THE COMPONENTS OF PUBLIC INVESTMENT

AND

ECONOMIC GROWTH

THE CASE OF THE PROVINCES OF TURKEY, 1975-2001

Thesis submitted in accordance with the requirements of the University of Liverpool for the degree of Doctor in Philosophy by Gökçen Yılmaz.

July, 2015

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Abstract

The effect of public investment on economic growth is a popular topic in economic literature. Although there are endogenous growth models that incorporate public expenditure as a factor that promotes growth, findings in empirical literature provide conflicting results. This thesis contributes to this debate by providing a comprehensive analysis of the relationship between public investment and development by using a new panel dataset for Turkish provinces.

For analyses, public investment is disaggregated as energy infrastructure, city infrastructure and security, education, health, transportation and communication, agriculture, mining, manufacturing, tourism and housing. The outcome variables are chosen as economic growth rate, the gross enrolment rate for primary and middle school, and the infant mortality rate.

With regard to the econometric method, the fixed-effects technique is chosen. The dependent variables are calculated as the five-year forward moving averages of the outcome variables. Standard errors are corrected for serial correlation, cross-sectional dependence and heteroscedasticity.

Findings in this thesis suggest that public investments in education, agriculture, tourism and energy infrastructure are associated with higher growth rates. There does not appear to be any statistical relationship between public city infrastructure and security investment and economic growth. However, public city infrastructure and security investment is related to the long-run gross enrolment rate positively, and the long-run infant mortality rate negatively. Additionally, public investment in energy infrastructure appears to have a negative relationship with the long-run infant mortality rate. Finally, results show that public investment in mining, transportation and communication are negatively related to the long run growth.

The results provide partial support for the predictions of the model in Barro (1990) in the second chapter and the development literature in the third and the fourth chapters. Public policies in the sectors mentioned above arise as a factor that has an impact on the outcome of public investment.

Post-estimation diagnostics and robustness analyses provide statistical evidence that support the findings.

ACKNOWLEDGEMENTS

I would like to thank my supervisors, Dr. Stephan Pfaffenzeller and Dr. Supriya Garikipati, for their support and helpful comments, my friend John Picton for good advice, and to acknowledge the Ministry of Education in Turkey who funded the research project.

This thesis is dedicated to my family and friends.

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CHAPTER 1: MAIN INTRODUCTION

The relationship between government expenditure and economic growth is a controversial topic in economic literature. Economic theories prior to the 1990s had offered public policies that emphasised the role of government in economic development. Many countries that aimed to become more industrialised followed import substitution policies and heavily regulated their economies. However, after hyperinflation due to petrol crises in the 1970s, and the Latin American debt crises in the 1980s, developing countries were encouraged to reduce the size of government in their economies in order to promote growth.

This thesis, firstly, aims to contribute to the ongoing debate by providing statistical evidence that is obtained from a new panel dataset for public investment in Turkish provinces for the years between 1975 and 2001.

The theoretical relationship between public expenditure and economic growth is analysed in economic models derived from the endogenous growth theory. A general version of these models is provided by Barro (1990), in which government expenditure is an input that complements private sector production. Some models focus on a specific component of government expenditure in analyses, such as public infrastructure expenditure (Glomm and Ravikumar, 1994; Agénor, 2005a), public education expenditure (Blankenau and Simpson, 2004; Glomm and Ravikumar, 1992, 1998), or public health expenditure (Aisa and Pueyo, 2006). A group of papers studies the effect of changes in the allocation of government expenditure in infrastructure, education and health on economic growth (Glomm and Ravikumar, 1997; Agénor, 2008, 2005b; Agénor and Neanidis, 2011; Agénor and Moreno-Dodson, 2006). Another group of papers models the relationship between the composition of public expenditure, in terms of capital and current expenditure, and economic growth (Lee, 1992; Turnovsky and Fisher, 1995; Devarajan, Swaroop and Zou, 1996).

Although public infrastructure expenditure, public education expenditure, and public health expenditure have been suggested as types of public expenditure that could contribute to growth due to their public good characteristic, empirical results are not conclusive. In relation to the topic, some empirical studies (Tanzi and Davoodi, 2000; Mauro, 1995, 1996, 1998) point out the incentives for corruption in public investment projects. Thus, despite being a widely researched topic, the relationship between public expenditure and economic growth has remained a controversial one.

Secondly, this thesis aims to investigate the outcomes of public investment projects that were carried out by the State Planning Organisation in Turkey between 1975 and 2001. In Turkey, between 1960 and 1980, state-led economic development programmes were followed. For this purpose, the State Planning Organisation was founded in 1963. One of the functions of the State Planning Organisation has been to draft annual public investment programmes, and to implement them. Although the economy has been liberalised and free-market-promoting policies have been adopted since 1980, the State Planning Organisation has remained, and the government has continued to carry out public investment projects according to annual public investment programmes. The purpose of this thesis is to analyse the effect of public investment in various sectors on economic growth, the gross enrolment rates, and the infant mortality rates.

1.1 Contribution of the Thesis

The contribution of this thesis to the literature is a comprehensive empirical analysis of the relationship between public investment and development. As part of the research project, a new panel dataset for public investment, the gross enrolment rates, and the infant mortality rates for provinces of Turkey for the years between 1975 and 2001 has been provided. Public investment is disaggregated to education, health, transportation and communication, energy infrastructure, city infrastructure and security, agriculture, mining, tourism, manufacturing, and housing.

The United Nations Development Programme calculates the human development index by taking the average of indicators that measure the level of income, education and longevity in a nation. In a similar manner, in this thesis, the second chapter analyses the relationship between public investment and economic growth, the third chapter focuses on the relationship between public investment and the primary and middle school gross enrolment rates, and the fourth chapter investigates the relationship between public investment and infant mortality rates. School enrolment rates are considered to be proxies of human capital (Barro, 1991), which is proposed to be the source of economic growth in endogenous growth models (Lucas, 1988; Romer, 1989; Glomm and Ravikumar, 1992), while the infant mortality rates have a strong association with poverty (Gortmaker, 1979; WHO, 2015b).

The literature provides many examples of research that studies the relationship between public expenditure and economic growth by disaggregating data to components such as education, health, agriculture, transportation and communication, and defence. The majority of these studies use time-series data, or panel data for cross-sections of countries. Results using time-series data are prone to be biased if unit roots and seasonality in data are not addressed by correct econometric techniques. Panel data for cross-sections of countries are not reliable due to the differences in the calculation of economic indicators across nations. The second chapter analyses the relationship between disaggregated public investment and economic growth by using panel data for provinces in Turkey.

The third and fourth chapters contribute to the literature by providing empirical studies that analyse the relationship between public social infrastructure investment and development indicators. Although the development literature indicates a positive link between access to safe water, sanitation facilities, modern energy sources and the gross enrolment rate, and a negative association between these factors and the infant mortality rate, current literature lacks an empirical study that analyses the relationship between public investment in these facilities and the development indicators in question.

1.2 Method

The chosen econometric technique is the fixed-effects method with Driscoll and Kraay (1998) standard errors that are robust to cross-sectional dependence, serial correlation and heteroscedasticity. To avoid reverse causality between the dependent variables and the explanatory variables, the dependent variables are calculated as the five-year forward moving average of the economic growth rate in the second chapter, the five-year forward moving arithmetic average of the gross enrolment rate in the third chapter, and the five-year forward moving arithmetic average of the infant mortality rate in the fourth chapter. This also allows for a lag in the effect of public investment on economic growth rate, the gross enrolment rates, and the infant mortality rates. Thus, the analyses are carried out for the relationship between public investment and the outcome variables for the long run.

The robustness of the results to the change in the length of time in the dependent variables, the calculation of the dependent variables and to outliers is provided in the chapter appendices. The chosen econometric technique and the motivation for using Driscoll and Kraay standard errors are explained in the fifth chapter. This chapter additionally provides the post-estimation diagnostics for the chosen regression models in the second, third and fourth chapters.

1.3 Findings

Findings in this thesis are in accordance with the endogenous growth models that suggest a positive relationship between public infrastructure and education investment and economic growth rate. Additionally, as discussed in the development literature in the third and the fourth chapters, public infrastructure investment appears to have a positive impact on the level of education and health. Finally, the results appear to support the observations in the development plans that were published by the State Planning Institution between the years 1975 and 2001 regarding the public policies in the sectors in question.

In the second chapter, public education investment, public energy infrastructure investment, public agricultural investment, and public tourism investment arise as types of investment that have a positive and statistically significant relationship with the five-year forward moving geometric average of the growth rate of real GDP per worker. Examination of development plans and public investment projects in the agriculture, tourism and energy sectors shows that public policies for these sectors aim to improve public infrastructure services.

Additionally, public agricultural investments appear to be implemented in relation to rural development programmes. One of the objectives of public tourism investments is to increase the country’s exports to reduce the deficits in the balance of payments. Public energy investments aim to establish power plants, to finance research that focuses on new energy sources, and to install electricity networks for households. In relation to public energy investment, constraints for obtaining funds are mentioned as one of the rationales for public intervention in this area. Public energy investment also has a negative relationship with the five-year forward moving average of the infant mortality rates in the fourth chapter.

Public education investment is predicted to have a positive relationship with economic growth by endogenous growth models that associate the source of growth with knowledge spillovers and innovation in technology. Barro (1990) considers public education investment as a type of investment that complements private sector capital, and thus contributes to growth.

However, the results in the third chapter do not provide any statistical evidence for a positive relationship between public education investment and the five-year forward moving arithmetic average of the gross enrolment rates. Nevertheless, public investment in education, in addition to investment projects for primary education, includes other types of projects that finance secondary and tertiary education. Therefore, the relationship between public education investment and economic growth may be arising from public investment projects in secondary or tertiary education. Development plans that cover the years between 1975 and 2001 provide statements that, with regards to technology and innovation, public policies aimed to coordinate universities to carry out research activities that could be implemented in the industries. In addition, they show that both industries and the state needed qualified workers for investment projects. This suggests that public education investment may have contributed to both innovation of technology and human capital, and thus economic growth.

In addition to the findings above, the results in the second chapter reveal that public transportation and communication investment and public mining investment have negative and statistically significant coefficients. There are two factors that could be resulting in a negative relationship between public mining investment and economic growth. Firstly, mining sector was monopolised by the state which excluded private sector production in this sector until the late 1990s. The fourth development plan shows that public policies in this sector led to supply shortages, and failures in implementing investment projects. Public policies in mining sector failed to meet the demand for minerals that are used as intermediate goods by the industry. Secondly, public mining investment could be negatively related to growth as the theory of natural resource curse suggests that discovery of natural resources (oil and other minerals) and the expansion of the sector can reduce the competitiveness and the resources for the tradable sectors, such as manufacturing, in the economy.

To shed light on the results for public transportation and communication investment, the seventh development plan is consulted. This plan provides the economic and social outlook of the country for the 1990s and an overview of public investment projects and public policies for this time period. It lists the inefficiencies and structural problems in implementing public transportation investment that may offer an explanation for its negative and statistically significant coefficient. This variable is not statistically related to the long-run gross enrolment rates in the third chapter or the long-run infant mortality rates in the fourth chapter either.

The model in Barro (1990) also predicts a positive relationship between public health investment, public city infrastructure and security investment and economic growth. For public health investment, the results in this thesis do not provide any statistical evidence for its impact on economic growth in the second chapter, gross enrolment rates in the third chapter or infant mortality rates in the fourth chapter. The reason behind the statistically insignificant coefficient for public health investment in this thesis is likely to lie in the failures in public health policies. The seventh development plan discusses the inefficiencies in public health sector in the 1990s. It refers to the lack of productivity in public health investment, and identifies one of the inefficiencies of public investments in health as not focusing on low-cost preventive care, and instead financing projects for patient's treatment in the bed which is more expensive. In the fourth chapter, the statistically insignificant relationship between public health investment and the five-year forward moving average of the infant mortality rate appears to support the observations regarding public health policies in the seventh development plan.

Public city infrastructure and security investment does not appear to be related to economic growth, but the third and the fourth chapters provide statistical evidence for its positive impact on the long-run gross enrolment rates, and negative impact on the long-run infant mortality rates. When the fourth and seventh development plans are consulted regarding public policies for city infrastructure, it can be observed that rural areas and remote villages that lacked access to safe water and sanitation were prioritised to reduce the gap between standards of living between rural and urban areas, in other words, the provinces in the East and the West. This appears to be the case for security investments too. The seventh development plan mentions terror as a problem in the East of the country that was driving away private investment in 1990s. These areas also lack industries that could promote growth. They tend to suffer from higher unemployment rates, and this leads to domestic migration from the East of the country to the West. This is because the industrial sectors that provide employment are clustered in cities in the West of the country.

These industries are considered to benefit from the economies of scale. Given these facts, results imply that public investment in city infrastructure and security in rural areas, despite improving social indicators such as the gross enrolment rates and infant mortality rates, may have not been sufficient to attract private investment to these locations.

There does not appear to be any statistical relationship between public manufacturing investment, or public housing investment and economic growth rate. Prior to the 1980s, Turkey followed import substitution industrialisation, and thus the government invested in manufacturing sectors to promote economic development. The share of manufacturing in public investment was reduced after policy reforms that aimed to liberalise the economy. Public manufacturing investment is not considered to be a type of investment that would complement private capital in Barro (1990), and accordingly it has a statistically insignificant coefficient in the results.

Public housing investment projects are carried out to address accommodation issues arising from rapid urbanisation. These projects also include providing housing for state employees, such as teachers, security members, lawyers and judges. Nevertheless, public housing investment is not considered to be a type of spending that would contribute to private sector productivity. Correspondingly, there does not appear to be a statistical relationship between public housing investment and the five-year forward moving geometric average of the growth rate of real GDP per worker.

With the exception of public transportation and communication investment, the results in the second chapter appear to support the predictions of Barro (1990). While public education investment, and the types of investment that are related to infrastructure services in the relevant sectors (agriculture, tourism and energy infrastructure), have a positive relationship with economic growth, public manufacturing and housing investment do not have any impact on it. For the overall results, public policies appear to be a factor that affects the outcome of public investment.

The tests for model specification and omitted variable bias in the fifth chapter fail to reject the null hypothesis that the estimated models are correctly specified in the second and third chapters. The statistical evidence for the robustness of the model specification for the fourth chapter is weaker. Unit root tests reject the null hypothesis that data for variables in the second chapters are non-stationary. The dependent variables and the adult education indicator that are used in the third and fourth chapters appear to have unit roots; however, when the unit root tests allow for the serial correlation, they reject the null hypothesis that the five-year forward moving arithmetic average of the gross enrolment rate and the five-year forward moving arithmetic average of the infant mortality rate contain unit roots. The adult education indicator appears to contain unit roots due to the calculation of the variable; however, excluding this indicator from the regression models does not change the results.

Further analyses in the chapter appendices suggest that the robustness of the results for public agricultural investment in the second chapter, and public city infrastructure and security investment in the fourth chapter is weaker. Co-linearity arises as a factor that reduces the robustness of inferential statistics for the third and fourth chapters for the regression models in which the dependent variable is calculated to cover the longer run.

1.4 Structure of the Thesis

In this thesis, the first chapter provides the main introduction and the sixth chapter presents the main conclusions derived from the thesis. The second chapter focuses on the empirical relationship between public investment and economic growth. For this purpose, public investment data that are disaggregated to agriculture, mining, manufacturing, energy, transportation and communication, education, housing, health, tourism and city infrastructure and security are used. To establish the theoretical relationship between the types of public investment and economic growth, Barro (1990)'s model is summarised. The dependent variable in this chapter is the five-year forward moving geometric average of the growth rate of real GDP per worker.

The third and fourth chapters investigate the empirical relationship between public investment, primary and middle school gross enrolment rates, and infant mortality rates. In these chapters, in estimated equations, public transportation and communication investment, public energy infrastructure investment, public city infrastructure and security investment, public health investment, and public education investment are included.

Each chapter provides an introduction, literature review, and sections for model, data, results, interpretation of results, and a conclusion. Post-estimation diagnostics are discussed in the fifth chapter. The robustness of the results to alternative specifications is analysed in the chapter appendices.

CHAPTER 2: THE COMPONENTS OF PUBLIC INVESTMENT AND ECONOMIC GROWTH

The history of Turkish economic policies can be summarised as follows: the Turkish government was founded in 1923 in an economy that was struggling after the collapse of the Ottoman Empire following the First World War. Between 1923 and 1933, liberal economic policies were implemented, but, due to a lack of infrastructure and the Great Depression, and as a result of the influence of Keynesian policies over all the world, the government shifted to mixed economic policies. After a coup d'état in 1960, the government's involvement in the economy increased. For this purpose, in 1963, the State Planning Organisation was established, which drafts and implements annual public investment programmes. "The planned period" ended with another coup d'état in 1980. The military government took actions to liberalise the economy. These policies have been adopted by the civilian governments that followed the coup d'état. A more detailed analysis of Turkish economic policies between 1923 and 2001 can be found in Aydin (2004).

Although the State Planning Organisation has remained after 1980 (and was renamed the Ministry of Development in 2011), it has changed the allocation of public investment in economic and social services since then. It has reduced the amount of public investment in economic activities in favour of infrastructure, health and education. This chapter aims to investigate the outcome of public investment projects carried out by the State Planning Organisation by using a model in Barro (1990). Firstly, an introduction and a literature review are provided; secondly, the model in Barro (1990) is presented and a regression model is specified, and then the dataset is explained. After the discussions of the estimation results, a concise conclusion is provided.

2.1 Introduction

The role of state in economic development has long been a centre of policy discussions. Rodrik (2005) divides the growth strategies into those that promote "the big push", planning, and import substitution policies, and those that recommend market-oriented economic growth policies. While the former was popular between 1950 and 1970, the latter gained popularity after 1970 (p.3).

Easterly (2006) traces the concept of "the big push" to Paul Rosenstein Rodan, who argues that, in order to help Eastern and South-Eastern Europe to grow in the 1940s, there was a need for large-scale externally financed investment, as the private sector structures in these countries would not allow for the required amount of investment (p.6).

Baer (1972) describes the motivation in import substitution industrialisation as changing the division of labour in the world. After the nineteenth century, it appeared that Latin America and most parts of Asia and Africa exported food and raw materials to countries in the North and imported manufactured products from them. It was thought that, for growth, instead of importing manufactured goods, these countries should establish the required industries to produce their own. It was argued that countries in the North had gone down the same path during their industrialisation in the nineteenth century. The import substitution industrialisation had a *"national character"* (pp.95-96).

The idea of import substitution policies originates from the Prebisch-Singer argument that, in international trade, the terms of trade were deteriorating against the countries that produced and exported raw materials and imported manufactured products. It was observed that this leads to deficits in balance of payments in countries that rely on agriculture and mining. Thus, import substitution policy arose as a solution that would protect the balance of payments in developing countries and assist their economies to become industrialised (Love, 2005).

Bruton (1998) traces the support for the argument about the terms of trade to the perception of markets before the 1950s. The two world wars and the great depression led to pessimistic views regarding economic prospects. The Keynesian view that the economy was not always operating at full employment and full capacity was dominant in economic policies. This was also the time that the Soviet Union, which relied on central planning for industrialisation, appeared to be a success due to its high economic performance between 1920 and 1940. Thus, the economic and political climate contributed to the idea that economic development could be achieved by industrialisation through government intervention (p.906).

The ideas that originated from the observations and thoughts about market disequilibria, the insufficient response to price incentives, and immobility in resources in less developed countries led to theories of economic development such as "the big push", "balanced growth", and import substitution industrialisation, all of which were later grouped under “structuralism”. The economists mentioned earlier, such as Paul Rosenstein-Rodan, Hans Singer, and Paul Prebish, are cited in this group (Arndt, 1985). Paul Prebish was also known as an authority on Keynes (Love, 2005). Accordingly, Singer (1997), who is considered to be among structuralists, defines the ideas for development for the years between 1945 and 1965 as Keynesian Consensus. He observes that the emphasis in Keynesian Consensus was on employment. Although inflation was recognised as a problem, it was thought that the fiscal policies could manage price volatilities. Thus, oil shocks, and as a consequence rising inflation in the 1970s, were one of the important reasons why the Keynesian Consensus was abandoned (pp.293-295). Furthermore, opinions concerning the role of government intervention in economic development began to shift to market-oriented views during the 1960s and 1970s as debt crises in Latin American and Caribbean countries manifested themselves (Birdsall, De la Torre and Valencia Caicedo, 2010, p.2).

Bruton (1998) lists a few of the significant factors that resulted in the loss of popularity of the state-led economic policies, as follows:

- Structuralists had anticipated that developing countries had only a low capability to export due to the composition of their economies; however, the boom decades between 1950 and 1960 proved that these countries could perform well in international trade as exporters. Economists of the 1940s expected recessions or depressions to be a potential problem after the Second World War, as the Great Depression had followed the First World War.
- Due to the economic climate at the time, Keynesians and structuralists were concerned with employment. However, in booming decades, inflation became the primary concern for economists. Also, structuralists were distrustful of price mechanisms (Arndt, 1985, p.1), but in the 1950s and 1960s it was observed that economic agents were more responsive to price incentives than structuralists imagined.
- Economists’ views regarding the production function in the 1940s and 1950s (such as theories about the incremental output-capital ratio by Harrod, the two-gap model and input-output models) were proved to be insufficient through empirical observations and emerging

neoclassical growth models. Economic theories of development prior to the 1950s predicted the source of growth as an increase in the physical capital, but neoclassical growth theory showed that the productivity of capital is also a factor in development. Similarly, development theories before neoclassical growth models had not addressed the importance of the mechanisms of technological and knowledge transfer, and were not able to explain the difference in productivity across countries.

- The Prebisch-Singer argument for deteriorating terms of trade against developing countries lost credibility. Additionally, import substitution policies, contrary to expectations, did not reduce imports for countries that purchased capital and intermediate products for their national industries.
- The failures of the Soviet system became more apparent internationally, and the experience of developing countries showed that governments could misallocate the resources too.

In 1989, Willamson (1990) provided a summary of economic policy reforms that were considered desirable by the financial institutions in Washington. This was in response to the debt crisis in the Latin American countries which were required to fulfil conditions proposed by the World Bank and the International Monetary Fund, that are also called Bretton Wood Institutions. Williamson lists this agreed set of policies as follows: he states that general consensus is maintaining a fiscal discipline in favour of a balanced budget. To achieve this, the composition of public expenditure matters and the general consensus in Washington is in favour of reducing private expenditure in subsidies, and allocating government sources to education, health and infrastructure services. He states that to maintain a balanced budget by raising taxes is considered as an *"inferior alternative"*. He further states that there is a general agreement that interest rates and exchange rates should be market oriented, and international trade (specifically imports) and foreign direct investment accounts should be liberalised. The policies required by the institutions in Washington also encourage privatisation, deregulation and maintaining property rights.

Regarding his earlier work, Williamson (2006) explains that, although not intended, the Washington Consensus was perceived to be a policy prescription for development. Rodrik and Bank (2006) observe that the timing of the publication of the policy reform coincided with the collapse of Soviet Russia, the fall of the Berlin Wall, and liberalisation in Latin America. However, policy reforms did not lead to the desired outcomes: Latin American countries did not grow as fast as expected, and transition economies experienced crises that were more severe and prolonged than anticipated. Although there were success stories in Sub-Saharan Africa, the policy reforms were not suitable to manage the public health problems that arose in these countries (p.974). China and India reduced the number of people living in poverty in the 1990s; however, they had not followed the Washington Consensus (*ibid*, p.975).

Stiglitz (2008) criticises the Washington Consensus for its neoliberal and market-oriented views, on the grounds of imperfect information in the markets, and incomplete markets due to the technology and learning element, especially in developing countries. He also argues that the policy reforms agreed in the Institutions in Washington are motivated by politics rather than economics. Stiglitz puts forward the presence of the "post-Washington Consensus", which takes into account both the government and market failures. The post-Washington Consensus considers the market and the government to be complementary, able to mutually improve each other's performance, and seeks balance in the role of government and markets in economic development.

In the 2000s, neo-developmentalism emerged in Latin American economic policies; it put the emphasis on macroeconomic stability instead of price stability. Macroeconomic stability could be achieved by maintaining stable inflation, exchange rates and balance of payments. Neo-developmentalism encouraged using monetary, fiscal, exchange rate and wage policies to provide a stable environment for the private sector by reducing uncertainty in markets through controlling demand, capital movements, fiscal sustainability and maintaining low interest rates. Neo-developmentalism recommends a set of policies that would increase both the involvement of the government in the economy and the competition in the markets (Filho and Morais, 2012).

In relation to discussions above, in this chapter Barro's (1990) approach is used in order to investigate the relationship between public investment and economic growth. Barro's (1990) model suggests that both the type of government expenditure and the size of the government in the economy matter. If the size of the government is too big, an increase in the level of public investment has reducing effects on the long-run growth rate. Accordingly, in this chapter, the public investment variables are specified as the shares of GDP to reflect both aspects of public policy. Public investment data cover the level of investment made in agriculture, mining, manufacturing, energy, transportation and communication, housing, tourism, education, health, and city infrastructure and security services. The dependent variable is specified as the five-year forward moving geometric average of GDP per worker growth rate to allow for a lag in the effect of public investment on economic growth and to avoid reverse causality.

The literature review in this chapter shows that a group of papers studies the relationship between public expenditure and economic growth by disaggregating public expenditure by its functions. Most of these studies use public expenditure in transportation and communication, education, health, defence, and agriculture, whilst a few include public expenditure in energy. The majority of research that uses a disaggregating approach relies on time-series data, or panel data for a cross-section of countries. This chapter contributes to this literature by applying a disaggregating approach to panel data for the cross-section of Turkish provinces for the years between 1975 and 2001. It differs from the rest of the literature by using public investment data in fixed capital in energy, tourism, mining, manufacturing, city infrastructure and security, housing, health, education, transportation and communication, and agriculture.

Findings in this chapter appear to support the Barro (1990) model's implications that public investment in infrastructure and education are associated with higher growth rates, with the exception of public transportation and communication investment. Results also appear to be in accordance with public policies that are discussed in development plans that are published by the State Planning Institution.

Discussions of public policies for the years between 1975 and 2001 in development plans show that public investment in agriculture, tourism and energy aimed to improve public infrastructure. One of the objectives of public education investment aimed to improve increase enrolment rates in primary, secondary and tertiary education. Additionally, there appears to be effort to coordinate the universities' research activities for industrial development.

Regarding public transportation and communication investment, the seventh development plan lists a set of policy issues that could be the reason behind the negative and statistically significant coefficient. Public policies in health investment, which appears to be statistically insignificant in results, are criticised for not focusing on preventive health care but spending in projects for treatment in the bed (such as hospital treatment) which are more costly. The seventh development plan also refers to policy problems at implementing investment projects in health sector that are discussed in more detail in the fourth chapter.

Finally, public policy appears to have put emphasis on providing access to water and sewage system in rural areas regarding public city infrastructure and security investment. These areas lack industries and suffer from high unemployment rates. Thus, results appear to indicate that public city infrastructure and security investment was not sufficient to attract private investment to the rural areas. This is likely to be due the fact that industries in Turkey are clustered in the West of the country, and benefit from the economies of scale.

There appears to be a negative relationship between public mining investment and economic growth, possibly because the economic activities in this sector had been monopolised by the government until recent years. Additionally, economic the theory of "natural resource curse" suggests that the discovery of natural resources (such as petroleum and minerals) has a negative effect on traded sectors such as manufacturing. This appears to provide further insight for the negative sign for public mining investment in the second chapter.

There does not appear to be any relationship between public investment in manufacturing or housing and the five-year forward moving geometric average of the growth rate of GDP per worker. However, these types of investment are considered to crowd out private investment.

The econometric technique is the fixed-effects panel model with Driscoll and Kraay standard errors. The method and the motivations for robust standard errors are explained in detail in the fifth chapter. Model specification tests in the fifth chapter provide evidence that the regression model is correctly specified, and unit root tests indicate that the panel data for the variables are stationary. The robustness analyses in Appendix- Chapter 2, A.2.3 show that the results are robust to outliers, issues specific to the dataset, and alternative calculations of the dependent variable. However, the statistical significance for public agricultural investment disappears when potential outliers or the provinces that change administrative status between 1975 and 2001 are excluded from the sample. Additionally, the size of the coefficient of public tourism investment appears to be sensitive to the exclusion of potential outliers from the sample.

2.2 Literature Review

In the literature, the theoretical relationship between government expenditure and economic growth is discussed in relation to neoclassical economic models and endogenous growth models. According to neoclassical economic models, as the rate of economic growth is exogenously determined, the government investment does not have any positive impact on economic growth. Public investment crowds out private investment, because a government finances its spending either by taxes, which reduces the disposable income, or by borrowing, which reduces the financial source for the private companies. In the majority of empirical studies cited below (Odedokun, 1997; Khan and Reinhart, 1990; Ram, 1996; Ramirez and Nazmi, 2003; Chamorro-Narvaez, 2012; Lachler and Aschauer, 1998; Khan and Kumar, 1997), the estimated equations are derived from the neoclassical economic theory.

In a variety of endogenous growth models, government expenditure (such as in education, health, or infrastructure) is predicted to have a positive effect on economic growth. In this chapter, a model with public services and taxes by Barro (1990) is provided for its generality.

The empirical literature that studies the statistical relationship between public investment and economic growth can be grouped according to the type of public expenditure the scholars focus in their investigation. One group of papers studies the effect of a change in the composition of public capital and consumption expenditure on economic growth, while another group of studies focuses solely on the relationship between public investment (or public capital expenditure) and economic growth. Finally, a branch of empirical work in this field is carried out by disaggregating public expenditure to education, health, transportation and communication, security/defence, agriculture and energy.

The group of empirical studies, that investigates the relationship between the composition of public capital and current expenditure and economic growth, tests whether a higher share of government capital expenditure in output is associated with higher rates of economic growth. The findings in the majority of these studies show that public capital expenditure has positive relationship with growth, while public consumption expenditure has a negative association with it. These papers can be grouped by the approach they use. Deverajan, Swaroop and Zou (1996) and Gregoriou and Ghosh (2008) consider the effect of a change in the shares of capital and consumption expenditure for a given size of government in the economy. They report that public capital expenditure is negatively associated with economic growth rate. However, Haque (2004), who uses the same technique and reports similar results, shows that the indicators for the share of government expenditure contain unit roots. After treating the data for the unit roots, Haque (2004) finds that government public capital is positively associated with output growth.

