the development indicators used in this paper. Its coefficient is negative and statistically significant in Table 5, which is likely to be a result of cross-sectional dependence between the standard errors. The findings are not consistent with the empirical literature that suggests a positive relationship between public transportation and communication investment and economic growth (Aschauer, 1989; Easterly and Rebelo, 1993; Odedokun, 2001; Shioji, 2001; Leon-Gonzalez and Montolio, 2004; Pereira and Andraz, 2005). Additionally, case studies show that access to transportation and communication facilities improves school enrolment rates (Levy, 2004; Brenneman and Kerf, 2002).

Thus, the results of the coefficient for public transportation and communication investment might be an indication of a failure in public policy. In Turkey, there are several possible reasons that might have led to failure in the provision of transportation and communication facilities, such as the lack of well-developed transportation plans, the inadequacy of existing roads and highways leading to increased traffic accidents, inability to increase road capacities through public investment projects, backwardness of the railroad technology, and the failure to meet the needs arising from an increasing number of privately owned cars (Devlet PlanlamaTeşkilatı, 1995).

Public education investment appears to be positively correlated with economic growth, which is consistent with the findings in empirical literature (Ramirez and Nazmi, 2003; Devarajan, Swaroop and Zou, 1996). A 1% increase in the share of public education investment in GDP is associated with a 0.6% increase in the five-year forward-moving average of the growth rate of real GDP per capita. However, there does not seem to be any statistical relationship between public education investment and the five-year forward-moving arithmetic average of gross enrolment rate (for primary and middle school). The overall results suggest that although public investment education is not related to primary and middle school gross enrolment rate, it could be positively associated with other types of education indicators which might be contributing to the five-year forward-moving average of the growth rate of real GDP per capita. Public education investment in Turkey consists of spending on school facilities (such as school buildings, dormitories, equipment) at primary, secondary and tertiary levels. It includes investment projects that aim to improve education among adults, too. Thus, although the results do not provide any statistical relationship between public education investment and the five-year forward-moving arithmetic average of primary and middle school gross enrolment rate, such investment may have a positive impact on other types of education indicators.

Additionally, public investment in health does not appear to be statistically related to any of the development indicators used in this paper. In the literature, statistical evidence for the positive relationship between public health investment and economic growth is weak. While some report a statistically insignificant relationship between public health expenditure and economic growth (Ramirez and Nazmi, 2003; Devarajan, Swaroop and Zou, 1996; Odedokun, 2001), some find a positive association between these variables (Ramirez and Nazmi, 2003). The findings regarding the association between public health expenditure and infant mortality are also inconsistent. While Baldacci, Guin-Siu and Mello (2003), and Schell et al. (2007) find no relationship between public expenditure on health and the infant mortality rate, Anyanwu and Eskisopar (2009), Ravikumar and Swaroop (2008), Bhalotra (2007), and Farahani et al. (2010) report a positive relationship.

The mixed results are likely to arise from the fact that the infant mortality rate is correlated with expenditure on preventive healthcare that improves nutrition, sanitation and vaccination rather than spending on treatment facilities (such as hospitals) (Bhargava, Jamison, Lau and Murray, 2001). This appears to be the case in Turkey where public investment projects tend to finance treatment in bed instead of the provision of preventive healthcare, which is more costly and less efficient (Devlet PlanlamaTeşkilatı, 1995). This could be the reason as to why public health investment is not correlated with any component of development in the results.

The share of private capital in GDP appears to be positively related to the five-year forward-moving arithmetic average of the growth rate of the real GDP per capita in Table 3 column (1). This variable measures the level of private capital only in the manufacturing sector; hence, it rather reflects the state of the manufacturing sector in the provinces. Thus, the positive and significant coefficient for the share of private capital in GDP could be interpreted as provinces that have a larger manufacturing sector have higher growth rates. If this variable was considered to proxy for the level of total private capital, then its positive coefficient could be interpreted as a positive relationship between private sector investment and the five-year forward-moving average of the growth rate of real GDP per capita. This would be in accordance with empirical literature on the relationship between private sector investment and economic growth (Khan and Kumar, 1997).

The five-year forward-moving arithmetic average of the primary and middle school gross enrolment rate and the five-year forward-moving average of the infant mortality rate do appear to be weakly related to the logarithm of GDP per capita. The statistical significance of the logarithm of GDP is sensitive to outliers and cross-sectional dependence between the standard errors. It also appears to have a large variance inflation factor, which signals multi-collinearity. Nevertheless, the findings for the logarithm of GDP per capita are in accordance with the literature.