Gupta, Clements, Baldacci and Mulas-Granados (2005), who also treat their data for unit root, study the effect of the share of public capital and current expenditure in GDP on economic growth rate and report that, while public capital expenditure is positively correlated with growth rate, public consumption expenditure is negatively associated with it. Afonso and Furceri (2010) study the effect of government capital and consumption expenditure in terms of its size and volatility, and find that the size of public consumption expenditure is negatively related to growth. Chamorro-Narvaez (2012), instead of using the shares of public capital and consumption expenditure in GDP, uses the logarithm of the data, and finds no statistical relationship between public current, or capital expenditure and economic growth.

The findings in the group of studies that focuses on the relationship between public investment and economic growth suggest a positive association between these variables (Khan and Kumar, 1997; Nazmi and Ramirez, 1997; Milbourne, Otto and Voss, 2003; Leon-Gonzalez and Montolio, 2004; Ramirez and Nazmi, 2003; Ghani and Din, 2006). Additionally, Warner (2014) reports a weak positive relationship between the variables in the short run, and suggests the possibility of reverse causality, which biases the results. There are only a few studies in the literature that find a negative relationship between public investment and output growth (Landau (1985), and Ghali, 1998)). Barro (1991) does not find any statistical relationship between public capital expenditure and economic growth.

In the literature, it is also possible to find studies that focus on a specific component of public expenditure that is expected to have a positive relationship with economic growth rate. These components are public transportation and communication expenditure, public education expenditure, public health expenditure, and public security or defence expenditure. The disaggregated data in these sectors include both public investment and consumption data. Additionally, there are studies that investigate the relationship between public agricultural expenditure and economic growth due to the importance of the agricultural sector in the transition to industrialisation.

The empirical studies that use disaggregated public expenditure can be divided into those that use panel data for a cross-section of countries and those that use time-series data for a country. The results according to studies that use panel data suggest a positive relationship between public transportation expenditure and economic growth (Aschauer, 1989; Easterly and Rebelo, 1993; Odedokun, 2001; Shioji, 2001; Leon-Gonzalez and Montolio, 2004; Pereira and Andraz, 2005). There are, however, fewer studies that use panel data to investigate the effect of public spending in education or health on economic growth rate (Ramirez and Nazmi, 2003; Devarajan, Swaroop and Zou, 1996; Odedokun, 2001). Among these studies, only Ramirez and Nazmi (2003) find a positive relationship between public health spending and the rate of growth of output. Others find no statistically significant relationship. The results in both Ramirez and Nazmi (2003) and Devarajan, Swaroop and Zou (1996) suggest a positive statistical relationship between public education spending and economic growth; however, the evidence for this is weaker in Devarajan, Swaroop and Zou (1996), who find a negative coefficient for public total expenditure but a positive coefficient for subsidiary spending in education for teaching, research and development. It should be noted that Haque (2004) states that Devarajan, Swaroop and Zou (1996) do not account for unit roots in the data which may bias their results.

The results regarding the effect of public expenditure in education, health, transportation, agriculture, defence, and energy on economic growth are inconsistent among the studies that use time-series data. It is likely the findings in these studies are sensitive to the specific characteristics of the countries in question, the time frame of the data, the variables included in the regression models, and the econometric methods. For example, for Nigeria, while Nurudeen and Usman (2010) report a negative relationship between public education expenditure and economic growth for 1970-2008, Ebiringa, and Charles-Anyaogu (2012), for 1977-2011, and Fasoranti (2012), for 1977-2009, find a positive coefficient for this public expenditure indicator. On the other hand, for the same country, for 1980-2009, Loto (2011) shows that there is statistically no relationship between public education expenditure and economic growth. Similarly, in the aforementioned papers, the results for public expenditure in agriculture, health, transportation and defence are not consistent, even though they all use time-series data for Nigeria.

The inconsistency in results across papers that use time-series data becomes more apparent when the results for Lebanon (Saad and Kalakech, 2009), Malawi (Musaba, Chilonda and Matchaya, 2013), India (Bhunia, 2011), Barbados (Belgrave and Craigwell, 1994), the United States (Cullison, 1994), and Turkey (Yildirim, Deniz and Hepsag, 2001, and Kurt 2015) are taken into account. The findings in empirical studies that use time-series data for the relationship between public expenditure and economic growth suggest that a type of public expenditure that is beneficial for growth in one country may have growth-reducing effects in others.

The literature review shows that studies that analyse the effect of public expenditure on economic growth by disaggregating data rely on either time-series data or panel data for a cross-section of countries. Wooldridge (2008, p.8) points out that the analysis of time series is more complicated as the observations are likely to be dependent. Agell, Lindh and Ohlsson (1997, p.41) state that data for the cross-sections of countries are prone to suffer from measurement problems as economic indicators are calculated by different methods in different countries, which reduces the compatibility of the data. This chapter addresses the gap in the literature by providing an empirical analysis using a new panel dataset for the cross-section of Turkish provinces for the years between 1975 and 2001, in order to investigate the impact of disaggregated public investment on economic growth.

This chapter contributes to the literature by providing an empirical analysis of the effects of public energy infrastructure investment, public mining investment, public tourism investment, public manufacturing investment, public city infrastructure and security investment, public housing investment, public transportation and communication investment, public education investment, public health investment, and public agricultural investment on economic growth.

2.3 Model

There are various approaches that are adopted to derive economic models to analyse the relationship between government expenditure and economic growth, and there does not seem to be any relationship between the chosen approach and the results. In this section, models adopted in some of the papers that are provided in the literature review are discussed. These studies generally use panel data for cross-sections of countries. The papers that use disaggregated time-series data generally lack a theoretical model. This is because the majority of them employ econometric techniques to test causality between the growth rate and public expenditure.

Romp and Haan (2007) summarise the approaches adopted in the literature to analyse the effect of government expenditure on economic growth as production function and cost function approaches. Exogenous and endogenous economic growth models are used to derive models that explain the theoretical relationship between the two variables.

The production function approach can be described as including public capital, identifying the production function as the Cobb-Douglas production function, and taking the logarithm of this function for estimation. In this method, the coefficient for public capital happens to be the elasticity of economic growth with respect to public capital in the estimated equation. In the literature provided above, Odedokun (1997), who derives his model from Khan and Reinhart (1990) and Ram (1996), employs this method.

Nazmi and Ramirez (2003) use a cost function approach with a dynamic optimisation model adapting a modified version of neoclassical growth theory. They use a model in which public capital and technology are purchased by firms who optimise their profits by choosing the level and cost of their production over time, and they solve the dynamic optimisation problem by setting up a Hamiltonian function. An important and perhaps instructive feature of their model is that technology is not considered to be promoted by government in any way but simply bought from the outside world. This is because the authors are analysing the case for Latin American countries, which are developing countries.

Romp and Haan (2007) praise the cost function approach for imposing fewer restrictions on the production function, but also state that using this model requires a large sample of data and enough variability, otherwise, it would suffer multi co-linearity since the function would require including second orders of the terms such as inputs. However, this does not appear to be the case in Nazmi and Ramirez's (2003) study. The authors find that both private and public investments have a positive effect on economic growth, while public consumption expenditure has a negative effect on growth, and public education and health expenditure have a positive impact on long-run growth (and private investment).

Apart from these two approaches, the neoclassical growth model developed by Solow (1956) is adopted to analyse the relationship between public investment and economic growth. Amongst the studies cited here (Lachler and Aschauer, 1998; Chamorro-Narvaez, 2010; Khan and Kumar, 1997), the most commonly used version is by Mankiw, Romer and Weil (1992), who derive an estimation equation by manipulating the model by including a variable for human capital in the production function. Lachler and Aschauer (1998) and Chamorro-Narvaez (2012) include a term for public investment in the neoclassical production function along with a variable for human capital and proceed as Mankiw, Romer and Weil do in their theoretical framework, whereas Khan and Kumar (1997) replace human capital in the production function with public capital.

The approach adopted by manipulating Mankiw, Romer and Weil's (1992) model seems similar to the basic production function approach mentioned above, but differs by defining capital as in Solow's model; as a result, the logarithm of the Cobb-Douglas production function includes terms for population growth and depreciation rate. To account for a long-run effect, Chamorro-Narvaez (2012) uses the five-year averages of economic growth rates, and states that an alternative method such as one with a five-year average of lagged variables is not used due to data restrictions. Khan and Kumar (1997) use lagged values of explanatory variables for the preceding five years. A possible problem with this approach is that one should correctly predict the values of the depreciation rate and the technological growth rate for correct estimates.

Shioji (2001) uses the Ramsey model with adjustment costs for investment and a fixed interest rate in Barro and Sala-I Martin (2003) by including public capital in his model. The Ramsey model is a growth model that allows for consumer optimisation and change in the savings rate. Barro and Sala-I Martin show that Solow's growth model is a special case of this model when the saving rates are assumed to be fixed. Shioji (2001) states that the reason for preferring this model is to analyse the effect of government expenditure on economic growth on a regional level where capital is mobile and the interest rate is accepted as exogenous by firms in a country.

Neoclassical growth models do not allow for government policy in analyses as the long-run growth is determined by the technological progress. Thus, the model predicts that a government policy to increase saving rates can only change the level of income per capita in the steady-state but not the long-run economic growth rate.

Government policy has arisen as a tool that could increase the long-run growth rate after the introduction of endogenous growth models which make a distinction between private and social returns to capital. In these models, knowledge is considered to be the source of long-run growth. It has positive externalities which lead to sub-optimum equilibrium under private sector decisions. In these models, the Pareto-optimum growth rate is achieved by government intervention in the form of taxation or under a centralised economy in which the government makes investment decisions.

Endogenous growth literature provides many examples of models that incorporate government expenditure in analysis; for example, public infrastructure spending (Glomm and Ravikumar, 1994; Agénor, 2005a), public education spending (Blankenau and Simpson, 2004; Glomm and Ravikumar, 1992, 1998) or public health spending (Aisa and Pueyo, 2006). In this chapter, the model in Barro (1990) will be used for analyses because of its generality. A short summary of Barro's (1990) model will be provided as a framework for analysing the results.

Barro (1990) defines an inter-temporal utility function as in the earlier chapter:

$$U = \int_0^\infty \mathrm{u}(c_t)\, e^{-\rho t} dt$$

He defines the production function as:

$$y = f(k, g) = k\, f\left(\frac{g}{k}\right)$$

in which k is capital per capita, and g is government expenditure per capita. Private capital is defined in broad terms (comprised of both human and physical capital), but the production function has diminishing returns to scale if private capital is increased while the government input is kept constant. The production function has constant returns to scale in the sum of capital per capita and government expenditure per capita, which generates endogenous growth.

In the model, g is equal to the amount of tax (T), which is the share of income (τy) . It is assumed that the government runs a balanced budget. Additionally, the households are not charged a user fee for government services.

Government expenditure and private capital are represented separately in the production function because they are not considered close substitutes. This is because non-excludable and/or non-rival characteristics of public goods cause market failure.

The marginal product of private capital as a function of government expenditure is provided as follows:

$$\frac{\delta y}{\delta k} = f\left(\frac{g}{k}\right)(1 - f' * \frac{g}{y})$$

The steady-state growth rate is given as:

$$= \frac{1}{\sigma}\left((1-\tau)a * \ f\left(\frac{g}{k}\right) * (1 - f' * \frac{g}{y}) - \rho\right)$$

in which $f' * \frac{g}{y}$, for a given k, is the elasticity of income with respect to government expenditure. $\frac{g}{y}$ represents the size of the government. The model does not have a transition stage to steady-state growth rate. Thus, according to Barro's (1990) analyses, for a given value of private capital, an increase in government expenditure per capita (g) increases the steady-state growth rate when its impact on the productivity of private capital is higher than the negative effect of an increase in tax rate that finances the government expenditure on economic growth. This condition is met only when the size of the government $\frac{g}{y}$ is sufficiently small. Accordingly, the public investment variables in the next section are defined as the shares of GDP.

Barro and Sala-I Martin (1992, p.648) consider public services such as highways and water and sanitation infrastructure as goods that are rivals but partially not-excludable. They regard education and health as goods and services that have both public and private good characteristics. Thus, according to Barro (1990), it is more likely that government spending in these sectors will be complementary to private sector production. Accordingly, in this chapter, public investment data for energy infrastructure, transportation and communication, city infrastructure and security, health and education are included in the estimated model. For empirical analyses of the data, the results for public agricultural investment, public mining investment, public housing investment, public tourism investment and public manufacturing investment are also reported.

For empirical analyses, a linear relationship is assumed between the explanatory variables and the dependent variable. The estimated equation is given below, in which the dependent variable, γ, is the five-year forward moving geometric average of the growth rate of real GDP per worker.

$$\gamma = x_0 + x_1\left(\frac{g}{y}\right) + \sum_{1}^{k} x_k Other\ Control\ Variables$$

In the equation, $\frac{g}{y}$ represents the share of each component of public investment in GDP. $Other\ Control\ Variables$ are the share of private capital in GDP, the population growth rate, a variable for martial law, and dummy variables for the years. The population growth rate is included in the regressions to control for demographic effects. A dummy variable for martial law is used as the governance in some provinces was taken over by the military in political or security crises. The share of private capital in GDP in the manufacturing sector is included as an economic indicator for the private sector. To capture the time effect, dummy variables for the years between 1975 and 1995 are used.

2.4 Data

In this section, firstly, the source of the data will be provided, and, secondly, the summary statistics will be presented and discussed. This thesis contributes to the literature by providing a dataset for public investment data per sector and per province for the years between 1975 and 2001. The method for the collection of data is explained in more detail under the sub-section for the source of the data. The scope of the dataset is limited by the available data for GDP per province. Although data for public investment are provided for provinces up to 2014, GDP series are available for provinces only for the years 1975-2001. The data for GDP have not been reported for provinces after 2001.

2.4.1 Public Investment per Sector and per Province

The source of the public investment data will be discussed in isolation from other variables, as one of the contributions of the thesis is to provide a dataset for public investment for the years between 1975 and 2001. The data are deflated for

1987 using "public investment deflators" provided by the State Planning Organisation. The deflator series for public investment data are provided in Appendix- Chapter 2, A.2.1.

2.4.1.1 The Source the Data and the Contribution of the Thesis

The main source of the dataset is the public investment programmes that are published annually by the State Planning Organisation for the years between 1975 and 2001. Data provided in these booklets are raw data, as they provide the annual estimated cost of each project for individual provinces and sectors. It is not possible to use these data without grouping and summing the cost of all projects per sector and per province, which is a cumbersome task.

The State Planning Organisation provides the sum of the cost of the projects per sector, per province for the years between 1990 and 2001 on their website in Excel format. Data for the years between 1975 and 1981 can be found in Kutbay (1982). The data in this source are reported in a slightly different format, and need to be transferred to Excel files to obtain electronic copies of tables identical to those of the State Planning Organisation. However, for the years between 1982 and 1990, only raw data are available. The raw data have been processed and organised in table format. The nature of raw data and how they have been processed is explained in detail in Appendix- Chapter 2, A.2.2.

2.4.1.2 Components of Public Investment

The components of public investment are grouped by the State Planning Organisation as follows: agriculture, mining, manufacturing, energy, communication and transportation, housing, tourism, education, health, and "other public services".

Public investment programmes for the years between 1975 and 2001 reflect the change in economic policies. In Turkey, the years between 1960 and 1980 are called "the planned period", which means deeper involvement of the government in economic activities in all sectors. Accordingly, public investment projects include investments in factories, facilities for economic activities, infrastructure projects, research and development projects, education projects and health projects. Although it is not possible to measure the amount of public investment in the sub-categories of each component, a visual examination of the public investment programmes gives a crude idea of the characteristics of public investment projects. For instance, the bulk of the investment projects in public manufacturing investment are related to construction and operation of factories. Similarly, public investment in housing includes projects that are related to construction of accommodation for staff and housing estates for people.

Public investment projects in mining, agriculture and tourism sectors appear to have the characteristics of infrastructure investment. For example, public investment projects in agriculture include irrigation projects, rehabilitation of swamps, research, and training. This is the case for public investment in tourism, which consists of investment projects for construction of seaports and piers, roads, and research to promote tourism in certain areas. Public investment projects in mining are about searching for minerals, training, and research. However, it should be noted that the mining sector was heavily nationalised in a way that excludes private sector activities until the 1990s, whereas the political reforms to privatise the agriculture sector started in the 1980s (TEKGIDA-İŞ, 2009).

In this study, some components of public investment are renamed for clarity. The phrase "public investment in energy" in the source documents is renamed "public investment in energy infrastructure" in the thesis, because the majority of the projects in this sector appear to be related to infrastructure. The purpose of these projects is the construction of electricity networks, power plants, and research projects. Similarly, public investment in "other public services" is called "public investment in city infrastructure and security" in this study. This is because the investment projects in this group are sub-categorised by the State Planning Organisation as "Other Public Services: Security", "Other Public Services: Social infrastructure". Parts of the projects that are related to social infrastructure are investment in construction of clean water pipe networks, and sewage systems. This component includes public investment in administrative services as well.

The names are adopted as suggested by the State Planning Organisation for the components of public investment that reflect the type of investment projects they include. Public investment projects in transportation and communication are comprised of roads, railway, airport, seaport projects, and projects related to telephone lines, mail services, and the national TV channel. Similarly, public investment projects for education and health are related to building schools, hospitals, and relevant facilities, buying equipment, and spending on accommodation for students and staff.

In summary, public investment programmes related to energy, transportation and communication, city infrastructure and security, education and health can be considered the types of public spending that complement the private sector capital in the overall economy. Public investment projects in agriculture, mining and tourism are more specific to the needs of these sectors, and thus they are more likely to increase the productivity of companies operating in the respective sectors. Public manufacturing and housing investment projects appear to be aimed at carrying out economic activities, which may crowd-out private sector investment. Additionally, the productivity of public agricultural investment, public mining investment, and public tourism investment depends on the economic policies in place at the time, which may restrict private sector production.

2.4.2 Other Variables in the Model

The rest of the data are for gross domestic product, private capital in the manufacturing sector, population growth rate, the number of workers, and martial law. The dependent variable is explained at the end of the section.

2.4.2.1 Gross Domestic Product

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). Karaca calculates GDP series for 1975-1986 by the same technique used by the Turkish Statistical Institute, so the data are consistent between series.

GDP series, for the years between 1975 and 1986 by Karaca (2004) and by the Turkish Statistical Institute for the years between 1987 and 2001, are provided as deflated series for the base year, 1987.

2.4.2.2 Private Capital in the Manufacturing Sector

Data for private capital include gross investments in fixed capital in the manufacturing industry. The values of this variable for 1985 are not available. The data are collected by annual manufacturing industry surveys which are carried out by the State Statistical Institute. There has been a change in the measurement of private capital due to the change in the scope of the industry census. For the years between 1983 and 1993, only companies that employ more than 25 workers are included in the survey. However, for the years before 1983 and after 1993, companies that employ more than 10 workers are also included.

There are provinces with no available private capital data, and the value of the variable is higher for some provinces than reported in the census. This is because some companies prefer not to report statistics to protect their data. Therefore, for provinces that are too underdeveloped (such as Agri and Bingol) census data are unavailable. The values of private capital for these provinces are taken as zero for two reasons. Firstly, because these provinces are very rural, and so, they are not likely to have a significantly sized manufacturing industry. Secondly, the unavailability of data indicates that the number of firms in the manufacturing sector is very low in these provinces. These firms choose not to report data because reported data cannot remain anonymous. The robustness of results is tested for the measurement of private capital by excluding this variable from the regression model in Appendix- Chapter 2, A.2.3, in Table A.2.3.2.

2.4.2.3 The Population Growth Rate

The population growth rate is included in the regressions because it is one of the determinants of the size of labour, which has an effect on the denominator of GDP per worker. The population growth rate is calculated using census statistics. Census statistics were collected in 1975, 1980, 1985, 1990 and 2000. The values of population growth rate are computed by finding the annual growth rate for the years between census years.

The formula is $n_{t,t+m} = \sqrt[m]{\frac{N_{t+m}}{N_t}} - 1$, in which $n_{t,t+m}$ is the annual population growth rate between years t and $t+m$, N_{t+m} is the size of the population in census year $t+m$, and N_t is the size of the population in census year t. For instance, the population growth rate for the years between 1975 and 1980 is found by $n_{1975,1980} = \sqrt[5]{\frac{N_{1980}}{N_{1975}}} - 1$. The formula to calculate the annual population growth rate for the years between 1990 and 2000 is $n_{1990,2000} = \sqrt[10]{\frac{N_{2000}}{N_{1990}}} - 1$, in which m equals 10 as there are 10 years between these census years.

2.4.2.4 Martial Law

"Martial law" refers to the years and provinces when and where martial law or a state of emergency is declared. Martial law took place in certain provinces in Turkey in 1975 due to the crisis in Cyprus, between 1978 and 1980 because of political and social turmoil, and in 1980, throughout the country, due to the military coup. Martial law was declared to be over for different provinces for different years. In provinces in Southeast Anatolia, it lasted until 1987, and then was replaced by a type of governance called “governance in the state of emergency”. The governors of these provinces had a broader authority compared to the governors of other provinces, and were sometimes referred as “the super governors” in the media. After 1996, this system was phased out. No provinces have been under the administration of state of emergency governance since 2002. Martial law is a dummy variable, and takes the value of “1” for provinces that were governed by the army or by “the super governors”. Information regarding the change in status for provinces is taken from Hürriyet (2002), Bianet (2001) and Şık (2002).

2.4.2.5 The Dependent Variable

The dependent variable is specified as the five-year forward moving geometric average of the growth rate of real GDP per worker, which is calculated using the formula below.

Firstly, GDP per worker is calculated by dividing real GDP to the number of workers. The number of workers is obtained from census data which are collected in 1975, 1980, 1985, 1990, and 2000. The values of the number of workers for the years between censuses are calculated by assuming the number of workers in a census year grows at an annual growth rate. The annual growth rate of the number of workers between the census years is found by using the formula explained previously, $n_{t,t+m} = \sqrt[m]{\frac{L_{t+m}}{L_t}} - 1$. In this case, $n_{t,t+m}$ corresponds to the annual growth rate of the number of workers between the census years t and $t + m$; L_{t+m} denotes the number of workers in the census year $t + m$; and L_t represents the number of worker in the census year t. Thus, the number of workers in $t + 1$ can be found by assuming L_t would increase by $n_{t,t+m}L_t$ between t and t+1; then, the number of workers in the year $t + 1$ would equal $(1 + n_{t,t+m}) * L_t$. Because calculating the number of workers by this method is likely to underestimate or overestimate the values of the variable, in Appendix-Chapter 2, A.2.3, in Table A.2.3.4, the robustness of the results is checked by using GDP per capita for the dependent variable instead of GDP per worker.

In the analysis, public investment that is made in year t is expected to have an impact on economic growth rate in year t+1, t+2, t+3, t+4 and t+5.

The growth rate of GDP per worker in year $t+1$, γ_{t+1} , is calculated as the change in GDP per worker in $t+1$ with respect to GDP per worker in t:

$$\gamma_{t+1} = \frac{GDP\ per\ worker_{t+1}}{GDP\ per\ wprker_t} - 1$$

The five-year forward moving geometric average of the growth rate is calculated by the formula below:

$$\gamma_{t,t+5} = \sqrt[5]{(\gamma_{t+1}+1)(\gamma_{t+2}+1)(\gamma_{t+3}+1)(\gamma_{t+4}+1)(\gamma_{t+5}+1)} - 1$$

This expression is equivalent to $\sqrt[5]{\frac{GDP\ per\ worker_{t+5}}{GDP\ per\ wprker_t}} - 1$, as

$$(\gamma_{t+1}+1) = \frac{GDP\ per\ worker_{t+1}}{GDP\ per\ wprker_t}$$

and,

$$\gamma_{t,t+5} = \sqrt[5]{\frac{GDP\ per\ worker_{t+1}}{GDP\ per\ wprker_t} * \frac{GDP\ per\ worker_{t+2}}{GDP\ per\ wprker_{t+1}} * \frac{GDP\ per\ worker_{t+3}}{GDP\ per\ wprker_{t+2}} * \frac{GDP\ per\ worker_{t+4}}{GDP\ per\ wprker_{t+3}} * \frac{GDP\ per\ worker_{t+5}}{GDP\ per\ wprker_{t+4}}} - 1$$

The dependent variable is chosen as the forward moving average of the growth rate of real GDP per worker to allow for a lag in the effect of public investment on the growth rate. This is also to avoid contemporaneous correlation, which can lead to reverse causality in the results. These issues are discussed in more detail under the section for results. The results for the seven-year, ten-year and fifteen-year forward moving geometric average of the growth rate of real GDP per worker, the five-year forward moving arithmetic average of the growth rate of real GDP per worker are provided in the section for the robustness of the results in Appendix- Chapter 2, section A.2.3, in Table A.2.3.3.

2.4.3 Summary Statistics

Summary statistics are provided in Table 2.1. The number of observations (N) in the sample is 1407. The sample is divided into 67 panels (n) that contain 21 years (T). The number of observations in the original dataset for public investment indicators is 1809. The dataset consists of 67 panels (n) and 27 (T) years. However, the size of the dataset reduces when the dependent variable is calculated as the five-year forward moving average of the growth rate of real GDP per worker. This is because real GDP worker is available only for the years between 1975 and 2001. Thus, it is not possible to calculate the value of the dependent variable for the years after 1996, as the value of real GDP per worker is not available for 2002 and onwards. Additionally, the share of private capital in GDP is not available for 1985. Thus, the sample consists of 67 panels and 21 years.

In Table 2.1, "Overall" sample statistics provide the standard deviation, and minimum and maximum values for the pooled data. If x is the value of the observation, and $\bar{x}$ is the sample mean, then the standard deviation for the overall sample equals $\sqrt{\frac{\sum_1^N (x-\bar{x})^2}{N-1}}$. The maximum and minimum values are the maximum and minimum values of the observations in the sample.

"Between" statistics are reported for the panels. Each panel contains the value of the variables for the years 1975-1996 for a province. There are 67 provinces, thus there are 67 panels. The standard deviation between panels shows the average deviation of a panel mean from the sample mean. If the panel mean is denoted by $\bar{x}_i$ for the province i, the sample mean by $\overline{x}$, and the number of panels by n, then the standard deviation between panels equals $\sqrt{\frac{\sum_1^n (\bar{x}_i-\bar{x})^2}{n-1}}$. The maximum and minimum values between the panels show the maximum and minimum values of the panel means.

"Within" statistics give information regarding the change in the values of a variable within panels between 1975 and 1996. The maximum and minimum values for the variables within a panel show the maximum and minimum values of the difference between the value of the observation and the panel mean, plus sample mean: $x - \bar{x}_i + \bar{x}$. The standard deviation within the panels is found by using the difference between the value of an observation and the panel mean: $\sqrt{\frac{\sum_1^N (x-\bar{x}_i)^2}{N-1}}$

Thus, for panel data, 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. Finally, within standard deviation shows the average deviation for an observation from its panel mean.

The summary statistics for the variables are provided in Table 2.1. Statistics show that the average of the five-year forward moving geometric mean of the growth rate of real GDP per worker is 1.8% between 1975 and 1996. It can be seen that the value of an observation deviates from the sample mean by 3.2% on average. There is high variation across observations in the value of the five-year forward moving geometric average of the growth rate of real GDP per worker. The value of the standard deviation between and within panels shows that this is due to the change in the growth rate over time, rather than across provinces. Although the deviation of the panel means from the overall mean is also high (1.1%, as high as the sample mean), within standard deviation shows that an observation deviates from its panel mean by 3.2% (twice as high as the sample mean). These statistics show that there is a high variation in the growth rate of the provinces across the country, but a higher variation in the value of the dependent variable in time.

The minimum and maximum values of the dependent variable across observations, between panels, and within panels provide examples of extreme cases. The highest value of the five-year forward moving geometric average of the growth rate is observed in Adiyaman in 1986, which is 17.8%.[1] The minimum value of the dependent variable across observations is -9.1%, which is observed in Mus in 1982. This is likely to be related to the economic crisis between 1978 and 1981, which may have affected Mus in the following years.

Bilecik has the maximum panel mean for the five-year forward moving geometric average of the growth rate of real GDP per worker (4.9%), while Mus has the lowest value of the panel mean for the dependent variable (-1.9%).

Statistics also show that the highest positive deviation from the panel mean for the dependent variable is observed in Adiyaman in 1986, while the highest negative deviation is observed in Giresun in1977.

Summary statistics for the dependent variable suggest that the growth rate for provinces is very volatile in time. This is likely because Turkey experienced many economic crises between 1975 and 2001, and thus sharp increases and decreases in the economic growth rate. Additionally, summary statistics suggest that there is high variation in the five-year forward moving geometric average of the growth rate across provinces.

[1] The dataset is examined for errors in data entry and the calculation of the dependent variable but none of these appear to be the case. There are 15 observations for which the value of the five-year forward moving geometric average of the growth rate is higher than 10%. Nevertheless, the robustness of the results is examined for the possibility of error in the measurement of GDP series by excluding the observations for which the value of the dependent variable is higher than 5%, and lower than -5% in Appendix- Chapter 2, A.2.3, in Table A.2.3.1. The results remain similar to those reported in the section for the results.

The average shares of public investment in GDP can be ordered from largest value to smallest value as public energy infrastructure investment (1.8%), public manufacturing investment (1.6%), public city infrastructure and security investment (0.7%), public agricultural investment (0.6%), public mining investment (0.6%), public transportation and communication investment (0.5%), public education investment (0.5%), public housing investment (0.2%), public health investment (0.2%), and public tourism investment (0.1%).

Some provinces do not receive any public investment in some sectors. Thus, the minimum values of the shares of public investment in GDP are zero. The overall minimum value of the share of public city infrastructure and security investment in GDP is approximately zero.

The values of standard deviation for the overall sample, between panels, and within panels show that the highest variation in the distribution of the components of public investment across provinces and time is in public housing investment, public mining investment, public tourism investment and public energy investment. The minimum variation is in public education investment, public health investment, and public city infrastructure and security investment. However, it must be noted that the values of standard deviation for the overall sample, between panels and within panels are high (in proportion to the respective sample mean) for all types of public investment.

Table 2.1 shows that the share of public investment in GDP is 6.7% on average. The values of the standard deviations for the overall sample, between panels, and within panels are either higher than the mean, or very close to the mean. It has already been discussed above that the distribution of the components of public investment is uneven across provinces. This appears to be the case for the share of public investment in GDP too.