Finally, population growth rate appears to be statistically related to the five-year forward-moving arithmetic average of the primary and middle gross enrolment rate. In Turkey, population growth rate is determined by the domestic migration and fertility rates. Fertility rates tend to be higher in the Eastern provinces, compared to the Western provinces. However, Eastern provinces experience a negative population growth rate due to emigration.

While the fertility rate has a negative relationship with economic growth and gross enrolment rate and a positive association with infant mortality rate, the migration rate is expected to have an opposite effect on these indicators. This is because the direction of migration is from the East, which is worse off in terms of household income, infant mortality and gross enrolment rate, to the West.

The results imply that the impacts of fertility and migration rates on infant mortality rate or economic growth rate cancel each other out. This could be the case if the industrialised areas integrate the new arrivals successfully, which would reduce the infant mortality rates among migrants and help them contribute to the economy of these areas. In the same line of logic, the negative relationship between the population growth rate and the five-year forward-moving average of the gross enrolment rate could be arising from a failure to raise enrolment rates among migrants who move to big cities.

5. Conclusion and limitation

In this paper, the relationship between public infrastructure and development is investigated by using a panel dataset for Turkish provinces for the years between 1975 and 2001. Development is measured by three indicators: infant mortality rate, primary and middle school gross enrolment rate, and economic growth rate. To account for a lag in the effect of public investment on outcome variables, and to address the issue of endogeneity of public policy decisions regarding public investment in the econometric analyses, the dependent variables are calculated as the five-year forward-moving arithmetic average of the infant mortality rate, the five-year forward-moving arithmetic average of the primary and middle school gross enrolment rate, and the five-year forward-moving arithmetic average of the growth rate of real GDP per capita.

The results provide evidence for a positive relationship between public city infrastructure, public energy infrastructure and development. They appear to be in accordance with literature that puts emphasis on provision of water and sanitation facilities and enabling public access to modern energy sources in order to improve health, education and economic growth. However, multi-collinearity and the cross-sectional dependence among error terms appear to be factors that reduce the reliability of inferential statistics.

The limitations of this study are firstly the potential simultaneity and dynamic endogeneity in the relationship between the dependent variable and public investment indicators. Although the dependent variables are calculated as five-year forward-moving averages to address this issue, the time horizon for public policy to become exogenous to development indicators might be longer. Thus, a robust analysis requires the dependent variables to cover a longer time period. However, this option is not preferred in this paper, as increasing the time horizons of the dependent variables reduces the data available for empirical analyses.

Secondly, this paper implicitly assumes that the impact of public investment on development in a particular region is limited by official boundaries; in other words, there is no geographical spill over effects. This assumption might not be valid in the national context, as domestic population is highly mobile within countries. Thus, a public intervention in a province might have an impact on the state of development in the neighbouring provinces if it becomes a source of attraction for domestic migration.

Overall, the findings regarding the relationship between public infrastructure investment and development have two implications. Firstly, they lend support to those who recommend enhancing the accessibility of infrastructure for inclusive development (Klasen, 2010) and sustainable development (UNDP, 2016). Secondly, results in this paper indicate that public infrastructure investment may have a positive effect on human capital. In this regard, the findings in this paper encourage further research about alternative channels between public infrastructure and economic growth, as proposed in Agénor and Moreno-Dodson (2006).

References

Adukia, A. (2017), 'Sanitation and Education', *American Economic Journal: Applied Economics*, 9(2), 23-59.

Agénor, P.R. and Moreno-Dodson, B. (2006), 'Public Infrastructure and Growth: New Channels and Policy Implications', *World Bank Policy Research Working Paper Series*, 4064, retrieved on June 8th 2014, from <http://papers.ssrn.com/abstract=2005043>.

Anyanwu, J.C. and Erhijakpor, A.E.O. (2009), 'Health Expenditures and Health Outcomes in Africa', *African Dvelopment Review*, 21(2), 400-433.

Aschauer, D.A. (1989), 'Is Public Expenditure Productive?', *Journal of Monetary Economics*, 23(2), 177–200.

Baldacci, E., Guin-Siu, M.T. and Mello, L.D. (2003), 'More on the Effectiveness of Public Spending on Health Care and Education: A Covariance Structure Model', *Journal of International Development*, 15(6), 709-725.