The maximum value for the overall observations is 99.7%. There are three provinces for which the share of public investment in GDP exceeds 95%. These are Bingol in 1998, Kahramanmaras in 1977 and 1978, and Sanliurfa in1989. Kahramanmaras additionally has the highest panel mean (30.1%). The lowest panel mean is seen in Usak. While the highest positive deviation from the panel mean (80.9%) is observed in Sanliurfa, the highest negative deviation from the panel mean (-22.4%) is observed in Kahramanmaras.

The average of the population growth rate between 1975 and 1996 is 1.6%. An observation deviates from the sample mean by 1.5%, and the mean of a panel deviates from the sample mean by 1.3%. As the values of standard deviations across observations and between panels are as high as the average of the population growth rate, it can be said that the variation of this indicator across provinces is high. The standard deviation for a panel within time is given as 0.8%, indicating that the population growth rate for a province remained relatively stable between 1975 and 1996.

The statistics show that the value of population growth rate is negative for some provinces, and it can be as low as -3.4%. This is a result of internal migration, which leads to negative population growth rates for provinces from which people emigrate. Migration also causes the rate of population growth to be considerably higher in provinces that receive domestic migrants. The maximum value of the overall sample is 10.1%. The minimum value of the panel means shows that some provinces consistently had a negative population growth rate between 1975 and 1996.

Finally, summary statistics show that the average share of private capital in GDP for Turkey in the estimated sample is 1%. The share of private capital in GDP is as high as 37% for Kirsehir in 1993, and as low as -0.5% for Isparta in 1982. The standard deviation shows that it varies across provinces for a given year by 1.9% and within panels by 1.8%.

Table 2.1 Summary Statistics

Variable		Mean	Std. Dev.	Min.	Max.	Obs.[ǂ]
Five-Year Forward Moving Geometric Average of the real GDP per Worker Growth Rate	overall		0.032	-0.091	0.178	N = 1407
	between	0.018[†]	0.011	-0.019	0.049	n = 67
	within		0.030	-0.080	0.166	T = 21
Agriculture Proportion of GDP	overall		0.009	0.000	0.134	N=1407
	between	0.006	0.006	0.000	0.037	n=67
	within		0.006	-0.017	0.131	T=21
Mining Proportion of GDP	overall	0.006	0.026	0.000	0.455	N=1407
	between		0.015	0.000	0.079	n=67
	within		0.021	-0.073	0.387	T=21
Manufacturing Proportion of GDP	overall		0.033	0.000	0.363	N=1407
	between	0.016	0.016	0.002	0.107	n=67
	within		0.029	-0.090	0.271	T=21
Energy Infrastructure Proportion of GDP	overall		0.060	0.000	0.861	N=1407
	between	0.018	0.037	0.001	0.194	n=67
	within		0.048	-0.174	0.739	T=21
Transportation and Communication Proportion of GDP	overall		0.008	0.000	0.116	N=1407
	between	0.005	0.004	0.001	0.028	n=67
	within		0.007	-0.016	0.112	T=21
Tourism Proportion of GDP	overall		0.004	0.000	0.156	N=1407
	between	0.001	0.001	0.000	0.008	n=67
	within		0.004	-0.007	0.148	T=21
Housing Proportion of GDP	overall		0.009	0.000	0.236	N=1407
	between	0.002	0.003	0.000	0.024	n=67
	within		0.009	-0.022	0.214	T=21
Education Proportion of GDP	overall		0.006	0.000	0.095	N=1407
	between	0.005	0.004	0.001	0.026	n=67
	within		0.004	-0.019	0.089	T=21
Health Proportion of GDP	overall		0.003	0.000	0.074	N=1407
	between	0.002	0.001	0.000	0.006	n=67
	within		0.003	-0.004	0.072	T=21
City Infrastructure and Security Proportion of GDP	overall		0.006	0.000	0.051	N=1407
	between	0.007	0.004	0.002	0.023	n=67
	within		0.005	-0.010	0.049	T=21

Public Investment (Proportion of GDP)	overall		0.088	0.004	0.997	N = 1407
	between	0.067	0.053	0.013	0.301	n = 67
	within		0.071	-0.224	0.809	T = 21
Population Growth Rate	overall		0.015	-0.035	0.101	N = 1407
	between	0.016	0.013	-0.020	0.046	n = 67
	within		0.008	-0.025	0.071	T = 21
Private Capital (Proportion of GDP)	overall		0.027	-0.005	0.377	N = 1407
	between	0.014	0.019	0	0.092	n = 67
	within		0.019	-0.078	0.371	T = 21

† The summary statistics are expressed in decimal numbers. Thus, "0.018" should be read as "1.8%".

‡Std.Dev.: Standard Deviation

ˡ Obs.: The number of observations: N, the number of observations in the sample; n, the number of panels (provinces) in the sample; T, the number of time periods in the sample.

2.5 Results

The econometric technique is chosen as the fixed-effects technique. The standard errors are corrected for heteroscedasticity, serial correlation and cross-sectional dependence using Driscoll and Kraay's (1998) method. More information regarding the econometric technique and the standard errors is provided in the fifth chapter.

The results are reported in Tables 2.2.a and 2.2.b. The results indicate a positive and statistically significant relationship between the share of private capital (in manufacturing sector) in GDP and the dependent variable. The coefficients for the martial law and the population growth rate are not statistically significant. The results for the year dummy variables suggest that the time effect is negative for the years between 1975 and 1980, but positive for the years 1981 and onwards.

When the public investment components are included in the regressions in isolation from each other, the results show statistically significant coefficients for public agricultural investment in the first column of Table 2.2.a, public energy investment in the fourth column of the same table, and public education investment for the second column of Table 2.2.b.

Additionally, in Table 2.2.b, in column (5), when all components are included in the regression model, the results show that public mining investment, public transportation and communication investment have negative and statistically significant coefficients. In this column, in addition to public education, agriculture an energy infrastructure investment, public tourism investment appears to be positively related to the dependent variable.

Finally, in the sixth column of Table 2.2.b, the results show that the share of the sum of public investment in GDP has a statistically significant and a positive coefficient.

Interpretations of the results are provided in the next section.

Table 2.2.a Relationship between the Size of Public Investment and the Long-Run Growth‡

	(1)	(2)	(3)	(4)	(5)	(6)
Public Agricultural Investment	0.367					
Proportion of GDP	(0.138)**					
Public Mining Investment		0.013				
Proportion of GDP		(0.016)				
Public Manufacturing Investment			0.044			
Proportion of GDP			(0.042)			
Public Energy Infra. Investment				0.101		
Proportion of GDP				(0.012)**		
Public T. and C. Investment					-0.259	
Proportion of GDP					(0.172)	
Public Housing Investment						0.082
Proportion of GDP						(0.064)
Public Tourism Investment						
Proportion of GDP						
Public Education Investment						
Proportion of GDP						
Public Health Investment						
Proportion of GDP						
Public City Infra. and S. Investment						
Proportion of GDP						
Sum of Public Investment						
Proportion of GDP						
Population Growth Rate	-0.091	-0.089	-0.092	-0.123	-0.125	-0.092
	(0.147)	(0.141)	(0.142)	(0.147)	(0.151)	(0.141)
Private Capital	0.035	0.039	0.039	0.048	0.040	0.039
(Proportion of GDP)	(0.014)*	(0.013)**	(0.013)**	(0.013)**	(0.013)**	(0.013)**
Martial Law	0.004	0.004	0.004	0.002	0.004	0.004
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
1975	-0.001	-0.001	-0.002	0.000	0.002	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
1976	-0.013	-0.012	-0.013	-0.012	-0.010	-0.012
	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.002)**	(0.001)**
1977	-0.017	-0.016	-0.018	-0.016	-0.013	-0.015
	(0.001)**	(0.001)**	(0.002)**	(0.001)**	(0.002)**	(0.001)**
1978	-0.013	-0.012	-0.014	-0.013	-0.010	-0.012
	(0.002)**	(0.001)**	(0.002)**	(0.001)**	(0.002)**	(0.001)**
1979	-0.005	-0.004	-0.005	-0.004	-0.002	-0.004
	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.002)	(0.001)**
1980	0.006	0.007	0.006	0.008	0.007	0.007
	(0.003)*	(0.002)*	(0.003)*	(0.003)**	(0.002)**	(0.002)**
1981	0.007	0.009	0.008	0.010	0.010	0.009
	(0.003)*	(0.003)**	(0.003)*	(0.003)**	(0.003)**	(0.003)**
1982	0.018	0.019	0.019	0.021	0.021	0.020
	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**
1983	0.015	0.016	0.015	0.017	0.017	0.016
	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**
1984	0.009	0.009	0.009	0.009	0.010	0.009
	(0.002)**	(0.002)**	(0.002)**	(0.002)**	(0.002)**	(0.002)**
1986	0.012	0.013	0.013	0.013	0.014	0.013

	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**
1987	0.012	0.012	0.012	0.013	0.013	0.013
	(0.001)**	(0.000)**	(0.000)**	(0.001)**	(0.001)**	(0.001)**
1988	0.019	0.020	0.020	0.020	0.020	0.020
	(0.001)**	(0.000)**	(0.000)**	(0.001)**	(0.001)**	(0.001)**
1989	0.016	0.018	0.017	0.017	0.018	0.018
	(0.001)**	(0.000)**	(0.000)**	(0.000)**	(0.001)**	(0.000)**
1990	0.010	0.011	0.011	0.011	0.012	0.011
	(0.001)**	(0.000)**	(0.000)**	(0.000)**	(0.001)**	(0.000)**
1991	0.020	0.020	0.020	0.021	0.020	0.020
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
1992	0.023	0.023	0.023	0.024	0.023	0.023
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
1993	0.021	0.021	0.021	0.021	0.021	0.021
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
1994	0.019	0.019	0.019	0.020	0.019	0.019
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
1995	0.023	0.023	0.023	0.023	0.023	0.023
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
Constant	0.007	0.008	0.008	0.007	0.009	0.008
	(0.002)**	(0.002)**	(0.002)**	(0.002)**	(0.002)**	(0.002)**
Observations	1407	1407	1407	1407	1407	1407
Number of groups	67	67	67	67	67	67
F	14.26	4.65	7.70	18.71	12.57	5.01
Within R-Squared	0.18	0.17	0.17	0.20	0.18	0.17

Standard errors in parentheses.
* Significant at 5%, ** significant at 1%
‡The coefficients show the effect of a one-unit change in the value of an indicator on the dependent variable. The values of the variables are expressed in decimal numbers in Table 2.1.This means that a unit change in Table 2.2.a corresponds to a 100% change in the value of a variable.

Table 2.2.b Relationship between the Size of Public Investment and the Long-Run Growth‡

	(1)	(2)	(3)	(4)	(5)	(6)
Public Agricultural Investment					0.214	
Proportion of GDP					(0.077)**	
Public Mining Investment					-0.066	
Proportion of GDP					(0.017)**	
Public Manufacturing Investment					0.042	
Proportion of GDP					(0.037)	
Public Energy Infra. Investment					0.103	
Proportion of GDP					(0.012)**	
Public T. and C. Investment					-0.388	
Proportion of GDP					(0.123)**	
Public Housing Investment					-0.005	
Proportion of GDP					(0.036)	
Public Tourism Investment	0.077				0.337	
Proportion of GDP	(0.135)				(0.120)**	
Public Education Investment		0.618			0.644	
Proportion of GDP		(0.212)**			(0.161)**	
Public Health Investment			0.251		0.134	
Proportion of GDP			(0.199)		(0.167)	
Public City Infra. and S. Investment				0.572	0.588	
Proportion of GDP				(0.424)	(0.368)	
Sum of Public Investment						0.068
Proportion of GDP						(0.007)**
Population Growth Rate	-0.088	-0.092	-0.091	-0.037	-0.120	-0.100
	(0.138)	(0.139)	(0.141)	(0.162)	(0.163)	(0.152)
Private Capital	0.039	0.038	0.040	0.040	0.050	0.046
(Proportion of GDP)	(0.013)**	(0.013)**	(0.013)**	(0.013)**	(0.013)**	(0.013)**
Martial Law	0.004	0.004	0.004	0.005	0.003	0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
1975	-0.001	-0.000	-0.001	-0.000	0.003	-0.003
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)*	(0.001)**
1976	-0.012	-0.012	-0.012	-0.012	-0.012	-0.016
	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**
1977	-0.016	-0.018	-0.016	-0.016	-0.019	-0.022
	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.002)**	(0.001)**
1978	-0.012	-0.011	-0.012	-0.011	-0.011	-0.016
	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.002)**	(0.001)**
1979	-0.004	-0.004	-0.004	-0.002	-0.000	-0.007
	(0.001)**	(0.001)**	(0.001)**	(0.002)	(0.002)	(0.001)**
1980	0.007	0.008	0.007	0.008	0.012	0.006
	(0.002)**	(0.002)**	(0.002)**	(0.003)*	(0.003)**	(0.003)*
1981	0.009	0.010	0.009	0.010	0.011	0.007
	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)*
1982	0.020	0.021	0.020	0.020	0.023	0.017
	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**
1983	0.016	0.017	0.016	0.016	0.019	0.015
	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**
1984	0.009	0.011	0.009	0.011	0.013	0.008
	(0.002)**	(0.002)**	(0.002)**	(0.003)**	(0.002)**	(0.002)**
1986	0.013	0.015	0.013	0.011	0.013	0.012

	(0.000)**	(0.001)**	(0.000)**	(0.002)**	(0.001)**	(0.001)**
1987	0.013	0.014	0.013	0.011	0.012	0.012
	(0.000)**	(0.001)**	(0.000)**	(0.001)**	(0.001)**	(0.001)**
1988	0.020	0.021	0.020	0.019	0.020	0.019
	(0.000)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**
1989	0.018	0.018	0.018	0.017	0.016	0.016
	(0.000)**	(0.001)**	(0.000)**	(0.001)**	(0.001)**	(0.001)**
1990	0.011	0.012	0.011	0.010	0.011	0.011
	(0.000)**	(0.001)**	(0.000)**	(0.001)**	(0.001)**	(0.001)**
1991	0.020	0.022	0.020	0.021	0.023	0.021
	(0.000)**	(0.001)**	(0.000)**	(0.000)**	(0.001)**	(0.000)**
1992	0.023	0.023	0.023	0.024	0.024	0.024
	(0.000)**	(0.000)**	(0.000)**	(0.001)**	(0.001)**	(0.000)**
1993	0.021	0.024	0.021	0.022	0.025	0.021
	(0.000)**	(0.001)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
1994	0.019	0.020	0.019	0.020	0.022	0.020
	(0.000)**	(0.000)**	(0.000)**	(0.001)**	(0.000)**	(0.000)**
1995	0.023	0.024	0.023	0.024	0.025	0.023
	(0.000)**	(0.000)**	(0.000)**	(0.001)**	(0.000)**	(0.000)**
Constant	0.008	0.004	0.008	0.003	-0.002	0.005
	(0.002)**	(0.002)*	(0.002)**	(0.004)	(0.004)	(0.002)**
Observations	1407	1407	1407	1407	1407	1407
Number of groups	67	67	67	67	67	67
F	5.20	5.67	4.92	6.08	66.95	29.35
Within R-Squared	0.17	0.18	0.17	0.18	0.22	0.20

Standard errors in parentheses.
* Significant at 5%, ** significant at 1%
‡The coefficients show the effect of a one-unit change in the value of an indicator on the dependent variable. The values of the variables are expressed in decimal numbers in Table 2.1.This means that a unit change in Table 2.2.b corresponds to a 100% change in the value of a variable.

2.6 Interpretation of Results

In this section, the results are discussed for each variable in the regression models in Tables 2.2.a and 2.2.b.

First and foremost, it should be mentioned that R-squared statistics for the fixed-effects technique show that the variables in the regression model in Table 2.2.b in panel (5) explain 22% of the change in the five-year forward moving geometric average of the growth rate of real GDP per worker. F statistics reject the null hypothesis that the coefficients for the variables jointly equal zero.

Post-estimation diagnostics for the results in panel (5) in Table 2.2.b are provided in the fifth chapter. The robustness of the results is examined for outliers, for the change in the calculation of the dependent variable, and for the longer run in Appendix- Chapter 2, section A.2.3.

2.6.1 Public Investment in Agriculture

The results in the first column of Table 2.2.a and the fifth column of Table 2.2.b indicate a positive and statistically significant relationship between public agricultural investment and the long-run economic growth. When public investment projects in this sector are examined, and the development plans are consulted regarding public policies in agriculture, it can be suggested that the results for public agricultural investment are in accordance with the implications of the model by Barro (1990) that public infrastructure investment is associated with higher economic growth.

The majority of projects in these sectors are related to investments such as pest control, irrigation, rehabilitation of areas (such as swamps) for cultivation, research, veterinarian surgeons. It can be suggested that projects related to rehabilitation of areas for cultivation, providing irrigation systems, pest control, veterinarian surgeons, and research investment are related to agricultural infrastructure, research and training, which could encourage private sector investment and increase the productivity of the existing firms.

In Turkey, for the years between 1975 and 2001, agricultural policies were carried out along with the rural development plans. The fourth development plan equates the development of agriculture to the progress of the rural population. It lists five instruments in order to improve income distribution between rural and urban population: land reforms, cooperatives, state regulations and subsidies, and villageoriented production systems (DPT, 1980, p.288). Both agricultural and rural development policies were set out, implemented and monitored by the Ministry of Agriculture and Rural Affairs in cooperation with the State Planning Organisation, which is responsible for public investment projects. The objectives of the rural development policies can be summarised as increasing the standard of living in rural areas, and decreasing the rate of migration to urban areas. For these purposes, the rural development projects aimed to improve the transport and communication, education, health care facilities and agricultural infrastructure in rural areas (OECD, 2011, p.58).

The results can also be related to the literature by assuming public investment in agriculture has a positive impact on the agriculture sector, and thus economy. The World Development Reports (1982) and (2007) state that growth in the agricultural sector can reduce rural poverty. Very early studies discuss the relationship between the agricultural sector and economic growth. Mellor (1995), for instance, defines economic development as the transition from a rural, agricultural economy to an urban and industrialised one. Hwa (1983) suggests that the agricultural sector can contribute to economic development by providing markets for the non-agricultural sector, supplying food, and by accumulating human capital and know-how that may benefit industrial sectors. Elias (1985) finds that government expenditure in research and irrigation for the agricultural sector is associated with a higher level of agricultural output. In accordance with these studies, Turkey seems to have experienced a transition from agricultural economy to industrial economy. The share of agriculture in the economy in 1975 was 36.5%, while it was approximately 10% in 2001 (World Development Indicators, 2015).

2.6.2 Public Investment in Tourism

The results in Table 2.2.b in column (5) show a positive and statistically significant relationship between public tourism investment and economic growth. A part of public investment projects in this sector is concerned with maintenance of historical sites, dealing with environmental issues (such as pollution), building seaports and piers, and research. The seventh development plan diagnoses one of the issues in the tourism sector as the insufficient infrastructure, including sewage systems, pipe water, roads, garbage collection and disposal, and decontamination. The inadequacy of land, air and marine transportation facilities is also stated as one of the shortcomings in the tourism sector. The financial constraints on building and improving infrastructure facilities are also noted. The development plan aims to remedy these problems in the tourism sector (DPT, 1995, p.162).

Dritsakis (2004) lists the benefits of the tourism sector in the economy as creating employment, reducing internal emigration, and, by generating income for the areas that are less developed, improving the income distribution for the country as a whole. Attracting tourists encourages investment in better public infrastructure, which benefits all economic sectors and the population of the touristic areas.

There are several studies that find a positive relationship between the tourism sector and economic growth (Balaguer and Cantavella-Jordá, 2002; Dritsakis, 2004; Lee and Chang, 2008), whilst, specifically in the case of Turkey, Gunduz and Hatemi (2005) find evidence that growth of the tourism sector benefits economic growth here.

In Turkey, because the tourism sector generates a source of income to finance the deficits in the balance of payments, it was used as an instrument when the government adopted an export-led growth strategy in the 1980s (Tosun, 2001, p.289). It is acknowledged that the public policies regarding the tourism sector could target improving the less developed areas to reduce the disparity between the West and the East (Tosun, Timothy and Öztürk, 2003, p.142). However, Seckelman (2002, p.87) observes that in Turkey it is usually the provinces in the West of the country that receive investment for the tourism sector, which increases the inequality in development across the provinces.

2.6.3 Public Investment in Mining

The results show a negative and statistically significant relationship between public mining investment and the five-year forward moving geometric average of the growth rate of GDP per worker. Investment projects in the mining sector include projects that aim to search for minerals, to map areas, and those related to training and research. Although some of these are also concerned with infrastructure, the mining sector was monopolised by the state until the late 1990s (Türk, 2004; TEKGIDA-İŞ, 2009).

The fourth development report assesses the outcomes of the mining policies in Turkey and lists the failures in the mining sector as follows: inability to produce sufficient amounts of oil, insufficient investments in the sector, inadequate or unfinished feasibility projects, the lack of productivity in the production process, the mismatch in the demand and supply of the minerals that are used as intermediate goods by industries, low levels of exports, and the inability to meet the demands of the domestic market (DPT, 1980, p.379 and p.384). The report also points out the necessity for policy reforms.

The relationship between the mining sector and economic growth appears to be related to a phenomenon called the “natural resource curse”. It has been shown that available natural resources are negatively related to economic growth (Sachs and Warner, 1995). Discovery of a natural resource can reduce the competiveness and the resources of the traded sectors (such as the manufacturing sector) that do not require natural resources, through the spending effect and the resource-pull effect. The spending effect takes action by an increase in the real exchange rate, as the income generated from the natural-resource-oriented sector is spent in non-traded sectors, which results in an increase in prices and a decrease in real wages in this sector. This results in the appreciation of the real exchange rate, which reduces the competitiveness of the traded sectors that do not rely on natural resources, such as the manufacturing sector. The resource-pull effect is the negative effect of the booming sector on other traded sectors by attracting capital and labour from these sectors. The spending and resource-pull effects become larger as the booming sector requires more labour, or as the higher share of the booming sector is owned by the domestic market (Leite and Weidmann, 1999).

Available natural resources can also give an incentive to government to seize control of the economy, or it can encourage rent-seeking behaviour; both of which reduce the efficiency of resource allocation in the overall economy and negatively impact on economic growth (Gylfason, 2001). This is relevant in the case of Turkey as economic reforms to increase the private sector’s activity in the mining sector started only recently.

The presence of natural resources may discourage education in society if the marginal value of labour is higher in the booming sector compared to the service or manufacturing sector. This is because the level of education required for manufacturing and service sectors is higher (Sachs and Warner, 1995).

These points can explain the negative sign for the share of public mining investment in GDP. Even though investment in mining may increase the output of the mining sector, this may have a negative impact on the economy. Although the agriculture and tourism sectors depend on natural resources too, economic literature also suggests that the growth of these sectors can be beneficial to growth of the overall economy.

2.6.4 Public Investment in Education

The results in Table 2.2.b columns (2) and (5) appear to support the model's implication provided in this chapter that suggests a positive relationship between public expenditure and the economic growth rate. In Barro (1990), public expenditure for goods and services that complement the private sector products has positive growth effects.

In the context of economic growth, education emerges as an investment that increases the productivity of a worker through its impact on the level of technology. Schultz (1961) defines acquiring skills and knowledge as a type of capital, and he proposes that the increase in investment in human capital accounts for the high economic growth rate that was experienced in Western societies. Nelson and Phelps (1966) suggest that education raises the speed of technological diffusion in production, because better-educated managers and workers are more likely to adopt the new techniques. They provide the United States' agricultural sector as an example, where it was found that more educated farmers are more likely to use new farming methods.

According to endogenous growth models such as in Lucas (1988), Romer (1989), and Glomm and Ravikumar (1992), education is an input that increases the human capital. In Lucas (1988), individuals invest in human capital by studying as there are non-decreasing returns to human capital (which generates economic growth). Romer (1989) provides an endogenous growth model in which human capital is a function of schooling. In a model of overlapping generations in Glomm and Ravikumar (1992), the change in human capital is explained by parent's stock of human capital, time spent in school, and the quality of schools.

Public education investment in Turkey consists of spending on school facilities (such as school buildings, dormitories, equipment) in primary, secondary, and tertiary levels. It includes investment projects that aim to improve education among adults too. It is likely that the relationship between public education investment and economic growth arises from the positive externalities of education. However, the third chapter, which focuses on the relationship between public education investment and primary and middle school gross enrolment rates, does not provide any statistical evidence to support the findings in this chapter. Nevertheless, as discussed in the third chapter, public investment in education may have a positive impact on other schooling indicators such as persistency ratios and the quality of schools, or it may have a positive effect on schooling rates at secondary or tertiary levels.

In relation to the discussions above, the seventh development plan observes that the demand for qualified workers was increasing in the economy in the 1990s (DPT, 1995, p.134). Development plans published between the years 1975 and 2001 state that public policy in research and development aimed to coordinate university activities and industries to encourage innovation of production technologies (DPT, 1980, p.319, 1988, p.68, 1994, p.153, 1995, p.68). Thus, the positive relationship between public education investment and economic growth could have arisen from projects that were led according to the policies that aimed to increase research in the universities that could be applied in the industries. Given the demand for qualified workers, it may also have had a positive impact by contributing to human capital.

2.6.5 Public Investment in Energy Infrastructure

The results show a positive and statistically significant relationship between public energy investment and the dependent variable. When public investment programmes are investigated closely, it can be seen that those on energy infrastructure consist of investment spending related to nuclear energy, construction and maintenance of hydro-electric centres, and the construction of electricity networks. There are also research projects and feasibility projects. Energy and electricity services are regarded as public services in infrastructure by the World Bank (1994).

Barnett (1992) provides three reasons that necessitate government intervention in the energy sector. Firstly, the sector has characteristics that give rise to natural monopolies. Secondly, the scale of investment projects in the energy sector tends to be large compared to those in other sectors in the economy. Finally, the sector is financially challenging because, for power projects, the cost incurred by companies is in foreign currency but the income earned by them is in local currency. He explains that the common ways to finance these kinds of projects are retained earnings, aid and commercial sources that are usually against government guarantees. He adds that the social and development targets set by the governments for power utility companies are also challenged by the shortage of local funds (pp.326-327).

Nevertheless, after the 1980s, many developing countries altered their policies and privatised major utilities. The policies' objectives have become to increase competition in the market, assisting the companies to access international capital markets, and facilitate the process for the private sector regarding the projects' structures (Bond and Carter, 1995).

In accordance with the statements above, BOTAŞ (2008, p.19) addresses Turkey's difficulty in obtaining funds in the energy sector. Additionally, Turkey aimed to privatise the companies in the energy sector following the policy reforms in the 1990s. Nevertheless, the seventh development plan, for the years between 1996 and 2000, provides an account of the privatisation process in the years preceding the publication, and states that, due to the vagueness in plans regarding the roles of the institutions in the sector, the investment projects continued to be carried out by the government. The report refers to success in the increment of electricity supply, but also points at the sustainability of the energy as a potential problem (DPT, 1995, p.137).

In the literature, energy is considered to be one of the main inputs for development, and electricity is regarded as vital for social-economic advancement (Ghosh, 2002). Mozumder and Marathe (2007), for example, discuss how the drawbacks in energy infrastructure affect the economy in Bangladesh. They point out that inefficiencies in the distribution of electricity impact industrial production negatively, which, in turn, affects the economy negatively.

Davis (1998) groups the benefits of rural electrification projects as social and educational, health, environmental and economic. The presence of electricity in rural areas improves the standard of living by enabling access to appliances that operate with electricity, contributing to communication networks by increasing the use of radio and television, increasing security by increasing the number of streets lit at night, and improving education by providing better lighting in schools. Electricity supply positively impacts on the environment in rural places by reducing the pressure on woodlands and by reducing the need for wood for lighting and heating, enabling the usage of fridges and other appliances that provide better food storage conditions and reducing indoor pollution by diminishing the need for cooking by burning wood or coal. It benefits the economy in the area as its presence encourages the use of machinery in agriculture, and better irrigation systems, hence increasing the number of enterprises and thus potential employment opportunities.

2.6.6 Public Investment in Transportation and Communication

Theoretically, public investment in transportation and communication has a positive impact on the productivity of the private sector as it complements private sector capital. It also has indirect linkages with the level of health and education. For example, Levy (2004) provides an account of the effect of the National Rural Road Program-1 which started in 1995 on development in Morocco in the subsequent years. He reports that, besides many other benefits, the rural road project increased the school enrolment rates by reducing the cost of transportation for children in isolated areas, and the risks of travelling to school, which specifically affects the gross enrolment rates for females. Additionally, the rural road project improved the accessibility of health services for the public. It increased the quality of education and health services by attracting education and health staff to the areas, and by reducing the price of medical and educational equipment.

Other effects were listed as: introducing butane gas for households, which had been expensive to transport to rural areas, which reduced the time that women in rural households spent in cooking preparation; it increased the potential markets for farmers, reduced the cost of agricultural production and increased the quality of the products (through better fertilisers and pesticides); and it also improved the diets of people living in rural areas by connecting these areas to the markets.

Similarly, public investment in communication is expected to contribute to private sector productivity. Providing an infrastructure for communication mediums can reduce the cost of establishing a network for business, and searching, ordering and gathering information for the private sector (Roller and Waverman, 2001, pp.909–910). Communication infrastructure can also contribute to the growth of information technologies, which would have spillover effects on the growth of other sectors.

However, the results in this chapter provide statistical evidence for a negative relationship between public transportation and communication investment and economic growth. This may be a result of public policies that could have affected the outcome of public investment projects in this sector. For the 1990s, the seventh development plan published by the State Planning Institution observes a set of problems in implementing public investment projects, as follows (DPT, 1995, p.156):

- Public policies in Turkey lacked a dynamic transportation plan that would be in harmony with the investments in other sectors, and that would treat the transport sector as a single system.
- The targets and the policies in the transport sector could not be determined harmonically due to the lack of coordination between the institutions in the sector.
- The vehicles for international transportation were old.
- The infrastructure of the roads and highways was inadequate to carry traffic loads. This led to an increase in traffic accidents.
- The legal and structural regulations that could increase the efficiency of traffic services were lacking.
- The regulations encouraged transportation through roads and highways. This resulted in excessive erosion of the infrastructure.
- The investments focused on the improvement of superficial characteristics of roads and highways. They did not concentrate on the types of investment that would increase the capacity of the infrastructure. This also raised the cost of investment projects.
- The railway infrastructure technology was backward.
- The number of privately owned cars had increased but public transport had not improved sufficiently. This led to congestion, which put further pressure on available transport infrastructure in the cities.

Regarding the communication sector, the fourth development plan mentions the shortcomings of public investment projects. It refers to financial constraints and the lack of qualified labour to carry out public investment projects in this sector (DPT, 1980, p.419).