Barro, R.J. (1990), 'Government Spending in a Simple Model of Endogenous Growth', *Journal of Political Economy*, 98(5), 103-125.

Bhalotra, S. (2007), 'Spending to Save? State Health Expenditure and Infant Mortality in India', *Health Economics*, 16(9), 911-928.

Bhargava, A., Jamison, D.T., Lau, L.J. and Murray, C.J. (2001), 'Modelling the Effects of Health on Economic Growth', *Journal of Health Economics*, 20(3), 423-440.

Brenneman, A. and Kerf, M. (2002), 'Infrastructure & Poverty Linkages: A Literature Review', *The World Bank*, retrieved on January 14th 2017, from <http://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_policy/-- invest/documents/publication/wcms_asist_8281.pdf>.

Chen, X., Ender, P., Mitchell, M. and Wells, C. (2003), *Regressions with Stata*, Stata Web Books, retrieved on January 14th 2017, from <https://stats.idre.ucla.edu/stata/webbooks/reg/>.

Cheng, J.J., Schuster-Wallace, C.J., Watt, S., Newbold, B.K. and Mente, A. (2012), 'An Ecological Quantification of the Relationships between Water, Sanitation and Infant, Child, and Maternal Mortality', *Environmental Health*, 11(1), 1-8.

Devarajan, S., Swaroop, V. and Zou, H. (1996), 'The Composition of Public Expenditure and Economic Growth', *Journal of Monetary Economics*, 37(2), 313-344.

Devlet PlanlamaTeşkilatı (1995), *Yedinci Beş Yıllık Kalkınma Planı, 1996-2000*, retrieved on October 10th 2016, from <http://kutuphane.tuik.gov.tr/yordambt/yordam.php?-ac=arama&demirbas=0006910>.

Easterly, W. and Rebelo, S. (1993), 'Fiscal Policy and Economic Growth', *Journal of Monetary Economics*, 32(3), 417-458.

Farahani, M., Subramanian, S.V. and Canning, D. (2010), 'Effects of State-Level Public Spending on Health on the Mortality Probability in India', *Health Economics*, 19(11), 1361-1376.

Fay, M., Leipziger, D., Wodon, Q. and Yepes, T. (2005), 'Achieving Child-Health-Related Millennium Development Goals: The Role of Infrastructure', *World Development*, 33(8), 1267-1284.

Gamper-Rabindran, S., Khan, S. and Timmins, C. (2010), 'The Impact of Piped Water Provision on Infant Mortality in Brazil: A Quantile Panel Data Approach', *Journal of Development Economics*, 92(2), 188-200.

Glomm, G. and Ravikumar, B. (1992), 'Public versus Private Investment in Human Capital: Endogenous Growth and Income Inequality', *Journal of Political Economy*, 100(4), 818-834.

Günther, I. and Fink, G. (2011), 'Water and Sanitation to Reduce Child Mortality: The Impact and Cost of Water and Sanitation Infrastructure', *Social Science Research Network*, retrieved on March 1st 2015, from <http://papers.ssrn.com/abstract=1799842>.

Karaca, O. (2004), 'Türkiye'de Bölgeler Arası Gelir Farklılıkları: Yakınsama Var mi?', *Turkish Economic Association Discussion Paper*, No.2004/7, retrieved on October 10th 2016, from <http://www.tek.org.tr/dosyalar/O-KARACA.pdf>.

Khan, M.S. and Kumar, M.S. (1997), 'Public and Private Investment and the Growth Process in Developing Countries', *Oxford Bulletin of Economics and Statistics*, 59(1), 69-88.

Klasen, S. (2010), 'Measuring and Monitoring Inclusive Growth: Multiple Definitions, Open Questions, and Some Constructive Proposals', *Sustainable Development Working Papers*, retrieved on August 28th 2016, from <http://www.adb.org/publications/measuring-and-monitoring-inclusive-growth-multiple-definitions-open-questions-and-some>.

Leon-Gonzalez, R. and Montolio, D. (2004), 'Growth, Convergence and Public Investment: A Bayesian Model Averaging Approach', *Applied Economics*, 36(17), 1925-1936.

Levy, H. (2004), 'Rural Roads and Poverty Alleviation in Morocco', The World Bank, 1(1), 1-27, retrieved on October 10th 2016, from <http://documents.worldbank.org/curated/en/2004/05/5490741/rural-roads-poverty-alleviation-morocco>.