Thus, although theory suggests a positive relationship between public transportation investment and economic growth, the issues listed above may have reduced the productivity of investment projects in Turkey. This may have resulted in a negative relationship between public investment in transportation and communication investments and economic growth in the long run.

2.6.7 Public Investment in Health

The results do not provide any statistical relationship between public health investment and economic growth. As discussed earlier in this chapter, endogenous growth models predict a positive relationship between human capital and economic growth. Health is also considered to be a component of human capital (Schultz, 1999).

There are several linkages between the level of health and growth. The direct effect of health on the economy is through the wellbeing of workers. Healthier societies constitute a better source of labour. The indirect effects of health on the economy are via its positive effect on the level of education a person can acquire. Firstly, better health is associated with improved cognitive skills, better ability to learn, and higher attendance ratios. Secondly, an increase in life expectancy prompts the working population to save for retirement. This positively impacts on investment and the amount of physical capital. Finally, the level of health may put upward pressure on the population growth rate by reducing the mortality rates, but in the long run, a reduction in child and infant mortality rate may lead to a decrease in the fertility rate (Weil, 2005, p.1266).

The results in this chapter do not support the predictions above. This could be a consequence of failures in public policy. As discussed in more detail in the fourth chapter, the seventh development plan (DPT, 1995, p.14) observes inefficiencies in public health policy, and points out the lack of productivity in public investment projects. It underlines that public investment projects do not focus on providing preventive health care, but finances the types of projects for patients' treatment in bed which is more costly. In relation to preventive health care, Bhargava, Jamison, Lau and Murray (2001, p.5) states that the gains in health in the twentieth century are attributed to better nutrition, sanitation, innovations in medical technologies, and public health infrastructure. Child mortality is considered to be the main determinant of life expectancy, and it is suggested that in developing countries, reduction in child mortality rates can be achieved by low-cost preventive health care such as antenatal care and vaccination. Given the failures of public health policy as explained in the seventh development plan, the results in the third chapter do not provide any statistical evidence for a relationship between public health investment and the long-run infant mortality rates either. This may be interpreted as evidence that support the findings in this chapter.

2.6.8 Public Investment in City Infrastructure and Security

Public investment in city infrastructure and security includes investments in pipe water for households, and providing sewage systems. It also consists of projects to build police, gendarme or military stations and accommodation. Additionally, projects for administrative services are included under this section.

According to Barro (1990), public investment in city infrastructure and security is a type of investment that would complement private sector investment. Although results in the third and the fourth chapters provide statistical evidence for education and health benefits of public city infrastructure and security investment, the results in this chapter show that there is no statistical relationship between this variable and the long-run economic growth rate.

Regarding public investments in pipe water and sewage systems, the development plans appear to put emphasis on providing facilities in rural areas and remote villages. For example, the fourth development plan presents the number of villages in rural areas that lack or have limited access to safe water, and refers to projects that aim to provide safe water to the villages in these areas (DPT, 1980, p.95). The fifth development plan targets giving access to sufficient infrastructure including safe water for rural areas (DPT, 1988, p.172). The seventh development plan states that only 21% of the villages in the rural areas have access to safe water, and only 0.3% of villages have a sewage system. It states that public policy would aim to prioritise areas that lack safe water in order to provide the relevant facilities to meet their demands (DPT, 1995, p.156). Thus, the objective of the public policy is to reduce the inequality in the standards of living between rural and urban areas, the Eastern provinces and the Western provinces. The statistically insignificant coefficient for public city infrastructure and security investment could be due to the lack of industries that could promote growth in these rural areas.

The industries in Turkey are clustered in the West of the country, in places such as Istanbul, Izmir, Ankara, where they benefit from economies of scale (Akgüngör, 2006, p.170). The fourth development plan observes that Marmara region has the highest share of manufacturing in the economy. Nearly 50% of the companies in the textiles, chemicals, machine manufacturing and automotive sectors are located in Istanbul. The population growth rate in the West of the country is also considerably higher than in the East of the country due to the rapid domestic migration (DPT, 1980, p.72). One of the important motivations of migration between provinces is seeking employment (Gökhan and Filiztekin, 2008). DPT (1995, p.50), for the 1990s, observes that high unemployment in the East of the country had become a characteristic of the region.

Similarly, regarding security, the East of the country is more severely affected by the political conflicts that create instability in the area, which is one of the factors that drives private investment away. The seventh development plan refers to terror as a problem that reduces the level of investment in the East and the Southeast of the country (DPT, 1995, p.170).

Consequently, the results imply that, for the years between 1975 and 2001, although public city infrastructure and security investment may have improved the standards of living in the rural areas, it may not have had an effect on the economy of these places. Overall, public policy may have not been sufficient to attract private investment from the West of the country to the East, and thus to contribute to economic growth in the latter region.

2.6.9 Public Investment in Manufacturing

Turkey implemented import substitution industrialisation policies between the years 1960 and 1980, thus the share of manufacturing investment was high until the 1980s. Following the coup d'état in 1980, the economy was liberalised, and the share of manufacturing in public investment was reduced. The data in this thesis show that the average share of manufacturing in public investment changes between 20 and 45% between 1975 and 1983. After 1983, its share gradually decreases and remains under 10%.

According to the model in Barro (1990), public manufacturing investment is not considered to be a type of investment that would complement private capital; thus, the model does not predict a relationship between public manufacturing investment and economic growth. The model does predict that a rise in the size of government in the economy has a negative impact on economic growth. A higher government share in the economy signifies an increase in the intensity of government intervention, which distorts the markets.

The issues relating to public investment projects for the manufacturing sector are provided in the fourth development plan. These problems are in accordance with the critics of import substitution industrialisation. The fourth development plan mentions the supply and demand shortages caused by price regulations. Additionally, the failure to meet domestic demand for intermediate goods appears to be one of the problems at implementation of public investment projects in this sector. Finally, the fourth development plan refers to the manufacturing sector falling short of its export targets (DPT, 1980, pp.487–601)

2.6.10 Public Investment in Housing

Public investment in housing consists of construction projects for accommodation for people employed by the state, such as teachers, police, civil servants, and governors. Investment projects for mass housing to meet housing demand are also a part of public housing investment. The seventh development plan identifies the increasing demand for accommodation due to rising rates of population growth, rapid domestic migration and the rate of urbanisation as a potential problem. (DPT, 1995, p.173). Thus, it appears that the government has made public investment in housing to address this issue.

Nevertheless, this type of investment is not considered to complement private capital in the model in Barro (1990). Public housing investment is expected to substitute private sector capital. Accordingly, the results do not provide any statistical evidence for a relationship between public housing investment and economic growth.

2.6.11 Share of Total Public Investment in GDP

When the share of total public investment in GDP is included in the regression model in column (6) in Table 2.2.b, the results reveal that its overall effect on the five-year forward moving geometric average of the growth rate of real GDP per worker is statistically positive.

Economic theories suggest that public investment in infrastructure can increase private sector productivity and hence economic growth, but it may also reduce the available funds for the private sector. The statistical results in this chapter show that the transportation, communication and mining components of public investment have growth-reducing effects, while education, agriculture, energy, and tourism are positively related to the long-run growth. Nevertheless, it appears that the effects of the types of public investment that positively impact on economic growth outweigh the effects of the types of public investment that are negatively associated with the growth.

Khan and Kumar (1997), Nazmi and Ramirez (1997), Leon-Gonzales and Montolio (2004), and Nazmi and Ramirez (2003) also report a positive relationship between the level of public investment and economic growth, while Ghali (1998) finds that the impact of public investment on growth is negative for Tunisia in the long run. In this study, results show that a 1% increase in the share of public investment in GDP is associated with a 0.02 to 0.04% increase in long-run growth. This is in agreement with Khan and Kumar (1997), who find that the rate of returns for public capital for the years 1970-1990 for a cross-section of 95 countries is 0.29%.

2.6.12 The Share of Private Capital in GDP

The share of private capital in GDP appears to be positively and significantly associated with the five-year forward moving geometric mean of the growth rate of real GDP per worker. 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. In accordance with that, the share of private capital in GDP for provinces in the East which have agricultural economies is very low. Thus, the positive and significant coefficient for the share of private capital in GDP could be interpreted as provinces which have a larger manufacturing sector have higher growth rates in the long run. If this variable was considered to proxy for the level of total private capital, then the positive coefficient for this variable could be interpreted as a positive relationship between private sector investment and long-run growth.

Khan and Kumar (1997) find the rate of return to private investment is 0.4% for the years between 1970 and 1990 for the cross-section of developing countries. This is in agreement with the finding of this study, that a 1% increase in the share of private sector capital in GDP in the manufacturing sector appears to be associated with a 0.04 to 0.05% increase in long-run growth.

2.6.13 Population Growth Rate

The population growth rate is included in the regression to control for the effect of a change in population on long-run economic growth. Additionally, it is included as there is rapid internal migration between provinces, which reduces the size of the local labour force, and thus increases GDP per worker, in provinces that are senders, from which labour emigrates; and increases the size of the local labour force, and thus reduces GDP per worker, in provinces that are the net recipients of immigration. Becker, Glaeser and Murphy (1999) show that, although the effect of population becomes negative as land and other natural resources have diminishing returns, it can also be one of the sources of growth through its positive impact on human capital. In the case of Turkey, it appears that the statistical relationship between population and the economic growth rate arises in the longer run, when the dependent variable is the ten-year and fifteen-year forward moving geometric average of the per worker growth rate (see Appendix- Chapter 2, A.2.3, Table A.2.3.3). The results show that higher population growth rates are associated with lower growth rates in the long run, implying that GDP reacts less than proportionately to an influx of labour resources.

2.6.14 Year Dummies and Martial Law

Dummy variables for the years control for the time effect. The estimated sample consists of 67 panels for the years between 1975 and 1996. In Tables 2.2.a and 2.2.b, the dummy variable for 1996 is left out of the regressions to avoid the dummy variable trap.

In Tables 2.2.a and 2.2.b, the dummy variables for the years capture the time effect with respect to the dummy variable for the year that is left out of the regressions. In these tables, the dummy variable for 1996 is left out, hence negative signs for the years between 1975 and 1980 show that the growth rates in these years are lower compared to 1996. In the years after 1981, the growth rates are higher compared to 1996. Overall results indicate that the time effect is statistically significant in explaining long-run growth rate for the provinces.

In addition to dummy variables, martial law is included in the regressions, to capture the effect of a change in the governance; however, this variable does not appear to be statistically significant in any of the tables.

2.7 Conclusion

In this chapter, the relationship between the level of public investment and economic growth has been analysed. The results provide statistical evidence for a positive relationship between public agricultural investment, public education investment, public tourism investment, public energy investment and the five-year forward moving geometric average of the growth rate of real GDP per worker. Statistical evidence also indicates a negative relationship between public mining investment, public transportation and communication investment and the long-run growth rate. The coefficients for public health investment, public city infrastructure and security investment, public housing investment and public manufacturing investment are statistically insignificant.

Analyses in Appendix- Chapter 2, A.2.3 show that the positive relationship between public agricultural investment and economic growth is not robust to the presence of potential outliers. Also, the size of the coefficient for public tourism investment appears to be sensitive to the presence of potential outliers.

The results here are only partially consistent with the implications of the model provided in the relevant section. While the model in Barro (1990) suggests public investment in infrastructure, education and health to have a positive effect on economic growth, the results in this chapter provide statistical evidence for a negative relationship between public investment in transportation and communication and the dependent variable. Public health investment and public city infrastructure and security investment do not appear to be related to economic growth. Public investment in mining also appears to have a negative impact on the five-year forward moving geometric average of the growth rate of real GDP per worker.

Public investment in the mining sector can be detrimental to growth for two reasons: firstly, this sector was state owned until the 1990s, and, secondly, growth via expansion in the mining sector can distort industrial sectors in the long run. To explain the negative relationship between public transportation and communication investment and economic growth, further research needs to be carried out. The seventh development plan lists a set of problems that are encountered in public investment projects in transportation and communication, which may indicate a lack of productivity in this sector. This plan provides a list of inefficiencies in public health sector, and mentions a lack of productivity in public health investment. It criticises the public health investment projects for not focusing on low-cost preventive health care.

Finally, the development plans indicate lenience towards providing access to city infrastructure and security services in rural areas and remote villages; however, in Turkey, industries are clustered in cities, and in the West. Thus, the results appear to imply that investments for clean water and sewage systems or security services alone are not sufficient to attract the industry activities to these areas. This could be the reason for the statistically insignificant coefficient of the public city infrastructure and security investment in regressions.

The results regarding the positive effect of public agricultural investment, public tourism investment, public energy infrastructure investment and public education investment are in accordance with the implications of the endogenous growth model provided in this chapter. Public investment projects in these sectors have the characteristics of infrastructure investment which can contribute to the productivity of private companies operating in the sectors. Nevertheless, for more conclusive assessments, investment projects in these sectors should be grouped according to their purpose (such as research and development, training, irrigation, transportation, etc.), and further analyses should be carried out, which is beyond the scope of this research project due to time and resource limits.

Nevertheless, the results appear to imply that, to promote economic development, public investment projects should focus on providing infrastructure rather than economic activities. The results show that there is no statistical relationship between public manufacturing investment, public housing investment and economic growth. Public mining investment appears to have a negative relationship with it. The majority of public investment indicators that have a statistically significant relationship with the dependent variable aim to improve infrastructure or education in the relevant sectors. The only exception is public investment in transportation and communication, which has a negative and statistically significant coefficient.

CHAPTER 3: PUBLIC INVESTMENT AND EDUCATION

In the second chapter, an economic model by Barro (1990) has been provided which attributes the positive effect of public expenditure on economic growth to the type of spending and its size in the economy. In the model, the government purchases goods and services that are complementary to private input. These kinds of goods and services are considered to be non-excludable, and thus difficult for the private sector to charge a user fee for (such as national defence, and the maintenance of law and order). Barro suggests that, for non-rival goods and services or for goods and services with high externalities, private investment would be too low, and so charging user fees for these types of goods and services would not be desirable (*ibid*, pp.107-108).

In endogenous growth models that incorporate capital in the production function as physical and human capital, education arises as a type of service that has high externalities that lead to underinvestment by the private sector, and sub-optimum growth rates as a consequence. Due to the positive externalities of human capital, in these models social returns to capital are proposed to be higher than private returns to capital. Thus, the optimum growth rate can be achieved when the government makes investment decisions by taking social returns into account.

In accordance with the implications of the model in Barro (1990) and the endogenous growth models that associate human capital positively with economic growth, the results in the second chapter show a positive and statistically significant relationship between public education investment and the five-year forward moving geometric average of the growth rate of GDP per worker. Due to the importance of human capital, and thus education, as an input, in this chapter, the relationship between public investment and the gross enrolment rates will be analysed.

In Turkey, improving school enrolment ratios has been one of the policy targets since the foundation of the country, and the absence of schools in underdeveloped areas has been addressed in development plans with a view to remedying this since that time. Dulger (2004) states that the government attempted to increase compulsory education from five years to eight years in 1973, but the law could not be enforced due to lack of facilities (in addition to other reasons) by the government at the time. After compulsory education was finally extended to eight years in 1997, in addition to providing a free school transportation system for students, increasing numbers of regional and provincial boarding schools have been built to reduce the negative effect of remoteness to schools on children's education (Dulger, 2004; Elis, Celik, Ercan and Carkoglu, 2008).

The outcome of public investment projects on the gross enrolment rates is not clear due to the rapid changes in education policy. Providing free bus services for schools, for example, is likely to improve the school enrolment and attendance rates, but it is reported that schools were closed down in the areas where this service has been made available (Dulger, 2004). Similarly, while extending compulsory education to eight years is a policy that is likely to improve education, this came at the cost of education programmes that were provided by the Ministry of National Education and which attracted many households (Dulger, *ibid*). Due to the conflicting nature of preceding education policies, it is not clear whether public investments have been made with efficient resource allocation, or the decisions on the location, and type of schools were poorly made, and hence had no or a negative effect on children's education. Thus, in this third chapter, the relationship between public investment and the five-year forward moving arithmetic average of the gross enrolment ratio is studied. As public investment indicators, the shares of public city infrastructure and security investment, public education investment, public energy infrastructure investment, public transportation and communication investment, and public health investment in GDP are used.

The sections are organised similar to the earlier chapter. Firstly, the topic is introduced, and a summary of findings is provided. The second section is the overview of papers that have studied the same topic. A model that helps in analysing the relationship between public investment and the gross enrolment ratio is provided in the third section, and the data are discussed in the fourth section. The results are reported in the fifth section, the interpretations of the results are provided in the sixth section, and conclusions are drawn in the final section.

3.1 Introduction

Education is considered to be essential for development due to its positive impact on economic growth, health, alleviation of poverty and inequality. Given its large positive externalities, promoting education has become a public policy for developing countries. Accordingly, the literature review in this chapter provides many examples of studies that find a positive relationship between public education expenditure and children's schooling ratios. However, there has been little attention given to the effect of public infrastructure investment on educational outcome. The literature review shows that qualitative studies which focus on the determinants of schooling ratios report that the availability of basic infrastructure (such as toilet facilities) at schools is a factor that increases enrolment. This chapter contributes to the literature by providing an empirical analysis for the relationship between public infrastructure investment and the five-year forward moving arithmetic average of the gross enrolment rate.

The dataset consists of public investment indicators for 67 Turkish provinces for the years between 1975 and 2001. The public investment indicators are the share of public city infrastructure and security investment in GDP, the share of public energy infrastructure investment in GDP, the share of public transportation and communication investment in GDP, the share of public education investment in GDP, and the share of public health investment in GDP.

As in the earlier chapter, the dependent variable is the five-year forward moving arithmetic average of the outcome variable. This is firstly to reduce the possibility of contemporaneous correlation between public investment indicators and the gross enrolment rate, and secondly to account for the long-run effect of public investment on the gross enrolment rate, as construction of facilities is likely to impact on the gross enrolment rate with a lag. The fixed-effects method is used as the econometric technique, and standard errors are corrected for serial correlation according to Driscoll and Kraay (1998), as in the previous chapters.

The results show that public investment in city infrastructure and security services, which includes projects to supply clean water and sanitary facilities, has a positive relationship with the long-run gross enrolment ratios. There does not appear to be a statistical relationship between the share of public education investment in GDP, the share of public health investment in GDP, the share of public transportation and communication investment in GDP, or the share of public energy infrastructure investment in GDP and the long-run gross enrolment rate.

Post-diagnostics of the estimates for this chapter fail to reject the null hypothesis that the regression model is correctly specified. The unit root tests indicate that the data for all variables are stationary, except for the adult education indicator. Still, the results do not change when the adult education indicator is excluded from the regressions. In robustness analyses in the Appendix-Chapter 3, A.3.1, co-linearity arises as a problem that reduces the reliability of inferential statistics. Nevertheless, the results hold for the ten-year and fifteen-year forward moving arithmetic averages of the gross enrolment rate, and for the geometric average of the dependent variable.

3.2 Literature Review

The positive impact of education on development has been well documented in the literature. A review of the empirical papers that study the relationship between the level and quality of education and economic growth can be found in Glewwe, Maiga and Zheng (2014). Education arises as a factor that assists in the alleviation of poverty due to its positive impact on the likelihood of employment and earning higher wages (Cremin and Nakabugo, 2012), and the likelihood of children's survival by reducing the fertility rate and increasing the quality of care provided by mothers (Bruns, Mingat and Rakotomalala, 2003).

The provision of education by the government is justified on the grounds of social and economic benefits, and equal opportunities (Poterba, 1994). However, the question of whether higher public expenditure can be translated to better education is yet to be investigated.

There is a range of studies that examine the relationship between the existence of schools and school enrolment rates, the majority of which (Pitt, Rosenzweig and Gibbons, 1993; Foster and Rosenzweig, 1996; Bommier and Lambert, 2000; Duflo, 2001; Handa, 2002) report that the effect of having an available school nearby on school enrolment rates is positive. Filmer (2007), who provides a review of the articles mentioned, confirms that there is a positive relationship between school availability and school enrolment rates, but adds that the scale of the effect is small. Gupta, Verhoeven and Tiongson (1999) and Gallagher (1993) provide empirical evidence for a positive relationship between public education expenditure and school enrolment rates

Accordingly, the recent literature points to the available infrastructure at schools as one of the determinants of schooling ratios, such as enrolment rates and dropout rates. Adukia (2013), who provides a review of qualitative studies that report that provision of toilet facilities increases attendance rates for children, presents results using quantitative methods that back up this hypothesis.

The literature also suggests a positive link between access to transportation and schooling ratios. Studies on the determinants of children's education (Tansel, 2002a; King and Lillard, 1987; Behrman and Wolfe, 1987; Birdsall, 1985) report proximity of schools and residing in urban areas as important factors among others (such as parent's income and education) that are associated with higher school enrolment rates. Safety issues associated with travelling longer distance are reported to discourage parents from sending their children to schools (Tansel, 2002).

Similarly, infrastructure enabling the use of modern energy, such as electricity, can have a positive impact on the attendance ratios, and improve the quality of education by providing lighting and heating, and increase the accessibility of educational equipment (Brenneman and Kerf, 2002).

Although there are indications for the positive impact of infrastructure on educational outcome, the literature lacks empirical analyses that focus on the relationship between infrastructure investment as an input and schooling ratios. To address this gap, in this chapter, the effect of public infrastructure investment on the long-run primary and middle school enrolment rates is studied. The indicators for public infrastructure investment are the share of public city infrastructure and security services in GDP, the share of public transportation and communication investment in GDP, and the share of public energy infrastructure investment in GDP. The long-run primary school enrolment rate is specified as the five-year forward moving arithmetic average of the gross enrolment rate. More explanation for the choice of the dependent variable is provided in the next section.

3.3 Regression Model

The estimated equation is:

$$GER_{FMA_{t\,to\,t+n}} = \propto + \beta_1 * \left(\frac{Energy}{GDP}\right) + \beta_2 * \left(\frac{Transportation}{GDP}\right) + \beta_3 * \left(\frac{Education}{GDP}\right) + \beta_4 * \left(\frac{Health}{GDP}\right) + \beta_5 * \left(\frac{Public\ City\ InfandSec.}{GDP}\right) +$$

$$\beta_6 * Infant\ Mortality\ Rate + \beta_7 * \ln(\text{GDP per capita}) + \beta_8 * \text{Martial Law} + \sum_1^k \beta_k Year\ Dummies + u_i$$

In the equation, the intercept, $\propto$, is the fixed (or individual) effects.

$GER_{FMA_{t\,to\,t+n}t}$ is the dependent variable, which is the five-year forward moving arithmetic average of gross enrolment rate.

To compute the dependent variable, as an education indicator, the gross enrolment rates for primary and middle school are chosen. The gross enrolment rate is considered to show the level of participation in education. Its value can exceed 100% as it includes students who are over school age, and repeaters. The choice of the education indicator is primarily due to the unavailability of data for other education indicators that measure the outcome of the education (such as primary school completion rates), or the efficiency of the education (for instance, persistence to grade 5). These data are available for Turkish provinces for the years between 1975 and 2001 only in archival sources. For this research project, only the data for the gross enrolment rates could be obtained due to time and resource limits.

Despite its limitations, the gross enrolment rate is a crude measure of the level of children's participation in education. For this chapter, the gross enrolment rates for primary and middle school are used for the regressions. This is because the enrolment rates in primary and secondary education are used as development indicators by the UNDP and the World Bank.

To measure public infrastructure investment, three variables are used. $\frac{Public\ City\ Inf andSec.}{GDP}$, the share of public city infrastructure and security investment in GDP, $\left(\frac{Energy}{GDP}\right)$, the share of public energy infrastructure investment in GDP, and, $\left(\frac{Transportation}{GDP}\right)$, the share of public transportation and communication investment in GDP.

Public city infrastructure and security investment includes investment projects to establish clean water-pipe networks and sewage systems in the areas, which improves access to safe water and sanitation facilities for residents. It also includes public investment in security and administrative services.

Availability of water and sanitation facilities in an area impacts on children's education through various channels. Firstly, the presence of these facilities contributes to the welfare of the households in the area, which impacts positively on children. Rosenzweig and Wolpin (1982), using survey data for Indian households for the years between 1968 and 1971, estimate that having a river as the main source of water is associated with the lowest schooling levels for children, while tap water is reported to be associated with the highest values for children's education.

The World Bank (2015) reports that, when safe water is not provided in households, children, and generally girls, are tasked to fetch water from a water source, which reduces their schooling and studying time. It is also shown that unavailability of safe water and hygiene facilities in households can increase the prevalence of diseases, which can reduce the school attendance rates for girls, as the household gives the responsibility of taking care of the sick to young females.

Secondly, children’s education can be affected if the schools do not have safe water and sanitation facilities. Adukia (2013) finds that basic sanitation facilities (school toilets) at schools increase enrolment rates for both males and females in India, reflecting the negative impact of health concerns for children on their education.

The unavailability of sanitation facilities at schools is associated with poor schooling ratios for adolescent female students, due to the hypothesis that female students who menstruate miss school because they may have concerns for their privacy, which may be aggravated by cultural norms, and their hygiene (Adukia, 2013; World Bank, 2015). Missing school increases the likelihood of adolescent female students dropping out, as low attendance rates result in higher rates of failure, which reduces the likelihood of advancing to the next grade. Thus, it becomes less likely for adolescent female students to enrol in school in their later years (World Bank, 2015).

The availability of water and sanitation facilities improves hygiene at schools. As discussed in more detail in the next chapter, better hygiene reduces the prevalence of water-borne diseases, and the incidence of intestinal worms in children, both of which can stunt growth and cognitive abilities (World Bank, 2015).

Safety concerns for students also arise as a factor that reduces the enrolment rates for children, especially females. Tansel (2002) finds that parents are more reluctant to send their children to schools in remote areas due to the risks associated with travelling. Similar concerns affect schooling ratios for female students when the schools lack sanitation facilities, as students who would use the restroom seek privacy outside the school grounds, which increases the risk of harassment or assault. Thus, the security component of public city infrastructure and security investment can have a positive impact on gross enrolment rates if it improves safety in the area. Public investment in city infrastructure can enhance the sense of safety among children at schools when investment projects related to sanitation facilities enable schools to provide gender-specific restrooms (Adukia, 2015).

Public investment in transportation and communication can also increase school enrolment rates, as distance to school is reported to be one of the factors that reduces school enrolment rates for economic, practical and safety reasons (Tansel, 2002). The probability of school attainment is higher in urban areas for both boys and girls (Gupta, Verhoeven and Tiongson, 1999; Anyanwu and Erhijakpor, 2009).

The share of public energy investment in GDP is included in the model, as the lack of modern energy in schools can have disadvantages that may reduce the enrolment and attendance rates (Brennan and Kerf, 2002). Lack of lighting and heating can reduce the quality of the school environment, and even create difficulties for a school's operation. Access to modern energy sources in households has additional benefits that may indirectly impact on the enrolment and attendance rates. For example, it contributes to standards of living that have a positive impact on the level of household income (Brennan and Kerf, *ibid*). Availability of electricity networks can also increase the number of lit streets and roads, which may increase students' safety when travelling to school (Kaygusuz, 2011).

$\left(\frac{Education}{GDP}\right)$ denotes the share of public education investment in GDP, which can increase the enrolment rates by making education facilities (school buildings, dormitories, equipment) available for households. Pitt et al. (1993), Foster and Rozensweig (1996), Bomier and Lambert (2000), Duflo (2001), Handa (2002), and Jalan and Gilinskaya (2013) find a positive relationship between a rise in primary school access and primary school enrolment rates; however, Filmer (2007) states that the effect is small in scale.

Finally, $\left(\frac{Health}{GDP}\right)$ is the share of public health investment in GDP which can impact education indirectly by improving public health. In the literature, Pitt et al. (1993), using Indian household survey data for the years between 1976 and 1986, find that the presence of health clinics is associated with higher rates of schooling for female students. According to the Ministry of Health (2011), in Turkey, the health clinics have various tasks apart from providing treatment for patients. Staff in the health clinics provide public health education to local communities to increase general health knowledge (such as hygiene practices and family planning) and to create public awareness about contagious diseases that may threaten children's health. Health clinics also carry out public immunisation programmes for children which are coordinated by the directorates of health services in the provinces. As part of the immunisation programmes, children are vaccinated both in clinics and at schools. Staff in health clinics visits schools to conduct health scans which can help to diagnose prevalent diseases such as hookworm. Intestinal hookworm has negative effects on children's cognitive and physical development as it causes malnutrition in the body. Such public education and health services carried out by health clinics can promote education in the local communities, which may encourage more parents to enrol their children at schools.

The level of health status in the provinces is important for school enrolment rates. There are a variety of studies that show that children with better health have higher rates of school enrolment and attendance. Bleakley (2010) provides a detailed review of papers that lend support to this argument. For example, Almond (2006), and Meng and Qian (2006) find that people who were in the womb during famines had lower levels of schooling. Behrman and Rosenzweig (2004) study the effect of birth weight on income in twins in Minnesota, USA, and report that the twin with higher birth weight had higher educational attainment. Bleakley (2007a) examines the effect of a hookworm-eradication campaign in the southern US, and concludes that there are increases in school attendance, literacy (and income) in areas where children benefited from the campaign. Experimental studies such as Miguel and Kremer (2004), and Bobonis, Miguel and Sharma (2006) report that intestinal worms reduce school attendance. There are also findings that indicate that suffering from persistent malaria reduces school attendance and literacy (Bleakley, 2007b, (in Bleakley 2010); Lucas 2010). To control for the level of health status, the infant mortality rate is used as a proxy[2].

In Turkey, there appears to be a positive relationship between the level of parent's education and school enrolment rates, in particular for girls (Tansel, 2002). Baldacci et al. (2003) and Gupta, Verhoeven and Tiongson, (1999), who examine the relationship between public expenditure in education and the gross enrolment rate,

[2] A possible problem in including the infant mortality rate as the explanatory variable is the correlation between this indicator and public investment indicators. When the infant mortality rate is regressed on the rest of the explanatory variables in the model, results show that it is negatively and statistically significantly associated with public energy investment, and public city infrastructure and security services, and the logarithm of GDP per capita (in Appendix- Chapter 4, Table A.4.1.2). Nevertheless, excluding the infant mortality rate from the model provided in this section does not change the results for this chapter (see Appendix- Chapter 3 in Table A.4.1.5).

control for the adult literacy rate, as educated parents are more likely to send their children to school. In this chapter, due to data unavailability, the share of high school and university graduates in the adult population is used to control for parent's education.

A dummy variable is included for the provinces where martial law or state of emergency was declared. This variable and the rationales for including it in the regressions are explained in the second chapter.

A dummy variable for each year in the regressions is included to capture the time effect. For the five-year forward moving arithmetic average of gross enrolment rate, there are dummy variables for the years between 1975 and 1996.

Other determinants of schooling are related to the cost of education, and the incentives for education. The cost of education is a factor that is negatively related to schooling ratios. In Turkey, education is provided free for primary and secondary levels, but it is common for families to incur charges for school equipment such as school uniforms, books, and stationery. Additionally, for some households sending children to school means losing income that these children could earn, which is called the opportunity cost of schooling. This is especially the case for families who engage in farming or who are self-employed (Tansel, 2002b). 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). For example, this could be a factor for families who may be considering sending their daughters to school in a community that is biased against females' education.

The incentives for education are positively correlated with enrolment rates. One of the most important factors among the incentives is the return to education. Education is expected to increase the productivity of an individual, which equals wages. Thus, if households expect that an increase in the future wages of their children to be higher than the cost of educating them, they would be willing to purchase education. In this case, expected returns to education also depend on the existing employment opportunities, and the composition of the local economy, as wage rates vary across sectors such as agriculture, manufacturing and services (Tansel, 2002b).

The quality of education acts as a factor that increases the incentives for education. The schools that lack qualified teachers and equipment, that have a poor curriculum, or that provide education in an unfamiliar language, can be perceived by the households as inadequate to provide skills to their children (Mani, Hoddinott and Strauss, 2013).

In this chapter, to account for the factors that are related to the incentives for education, the logarithm of GDP per capita is used. The wage rates for 1975-2001 are not available for the provinces in Turkey. It is expected that the logarithm of GDP per capita will capture the effect of differing rates of return to education across the provinces. This is because the output per capita is higher in the industrialised provinces compared to those that are rural. Rural areas also suffer from higher unemployment rates (DPT, 1995, p.50).

Additionally, if the minimum cost of education were assumed to be fixed across the provinces, provinces that have higher GDP per capita would be expected to have higher gross enrolment rates. In this case, households in high-income provinces would be more likely to afford to send their children to school compared to those in low-income provinces.

Similarly, data to measure the quality of schooling such as teacher-student ratio or school-student ratio are not available for provinces for the years between 1975 and 2001. However, the quality of the schools that arises from province-specific characteristics that may be making them unfavourable for government investment or for teachers to work in them, is likely to be accounted for by the fixed-effects technique, as this method eliminates panel-specific means. The same could be expected for social factors such as religion and traditional characteristics of provinces that may affect schooling ratios. That is, the fixed-effects technique would remove province-specific social characteristics that remain constant over time.

Finally, in the regression model, u_i is the residual term. The properties of the residual term are discussed in the fifth chapter.

3.4 Data

The sources of the data for public investment, real GDP per capita, and martial law are explained in the earlier chapter, so they will not be discussed in this section. The source of the data for the gross enrolment rate, and the method of the calculating the dependent variable is provided below.

3.4.1 The Source of the Data

Data for education indicators are taken from annual statistics by the Ministry of National Education (Milli Egitim Bakanligi, MEB). Infant mortality rates are computed using data in Annual Death Statistics published by the Turkish Statistical Institute (formerly known as the State Statistics Institution). The data for the rest of the social and demographic indicators are taken from the census statistics published by the Turkish Statistical Institute.

The dependent variable is the five-year forward moving arithmetic average of the gross enrolment rate between t and $t+4$, which is calculated by using the formula below:

$$GER_{t\ to\ t+4} = \frac{GER_t + GER_{t+1} + \cdots + GER_{t+4}}{5}$$

in which GER_t is the gross enrolment rate for time t, and $GER_{t\ to\ t+4}$ is the dependent variable, the five-year forward moving arithmetic average of the gross enrolment rate.

In this study, to measure the participation in education, the gross enrolment ratio is used. The gross enrolment ratio is computed by dividing the total number of students enrolled at schools by the number of children who are at school age.

In Turkey, prior to 1997, the length of primary school education (which was compulsory) was five years. Between primary and secondary education, students could attend a school that would provide three years of additional non-compulsory education. These schools were called middle schools or junior high schools, and could be independent from primary schools and high schools. In 1997, the length of compulsory education was raised to eight years; hence, middle schools have become a part of primary education.

In this chapter, the gross enrolment rate is calculated by including the number of children who were enrolled in middle schools. This firstly allows continuity in data for the years before and after 1997. Secondly, Turkey achieved a 100% gross enrolment ratio for both males and females for primary school education in the 1990s. However, the gross enrolment ratio for middle schools was 77.5% for females and 82% for males in the same time period.

Data for the number of children who were enrolled in primary and middle schools are taken from annual statistics books published by the Ministry of Education in Turkey. Data include the number of children enrolled in independent primary, and middle schools, regional boarding schools, the eight-year-primary education schools, the middle education section of primary schools and high schools.

The number of children whose age is between six and 14 is computed using census data. Census data were collected in 1975, 1980, 1985, 1990 and 2000. It is assumed that the number of school-age children would grow at the average growth rate between census years.

For the robustness of data, the number of children is estimated for the years between censuses for each age group separately. For example, to find the number of children who are six years old in 1976 in province i, firstly, the annual growth rate between 1975 and 1980 is calculated. The formula is provided below:

$$n_{i;t+m,t} = \sqrt[m]{\frac{Z_{i,t+m}}{Z_{i,t}}} - 1$$

in which

$Z_{i,t}$ represents the number of children who are six years old in census year t in province i. $Z_{i,t+m}$ is the number of children who are six years old in census year $t+m$ in province i. $n_{i,t+m-t}$ shows the annual growth rate of the number of children who are six years old between census years t and $t+m$.

The number of children who are six years old in year $t+1$ for province i can be found by assuming $Z_{i,t}$ would grow at $n_{i,t+m-t}$ every year between censuses t and $t+m$:

$$Z_{i,t+1} = (n_{i;t+m,t} + 1) * Z_{i,t}$$

To calculate the gross enrolment rate for year $t+1$ in province i, this exercise is carried out to find the number of children in each age group separately. If the number of children in each age group for province i year $t+1$ was denoted as $Z_{i,t+1}^{age\ group}$, and the annual growth rate between census years t and $t+m$ was denoted in the superscript as $n_{i;t+m,t}^{age\ group}$, then the number of children for the age groups between six years old and 14 years old for $t+1$ in province i could be expressed as follows:

$$Z_{i,t+1}^{six} = \left(n_{i;t+m,t}^{six} + 1\right) * Z_{i,t}^{six}$$

$$Z_{i,t+1}^{seven} = \left(n_{i;t+m,t}^{seven} + 1\right) * Z_{i,t}^{seven}$$

$$Z_{i,t+1}^{eight} = \left(n_{i;t+m,t}^{eight} + 1\right) * Z_{i,t}^{eight}$$

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$$Z_{i,t+1}^{fourteen} = \left(n_{i;t+m,t}^{fourteen} + 1\right) * Z_{i,t}^{fourteen}$$

Then, the number of school-age children for province i for time $t+1$ would equal:

$$\sum_{six}^{fourteen} Z_{i,t+1}^{age\ group} = \sum_{six}^{fourteen} \left[\left(n_{i;t+m,t}^{age\ group} + 1\right) * Z_{i,t}^{age\ group}\right]$$

To achieve a dataset for the number of school-age children for the years between 1975 and 2001, the values of the variable for the years between censuses (1975, 1980, 1985, 1990 and 2000) are calculated using the formula above.

The adult education indicator is the sum of the proportion of high school graduates in the population over 17 years old, and the proportion of university graduates in the population over 21 years old. It is also computed using census data from the Turkish Statistical Institute. As stated earlier, these data are available for 1975, 1980, 1985, 1990 and 2000. The number of the population over 17 years old and 21 years old, and the number of high school and university graduates is calculated by the principle explained above. The reason for choosing the share of high school and higher education graduates is to exclude the population who are of school age, as this may create a spurious correlation between the adult education indicator and the dependent variable.

3.4.2 Summary Statistics

Summary statistics for the dependent variable, and control variables are presented in Table 3.1. The formulas for overall, between and within standard deviations have been provided in the second chapter. “Overall” statistics are provided for the pooled data. The overall standard deviation shows the average deviation in the values of observations from the sample mean. The overall maximum and minimum values provide the highest and lowest values of the variables across observations. “Between” statistics represent the panel statistics. “Between” standard deviation shows the average deviation in the values of the panel means from the sample mean. “Between” maximum and minimum values show the highest and lowest values of the panel means. “Within” statistics consider the change in the value of an observation within a panel. “Within” standard deviation shows the deviation of the value of an observation from its panel mean. “Within” maximum and minimum values are the highest positive and negative values of the difference between the value of an observation and its panel mean. This difference is summed up with the sample mean.

Summary statistics for the share of public city infrastructure and security, energy infrastructure, education, health, transportation and communication investment in GDP are already provided in Table 2.1 in the second chapter. However, these statistics are provided in Table 3.1 again. This is because the size of the sample changes between the second and third chapters. The number of observations in the second chapter is 1407, for 67 panels, and 21 years. In the third and fourth chapters, the number of observations is 1541, for 67 panels, and 23 years. The sample in the third and fourth chapters contains data for 23 years, while the sample in the second chapter contains data for 21 years. The original dataset contains 67 panels, for 27 years. Calculating the dependent variable as the five-year forward moving average reduces the dataset by four years. Additionally, in the second chapter, the dependent variable is calculated using the growth rate, which reduces the size of the dataset by another year. The regression model in the second chapter includes the share of private capital in GDP for which the values for 1985 are not available. Thus, while data for four years are missing for the third and fourth chapters, data for six years are missing for the second chapter.

Although the estimated sample is different for the shares of public investment in GDP, the summary statistics remain similar to those in Table 2.1. Average shares of public investment in GDP can be ordered as the share of public energy infrastructure investment in GDP (1.9%), the share of public city infrastructure and security investment in GDP (0.7%), the share of public education investment in GDP (0.5%), the share of public transportation and communication investment in GDP (0.4%), and the share of public health investment in GDP (0.2%). The size of the standard deviations for overall observations, between panels, and within panels with respect to the mean are considerably higher for public energy investment, and public transportation and communication investment compared to public health investment, public education investment, and public city infrastructure and security investment.

The mean of the five-year forward moving arithmetic average of the gross enrolment ratio is 68.5% .The standard deviations across observations, panels and time appear to be lower than the mean, which suggests that variation in the long-run gross enrolment rates between regions and time is low. This can be observed in the maximum and minimum values of the observations. While the maximum values of the five-year forward moving arithmetic average of the gross enrolment rate are between 83-89%, the minimum values of the dependent variable are between 30-50%, both of which can be considered to be close to the sample mean.

The maximum value of the five-year forward moving arithmetic average of the gross enrolment rate across the sample is observed in Istanbul in 1997, and the minimum value, in Hakkari in 1975. Similarly, the maximum value between panels, 83.2%, is observed in Istanbul. This means that the long-run gross enrolment rate is consistently higher in Istanbul for the years 1975-1997. While the minimum value across the sample is observed in Hakkari, the five-year forward moving arithmetic average of the gross enrolment rate is consistently lower in Bitlis, which has the minimum panel mean. The minimum and maximum values for within panels are for Hakkari, suggesting a higher variation in the value of the dependent variable in time for this province.

The average value of the infant mortality rate is approximately 1.5%. The values of standard deviations for the overall sample and between the panels are very close to the mean value of the infant mortality rate. This may imply that there is high variation in the infant mortality rate across provinces and time. Statistics show that the maximum quoted value for the infant mortality rate between 1975 and 1997 is 9.7% in Eskisehir in 1978, and the lowest is zero in Agri in 1996. The minimum mean for a panel for the years between 1975 and 1997 is 0.3%, for Gumushane, while the maximum mean for a panel is 5.5%, for Istanbul.

The statistics for GDP per capita show that a province in Turkey produces 1,094,424 Turkish Liras (TL) on average. The maximum value of GDP per capita for the overall observations is 4,674,362TL, which is in Kocaeli in 1997, and the lowest is 250,042.4TL in Hakkari in 1996. The lowest mean for a panel is 332,115.8TL for Agri, while the highest mean is for 3,825,649TL for Kocaeli. The standard deviations for the overall observations and between the panels indicate income disparity across provinces. The standard deviation within panels is 225,043.7TL, which implies relatively high fluctuations for GDP per capita in time.

For the regressions, the logarithm of GDP per capita is used and summary statistics for this indicator are provided in Table 3.1. In this case, the standard deviations reflect the deviation from the overall average proportionally. The deviation of the logarithm of GDP per capita for the provinces overall is 52.1% with respect to the mean, and, between panels of provinces, it is 49.5% with respect to the overall average. As stated earlier, these statistics reflect the income disparity between provinces. The standard deviation within the panels of provinces is 17.3% with respect to the overall mean, which shows the rate of fluctuation for income for a given province between the years 1975 and 1996.

The overall mean for the share of high school and higher education graduates in the population over 17 years old is 11.5%. The standard deviations for overall observations, between panels and within panels are 5.3%, 3.5% and 4.0% respectively, indicating high variations across the country and within time for this indicator. Its maximum value for the overall observations is 36.6%, observed in Ankara in 1997, and the minimum value is 2.5%, observed in Bingol in 1975. While Ankara has the maximum panel mean, suggesting that the adult education indicator is consistently higher for Ankara compared to the rest of the country, Corum has the minimum panel mean. Tunceli has the maximum positive and negative deviations within a panel.

Table 3.1 Summary Statistics

Variable		Mean	Std. Dev.‡	Min	Max	Obs. ᶧ
Five-Year Forward Moving Arithmetic Average of the Gross Enrolment Rate	Overall		0.097	0.305	0.898	N=1541
	Between	0.681†	0.090	0.450	0.832	n=67
	Within		0.038	0.516	0.895	T=23
Energy Infrastructure Proportion of GDP	Overall		0.061	0.000	0.861	N=1541
	Between	0.019	0.037	0.001	0.183	n=67
	Within		0.048	-0.163	0.731	T=23
Transportation and Communication Proportion of GDP	Overall		0.008	0.000	0.116	N=1541
	Between	0.004	0.004	0.001	0.027	n=67
	Within		0.007	-0.021	0.113	T=23
Health Proportion of GDP	Overall		0.003	0.000	0.074	N=1541
	Between	0.002	0.001	0.000	0.006	n=67
	Within		0.003	-0.004	0.072	T=23
Education Proportion of GDP	Overall		0.006	0.000	0.095	N=1541
	Between	0.005	0.004	0.001	0.027	n=67
	Within		0.004	-0.020	0.089	T=23
City Infrastructure and Security Proportion of GDP	Overall		0.006	0.000	0.051	N=1541
	Between	0.007	0.004	0.002	0.024	n=67
	Within		0.005	-0.011	0.049	T=23
Population Growth Rate	Overall		0.015	-0.035	0.101	N=1541
	Between	0.016	0.012	-0.020	0.045	n=67
	Within		0.008	-0.026	0.072	T=23
Ln(GDP per capita)	Overall		0.521	12.429	15.358	N=1541
	Between	13.770	0.495	12.699	15.150	n=67
	Within		0.173	13.229	14.353	T=23
GDP per capita, Turkish Liras (TL)	Overall		615080.5	250042.4	4674362.0	N=1541
	Between	1094424.0	576565.9	332115.8	3825649.0	n=67
	Within		225043.7	262172.1	2413048.0	T=23
Infant Mortality Rate	Overall		0.013	0.000	0.097	N=1541
	Between	0.016	0.012	0.004	0.055	n=67
	Within		0.007	-0.015	0.059	T=23
Adult Education Indicator	Overall		0.053	0.025	0.366	N=1541
	Between	0.115	0.035	0.071	0.269	n=67
	Within		0.040	0.011	0.280	T=23

†The summary statistics are expressed in decimal numbers. Thus, “0.681” should be read “68.1%”.

‡Std.Dev.: Standard Deviation

ᶧ Obs.: The number of observations: N, the number of observations in the sample; n, the number of panels (provinces) in the sample, T, the number of time periods in the sample.

3.5 Results

In this section, the results are reported. The fixed-effects method is chosen as the econometric technique as it accounts for the individual effects that may bias the results. Because the dependent variable is computed as the forward moving arithmetic average of the dependent variable, the standard errors suffer from serial correlation. Standard errors are corrected by Driscoll and Kraay's (1998) technique, which is made available by Daniel Hoechle in Stata.

The results are reported in Table 3.2. They show that the share of public investment in GDP is not related to the five-year forward moving arithmetic average of the gross enrolment rate, except for public investment in city infrastructure and security, which has a positive and statistically significant coefficient. The coefficient for the population growth rate is not statistically significant either. The share of high school and university graduates in the adult population appears to be negatively related to the long-run gross enrolment ratio. That is the case for the infant mortality rate too. The logarithm of GDP per capita does not have a statistically significant coefficient in any of the columns. Martial law appears to be positively associated with the forward moving arithmetic average of the gross enrolment rate in the table. All year dummies capture the time effect with negative and statistically significant coefficients. Post-estimation diagnostics are provided in the fifth chapter, and the robustness of results to alternative calculations of the dependent variable and co-linearity diagnostics are provided in the next section. Interpretations of the results are also provided in the next section.

Table 3.2 Relationship between the Level of Public Investment and the Long-Run Gross Enrolment Rates‡

	(1)	(2)	(3)	(4)	(5)	(6)
	Five-Year Forward Moving Arithmetic Average of the Gross Enrolment Rate					
Public Energy Infrastructure Investment	-0.002					-0.001
Proportion of GDP	(0.015)					(0.015)
Public Transportation and Com. Investment		-0.300				-0.364
Proportion of GDP		(0.200)				(0.200)
Public Education Investment			-0.327			-0.266
Proportion of GDP			(0.479)			(0.459)
Public Health Investment				0.131		0.121
Proportion of GDP				(0.214)		(0.190)
Public City Infra. and Security Investment					0.947	0.992
Proportion of GDP					(0.185)**	(0.173)**
Adult Education Indicator	-0.600	-0.586	-0.591	-0.602	-0.684	-0.666
	(0.182)**	(0.178)**	(0.190)**	(0.183)**	(0.196)**	(0.203)**
Population Growth Rate	-1.059	-1.102	-1.058	-1.061	-0.968	-1.014
	(0.209)**	(0.228)**	(0.213)**	(0.213)**	(0.220)**	(0.238)**
Log(GDP per capita)	0.019	0.020	0.018	0.019	0.025	0.026
	(0.017)	(0.017)	(0.019)	(0.017)	(0.017)	(0.017)
Infant Mortality Rate	-0.386	-0.397	-0.375	-0.385	-0.296	-0.299
	(0.105)**	(0.096)**	(0.112)**	(0.100)**	(0.059)**	(0.065)**
Martial Law	0.018	0.017	0.018	0.018	0.019	0.019
	(0.005)**	(0.004)**	(0.005)**	(0.005)**	(0.005)**	(0.005)**
1975	-0.163	-0.158	-0.163	-0.163	-0.172	-0.166
	(0.025)**	(0.023)**	(0.025)**	(0.025)**	(0.026)**	(0.025)**
1976	-0.161	-0.157	-0.161	-0.161	-0.171	-0.166
	(0.023)**	(0.022)**	(0.024)**	(0.023)**	(0.025)**	(0.024)**
1977	-0.158	-0.153	-0.157	-0.158	-0.167	-0.161
	(0.022)**	(0.020)**	(0.023)**	(0.022)**	(0.023)**	(0.023)**
1978	-0.154	-0.150	-0.155	-0.155	-0.161	-0.157
	(0.022)**	(0.020)**	(0.022)**	(0.022)**	(0.023)**	(0.022)**
1979	-0.139	-0.135	-0.139	-0.139	-0.143	-0.139
	(0.020)**	(0.019)**	(0.021)**	(0.020)**	(0.022)**	(0.020)**
1980	-0.133	-0.130	-0.134	-0.133	-0.136	-0.134
	(0.020)**	(0.019)**	(0.021)**	(0.021)**	(0.022)**	(0.021)**
1981	-0.117	-0.115	-0.118	-0.117	-0.121	-0.119
	(0.019)**	(0.018)**	(0.020)**	(0.020)**	(0.021)**	(0.020)**
1982	-0.106	-0.103	-0.107	-0.106	-0.111	-0.109
	(0.019)**	(0.018)**	(0.019)**	(0.019)**	(0.020)**	(0.019)**
1983	-0.095	-0.092	-0.096	-0.095	-0.100	-0.098
	(0.018)**	(0.017)**	(0.018)**	(0.018)**	(0.019)**	(0.018)**
1984	-0.084	-0.082	-0.086	-0.084	-0.086	-0.085
	(0.016)**	(0.015)**	(0.016)**	(0.016)**	(0.017)**	(0.016)**
1985	-0.076	-0.074	-0.077	-0.076	-0.081	-0.080
	(0.014)**	(0.013)**	(0.014)**	(0.014)**	(0.015)**	(0.014)**
1986	-0.083	-0.081	-0.084	-0.083	-0.091	-0.089
	(0.014)**	(0.013)**	(0.014)**	(0.014)**	(0.015)**	(0.014)**
1987	-0.085	-0.083	-0.085	-0.085	-0.092	-0.091
	(0.013)**	(0.013)**	(0.013)**	(0.013)**	(0.014)**	(0.013)**
1988	-0.087	-0.086	-0.088	-0.087	-0.092	-0.092
	(0.012)**	(0.012)**	(0.013)**	(0.013)**	(0.013)**	(0.012)**
1989	-0.089	-0.088	-0.090	-0.089	-0.093	-0.092
	(0.012)**	(0.011)**	(0.012)**	(0.012)**	(0.012)**	(0.012)**

1990	-0.094	-0.092	-0.094	-0.094	-0.098	-0.097
	(0.010)**	(0.010)**	(0.010)**	(0.010)**	(0.011)**	(0.010)**
1991	-0.098	-0.097	-0.099	-0.098	-0.100	-0.100
	(0.010)**	(0.009)**	(0.010)**	(0.010)**	(0.010)**	(0.009)**
1992	-0.102	-0.102	-0.103	-0.102	-0.103	-0.103
	(0.008)**	(0.008)**	(0.008)**	(0.008)**	(0.009)**	(0.009)**
1993	-0.105	-0.104	-0.107	-0.105	-0.105	-0.106
	(0.007)**	(0.006)**	(0.007)**	(0.007)**	(0.007)**	(0.007)**
1994	-0.092	-0.091	-0.093	-0.092	-0.091	-0.091
	(0.005)**	(0.005)**	(0.006)**	(0.005)**	(0.006)**	(0.005)**
1995	-0.068	-0.067	-0.069	-0.068	-0.066	-0.066
	(0.004)**	(0.004)**	(0.004)**	(0.004)**	(0.004)**	(0.004)**
1996	-0.036	-0.035	-0.036	-0.035	-0.035	-0.035
	(0.002)**	(0.002)**	(0.002)**	(0.002)**	(0.002)**	(0.002)**
Constant	0.608	0.590	0.623	0.602	0.530	0.517
	(0.234)*	(0.237)*	(0.260)*	(0.238)*	(0.230)*	(0.229)*
Observations	1541	1541	1541	1541	1541	1541
Number of groups	67	67	67	67	67	67
F	9.34	10.76	21.64	18.47	32.97	33.92
Within R-Squared	0.47	0.47	0.47	0.47	0.48	0.49

Standard errors in parentheses
* Significant at 5%; ** significant at 1%
‡The coefficients show the effect of a one-unit change in the value of an indicator on the dependent variable. The values of the variables are expressed in decimal numbers in Table 3.1.This means that a unit change in Table 3.2 corresponds to a 100% change in the shares of a public investment.

3.6 Interpretation of the Results

The interpretations for variables are provided in this section. Table 3.2 shows that the variables in the model explain 47% of the change in the dependent variable. F statistics strongly reject that the coefficients for the explanatory variables jointly equal zero. Post-estimation diagnostics for the results in panel (5) in Table 3.2 are provided in the fifth chapter. Further analyses for the robustness of analyses to outliers, alternative calculations of the dependent variable, and the alternative time horizons for the dependent variable are provided in Appendix- Chapter 3, in A.3.1.

3.6.1 Public Investment in City Infrastructure and Security

Public investment in city infrastructure consists of projects for building clean water-pipe networks and sanitation systems. Additionally, investment in this sector includes spending on security and administration. The presence of sufficient water and sanitation facilities has education and health benefits. Lack of these facilities is associated with poverty and vulnerability, as they increase the prevalence of diseases, which increases mortality rates among infants and other vulnerable groups (Mara, Lane, Scott and Trouba, 2010).

For Turkey, data for facilities at schools are not available; however, the lack of or the poor quality of sanitation facilities appear to have been a problem at schools in remote villages, especially in underdeveloped provinces, until recent years (NTV, 2010; Hürriyet, 2015), so it is safe to assume that some schools did not have sanitation facilities in the years between 1975 and 1997. Then, it can be suggested that public investment projects that aim to construct safe water-pipe networks and sanitation systems can enable schools to provide these facilities, or they can help schools which provide sanitation facilities to improve the quality of the restrooms.

As explained in the section for the regression model, the sanitation facilities at schools can impact on schooling ratios for several reasons. For girls, gender-specific facilities may increase their sense of privacy and safety, which may increase enrolment rates. Empirical evidence regarding the relationship between the availability of sanitation facilities and enrolment rates shows that the benefits of access to toilets at school are higher for the younger age group among children. Although sex-specific toilets benefit the enrolment rates for children at all age groups, their effects are reported to be greater for higher age groups at upper primary school level (Adukia, 2013).

Access to water and sanitation facilities in households may have indirect effects on schooling indicators for children. It can reduce the time children spend at home due to illness and improve the attendance ratios. Availability of clean water in households can reduce the time and effort children spend to collect water. It can also increase the amount of time parents spend in labour that would previously have been expended on fetching water, and may thus have a positive impact on the level of household income (Brennan and Kerf, 2002).

3.6.2 Public Investment in Education

The results do not show any statistically significant relationship between the share of public investment in education in GDP and the gross enrolment rates for Turkey. This could arise for several reasons. Firstly, as suggested in Filmer (2007), building schools alone may have only a small effect on children's education and the quality of teaching, school equipment and environment may be more effective for improving primary and middle school gross enrolment rates.

Although the results do not provide statistical evidence for a positive effect of public investment in education on primary and middle school enrolment rates, it is possible that it improves other education indicators, such as attendance, or persistence rates. Public investment projects related to primary schools and middle schools include construction of accommodation buildings for teachers and students, purchase of school equipment, and maintenance of schools. These investments may contribute to the quality of education in general. Public education investment includes projects that are related to the secondary and tertiary education too. Thus although there does not appear to be a statistical relationship between public education investment and the five-year forward moving arithmetic average of primary and middle school enrolment rate, it may have an impact on education indicators in secondary and tertiary education.

The regression model provided above assumes that the levels of investment in education, city infrastructure and security, health, transportation and communication, and energy infrastructure are determined independently from each other. This may not be the case for public investment in education, if the maintenance of a school in a given area depends on the availability or the quality of infrastructure in practice. This point is relevant to the discussions if the construction or the maintenance of sanitation facilities at schools as part of the public education investment depends on the existing city infrastructure.

In short, further research is needed to investigate the relationship between public education investment and the level of education in Turkey. This requires collecting data for education indicators to measure attendance and persistence ratios for primary, secondary and tertiary education. The analysis also requires indicators related to quality of education such as the number of students per classroom, and per teacher. Due to the time and resource limits, this exercise has not been carried out in relation to research for this thesis.

3.6.3 Public Investment in Transportation and Communication

There does not appear to be any statistical relationship between the share of public transportation and communication investment in GDP and the five-year forward moving arithmetic average of the gross enrolment rate. Considering the results and discussions in the earlier chapter, this can be interpreted as an indication of the lack of productivity in the investment projects in this sector.

3.6.4 Public Investment in Health

This public investment component is expected to have indirect linkages with the gross enrolment rate, as health clinics in Turkey engage in activities that provide public education and health to local communities, which can positively impact on gross enrolment rate. However, public investment in health does not appear to be related to the gross enrolment rate in primary and middle schools. Public investment in health is discussed in more detail in the fourth chapter.

3.6.5 Public Investment in Energy

Public investment in energy infrastructure is expected to have an impact on the gross enrolment rate by improving standards of living. As stated earlier, public investment projects in this sector are related to construction of energy sources and electricity networks. The effect of energy infrastructure on development is discussed in relation to access to modern energy sources. Similar to city infrastructure, available energy infrastructure can impact on the gross enrolment rate by its positive effect on household welfare and the quality of education at schools. However, results in this chapter do not provide any statistical relationship between public infrastructure investment and the gross enrolment rate.

3.6.6 Infant Mortality Rate

The results provide statistical evidence for a negative relationship between the infant mortality rate and the long-run gross enrolment rate. Infant mortality rate is included in the regressions as a proxy for children's health status in the provinces. It is also strongly associated with poverty (Peña, Wall and Persson, 2000). Infant mortality rates are associated with maternal education and health, environmental factors such as contaminated water, soil, air, and nutrition (Mosley and Chen, 1984, p.27). Thus, it is relatively safe to assume that the factors that are related to the causes of infant deaths in an area directly or indirectly affect school-age children.

In Turkey, the Death Statistics Report for 1975 (published by the Turkish Statistics Office) lists the most common causes of infant deaths as birth injury, difficult labour (and other anoxic and hypoxic conditions) and pneumonia. Twenty-two percent of infant deaths are related to birth, while 23% are due to pneumonia, both of which combined total half of all infant deaths. The other common causes of infant deaths in 1975 are enteritis and other diarrhoeal diseases (13%), and malignant tumours (4.5%). The causes of 23% of the infant deaths are categorised as "other reasons", and 3% of infant deaths appear to be due to symptoms and conditions that could not be associated with any diagnosis.

Among the several causes of death for infants, pneumonia, and enteritis and other diarrhoeal diseases are likely to be affecting a proportion of school-age children, which would have a negative impact on gross enrolment rates.

Infant deaths related to complications during labour can be interpreted as an indication of deprivation. Lawn et al. (2009) report a negative association between the neonatal death rates and access to skilled health care during labour, and state that countries with higher rates of neonatal mortality rate are also the countries with higher rates of maternal death during labour. In the majority of these cases, the labour takes place at home (p.12). The factors that lead to infant death due to labour complications (such as the lack of health facilities, or cultural preferences) are likely to affect children's education.