Lucas, R.J. (1988), 'On the Mechanics of Economic Development', *Journal of Monetary Economics*, 22(1), 3-42.

Mani, S., Hoddinott, J. and Strauss, J. (2013), 'Determinants of Schooling: Empirical Evidence from Rural Ethiopia', *Journal of African Economies*, 22(5), 693-731.

Odedokun, M.O. (2001), 'Public Finance and Economic Growth Empirical Evidence from Developing Countries', *WINDER Discussion Paper*, (2001)72.

OECD (2007), *Promoting Pro-Poor Growth: Policy Guidance for Donors*, OECD Publishing, retrieved on June 6th 2017, from <https://www.oecd.org/dac/povertyreduction/promotingpro-poorgrowthpolicyguidancefordonors.htm#How_to_access>.

Pereira, A.M. and Andraz, J.M. (2005), 'Public Investment in Transportation Infrastructure and Economic Performance in Portugal', *Review of Development Economics*, 9(2), 177-196.

Rajkumar, A.S. and Swaroop, V. (2008), 'Public Spending and Outcomes: Does Governance Matter?', *Journal of Development Economics*, 86(1), 96-111.

Ramirez, M.D. and Nazmi, N. (2003), 'Public Investment and Economic Growth in Latin America: an Empirical Test', *Review of Development Economics*, 7(1), 115-126.

Rauniyar, G. and Kanbur, R. (2010), 'Inclusive Development: Two Papers on Conceptualization, Application, and the ADB Perspective', *ADB Working Paper*, No. 2010/1 retrieved on June 7th 2017, from <http://publications.dyson.cornell.edu/research/researchpdf/wp/2010/Cornell_Dyson_wp1001.pdf>.

Romer, P.M. (1989), 'Human Capital and Growth: Theory and Evidence', *NBER Working Paper* Series, 3173, 251-286.

Rosenzweig, M.R. and Wolpin, K.I. (1982), 'Governmental Interventions and Household Behavior in a Developing Country: Anticipating the Unanticipated Consequences of Social Programs', *Journal of Development Economics*, 10(2), 209-225.

Schell, C.O., Reilly, M., Rosling, H., Peterson, S. and Ekström, A.M. (2007), 'Socioeconomic Determinants of Infant Mortality: A Worldwide Study of 153 Low-, Middle- and High-Income Countries', *Scandinavian Journal of Public Health*, 35(3), 288-297.

Schultz, T.W. (1961), 'Investment in Human Capital', *The American Economic Review*, 51(1), 1-17.

Shioji, E. (2001), 'Public Capital and Economic Growth: A Convergence Approach', *Journal of Economic Growth*, 6(3), 205-227.

Tansel, A. (2002), 'Determinants of School Attainment of Boys and Girls in Turkey: Individual, Household and Community Factors', *Economics of Education Review*, 21(5), 455-470.

TÜİK (2016), *Per Capita Gross Domestic Product, 1923 - 1997*, retrieved on October 8th 2016, from <http://www.tuik.gov.tr/PreIstatistikTablo.do?istab_id=2218>.

UNDP (1990), *Human Development Report 1990*, New York Oxford university press, retrieved on February 2017, from <http://hdr.undp.org/sites/default/files/reports/219/hdr_1990_en_complete_nostats.pdf>.

UNDP (2016), *Sustainable Development Goals*, retrieved on 8th October 2016, from <http://www.undp.org/content/undp/en/home/sustainable-development-goals.html>.

United Nations General Assembly (2015), *Transforming our World: The 2030 Agenda for Sustainable Development | UNFPA - United Nations Population Fund*, retrieved in August 28th 2016, from <http://www.unfpa.org/resources/transforming-our-world-2030-agenda-sustainable-development>.

Wang, L. (2003), 'Determinants of Child Mortality in LDCs: Empirical Findings from Demographic and Health Surveys', *Health Policy*, 65(3), 277-299.

World Health Organization (2006), *Fuel For Life: Household Energy and Health*, WHO Press, retrieved on June 6th 2017, from <http://www.who.int/indoorair/publications/fuelforlife/en/>.

Woldemicael, G. (2000), 'The Effects of Water Supply and Sanitation on Childhood Mortality in Urban Eritrea', *Journal of Biosocial Science*, 32(2), 207-227.

World Bank (2015), *World Development Indicators | Data*, retrieved on August 28th 2016, from <http://data.worldbank.org/data-catalog/world-development-indicators>.