3.6.7 Adult Education Indicator

For the adult education indicator, the share of high school and university graduates in the adult population is used. The coefficient for the adult education indicator is negative, which contradicts findings in the literature (Bangaarst, Frank and Lesthaeghe, 1984; Clealand, Casterline, Singh and Ashurst, 1984; Cleland and Roriguez, 1988; Martin, 1995; Ainsworth, Beegle and Nyamete, 1996) which suggest that parent's education has a positive impact on children's education.

The adult education indicator may have a negative coefficient firstly because the share of high school and university graduates in the adult population may not be a correct proxy for parent's education. Summary statistics show that only a small proportion of the population in the sample has a high school or university degree. On average, the adult literacy rate is expected to be considerably higher than the value of the adult education indicator across the country. Secondly, the negative sign for this variable could arise due to the internal migration between provinces. Kocaman and Bayazit (1993) indicate that the primary reason for internal migration in Turkey is unemployment. This would reduce the adult education indicator for the industrialised provinces in the long run, as these provinces are likely to accumulate higher shares of unskilled labour in the long run. Industrialised provinces would also be those with higher gross enrolment rates due to better infrastructure and more available schools.

3.6.8 GDP per capita

There does not appear to be a statistically significant relationship between the logarithm of GDP per capita and the five-year forward moving geometric average of the gross enrolment rate. GDP per capita is included in the regressions to control for the effect of income level on enrolment rates. It is expected to have a positive relationship with the long-run gross enrolment ratio, as families with higher income are more likely to send their children to school as the cost of education puts less strain on their budget relative to low-income groups. It can be considered to be a control variable for the wage rates too, which provides an incentive for education.

There are a few possible reasons for the statistically insignificant relationship between GDP per capita and the five-year forward moving arithmetic average of the gross enrolment rate. Firstly, if GDP per capita were considered to be a proxy for household income level, results would suggest a weaker relationship between the household income and gross enrolment rate in the long run compared to the short run. That is, households may decide to enrol their children in school depending on their income in the given year. The effect of household income in time t on the decision to enrol children at school in time $t+1$, $t+2$, $t+3$ and $t+4$ may gradually decrease and vanish.

Similarly, if GDP per capita were reflecting the differences in wage rates across provinces, the results would suggest that households make schooling decisions every year by taking the contemporaneous values of the wage rates into account. Thus, the effect of wage rates in year t on the decision to enrol children at school in the years $t+1$, $t+2$, $t+3$ and $t+4$ may gradually diminish and disappear as the time gap increases.

Column (1) in Table A.3.1.2 in Appendix A.3.1 shows that there is a positive relationship between the logarithm of GDP per capita and the contemporaneous values of the gross enrolment rate. Thus, the results in the appendix appear to support the explanations above.

In both cases, the relationship between the current values of the wage rate or household income and schooling decision may weaken in the long run due to uncertainty. For example, as the uncertainty increases, current values of the wage rate would become less reliable for predicting the future returns to education. In Brown, Fang and Gomes (2015) and Jensen (2010), uncertainty is suggested to be a factor that reduces the expected (or perceived) returns to education.

Additionally, if the households expect variations in their future income, they may make schooling decisions for their children for the short run. That is, if the household income is volatile, the households may enrol their children at schools only when they can afford the cost of their education. Thus, the volatility of household income may reduce the effect of this indicator on the schooling decision in the subsequent time periods.

Considering that Turkey experienced a debt crisis in 1977, a foreign exchange crisis between 1978 and 1980, a military coup in 1980, and financial crises in 1991, 1994, 1998 and 1999, uncertainty may arise as a major factor that weakens the relationship between income or wage rate and the gross enrolment rate in the long run.

The other possible explanation for a statistically insignificant relationship between GDP per capita and the five-year forward moving arithmetic average of the gross enrolment rate is the inadequacy of this indicator to reflect the level of household income or the wage rate. As explained in the section about the regression model, GDP per capita is used instead of these variables as data for wage rates or household income are not available for the provinces for the years between 1975 and 2001.

3.6.9 Population Growth Rate

The results indicate a negative relationship between population growth rate and the long-run gross enrolment rates for primary and middle school. Population growth rate is included in the regressions to control for the number of school-age children in the population. As it increases the denominator of the dependent variable, there appears to be a negative relationship between the population growth rate and the five-year forward moving arithmetic average of the gross enrolment rate.

3.6.10 Martial Law

The variable for martial law has a positive and statistically significant coefficient in all columns. This could be due to the positive effect of security on enrolment rates. Martial law controls the effect of change in governance and takes the value of “1” at times of military governance. In provinces where the army steps in to provide governance, the sense of security may improve in the long run, increasing the enrolment rates for children.

3.6.11 Dummy Variables

Finally, the coefficients for dummy variables are negative and statistically significant for the years between 1975- 1983 and 1986-1996 for the five-year forward moving arithmetic average of the gross enrolment rate. The dummy variable for the year 1997 is left out of the regressions to avoid perfect co-linearity. Thus, the dummy variables for the years in the regressions show the effect of the given year.

For the years between 1975 and 1997, the trend of the five-year forward moving arithmetic average of the gross enrolment rate is positive for Turkey, and, hence, the value of the dependent variable takes the highest value in 1997. Because the dummy variables for the years take the value of “1” for all years except 1997, and because the value of the dependent variable is higher for 1997 compared to preceding years, the time effect for the year dummies in the regressions are all negative, and most of them are statistically significant.

3.7 Conclusion

The relationship between public investment and the long-run gross enrolment rates has been analysed in this chapter. The results indicate a positive relationship between public investment in city infrastructure and security and the long-run gross enrolment rates in Turkey for the years between 1975 and 1996. Results for the positive effect of public city infrastructure and security investment appear to lend support to development literature which suggests that access to infrastructure positively impacts on education.

Although results in the second chapter show that public education investment is positively associated with the long-run growth, this third chapter does not provide any statistical evidence regarding the relationship between public education investment and the long-run gross enrolment rate. This can be an implication that gross enrolment rates are not reliable to measure the educational outcome. For thorough analyses, the data for attendance and persistence ratios should be obtained from archival sources for further empirical analyses.

For the econometric method, the fixed-effects panel technique with Driscoll and Kraay standard errors is chosen. Post-estimation diagnostics provide statistical evidence for the robustness of model specification and the functional form. Unit root tests provide evidence that data for variables are stationary, with the exception of the adult education indicator. Nevertheless, excluding the adult education indicator from the regressions does not change the results. Robustness analyses in the chapter appendix (A.3.1) provide co-linearity diagnostics that show a considerably high variance inflation factor, which reduces the reliability of the inferential statistics for the models in which the dependent variable is specified as ten-year or fifteen-year forward moving arithmetic average of the gross enrolment rates due to reduction in the sample.

This chapter supports the implications of the second chapter that policy makers should focus on providing sufficient infrastructure to increase enrolment in schools. Educational institutions that do not have access to city infrastructure can remain obsolete or ineffective, which can have a negative impact on the enrolment rates in the long run. The effect of public city infrastructure and security services on attendance and persistence ratios can be even higher. This chapter provides evidence that encourages further research in this topic.

CHAPTER 4: PUBLIC INVESTMENT AND HEALTH

The fourth chapter is about the effect of public investment in energy infrastructure, education, health, city infrastructure and security services, transportation and communication on long-run infant mortality rates in Turkey. Data, methods and results for this chapter are very similar to the third chapter; as a result, the sections are organised identically to the earlier chapter.

4.1 Introduction

Health, apart from being essential for individual welfare, is one of the factors that measure the level of development in a society. The majority of recent studies report a negative relationship between public health expenditure and infant/child mortality rates. As in the case of education, available public infrastructure can have an impact on health status. The effect of availability of public infrastructure is more prominent in the case of infant mortality rates, because this indicator has a strong relationship with poverty. The literature provides evidence that an increase in poverty is associated with higher infant mortality rates (Gortmaker, 1979; WHO, 2015b). In the development literature, poverty is understood to be a broad concept that has connections with a reduction in living standards. This relates poverty to a lack of facilities that would improve both quality and the length of life, such as access to safe water and sanitation facilities, to energy source, and to public transport, all of which constitute public infrastructure.

Although there have been attempts to examine the relationship between access to public infrastructure and poverty, the literature still lacks empirical analyses that investigate the effect of public investment in infrastructure on health. This chapter contributes to the literature by providing an empirical study of the relationship between public infrastructure investment and the long-run infant mortality rates. The variables for public infrastructure investment are public energy infrastructure investment, public city infrastructure and security investment, and public transportation and communication investment. The long-run infant mortality rate is measured by the five-year forward moving arithmetic average of the infant mortality rate.

Access to safe water and sanitation facilities has long been acknowledged as one of the factors associated with poverty. Availability of public transport has also been addressed as a factor that improves the accessibility of education and health facilities for the poor. Lack of access to energy has emerged as one of the dimensions of poverty recently, but since then there has not been any research carried out that examines the relationship between the level of public energy infrastructure investment and poverty or health. This chapter aims to address this gap. Additionally, in this chapter, the relationship between public health investment, public education investment and the long-run infant mortality rates is studied.

The dataset used in this chapter consists of 67 Turkish provinces, and 27 years. The fixed-effects method is used as an econometric technique and standard errors are corrected for serial correlation according to Driscoll and Kraay (1998).

The results provide evidence that the effect of public investment in energy infrastructure, city infrastructure and security services on the long-run infant mortality rates is negative. There does not appear to be a statistical relationship between the share of public education investment in GDP, the share of public health investment in GDP and the five-year forward moving geometric average of infant mortality rates.

Analyses in Appendix-Chapter 4 suggest that the robustness of the relationship between public city infrastructure and security investment and the five-year forward moving arithmetic average of the infant mortality rate is weak. Its coefficient becomes statistically insignificant when the provinces that change administrative status between 1975 and 2001 are excluded from the sample. Additionally, co-linearity arises as a problem in regressions. For the fifteen-year forward moving arithmetic average of the infant mortality rate, the coefficient for public city infrastructure and security investment becomes negative with a statistically significant sign. Further details can be found in the relevant section.

Post-estimation diagnostics in the fifth chapter show that the Ramsey regression specification error test rejects the null hypothesis that the regression model is correctly specified; however, this appears to be due to non-normality in the distribution of the error terms. The Lagrange multiplier test for model specification indicates that the model does not suffer from misspecification and omitted variable bias. As mentioned in the third chapter, the unit root tests for the adult education indicator accept the null hypothesis that the data for this variable contain a unit root. However, excluding this variable from the regression does not change the results.

4.2 Literature Review

The development literature that is concerned with the determinants of infant mortality rates indicates that access to public infrastructure increases the likelihood of survival for children (Fay, Leipziger, Wodon and Yepes, 2005). Public infrastructure can be grouped into three sub-categories: energy infrastructure, water and sanitation facilities, and public transport services.

The positive relationship between access to water and sanitation facilities and public health has been the focus of many studies (Woldemicael, 2000; Gamper-Rabindran, Khan and Timmins, 2010; Günther and Fink, 2011; Cheng et al., 2012). The effect of transportation facilities on infant health has been investigated by using "distance to nearest health facility" as an indicator (Feikin et al., 2009; Müller et al., 1998). Although access to modern energy sources is mentioned as a factor that is expected to contribute to the likelihood of children's survival (Mosley and Chen, 1984), there are only a few empirical papers in the literature that take "access to modern energy source" into account (Wang, 2003; Fay et al., 2005; Günther and Fink, 2011). Nevertheless, access to modern energy sources appears to have been studied in connection with poverty (Cecelski, 2000; Karekezi, 2002; Cook et al., 2008; Burke, Echagüe and Youngs, 2008).

Given the evidence above, this chapter contributes to the literature by providing empirical analyses for the relationship between public infrastructure investment and the infant mortality rates. As discussed in the second chapter, public infrastructure investment is considered to complement the private sector capital, and contribute to its productivity, which leads to economic growth. It is also assumed to have large positive externalities that offset the crowding-out and market distortion effects of government intervention. Considering the positive relationship between availability of public infrastructure and health, there appears to be grounds for public policy in this area.

As part of this study, results for the relationship between public health and education investment, and the long-run infant mortality rate will be provided and discussed. There is a vast body of literature that examines the relationship between public expenditure in health and health outcome. Indicators that are commonly used to measure health are infant mortality rate, under-five mortality rate, adult mortality rates, or life expectancy. Among the most recent studies, Baldacci, Guin-Siu and

Mello (2003), and Schell, et al. (2007) find no relationship between public expenditure on health and the level of health, while Anyanwu and Eskisopar (2009), Ravikumar and Swaroop (2008), Bhalotra (2007), and Farahani, et al. (2010) report a positive relationship between the level of public health expenditure and health outcome. The results in this chapter show that there is no statistical relationship between public health investment and infant mortality rates.

As in the earlier chapters, to account for a lag in the effect of public investment on the infant mortality rate, and to avoid reverse causality in the results, the dependent variable is specified as the five-year forward moving arithmetic average of the infant mortality rate. The variables for public infrastructure investment are, as in the third chapter, the share of public energy infrastructure investment in GDP, the share of public transportation and communication investment in GDP, and the share of public city infrastructure and security investment in GDP.

WHO (2015a, p.18) provides a list of indicators that measure health status. These are grouped as mortality, morbidity and fertility indicators. Life expectancy, adult mortality rate between 15 and 60 years of age, under-five mortality rate, infant mortality rate, neonatal mortality rate, and still birth rate are classified as mortality rates by age. Mortality indicators can also reflect the cause of death, such as maternal mortality ratio, tuberculosis mortality rate, AIDS-related mortality rate, and malaria mortality rate. Morbidity rates are the indicators that measure the incidence or prevalence of diseases such as vaccine-preventable diseases, HIV, Hepatitis B, sexually transmitted diseases, tuberculosis, malaria or cancer.

Hunt and McEwen (1980, p.233) observe that the advantage of the mortality rates is the availability of these data, but their disadvantage is that they are relatively crude indicators of health. The authors state that morbidity rates measure health in a broad sense, but data for these indicators tend to be scarce and of varying quality.

In this chapter, health outcome is measured by the infant mortality rate. This indicator has been used as a development indicator by the UNDP in human development reports since 1990. This is primarily due the fact that infants are in the population group most vulnerable to reduction in living standards due to their susceptibility to disease. In the case of Turkey, the high rate of infant mortality is addressed in the fourth development plan for the years between 1979 and 1983 as the most important factor that reduces life expectancy in the country (DPT, 1980, p.24).

High infant mortality rates are also mentioned as a problem in the fifth, sixth, and seventh plans for development, for the years between 1983-2000 (DPT, 1988, 1994, 1995).

Although it would be ideal to use other types of health indicators listed above in addition to the infant mortality rate for more robust analyses, the data for mortality rates for other age groups, or for the cause of death, or indicators of morbidity are not available for Turkish provinces for the years between 1975 and 2001. One could derive other types of mortality indicators using archival sources for death statistics; however, the time scope of this task exceeds the time and resource limits allocated for this research project.

4.3 Regression Model

In this chapter, the variables for the regression model are the same as in the third chapter. This is because both primary school enrolment rates and infant mortality rates are development indicators[3]; thus, factors that have an impact on one, have a relationship with the other. This is also due to the unavailability of indicators such as birth weight and vaccination that explain the change in the long-run infant mortality rate. Although some studies (Baldacci, Guin-Siu and Mello, 2003; Gupta, Verhoeven and Tiongson, 1999) use the urbanisation rate as one of the explanatory variables, the Ramsey and Lagrange multiplier tests for model specification and omitted variable bias cannot accept the null hypothesis that the model is correctly specified when the urbanisation rate is included in the regression model. In this thesis, the topics on the relationship between public investment, the long-run gross enrolment rate, and the relationship between public investment and the long-run infant mortality rate are analysed in separate chapters to provide more detailed explanations.

The estimated equation in regressions is:

$$Y = \propto + \beta_1 \frac{Public\ Energy\ Investment}{GDP} + \beta_2 \frac{Public\ Transportation\ Investment}{GDP} + \beta_3 \frac{Public\ Education\ Investment}{GDP} + \beta_4 \frac{Public\ Health\ Investment}{GDP} +$$

[3] One could argue that the five-year forward moving arithmetic average of the gross enrolment rate and the five-year forward moving average of the infant mortality rate are simultaneously determined. However, this is not likely to be the case, as the indicators are calculated for different age groups. For the same reason, in the regression model in the third chapter, the infant mortality rate was used as a proxy for school-age children's health. This is because it was expected in the analyses that the common cause of death in infants (such as water-borne diseases) would also affect the school-age children.

$$\beta_5 \frac{Public\ City\ InfrastructureandSecurity\ Investment}{GDP} \beta_6 \frac{Private\ Capital}{GDP} + \beta_7 Population\ Growth\ Rate + \beta_8 Martial\ Law + \beta_9\ Adult\ Education\ Indicator + \sum_1^t Dummy\ Variable\ for\ Years + u_i$$

The indicators in the equation above are described below:

$\propto$ is the intercept which also captures the fixed (or individual) effects. Y is the dependent variable, which is the five-year forward moving arithmetic average of the infant mortality rate.

The coefficients of interest are those for public investment in energy, β_1 , public investment in transportation and communication, β_2, public investment in education, β_3 , public investment in health, β_4 , and public investment in city infrastructure and security services, β_5. The variables are computed as the shares of GDP.

In the model, to measure health, the infant mortality rate is chosen as this is an indicator which is responsive to the change in living standards. Hence, the effect of public polices to improve public welfare can be observed as a fall in infant mortality rates in developing countries. Given that the government in Turkey set targets to reduce infant mortality rates in the years between 1975 and 2001 (DPT, 1979), the forward moving average of this indicator is used as the dependent variable to reduce the possibility of reverse causality in the results.

It should be noted that infant mortality rate is considered to be insufficient to measure the level of health in a population on its own, firstly because it does not always reflect the status of health in older population groups (Reidpath and Allotey, 2003). Mosley and Chen (1984) point out that it is restrictive to measure health by infant mortality rate. They recommend an index that includes a measure for growth faltering, malnutrition and child mortality rate which can reflect the cumulative effect of diseases. Height is recommended by Schults (2003) as an indicator that reflects the nutrition and the frequency of diseases experienced in childhood since children who fall ill periodically tend to grow less. However, data for these indicators (growth faltering, nutrition or average height of children) are not available for provinces in Turkey; as a result, the outcome variable is chosen as the five-year forward moving arithmetic average of the infant mortality rate.

There is strong evidence in the literature of a positive relationship between infrastructure and health. Accessibility of clean water and sanitation facilities is reported to have a strong relationship with infant and child mortality rates (Woldemicael, 2000; Gamper-Rabindran et al, 2010; Cheng et al, 2012). The relationship arises firstly because the availability of clean water and sanitation facilities reduces the prevalence of water-borne diseases, which are associated with mortality rates in the younger age group (Victora et al., 1988; Esrey, Potash, Roberts and Shiff, 1991). Secondly, the reduction in diarrheal diseases is associated with lower risk of malnutrition among children (Prüss-Üstün, 2008), which increases the likelihood of survival. Additional benefits are listed by Rosen and Vincent (1999) as improvements in nutrition through increased use of water for cooking, and potential cost benefits by reducing the time, energy and health costs of collecting water. In the literature, this factor is measured as the percentage of the population who have access to safe water and sanitation facilities (Gupta, Verhoeven and Tiongson, 1999; Filmer and Pritchett, 1997).

Kaygusuz (2011, pp.940–941) lists the use of energy services for basic needs as cooking, lighting, access to household appliances, and community uses. For cooking, poor households use wood, dung or charcoal, which are less effective compared to modern sources of energy such as bio-gas, LPG, kerosene or electricity. Lighting is pointed out to be a basic need that improves living standards. Public lighting and supply of energy for public services such as health centres can also contribute positively to the level of development.

WHO (2006) states that sources of energy used for cooking other than wood or coal – such as liquid petroleum, gas, electricity or solar power – help to reduce indoor air pollution, which contributes to protecting children's health. An energy infrastructure is needed for providing health services as the operation of staff and equipment requires electricity. Availability of electricity can reduce the cost of boiling water, which improves hygiene (Brenneman and Kerf, 2002). The evidence from studies that assess the willingness to pay for energy services shows that the poor are inclined to pay the full cost for electricity services, and that the cost of energy is higher for the poor in rural areas despite their having limited access to modern energy sources (Cook, Duncan, Sharma and Wu, 2005, p.16). In short, access to energy arises as an important factor that increases the quality of life.

It is observed in the literature that better transportation facilities increase the accessibility of health services for the poor, as the majority of the poor live in remote areas. Better transportation facilities can improve the quality of health care by attracting human resources to remote areas where the health centres tend to be understaffed (Brenneman and Kerf, 2002, p84). However, the difficulty in travelling to a health centre can discourage individuals from seeking health care (Feikin et al., 2009; Müller et al., 1998).

Availability of communication technologies is stated to be one of the factors that enhance health services. Health care providers require patient information and they operate by exchanging information between health centres, which can be done through communication facilities (Brenneman and Kerf, 2002, p57).

In the second chapter, it has been explained that the provision of public infrastructure services by governments is associated with higher growth rates as public capital complements private sector capital. Goods and services in this sector have high positive externalities, and non-rival characteristics that justify a government's intervention. In this chapter, public investment in energy, city and security services, and transportation and communication will be used as input measures.

In addition to the public investment indicators above, the empirical results for the relationship between public health investment and the long-run infant mortality rates will be provided as part of the research. Conley and Springer (2001) suggest two routes for how public health expenditure may reduce infant mortality rate. One of the routes is through the effect of public health spending on mother's health via screening, prenatal care, and risk reduction (such as by reducing consumption of cigarettes and alcohol during pregnancy). This is called the indirect effect of public health spending on infant mortality rates, and is named the "social effect". The second route is the direct effect of public health spending on infant mortality by providing better care for infants through better equipped and staffed hospitals and medical institutions. The authors point out the fact that, in the case of public expenditure in health in the form of capital, such as hospital buildings, vehicles or equipment for health care, the effect of public spending in health may take place with a lag. Current public health expenditure may also have a lagged impact on infant mortality, as the mother's health a couple of years before birth is one of the determinants of infant mortality.

In studies using household data to explain the determinants of infant mortality rate, parent's education is proposed as an important factor that increases the likelihood of an infant's survival (Martin, Trussell, Salvail and Shah, 1983;

Mellington and Cameron, 1999; McMahon, Kovar and Seldman, 1972; Rosenzweig and Schultz, 1982; Caldwell, 1979). Additionally, there are various studies that use a cross-section of countries that report a positive relationship between parent's education and children's health status (Filmer and Pritchett, 1997; Gupta, Verhoeven and Tiongson, 2002; Anyanwu and Erhijakpor, 2009; Martin et al., 1983; Mellington and Cameron, 1999; McMahon, Kovar and Seldman, 1972; Rosenzweig and Schultz, 1982; Caldwell, 1979).

Parent's education is also associated with lower fertility rates (Bangaarst, Frank and Lesthaeghe, 1984; Clealand et al., 1984; Cleland and Rodríguez, 1988; Martin, 1995; Ainsworth, Beegle and Nyamete, 1996), which has a negative relationship with child mortality rates (Conley & Springer, 2001). The infant mortality rate is strongly associated with the mother's education, as the infant's care – which changes the likelihood of the infant's survival – is provided by the mother. Feeding, hygiene, and benefits of health care during the infant's development improve as the mother's level of education increases (Peña, Wall and Persson, 2000).

In this study, to control for the effect of parent's education, the adult education indicator is included in the regressions[4]. The drawback of the adult education indicator is that it reflects the share of university and high school graduates over 17 years old in the population. However, in empirical studies for the determinant of infant or child mortality rates, the adult literacy rates are used to measure parent's education. Nevertheless, it is not possible to obtain data for the adult literacy rates at regional level for Turkey for the years between 1975 and 2001.

Public investment in education is also included in the regressions as this type of investment in Turkey includes projects to improve adult education in rural areas. Government policy for the years between 1975 and 2001 set targets to improve the level of education among adults in rural areas through informal education (DPT, 1989). This may have a positive impact on the literacy rates in poor areas, which may decrease the infant mortality rates.

[4] It is also possible to use the gross enrolment rate as a proxy for the adult literacy rate, as the school-age children who are enrolled in school are likely to become literate parents in the long run, especially in areas where the marrying age is below eighteen. However, when the adult education indicator is replaced by the gross enrolment rate, although results remain similar (see Table A.4.5 in Appendix- Chapter 4), both the Ramsey regression specification error test and the Lagrange multiplier test reject the null hypothesis that the model is correctly specified. The statistics for model specifications tests are provided in Appendix- Chapter 4.

As the infant mortality rate is very sensitive to the change in living standards, it is strongly related to the level of income at household and country level. Income per capita is included in regressions in papers (Kim and Moody, 1992; Filmer and Pritchett, 1997; Conley and Springer, 2001; Gupta, Verhoeven and Tiongson, 1999) that assess the impact of health expenditure on health status, because families with higher income tend to be able to afford better health care. Higher income would also be associated with more developed infrastructure due to the link between public infrastructure and economic growth. In this thesis, the logarithm of GDP per capita is used to capture the effect of income on health status in the provinces. GNI data are not available for the provinces for the years between 1975 and 2001.

There are additional factors that may have an impact on public health status, such as immunisation, child nutrition, and the birth weight for infants; however, these indicators are not available for the provinces in Turkey for the years between 1975 and 2001. For infants, vaccination, nutrition and birth weight are likely to be associated with the parent’s income, and education. Variables to control for income and parent’s education are included in the regressions. For the robustness of the results, model specification tests are provided in the fifth chapter.

4.4 Data

The sample used for this chapter is identical to the one in the third chapter except for the dependent variable. The summary statistics for control variables are discussed in the earlier chapter, and will not be repeated in this section. The dependent variable is calculated as the five-year forward moving arithmetic average of infant mortality rate, which is: $IMR_{it\ to\ t+4} = \frac{IMR_{it}+IMR_{it+1}+\cdots+IMR_{it+4}}{5}$

In the equation, IMR_{it} is the infant mortality rate for time t in province i and is defined as the share of the number of infant deaths in the total number of infants. $IMR_{FMA_{t\ to\ t+4}}$ is the five-year forward moving arithmetic average of the infant mortality rate.

Data for the number of infant deaths are taken from the annual death statistics published by the Turkish Statistical Institute. The dataset for the number of infants is derived from the census data collected in 1975, 1980, 1985, 1990, and 2000. The number of infants between censuses is calculated by assuming the value of the indicator in a census year would grow at the average annual growth rate between the censuses.

Summary statistics for the dependent variable are presented in Table 4.1. The average of the five-year forward moving arithmetic average of the infant mortality ratio is approximately 1.5%. For 1990, the average for the world is 6.27%, according to WorldBank data (2015). This is 1.19% for high-income countries. As a result, it can be seen that, for the years between 1975 and 2001, the average of infant mortality rate for Turkey is below the world average, but higher than the average of the infant mortality rates for high-income countries. The maximum is observed in Istanbul in 1975, and the minimum value, 0.006%, in Gumushane in 1987. The highest panel mean is 5.1% for Eskisehir, and the lowest is 0.03% for Gumushane. Both the maximum and the minimum deviation within panels are seen in Istanbul. Gumushane arises as the province that has the lowest overall minimum value and minimum panel mean for all the dependent variables. Istanbul and Gaziantep are the provinces that have the maximum values over all the observations and maximum means between panels for the five-year forward moving arithmetic averages of the infant mortality rate.

Table 4.1 Summary Statistics

Variable		Mean	Std. Dev. ‡	Min	Max	Obs. ł	
Five-year Forward Moving Arithmetic Average of the Infant Mortality Rate	Overall	0.015†	0.012	0.001	0.080	N =	1541
	Between		0.011	0.003	0.056	n =	67
	Within		0.006	-0.013	0.045	T =	23

†The summary statistics are expressed in decimal numbers. Thus, "0.015" should be read as "1.5%" or "15‰"

‡Std.Dev.=Standard Deviation

ł Obs=The number of observations: N, the number of observations in the sample; n, the number of panels (provinces) in the sample, T, the number of time periods in the sample.

4.5 Results

The results are reported in Table 4.2. The share of public energy infrastructure investment in GDP appears to be negatively related to the long-run infant mortality rates in all columns. Additionally, the share of public city infrastructure and security investment in GDP appears to have a negative relationship with the five-year forward moving arithmetic average of the infant mortality rate.

The coefficient for the population growth rate does not appear to be statistically significant in any columns, as in the previous chapters. The coefficient for martial law is positive and statistically significant in all columns. The coefficient for the logarithm of GDP does not seem to be statistically related to the long-run infant mortality rate. The share of high school and university graduates in the adult population has negative and statistically in significant coefficients in columns (1) to (4), and positive and statistically coefficients in columns (5) and (6). The variable for martial law has a positive and statistically significant coefficient. The dummy variables for almost all years appear to have positive and statistically significant signs in Table 4.2.

Table 4.2 Relationship between the Level of Public Investment and the Long-Run Infant Mortality Rates‡

	(1)	(2)	(3)	(4)	(5)	(6)
Public Energy Infrastructure Investment	-0.008					-0.009
Proportion of GDP	(0.002)**					(0.002)**
Public Transportation Investment		-0.034				-0.027
Proportion of GDP		(0.021)				(0.024)
Public Education Investment			0.078			0.078
Proportion of GDP			(0.047)			(0.045)
Public Health Investment				0.011		0.007
Proportion of GDP				(0.026)		(0.028)
Public City Infrastructure and Security Investment					-0.162	-0.158
Proportion of GDP					(0.076)*	(0.076)*
Population Growth Rate	-0.028	-0.036	-0.032	-0.031	-0.047	-0.047
	(0.030)	(0.034)	(0.032)	(0.032)	(0.026)	(0.027)
Ln(GDP per capita)	-0.001	-0.000	-0.000	-0.001	-0.002	-0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Martial Law	0.003	0.003	0.003	0.003	0.003	0.003
	(0.001)*	(0.001)*	(0.001)*	(0.001)*	(0.001)*	(0.001)*
Adult Education Indicator	-0.005	-0.003	-0.007	-0.005	0.010	0.008
	(0.006)	(0.007)	(0.007)	(0.007)	(0.014)	(0.014)
1975	0.010	0.011	0.010	0.010	0.012	0.012
	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**
1976	0.011	0.012	0.011	0.011	0.013	0.013
	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.002)**	(0.002)**
1977	0.011	0.012	0.011	0.011	0.013	0.013
	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.002)**	(0.001)**
1978	0.010	0.011	0.011	0.010	0.011	0.012
	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**
1979	0.010	0.011	0.010	0.010	0.011	0.011
	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**
1980	0.008	0.008	0.008	0.008	0.008	0.009
	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**
1981	0.008	0.008	0.008	0.008	0.008	0.009
	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**
1982	0.007	0.007	0.007	0.007	0.008	0.008
	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**
1983	0.006	0.006	0.006	0.006	0.007	0.007
	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**
1984	0.006	0.007	0.007	0.006	0.007	0.007
	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.000)**
1985	0.006	0.007	0.007	0.006	0.007	0.008
	(0.000)**	(0.001)**	(0.000)**	(0.000)**	(0.001)**	(0.001)**
1986	0.005	0.005	0.006	0.005	0.006	0.007
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.001)**	(0.001)**
1987	0.004	0.005	0.005	0.005	0.006	0.006
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.001)**	(0.001)**
1988	0.004	0.004	0.004	0.004	0.005	0.005
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.001)**	(0.001)**
1989	0.003	0.004	0.004	0.003	0.004	0.004
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.001)**	(0.001)**
1990	0.003	0.003	0.003	0.003	0.003	0.004
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.001)**	(0.001)**
1991	0.002	0.002	0.003	0.002	0.003	0.003

	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
1992	0.002	0.002	0.002	0.002	0.002	0.002
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
1993	0.001	0.002	0.002	0.002	0.002	0.002
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
1994	0.001	0.001	0.001	0.001	0.001	0.001
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
1995	0.001	0.001	0.001	0.001	0.000	0.001
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
1996	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)	(0.000)**
Constant	0.025	0.015	0.013	0.017	0.030	0.032
	(0.010)*	(0.011)	(0.010)	(0.010)	(0.010)**	(0.010)**
Observations	1541	1541	1541	1541	1541	1541
Number of groups	67	67	67	67	67	67
F	11.61	12.36	10.82	17.53	10.16	41.52
Within R^2	0.47	0.47	0.47	0.47	0.48	0.49

Standard errors in parentheses
* Significant at 5%; ** significant at 1%
‡The coefficients show the effect of a one-unit change in the value of an indicator on the dependent variable. The values of the variables are expressed in decimal numbers in Table 4.1.This means that a unit change in Table 4.2 corresponds to a 100% change in the shares of a public investment.

4.6 Interpretation of the Results

The interpretations for the indicators in Table 4.2 are presented in this section. According to within R squared statistics, the indicators in the model in Table 4.2 in panel (6) explain 49% of the change in the five-year forward moving arithmetic average of the infant mortality rate. F statistics reject the null hypothesis that the coefficients for the explanatory variables jointly equal zero. Post-estimation diagnostics for the regression model in panel (6) in Table 4.2 are provided in the fifth chapter. The robustness of the results is further examined for outliers, and for the change in the calculation of dependent variable, and for the seven-year, ten-year, and fifteen-year forward moving arithmetic average of the infant mortality rates in Appendix-Chapter 4, in A.4.1.

4.6.1 Public Investment in Energy

As discussed in the section on the model, availability of energy infrastructure increases the standard of living. It can reduce the time and effort required to heat the accommodation, and it can decrease indoor pollution if electricity is used to replace wood for cooking. A modern energy source such as electricity enables households to use appliances such as fridges, which provide better food storage (Davis, 1998). Having an available energy infrastructure can also enable governments to extend health services in areas where electricity networks are available (Brenneman and Kerf, 2002) .

The state of the energy infrastructure in Turkey for the years between 1975 and 2001 is roughly depicted in the development reports for these years by the State Planning Organisation. Electrification of rural areas appears to be one of the government's objectives. For example, the lack of electricity in rural areas is mentioned in the State Planning Organisation report (1980, p.403). The report states that the government plans to widen the electricity network to remote villages (*ibid*, p.403). The State Planning Organisation (1988, p.197) reports that the state aims to provide electricity in all rural areas, while the DPT (1994, p.340) shows that this target had been achieved by 1988. The State Planning Organisation (1988, p.196) additionally reports capacity and maintenance problems in electricity supply, which leads to interruption of public electricity, and explains ways to deal with this problem.

The State Planning Organisation (1980, p.473) reports that, in 1979, 49.3% of households in cities and rural areas had an installation enabling them to use electricity. In rural areas, only 20.2% of households had an electricity installation, while, in the three largest cities (Istanbul, Izmir, Ankara), 93.6% of households had an installation enabling them to benefit from electricity.

Energy infrastructure is also important in the case of Turkey as the household heating facilities depend on it. The State Planning Organisation (1980, p.474) reports that a stove is the most common heating facility used in households in Turkey in the 1970s. In rural areas, a fire pit is the second most common type of heating. The State Planning Organisation (1988, p.106) explains plans for implementing projects to enable the use of central heating systems. It also raises concerns about air pollution and states that it is aimed to find alternative fuel sources for heating (p.171).

In the second chapter, the results provide statistical evidence for the relationship between public investment in energy and economic growth. One could relate the results for public energy infrastructure investment to a correlation between the long-run infant mortality rate and long-run economic growth. The infant mortality rate may proxy for health, which is also considered to be human capital (Schultz, 1961). However, the robustness analyses for the second chapter do not provide any statistical relationship between the infant mortality rates and the economic growth rate (see section A.2.3, Table A.2.3.6). Alternatively, the negative relationship between public energy infrastructure investment and the long-run infant mortality rates may partially be due to the income-improving effect of public investment in this sector. Supply of a modern energy source can increase efficiency in local agricultural and manufacturing sectors, and may create new employment opportunities for locals, which can raise their income, and reduce the infant mortality rates.

4.6.2 Public City Infrastructure and Security Investment

It appears that there is a negative relationship between public city infrastructure and security investment and health. It is likely that the relationship arises due to the projects related to basic infrastructure services for the provinces. The availability of basic infrastructure services, such as clean water pipes and sanitation systems, contributes to the standard of living by reducing the prevalence of diseases. Diarrheal water-borne diseases are a common cause of death among children. A reduction in these types of diseases prevents malnutrition among children and increases their chances of survival (Gunther and Fink, 2011). As infants are considered to be the most vulnerable group in the population, an improvement in the living standards is likely to have an impact on the mortality rates among infants.

The State Planning Organisation (1995, p.155) states that, by 1996, only 62% of the villages in rural areas had access to a safe and sufficient water supply. Twenty-seven percent of villages in rural areas had access to a safe water supply, but the amount of water was not adequate, whilst 21% of villages in rural areas lacked safe water. Among villages that had access to a safe and sufficient water supply, only 30% had access to a water allocation system for households. Finally, the report states that only 0.3% of villages had access to a sewage system. The report also explains the difficulties of establishing an infrastructure for safe water and sewage systems, which arise from insufficient returns to project investments as a result of high inflation. The State Planning Organisation (1980, p.473) reports that, by 1979, only 37.2% of households in Turkey had access to an installation to use safe water. While in rural areas only 10.5% of households had access to safe water installations, in the largest three cities (Istanbul, Izmir, Ankara) 77% of households had access to an installation for safe water. Considering the insufficient infrastructure for the years between 1975 and 2001, it is likely that provision of water and sanitation facilities had a considerable impact on public welfare.

4.6.3 Public Investment in Health

The results do not provide any statistical evidence for the relationship between public investment in health and infant mortality rates. The seventh development plan (DPT, 1995) mentions the difficulties of implementing public health policies, and how these impact on infant mortalities:

"Basic health indicators such as infant mortality rates, under-five children mortality rates, maternal mortality rates, and immunisation rates could not have been improved sufficiently. This is not only due to the problems related to health sector, but also due to the factors related to environment, nutrition, education, housing, income distribution, provision of safe water and sanitation facilities." (DPT, 1995, p.14)

The report by the State Planning Organisation explains the problems in the health sector as: 1) inefficiencies in coordination and organisation which reduce the productivity of activities. 2) Unproductive investments due to the choice of location and capacity of investment projects. 3) Instead of focusing on basic health services, infrastructure and supplying a workforce, the focus is on providing health services that rely on treatment in bed, which is more expensive. 4) The inefficiencies in the operation of hospitals due to a lack of competition in the sector and the failure to transform these institutions to independent bodies that can manage their income and expenses. 5) Inefficiencies and organisational problems in using human capital in the health sector which lead to an unbalanced distribution of health workers in the country 6) Failure in covering the overall population with health insurance policies, and lack of standardisation of these policies (DPT, 1995, p14).

The report provided by the State Planning Organisation appears to be in accordance with the results which indicate a negative relationship between infrastructure investment and infant mortality rates. There may not be any statistical relationship between public health investment and the health outcome due to the problems mentioned in the State Planning Organisation (1995). The results are in accordance with Baldacci, et al. (2003) and Schell, et al. (2007), who report no statistically significant relationship between public health expenditure and health.

4.6.4 Public Investment in Transportation and Communication

The results in this chapter do not provide any statistical evidence for a relationship between public investment in transportation and communication and the five-year forward moving arithmetic average of the infant mortality rate. This could be due to the lack of productivity in investment in this sector. It is also possible that the infant mortality rate is more strongly correlated with the environmental factors that improve sanitation. Public investment in transportation and communication is expected to be associated with health by increasing the accessibility of health clinics, as the majority of the poor live in remote areas that lack public services. Considering that public health investment is not correlated with the five-year forward moving arithmetic average of the infant mortality rate, better transportation services may not have a significant impact on the dependent variable either. Although communication services may be correlated with the infant mortality rate through giving access to information regarding basic health care, communication technologies that require a modern energy source are not likely to be available in poor households.

4.6.5 Public Investment in Education

There does not appear to be any statistical relationship between public education investment and health outcome. Public investment in education is expected to impact on children’s health by improving parent’s education. Public education policy between 1975 and 2001 aims to provide informal education for adults in rural areas, and public education investment include projects to build facilities for this purpose. However, results do not show any statistically significant relationship between public education investment and the five-year forward moving arithmetic average of the infant mortality rates.

4.6.6 Adult Education Indicator

The adult education indicator measures the share of high school and university graduates among the population over 17 years old. It has a positive but statistically insignificant coefficient. As in the third chapter, this may imply that the adult education indicator is not a sufficient proxy for the parent’s education. The State Planning Organisation (1995, p.34) refers to mother’s lack of education, the frequency of birth, and the age of pregnancy as factors that increase the infant deaths (and women’s death in labour). And so, the adult education indicator is expected to have a negative coefficient.

4.6.7 Population Growth Rate

There does not appear to be a statistically significant relationship between the population growth rate and the five-year forward moving arithmetic average of infant mortality rate. As the population growth rate leads to an increase in the denominator of the dependent variable, it is expected to have a negative relationship with the five-year forward moving arithmetic average of the infant mortality rate. However, results do not provide any statistical evidence for this.

4.6.8 GDP per capita

The coefficient for the logarithm of GDP per capita does not appear to be statistically significant, but its coefficient becomes statistically significant with a negative sign when the share of university and high school graduates in the adult population is excluded from the regressions in Appendix-Chapter 4, in Table A.4.1.5.

Existing literature suggests a strong relationship between income and infant mortality rates, as higher income is associated with higher living standards (Schell et al., 2007; Baldacci, Guin-Siu and Mello, 2003; Gupta, Verhoeven and Tiongson, 1999). Similar to the discussions in the previous chapter, the relationship between income and the five-year forward moving arithmetic average of the gross enrolment rate may not be statistically significant because infant mortality rate may have a stronger association with the contemporaneous values of the household income compared to the forward values of it. The effect of household income in time t on the infant mortality rates in time $t+1$, $t+2$, $t+3$ and $t+4$ may decrease and disappear as the time gap grows.

The results in Table A.4.1.2 in column (1) in the chapter appendix appear to support this explanation. They show a negative and statistically significant relationship between the contemporaneous values of the logarithm of GDP per capita and the infant mortality rate. As stated in the previous chapter, a statistically insignificant relationship between the logarithm of GDP per capita and the long-run infant mortality rates could also be a result of the insufficiency of the indicator of output to proxy household income.

4.6.9 Martial Law

Martial law is included in the regressions to control for the type of governance in the provinces. Although Turkey is administered by a central government, due to political turmoil between 1975 and 2001 in some provinces, the army stepped in to stabilise the areas. There appears to be a positive relationship between the state of emergency or the governance by the army and the infant mortality rates. Findings contradict the results in the third chapter, as the variable for martial law appears to have a positive relationship with the gross enrolment rate. The positive relationship between the governance of the army and the infant mortality rate may be attributed to environmental factors that require military intervention. It may be that, while military intervention positively impacts on children's school enrolment rates in the long run, environmental factors that require the military intervention (such as conflicts fuelled by poverty and unemployment) are associated with higher infant mortality rates. This may be the case, as the majority of provinces in which the army took control in the years between 1975 and 2001 are located in the East of the country, in which poverty and unemployment prevail.

4.6.10 Year Dummies

Year dummies are included in the regressions to capture the time effects. When the dependent variable is calculated as the five-year forward moving arithmetic average of infant mortality rate, the size of the dataset reduces to the years between 1975 and 1997. This is because the calculation of dependent variable for 1998 requires the value of the infant mortality rate for the year 2002, which is not available in the dataset.

In Table 4.2, the dummy variables for the years between 1975 and 1996 are included in the regressions, and the dummy variable for 1997 is excluded to avoid perfect co-linearity. The dummy variables for the years between 1975 and 1996 show the effect of the change in the year with respect to 1997. This is because the dummy variables take the value of "1" for all years except 1997. The coefficients for all the dummy variables for the years are positive and statistically significant. This arises due to the negative trend in infant mortality rates in Turkey for the years between 1975 and 1997. The average value of the infant mortality rate is lowest in 1997. Thus, when other factors are fixed, the effect of a change in the year (from 19967 to 1995, or from 1996 to 1975) is positive and statistically significant for all dummy variables.

4.7 Conclusion

The relationship between public investment and the long-run infant mortality rates has been analysed in this chapter. The results indicate a negative relationship between public investment in energy infrastructure, city infrastructure and security spending and infant mortality rates in Turkey for the years between 1975 and 1998.

The results in this chapter are consistent with those in the second and third chapters. The second chapter provides statistical evidence for a positive relationship between public energy investment and the long-run economic growth. This fourth chapter supports these findings by indicating a negative relationship between public energy investment and long-run infant mortality rates. The results imply positive externalities for energy infrastructure, which appears to have a positive effect on long-run growth and a negative effect on the long-run infant mortality rates.

The third chapter indicates a positive relationship between public city infrastructure and security services and the long-run gross enrolment rates. This fourth chapter provides evidence for a negative relationship between public city infrastructure and security services and the five-year forward moving arithmetic average of the infant mortality rates. This confirms the findings in development literature that access to infrastructure improves the levels of both education and health.

The results in this chapter do not provide any statistical relationship between public health investment and the long-run infant mortality rates. The fourth development plan observes inefficiencies in public health investment which may explain the results regarding public health investment. It also emphasises the importance of environmental factors, such as education, nutrition, housing, access to safe water, to achieve a reduction in infant mortality rates.

Public investment in transportation and communication and public investment in education do not seem to be related to the long-run infant mortality rate, which is in accordance with the findings in the earlier chapters.

Post-estimation diagnostics for this fourth chapter provide mixed results for the model misspecification tests. While the Ramsey regression test for function specification rejects the null hypothesis that the regression model is correctly specified, the Lagrange multiplier test, which allows for non-normality in error terms, indicates otherwise. Unit root tests reject the null hypothesis that the data for variables are not stationary, except the adult education indicator. However, results remain similar when the adult education indicator is excluded from the regressions. Robustness analyses in the chapter appendix indicate co-linearity as a potential problem, and, accordingly, the results change considerably for the models in which the dependent variable is specified as the ten-year or fifteen-year forward moving arithmetic average of the infant mortality rate due to the reduction in the size of the sample. The results suggest a weaker statistical relationship between public city infrastructure and security investment and the long-run infant mortality rates.

The policy implications of this chapter reinforce the conclusions from the earlier chapters that, in order to reduce infant mortality rates in the long run, policy makers should improve access to infrastructure, such as clean water and sanitation, and modern energy sources.

CHAPTER 5: POST-ESTIMATION DIAGNOSTICS

As the same econometric technique is used in the preceding chapters, the post-estimation diagnostics are provided in this chapter. After a brief introduction, the econometric technique used in the thesis is explained. Then, the method and the motivations for robust standard errors are provided. The models in the earlier chapters are tested for model specification, and the results of these tests are presented. Finally, the data used in the earlier chapters are tested for unit roots. The chapter ends with a short conclusion, which is followed by the Main Conclusion section of the thesis.

5.1 Introduction

In this chapter, robustness analyses for the regressions in previous chapters are carried out. The results provide evidence that the regression models in previous chapters are correctly specified. Heteroscedasticity, serial correlation and cross-sectional dependence in error terms appear to be issues for all chapters; however, the chosen econometric technique addresses these problems. Finally, the results for the unit root tests provide statistical evidence that all variables in the second chapter are stationary. In the third and fourth chapters, the data for the adult education indicator appear to be non-stationary; nevertheless, the results remain similar when this variable is excluded from the regressions.

5.2 Econometric Technique

As the dataset used in this thesis is panel data, the fixed-effects technique is used as the econometric method. Panel data have two dimensions, time and entities, which could be individuals, firms, regions, countries, or – as in this study – provinces. Individuals (in this case, provinces) in the dataset are likely to have unobserved characteristics that have an impact on the behaviour of the dependent variable over time; thus, results according to standard OLS techniques are prone to suffer from omitted variable bias.

One of the solutions to this problem is to subtract the panel means of the variables in the dataset. This drops the individual specific effects that are fixed in time, as the mean of a constant equals to itself. To use the fixed-effects technique, the data are transformed by subtracting the panel means, and then the standard ordinary least squares method is applied. The statistical software (Stata) carries out the transformation when the relevant estimation command is used. The assumptions of the ordinary least squares that may have an impact on results if violated are listed below:

1) This technique relies on the assumption that there is no cross-sectional or serial correlation between the error terms, and the error terms have identical variances (homoscedastic). Violation of these assumptions does not bias the OLS results for coefficients, but the inferential statistics become unreliable due to the bias in the estimation of the variance.
2) The robustness of the inferential statistics relies on the assumption that the residuals have a normal distribution.
3) In this study, the estimated model assumes a linear relationship between the explanatory variables and the dependent variable. Violation of this assumption results in biased estimates of coefficients due to model misspecification and omitted variables.
4) OLS technique for time-series and panel data assumes that data are stationary.

To establish the robustness of the results in preceding chapters, the validity of these assumptions is examined. Related to the assumptions in (1) and (2), the motivation for using Driscoll and Kraay standard errors is explained. Then model specification tests are carried out to show that the assumption in (3) holds. Finally, the results for unit root tests are provided to discuss whether panel data in this thesis are stationary.

The regression models discussed in this chapter are the following;

- For the second chapter, the robustness analyses are carried out for the regression model in Table 2.2.b column (5). The estimated equation is provided below, in which the dependent variable is the five-year forward moving geometric average of growth rate of GDP per worker.

$$Y = \propto + \beta_1 \frac{Public\ Agriculture\ Investment}{GDP} + \beta_2 \frac{Public\ Mining\ Investment}{GDP} + \beta_3 \frac{Public\ Manufacturing\ Investment}{GDP} + \beta_4 \frac{Public\ Energy\ Investment}{GDP} + \beta_5 \frac{Public\ Transportation\ Investment}{TGDP} + \beta_6 \frac{Public\ Tourism\ Investment}{GDP} + \beta_7 \frac{Public\ Housing\ Investment}{GDP} + \beta_8 \frac{Public\ Education\ Investment}{GDP} + \beta_9 \frac{Public\ Health\ Investment}{GDP} + \beta_{10} \frac{Public\ City\ InfrastructureandSecurity\ Investment}{GDP} + \beta_{11} \frac{Private\ Capital}{GDP} + \beta_{12} Population\ Growth\ Rate + \beta_{13} Martial\ Law + \sum_1^n \beta_n Dummy\ Variable\ for\ Years + u$$

- For the third chapter, the robustness of the regression model in Table 3.2 in Column (6) is examined. The estimated equation is provided below, in which the dependent variable is the five-year forward moving arithmetic average of the gross enrolment rate.

$$Y = \propto + \beta_1 \frac{Public\ Energy\ Investment}{GDP} + \beta_2 \frac{Public\ Transportation\ Investment}{GDP} + \beta_3 \frac{Public\ Education\ Investment}{GDP} + \beta_4 \frac{Public\ Health\ Investment}{GDP} + \beta_5 \frac{Public\ City\ InfrastructureandSecurity\ Investment}{GDP} + \beta_6 \ln(GDP\ per\ capita) + \beta_7 Population\ Growth\ Rate + \beta_8 Martial\ Law + \beta_9\ Infant\ Mortality\ Rate + \beta_{10}\ Adult\ Education\ Indicator + \sum_1^z \beta_z Dummy\ Variable\ for\ Years + u$$

- For the fourth chapter, the regression model in Table 4.2 in Column (6) is discussed. The estimated equation is provided below, in which the dependent variable is the five-year forward moving arithmetic average of the infant mortality rate.

$$Y = \propto + \beta_1 \frac{Public\ Energy\ Investment}{GDP} + \beta_2 \frac{Public\ Transportation\ Investment}{GDP} + \beta_3 \frac{Public\ Education\ Investment}{GDP} + \beta_4 \frac{Public\ Health\ Investment}{GDP} + \beta_5 \frac{Public\ City\ InfrastructureandSecurity\ Investment}{GDP} + \beta_6 \ln(GDP\ per\ capita) + Population\ Growth\ Rate + \beta_8 Martial\ Law + \beta_9\ Adult\ Education\ Indicator + \sum_1^\ell \beta_\ell Dummy\ Variable\ for\ Years + u$$

5.3 Driscoll and Kraay Standard Errors

In this study, standard errors for standard fixed-effects technique (applied by "xtreg, fe" command in Stata) suffer from heteroscedasticity possibly due to serial correlation and cross-sectional dependence between the error terms. As shown in Table 5.1, results for the Wald test for group-wise heteroscedasticity strongly reject the null hypothesis that the variance is identical for all observations for models in previous chapters.

Table 5.1 Results for Wald Test for Group-wise Heteroscedasticity

H0: $\sigma_i^2 = \sigma^2$ for all	**Chapter 2 (Table 2.2.b, Column 5)**	**Chapter 3 (Table 3.2, Column 6)**	**Chapter 4 (Table 4.2, Column 6)**
χ^2(67)	2372.24	12237.05	21337.75
Prob>χ^2	0.0000	0.0000	0.0000

Additionally, computing the dependent variable as the five-year forward moving geometric average of the growth rate in the second chapter, the five-year forward moving arithmetic average of the gross enrolment rate in the third chapter, and the five-year forward moving arithmetic average of the infant mortality rate in the fourth chapter introduces serial correlation to the error terms, as the dependent variables between t and $t + 5$ become correlated (Devarajan, Swaroop and Zou, 1996). The standard errors are corrected for serial correlation up to five lags as the dependent variables are computed as the five-year forward moving averages of the outcome variable. The pair-wise correlation coefficients for the error terms are provided in Table A.5.1.1 for the second chapter, in Table A.5.1.2 for the third chapter, and in Table A.5.1.3 for the fourth chapter. The statistics show that the correlation between the error terms decreases as the number of time periods increases between them, but the size of the correlation between error terms remains high over all years in all tables.

Additionally, standard errors obtained from the standard fixed-effects technique suffer from cross-sectional dependence. Pesaran's, Friedman's and Frees' methods are employed for tests for cross-sectional dependence between error terms. For Stata, Breusch-Pagan test is the one that is commonly used for cross-sectional dependence for panel datasets, but this test cannot be used for panel datasets that have more panels (n) than the number of time periods (T). De Hoyos and Sarafidis (2006) provide tests for cross-sectional dependence in Stata using Pesaran's, Friedman's and Frees' methods which can be applied to a panel dataset for which the number of panels is greater than the number of time periods. In Table 5.2 and Table 5.3, the results for all three tests are provided. Sarafidis and De Hoyos (2006) note that Pesaran's and Friedman's methods are not reliable when the sign of the correlation between error terms switches signs, as their computation requires the sum of the pair-wise correlation coefficients instead of the sum of squared correlation coefficients. Thus, negative and positive correlation coefficients would cancel out the effect of each other according to these methods, which may result in accepting the null hypothesis that there is no cross-sectional dependence. Frees' test does not suffer from this drawback.

Table 5.2 Results for Pesaran and Friedman tests for Cross-Sectional Dependence

Correlation coefficient	Chapter 2 (Table 2.2.b, Column 5	Chapter 3 (Table 3.2, Column 6)	Chapter 4 (Table 4.2, Column 6)
Pesaran	-2.695	0.914	1.052
Probability	0.0070	0.3606	0.2926
Friedman	5.117	17.208	29.177
Probability	1.0000	1.0000	1.0000
Average Absolute Value of the Diagonal Elements in the Correlation Matrix	0.326	0.500	0.525

Table 5.3 Results for Frees' Test for Cross-Sectional Dependence

Correlation coefficient	Chapter 2 (Table 2.2.b, column 5)	Chapter 3 (Table 3.2, column 6)	Chapter 4 (Table 4.2, column 6)
Frees	5.228	17.281	18.802
	Critical Values from Frees' Q distribution for T<30		
α=0.10	0.1231	0.1124	0.1124
α=0.05	0.1611	0.1470	0.1470
α=0.01	0.2338	0.2129	0.2129

Test results for the second, third and fourth chapters are provided in Tables 5.2 and 5.3. Friedman's test accepts the null hypothesis that there is no cross-sectional dependence for all chapters, while Frees' test rejects the null hypothesis for all chapters. Pesaran's test accepts the null hypothesis only for the third and fourth chapters.

Here, the results according to Frees' test are taken into account because of the drawback of Pesaran's and Friedman's tests explained above. Sarafas and Hoyos suggest checking the value of the average absolute value of the correlation coefficients in the correlation matrix for the reliability of these tests. The average absolute values for correlation coefficients in Table 4.3 are high for all chapters. Thus, there is evidence that indicates Pesaran's and Friedman's tests for cross-sectional dependence are not reliable.

The distribution of the residuals for each chapter is provided in Figures A.5.2.4 to A.5.2.9, which plot the residual terms from Table 2.2.b, column (5), Table

3.2, column (6), and Table 4.2, column (6) against quartiles of normal distribution, and standard normal probability plot. While standard normal probability plot highlights the centre of distribution, quartile distribution plot underlines the tales of the distribution (stata.com, 2015). The histograms for the residuals can be seen in Figures A.5.2.1, A.5.2.2, and A.5.2.3 in Appendix- Chapter 5 in section A.5.2. It can be seen that the distribution of residuals for the second, third and fourth chapters resembles normal distribution; however, the residuals for the second and third chapters follow the quartiles of normal distribution and standardised normal probability plot more closely compared to the residuals for the fourth chapter. The difference can be seen in the histograms as well. For the second and the third chapters, the quartile distribution of residuals deviates from normal distribution plots at the tails.

A review of the methods to correct the standard errors for heteroscedasticity, autocorrelation and cross-sectional dependence in Stata can be found in Hoechle (2007). He explains that Newey and West standard errors are robust to heteroscedasticity and autocorrelation between error terms; however, Driscoll and Kraay (1998) state that this method’s asymptotic properties rely on large numbers of time periods in the data. Hoechle (2007) discusses Park and Kmenta standard errors and Beck and Katz standard errors that are computed to be robust to heteroscedasticity, serial correlation and cross-sectional dependence between error terms. However, these methods require the time dimension of the dataset to be greater than the panel dimension of the dataset, which is not the case in this study. Hoechle proposes Driscoll and Kraay’s (1998) method, which he makes available for Stata.

Driscoll and Kraay (1998, p.550) state that their method does not suffer from the restrictions regarding the size of the number of cross-sections in the data with respect to the number of time periods. The asymptotic approximation used in their method remains effective even in finite samples where the number of cross-sections is equal to or higher than the number of time periods. Thus, in this study, their method is chosen to produce robust standard errors.

5.4 Model Specification Tests

Two tests are employed to test for model misspecification. One of these tests is the Ramsey regression specification error test. It is considered to be the simplest test for omitted variable and inappropriate functional form (Shukur and Mantalos, 2004). This technique tests for misspecification by using the powers of the estimated dependent variable, which is expected to capture the effect of the omitted variable in the regression. It uses F test by the null hypothesis that the coefficients for the omitted variables jointly equal zero.

The Ramsey regression specification error test is not robust to heteroscedasticity and non-normality in error terms, and it can indicate a model is not correctly specified if the estimation results suffer from these issues. Therefore, additionally, the Lagrange multiplier test, which is robust to heteroscedasticity and non-normality in error terms, is used as a misspecification test (Long and Trivedi, 1992). The Lagrange multiplier test requires using the residual of the restricted model as the dependent variable against the unrestricted regression model. For approximation of the correct model, similar to the Ramsey regression specification error test, the powers of the fitted values of the dependent variable are included in the regression.

The results for the tests for the various chapters can be seen in Table 5.4. It can be seen that the Ramsey regression specification error test fails to reject the null hypothesis that the models are correctly specified for the results in the second and third chapters. The test indicates misspecification for the model used in the fourth chapter; however, this is likely due to non-normality of residuals in this chapter. The Lagrange multiplier test shows that the null hypothesis that the model in Chapter 4 is correctly specified cannot be rejected. The results are in accordance with the implications of the distribution of the residuals in Figures A.5.2.1 to A.5.2.9. Residuals for models in the second and third chapters follow the normal distribution plots more closely, compared to the residuals of the model in the fourth chapter, which is the only one rejected by the Ramsey regression specification error test. The Lagrange multiplier test fails to reject the null hypothesis that the models are correctly specified for all chapters.

Table 5.4 Results for Model Misspecification and Inappropriate Functional Form

	Chapter 2 (Table 2.2.b, Column 5)	Chapter 3 (Table 3.2, Column 6)	Chapter 4 (Table 4.2, Column 6)
Ramsey RESET	F(3,66)=1.73 Prob>F=0.1700	F(2, 66)=0.36 Prob>F=0.7024	F(3, 66)=21.08 Prob>F=0.0000
$\boldsymbol{LM} = \boldsymbol{n} \times \boldsymbol{R^2_{within}}$	0.174 χ^2 (3), α =0. 05 :7.805	.2619 χ^2(2), α=0. 05: 5.991	4.8614 χ^2(3), α=0. 05 :7.805

The results for the Hausman tests, in Table 5.5, show that the fixed-effect technique should be preferred in the second, third and fourth chapters. The results for pooled OLS are reported in Appendix- Chapter 5, in section A.5.3., Table A.5.3.1 for the second chapter, Table A.5.3.2 for the third chapter and Table A.5.3.3 for the fourth chapter. The results differ between pooled OLS and fixed effects for the third and fourth chapters, supporting the Hausman test results for these chapters in Table 5.5.

Table 5.5 Results for Hausman Specification Test

	Chapter 2 (Table 2.2.b, Column 5)	Chapter 3 (Table 3.2, Column 6)	Chapter 4 (Table 4.2, Column 6)
Hausman Specification Test	F(13, 66) = 116.40 Prob > F = 0.0000	F(10, 66)=704.89 Prob>F=0.0000	F(9,66)=212.70 Prob>F=0.0000

5.5 Unit Root Tests

In the analysis of panel data with high numbers of panels and time periods, whether the variables are stationary or non-stationary is a matter of concern. Standard econometric techniques for panel data are based on the assumption that the behaviour of indicators in time is stationary. There are several unit root tests available for panel data to examine the presence of unit roots, and Stata offers a command to use the majority of these. Hlouskova and Wagner (2006) call these tests *"first generation tests"* which assume that the error terms between panels are not correlated.

Tests available in Stata are based on the asymptotic properties of data. They require data to have a sufficiently large number of time periods (T) compared to the cross-sectional dimensions (n). For example, in the Levin-Lin-Chu (LLC) test, for fixed-effects technique, the number of time periods (T) should approximate to infinity faster than the number of cross-sections (n), so that n/T tends to zero. Similarly, the Breitung test requires the number of time periods to tend to infinity faster than the number of panels (n). Hadri (LM) has the same asymptotic properties as the Breitung test: that the number of periods and cross-sections should approximate to infinity sequentially, T being the first (Stata Press, 2009). Hlouskova and Wagner's (2006) findings indicate that these tests are not suitable for datasets that have a low number of time periods compared to the number of panels.

The size of the cross-sectional dimension in the dataset used for this study is greater than the number of time periods. Thus, to examine the presence of unit roots in panels, two tests are used: Harris-Tzavalis and Im-Pesaran-Shin (IPS). Both of these tests allow the number of time periods to be fixed while the number of panels tends to infinity, making them more suitable for this study. The Harris-Tzavalis test assumes that all panels have the same time-series properties, while the Im-Pesaran-Shin (IPS) test relaxes this assumption. For the Harris-Tzavalis test, the null hypothesis is that panels contain unit roots, while, for the Im-Pesaran-Shin (IPS) test, this is "all panels contain a unit root". The alternative hypothesis for the Harris-Tzavalis test is that panels are stationary, while, for the Im-Pesaran-Shin (IPS) test, it is that some panels are stationary (Stata Press, 2009).

The results for both test statistics are provided in Table 5.6 according to the Harris-Tzavalis method and in Table 5.7 according to the Im-Pesaran-Shin method. The unit root tests for panel data test the null hypothesis that the correlation between the value of the variable at time t and $t-1$, ρ equals 1, for all panels, against the alternative hypothesis that ρ is less than 1. An alternative hypothesis gives the condition for an autoregressive process of order one [AR(1)] to be weakly dependent. This means that data become stationary as t tends to infinity, because ρ approximates to 0. Both tests allow for panel-specific means and trend in the model. It is also possible to subtract the cross-sectional mean to control for cross-sectional dependence. In Tables 5.6 and 5.7, the tests are carried out by controlling panel-specific means and the trend in the models, but cross-sectional means are not removed. This is because the results in the preceding chapters rely on data that are subtracted from their panel means, but not their cross-sectional means.

The Harris-Tzavalis unit root test reports the predicted value of ρ, and uses the Z statistics, assuming all panels have a common ρ . The Im-Pesaran-Shin (IPS) test for unit root runs the augmented Dickey-Fuller (ADF) test for unit root for each panel individually by allowing ρ to change across panels. They provide three statistics: t-bar, t-tilde-bar and Z-tilde-bar. All statistics are reported for a fixed number of panels and time periods. While t-tilde-bar and Z-tilde-bar provide alternative but similar statistics to t-bar, t-tilde-bar is calculated by an estimator different than t-bar's estimator. Both t-bar and t-tilde-bar statistics have non-standard sample distribution. Z-tilde-bar reports the test results for standardised t-bar statistics. Im, Pesaran and Shin (2003) state that the performances of Z-tilde-bar and t-bar statistics are equivalent for sufficiently large numbers of observations and remains similar for smaller sample size. The Im-Pesaran-Shin test for unit root reports "the exact critical values" at 1%, 5% and 10% significance level for t-bar and t-tilde bar, and p statistics for Z-tilde-bar. The critical values for t-bar and t-tilde-bar statistics are originally provided in Im, Pesaran and Shin (2003, Table 2) for a given number of time periods and panels, and for normal-distributed error terms; thus, critical values should be considered exact values only when the size of the panel data matches those provided in their paper. For this reason, critical values reported in Table 5.7 are considered to be approximate values. This is because Im, Pesaran and Shin (2003) do not report critical values for the exact numbers of $n = 67, T = 27$, but the statistics reported correspond to the critical values for the dimensions of panel data between $n = 50$ and $n = 100, T = 25$ and $T = 30$.

Tables 5.6 and 5.7 show that both tests reject the null hypothesis that the data for the second chapter contain unit roots. The results for population growth rate are somewhat contradictory between tests. Although the Harris and Tzavalis test for unit root indicate that the panels contain a unit root, Z-tilde-bar statistics in the Im-Pesaran-Shin test reject the null hypothesis that all panels contain unit roots. However, it must be noted that t-bar and t-tilde-bar statistics are lower than the critical values at 1%, 5% and 10% significance level. This is the case for the adult education indicator which is calculated using census data, for which both tests indicate that the panels contain unit roots[5]. Table 5.9 shows that the results for the third and fourth chapters do not change when the adult education indicator is removed from the regression.

In Table 5.8, the five-year forward arithmetic average of the gross enrolment rate and the five-year forward arithmetic average of the infant mortality rate do not appear to be stationary either; however, when the Im-Pesaran-Shin (IPS) test is

[5] The unit roots for both the adult education indicator and population growth rate arise from the calculation of these variables.

carried out by allowing for serial correlation in these variables in Table 5.8, the test rejects the null hypothesis that all panels contain a unit root [6].

[6] It should be noted that, in this case, the asymptotic properties of the test rely on the assumption that the numbers of time periods and panels tend to infinity, sequentially.

Table 5.6 Unit Root Tests: Results According to the Harris-Tzavalis Test

Harris-Tzavalis unit-root test
Ho: Panels contain unit roots
Ha: Panels are stationary
AR parameter: Common
Asymptotics: N -> Infinity, T Fixed

Varıables	Rho	z	p-value	n	T
Dependent Variable, Chapter 2	0.5832	-4.3766	0.0000	67	23
Public Agricultural Investment (% of GDP)	0.3299	-20.5589	0.0000	67	27
Public Mining Investment (% of GDP)	0.2858	-22.7645	0.0000	67	27
Public Manufacturing Investment (% of GDP)	0.4945	-12.3349	0.0000	67	27
Public Energy Investment (% of GDP)	0.5150	-11.3084	0.0000	67	27
Public Transportation Inv. (% of GDP)	0.3224	-20.9349	0.0000	67	27
Public Tourism Investment (% of GDP)	-0.0292	-38.5023	0.0000	67	27
Public Housing Investment (% of GDP)	0.3041	-21.8499	0.0000	67	27
Public Education Inv. (% of GDP)	0.1766	-28.2173	0.0000	67	27
Public Health Inv. (% of GDP)	0.1616	-28.9665	0.0000	67	27
Public City Infra. & Sec. Inv. (% of GDP)	0.4073	-16.6930	0.0000	67	27
Public Investment (% of GDP)	0.5057	-11.7767	0.0000	67	27
Private Capital (% of GDP)	0.0345	-33.7388	0.0000	67	26
Population Growth Rate	0.7538	0.6187	0.7319	67	27
Dependent Variable, Chapter 3	0.9494	10.8645	1.0000	67	23
ln (GDP per capita)	0.6107	-6.5277	0.0000	67	27
Infant Mortality Rate	0.5521	-9.4567	0.0000	67	27
Adult Education Indicator	0.9873	12.2869	1.0000	67	27
Dependent Variable, Chapter 4	0.8512	6.5882	1.0000	67	23

Table 5.7 Unit Root Tests: Results According to the Im-Pesaran-Shin Test

Im-Pesaran-Shin unit-root test
Ho: All panels contain unit roots
Ha: Some panels are stationary
AR parameter: Panel-specific
Asymptotics: T,N -> Infinity sequentially
ADF regressions: No lags included
N-Fixed Exact Critical Values for t-bar and t-tilde-bar:
1%:-2.37 5%:-2.31 10%-2.28

Variables	t-bar	t-tilde-bar	Z-t-tilde bar	p-value	n	T
Dependent Variable, Chapter 2	-2.4289	-2.0928	-7.263	0.0000	67	23
Public Agricultural Investment (% of GDP)	-3.2037	-2.7054	-13.3232	0.0000	67	27
Public Mining Investment (% of GDP)	-*	-	-	-	67	27
Public Manufacturing Investment (% of GDP)	-3.3619	-2.7705	-14.0024	0.0000	67	27
Public Energy Investment (% of GDP)	-3.0477	-2.5593	-11.7976	0.0000	67	27
Public Transportation Inv. (% of GDP)	-3.2759	-2.6530	-12.7756	0.0000	67	27
Public Tourism Investment (% of GDP)	-3.6377	-2.7705	-14.0024	0.0000	67	27
Public Housing Investment (% of GDP)	-2.8487	-2.4169	-10.3099	0.0000	67	27
Public Education Inv. (% of GDP)	-3.6102	-2.9080	-15.4383	0.0000	67	27
Public Health Inv. (% of GDP)	-3.3806	-2.7092	-13.3619	0.0000	67	27
Public City Infra. & Sec. Inv. (% of GDP	-3.0214	-2.5884	-12.1015	0.0000	67	27
Public Investment (% of GDP)	-3.2219	-2.6727	-12.9808	0.0000	67	27
Private Capital (% of GDP)	-	-	-	-	67	26
Population Growth Rate	-1.9068	-1.8325	-4.2088	0.0000	67	27
Dependent Variable, Chapter 3	-0.0169	-0.1059	13.7748	1.0000	67	23
ln (GDP per capita)	-2.5324	-2.2482	-8.5492	0.0000	67	27
Infant Mortality Rate	-3.1535	-2.6449	-12.6911	0.0000	67	27
Adult Education Indicator	2.4859	1.3597	29.1214	1.0000	67	27
Dependent Variable, Chapter 4	-1.6969	-1.4338	-0.2319	0.4083	67	23

*IPS test requires at least seven observations per panel. The share of public mining investment remained zero for Bilecik, Burdur, Sinop, and Sanliurfa for the years between 1975 and 2001.

Table 5.8 Im-Pesaran-Shin Unit Root Test, Asymptotics: T,N -> Infinity, Sequentially

	W-t-bar	**p value**	**ADF regressions**
Dependent Variable, Chapter 3	-7.9324	0.0000	2.12 lags average (chosen by AIC)
Dependent Variable, Chapter 4	-6.3419	0.0000	3.63 lags average (chosen by AIC)

AIC: Akaike Information Criterion

Dependent Variable, Chapter 3: The five-year forward moving arithmetic average of the gross enrolment rate

Dependent Variable, Chapter 4: The five-year forward moving arithmetic average of the infant mortality rate

Dependent Variable for Chapters 2: The five-year forward moving arithmetic average of the growth rate of real GDP per worker

Table 5.9 Results for Chapter 3 and Chapter 4, Adult Education Indicator Excluded

	Chapter 3		**Chapter 4**	
	Dependent Variable			
	The Five-Year Forward Moving Arithmetic Average of Gross Enrolment Rates		The Five-Year Forward Moving Arithmetic Average of Infant Mortality Rates	
Public Energy Investment	0.001	0.001	-0.009	-0.009
Proportion of GDP	(0.014)	(0.013)	(0.002)**	(0.002)**
Public Transportation and Com. Investment	-0.374	-0.426	-0.027	-0.026
Proportion of GDP	(0.202)	(0.218)	(0.024)	(0.024)
Public Education Investment	0.191	0.064	0.007	0.008
Proportion of GDP	(0.187)	(0.175)	(0.028)	(0.026)
Public Health Investment	-0.171	-0.292	0.077	0.079
Proportion of GDP	(0.525)	(0.493)	(0.045)	(0.045)
Public City Infra. and Security Investment	1.034	0.771	-0.158	-0.155
Proportion of GDP	(0.172)**	(0.249)**	(0.076)*	(0.070)*
Population Growth Rate	-1.022	-1.106	-0.047	-0.046
	(0.244)**	(0.281)**	(0.027)	(0.028)
1975	-0.139	-0.061	0.012	0.011
	(0.022)**	(0.010)**	(0.001)**	(0.001)**
1976	-0.139	-0.063	0.013	0.012
	(0.021)**	(0.009)**	(0.002)**	(0.000)**
1977	-0.135	-0.063	0.013	0.012
	(0.020)**	(0.007)**	(0.001)**	(0.000)**
1978	-0.131	-0.064	0.011	0.011
	(0.020)**	(0.009)**	(0.001)**	(0.001)**
1979	-0.113	-0.052	0.011	0.010
	(0.019)**	(0.009)**	(0.001)**	(0.001)**
1980	-0.108	-0.055	0.008	0.008
	(0.019)**	(0.011)**	(0.001)**	(0.002)**
1981	-0.094	-0.041	0.008	0.008
	(0.018)**	(0.011)**	(0.001)**	(0.001)**
1982	-0.084	-0.033	0.008	0.007
	(0.018)**	(0.011)**	(0.001)**	(0.001)**
1983	-0.074	-0.025	0.007	0.006
	(0.017)**	(0.010)*	(0.001)**	(0.001)**
1984	-0.060	-0.014	0.007	0.006
	(0.015)**	(0.010)	(0.000)**	(0.001)**
1985	-0.057	-0.013	0.007	0.007
	(0.013)**	(0.010)	(0.001)**	(0.001)**
1986	-0.066	-0.023	0.007	0.006
	(0.013)**	(0.008)**	(0.001)**	(0.000)**
1987	-0.068	-0.027	0.006	0.005
	(0.012)**	(0.007)**	(0.001)**	(0.000)**
1988	-0.069	-0.031	0.005	0.004
	(0.012)**	(0.007)**	(0.001)**	(0.000)**
1989	-0.070	-0.036	0.004	0.004
	(0.011)**	(0.007)**	(0.001)**	(0.000)**
1990	-0.075	-0.044	0.003	0.003
	(0.010)**	(0.006)**	(0.001)**	(0.000)**
1991	-0.079	-0.052	0.003	0.002
	(0.009)**	(0.006)**	(0.000)**	(0.000)**
1992	-0.083	-0.060	0.002	0.002
	(0.009)**	(0.005)**	(0.000)**	(0.000)**
1993	-0.086	-0.068	0.002	0.002
	(0.007)**	(0.005)**	(0.000)**	(0.000)**
1994	-0.071	-0.058	0.001	0.001
	(0.007)**	(0.005)**	(0.000)**	(0.000)**
1995	-0.048	-0.040	0.001	0.000
	(0.006)**	(0.005)**	(0.000)**	(0.000)*
Ln (GDP per capita)	0.028	0.019	-0.002	-0.002
	(0.018)	(0.020)	(0.001)	(0.001)*
Infant Mortality Rate	-0.297	-0.316		
	(0.064)**	(0.094)**		
Martial Law	0.019	0.020	0.003	0.003
	(0.005)**	(0.005)**	(0.001)*	(0.001)*

Adult Education Indicator	-0.599		0.008	
	(0.169)**		(0.013)	
Constant	0.457	0.467	0.032	0.032
	(0.254)	(0.277)	(0.010)**	(0.010)**
Observations	1541	1541	1541	1541
Number of groups	67	67	67	67
F	434.84	177.81	181.16	70235.66
Within R-Squared	0.47	0.45	0.49	0.49

Standard Errors in parentheses.
* Significant at 5%, ** significant at 1%

5.6 Conclusion

In this chapter, post-estimation diagnostics have been provided for evidence that the results in the thesis are robust to heteroscedasticity, serial correlation, and cross-sectional dependence in error terms.

Both the Ramsey regression specification error test and the Lagrange multiplier test fail to reject the null hypothesis that the regression model is correctly specified for the second chapter. The data for the variables used in this chapter appear to be stationary, which increases the reliability of the results.

Unit root tests show that some panels for the adult education indicator in the third and fourth chapters are likely to be not stationary, which reduces the reliability of the results. Nevertheless, dropping the adult education indicator from estimates does not change the results.

While the Ramsey regression specification error test rejects the null hypothesis that the estimated model does not suffer from misspecification or inappropriate functional form for the third chapter, it rejects the null hypothesis for the fourth chapter. However, the Lagrange multiplier test provides evidence that the estimated models are correctly specified for all chapters.

CHAPTER 6: MAIN CONCLUSION

In this thesis, the relationship between public investment and economic development has been investigated. Firstly, the relationship between different types of public investment and economic growth was studied. Then, the effect of public investment on the primary and middle school gross enrolment rate was investigated. Finally, the effect of public investment on the infant mortality rate was taken into account. For the interpretations of the results, the development plans for the years between 1975 and 2001 that are published by the State Planning Organisation that drafts and implements the public investments in question are consulted. Specifically, the fourth and the seventh development plans provide observations regarding the progress in the socio-economic environment at the time of publication, and provide overviews regarding the outcomes of public policies and public investment projects.

The results partially appear to support the implications of endogenous growth models that suggest a positive relationship between public infrastructure investment and economic growth. The types of public investment that are concerned with improving infrastructure in relevant sectors, such as agriculture, tourism and energy, are statistically positively correlated with growth. Additionally, public education investment that is considered to increase labour force productivity has a positive relationship with economic growth. Public manufacturing and housing investments, which are the type of investments that substitute for the private sector production, do not have a statistical relationship with the five-year forward moving geometric average of the growth rate. Public mining investment is negatively associated with economic growth, which seems to be the case as mining sector was monopolised by the government until the late 1990s. This could also because of the negative effect of the growth of mining sector on the tradable sectors as suggested by the theory of the "natural resource curse".

Public health investment, which is considered to contribute to human capital, is not related to economic growth. It is not statistically related to the five-year forward moving average of the infant mortality rate or the gross enrolment rate either. The seventh development plan observes that, although public health policies aimed to reduce infant mortality rates, public investment projects did not focus on providing preventive health care sufficiently. This development plan identifies failures in public health policy that may have led to statistically insignificant relationship between public health investment and health, education and economic growth.

Public city infrastructure and security investment is positively related to the long-run gross enrolment rates, and negatively associated with the five-year forward moving arithmetic average of infant mortality rates, but it does not appear to be related to economic growth. The likely reason for these results is the emphasis on enabling access to basic city infrastructure such as water and sewage systems in rural areas and remote villages which lack industries and suffer from high unemployment rates. There is rapid migration from these areas to the urban areas, especially to those in the West of the country which host the majority of industries. Thus, public investment in city infrastructure and security services, despite its contribution to the level of health and education in rural areas, may not be sufficient to attract private investment to these areas, and so promote economic growth in these locations.

The evidence regarding the effects of public city infrastructure and security investment on the long-run gross enrolment and infant mortality rates appears to be in accordance with the development literature that suggests a positive relationship between access to safe water and sanitation, and both education and health. The negative and statistically significant coefficient for public energy investment in the fourth chapter provides further statistical evidence for the relationship between access to energy infrastructure and the long-run infant mortality rates.

Regarding the results for public energy investment in the second and the fourth chapter, one could suggest that public energy investment contributes to economic growth by improving health which is considered to be a component of human capital. This would imply a negative relationship between the infant mortality rate as a proxy for human capital and economic growth. But the robustness analyses for the second chapter do not provide any statistical relationship between the infant mortality rate and the long run economic growth.

Finally, public investment in transportation and communication arises as a type of public investment that is negatively associated with the five-year forward moving geometric average of the growth rate. The results appear to hold for the longer run. There does not appear to be any statistical relationship between public investment in transportation and communication and the long-run gross enrolment rates, or the infant mortality rates. The findings are in conflict with the economics and development literature. The seventh development plan provides a list of public policy issues in the transportation sector which could explain the findings in this thesis.

Overall findings in this thesis suggest that policy makers should shift the resources to infrastructure and education. The results also support the critics of public policies regarding the transportation sector and the health sector in the seventh development plan.

The findings in this thesis encourage further research in this area. For more precise conclusions, public investment data for transportation and communication can be disaggregated to sub-groups. Although the results indicate a negative relationship between public transportation and communication investment and the long-run economic growth, this relationship may be the result of public investment projects that are not related to roads and highways. Public transportation and communication investment projects are sub-grouped as roads, railways, marine transportation, airline transportation, mail services, and radio and television services. Disaggregation of data to subcomponents is also advisable for other types of public investment in question for more robust analyses.

Post-estimation diagnostics provide statistical evidence for the correct specification of regression models. Further analyses in the chapter appendices show that the results for the second chapter remain similar when the dependent variable is calculated as the seven-year, ten-year or fifteen-year forward moving averages of the growth rate of real GDP per worker. In this chapter, the results for public agricultural investment appear to be sensitive to the presence of potential outliers. The results in the third and fourth chapters change considerably when the dependent variables are calculated to cover the longer run. This appears to be due to higher co-linearity between variables in these chapters.

In the third chapter, there is a need for more data for education indicators. In this chapter, the dependent variable is specified as the five-year forward moving arithmetic average of the gross enrolment rate. However, the rate of attendance and achievement among students, and the quality of schooling can also be the outcome of public investment in education. Similarly, in the fourth chapter, the infant mortality rate is not sufficient on its own to measure the outcome of the effect of public investment, as it is highly correlated with poverty. Life expectancy at birth may be more appropriate as it can reflect the level of health among the adult population.

Finally, the time span of the panel data can be increased to cover the years after 2001. The primary obstacle to overcome to achieve this is substituting gross domestic production with an indicator of economic outcome that is available for the provinces for the years before and after 2001 to obtain a consistent dataset. Alternatively, it may be possible to calculate the value of the gross domestic production for individual provinces by using data from official achieves.

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APPENDICES

APPENDIX: CHAPTER 2

A.2.1 Deflators for Public Investment

Table A.2.1. 1 Deflator Series for Public Investment, Base Year 1987[7]

Year	Agriculture	Mining	Manufacturing	Energy	Transportation And Communication	Tourism	Housing	Education	Health	City Infrastructure and Security
1975	0.0126	**0.0094**	**0.0079**	**0.0090**	**0.0114**	**0.0120**	**0.0128**	**0.0129**	**0.0120**	**0.0125**
1976	0.0150	0.0111	0.0092	0.0101	0.0133	0.0156	0.0156	0.0155	0.0142	0.0155
1977	0.0201	0.0143	0.0117	0.0131	0.0174	0.0238	0.0217	0.0211	0.0191	0.0214
1978	0.0293	0.0206	0.0174	0.0196	0.0260	0.0337	0.0313	0.0306	0.0278	0.0315
1979	0.0475	0.0343	0.0287	0.0325	0.0427	0.0544	0.0512	0.0504	0.0459	0.0520
1980	0.0996	0.0709	0.0616	0.0703	0.0897	0.1125	0.1079	0.1064	0.0973	0.1132
1981	0.1433	0.1004	0.0907	0.1039	0.1282	0.1497	0.1386	0.1514	0.1357	0.1593
1982	0.1815	0.1294	0.1173	0.1297	0.1541	0.1880	0.1747	0.1915	0.1698	0.2028
1983	0.2341	0.1804	0.1687	0.1825	0.2075	0.2431	0.2271	0.2473	0.2229	0.2607
1984	0.3514	0.2838	0.2633	0.2826	0.3145	0.3494	0.3397	0.3518	0.3396	0.3594
1985	0.4964	0.4237	0.4036	0.4318	0.4500	0.5001	0.4928	0.5020	0.4878	0.5077
1986	0.6931	0.6433	0.6325	0.6738	0.6680	0.6976	0.6862	0.7005	0.6934	0.7094
1987	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1988	1.9736	1.8815	1.8132	1.8157	1.8815	1.8679	1.9553	1.8460	1.8897	1.7805
1989	2.8545	2.7202	2.6325	2.6243	2.7202	2.7211	2.8640	2.6856	2.7567	2.5796
1990	4.3188	4.0307	3.8768	3.8302	4.0307	4.0850	4.4303	4.0010	4.1699	3.7548
1991	7.6506	6.9030	6.4217	6.3985	6.9030	6.8724	7.6371	6.6896	7.0584	6.1610
1992	12.0926	11.1126	10.4265	10.4339	11.1126	11.0009	11.9451	10.7696	11.2341	10.0880
1993	21.0701	18.4702	16.5254	16.7437	18.4702	17.8212	20.0204	17.2956	18.3564	15.7769
1994	42.5833	40.9528	39.4485	39.4714	40.9528	40.7795	42.6444	40.2610	41.2782	38.5976
1995	71.9041	70.6167	68.5034	69.0715	70.6167	69.5310	70.5632	69.1539	69.8616	67.7548
1996	131.5128	128.2960	122.5950	124.8862	128.2959	124.0373	125.2345	123.5224	124.4676	121.4871
1997	250.0806	232.7460	215.5689	218.7607	232.7460	225.3388	239.1995	221.5218	229.0241	209.3699
1998	432.2317	406.9614	375.8491	385.6566	406.9613	386.9815	400.7613	382.7471	390.9110	368.3310
1999	666.8965	618.7092	563.3590	580.0937	618.7091	583.9418	611.1916	576.0108	591.4458	549.8650
2000	939.1969	870.9217	793.7690	816.2885	870.9215	823.7704	863.8870	812.1873	834.7616	774.1908
2001	1440.3770	1404.9030	1314.5740	1325.9530	1374.4400	1234.4170	1328.7970	1209.0060	1301.4470	1129.4140

Source: (DPT, 2002)

[7] The deflator series are originally provided for the base year 2002. As the GDP series are deflated to for the base year 1987, the deflator series for public investment are converted for the base year 1987. The base year for deflator series can be changed by dividing the values of deflators for all years to the value of the deflator for the new base year. One could suggest changing the base year for GDP series to 2002; however, GDP series are taken from separate sources, and this makes it more complicated (if not impossible) to obtain GDP series deflated for 2002.

A.2.2 Method for Collecting Public Investment Data

Table A.2.2.1 shows the detail for a public investment project taken from the public investment programme for 1983 as an example. Figure A.2.2.1 provides a page from the same programme which shows how the data are structured. The project chosen from the programme is grouped under “agricultural spending” by the State Planning Organisation. The public investment programme provides details such as the code, the name of the project, and its characteristics. The characteristic of the project provides additional information about what the money was spent on. It may specify the purpose of investment (whether it is for socialising, residence, for students, for staff) for construction projects, or the number of vehicles or the name of equipment, if any of these were bought for other types of project.

The public investment programme provides the start and completion years for the project, and the cost of investment for the overall project, and for a specific year. For investment projects that take more than a year, it provides an estimate of expenditure till the end of the previous year.

As a part of the research project for this thesis, the data in public investment programmes for the years between 1982 and 1990 have been processed by the following approach, which is used by the State Planning Organisation for the years between 1991 and 2001:

- Public investment projects have been grouped according to the sectors. This was already done by the State Planning Organisation.
- Then they have been grouped according to the province where the projects were carried out.
- The cost of projects grouped by sectors and provinces is summed up.
- The sum of projects for each sector and province has been recorded in a table. An example of this table for 1983 can be seen in Table A.2.2.2.

Table A.2.2.1 A Sample of a Table from the Public Investment Programme for 1983

Code		79A08200
Name of the project		Research Project for Citrus and Other Sub-tropic Fruit Construction Machine and Equipment Purchase Vehicle Research
Location (Province and district)		Antalya
Characteristic		Fog Greenhouse Supply construction Vehicle-11, 1 vehicle
The start and completion years for the job		1979-84
The Cost of the Project (External, and total)	External:	-
	Total:	120498000 (TL)
The estimated amount of spending till the end of 1982	External:	-
	Total:	68798000 (TL)
The cost for 1983	External	-
	Total:	35000000 (TL)

Table A.2.2.2 shows a cross-section of panel data used in the thesis, for 1983. Most of the projects that appear in Figure A.2.2.1 are not included in the numbers in Table A.2.2.2. This is because some investment projects are made in more than one province and the location is stated as "various provinces". This is one of the shortcomings of the dataset provided by the State Planning Organisation, and Kutbay (1982), and this thesis. The measurement issues related to the dataset are discussed in the section for the data in the second chapter under the title "A few notes on the dataset".

Figure A.2.2.1 Sample Data from the Public Investment Programme in 1983

SECTOR: AGRICULTURE
PROJECT OWNER: GENERAL DIRECTORATE OF AGRICTULTURAL AFFAIRS

(Thousand TL)

Project No	Project Name	Location	Characteristic	Start and End Date of the Job	Project Cost External	Project Cost Total	Estimated expenditure until the end of 1982 External	Estimated expenditure until the end of 1982 Total	Investment in 1983 External	Investment in 1983 Total
	ZİRAAT İŞLERİ GENEL MÜDÜRLÜĞÜ TOPLAMI				283 726	39 841 433	—	9 470 436	160 635	7 350 000
	ETÜD - PROJE İŞLERİ TOPLAMI				—	4 000	—	—	—	4 000
	a) 1983'de Bitenler			1983-83	—	4 000	—	—	—	4 000
83A110010	Oran. Fransızlık Tumurla Tarık Hiz. Bin. Projesi	Kütahya Ürt. İst.	Etüd Proje	1983-83	—	2 000	—	—	—	2 000
83A110020	Karacabey Hiz. Bin. ve Sos. Tes. Projesi	Bursa - Karacabey	Etüd Proje		223 735	34 481 083	—	—	—	2 000
	DEVAM EDEN PROJELER TOPLAMI				—	2 000	—	9 470 436	100 635	6 331 000
	a) 1982'de Bitenler			1982-82	—	489 985	—	344 235	—	345 750
78A110040	Köy Grubu Merk.	Sivas - Yıldızeli - Çırçırköy	Köy Gru. Mer. Bin. İnş.	1976-83	—	5 675	—	676	—	5 000
77A110420	Çorum - Çankırı Kırsal Kalkınma Prj.	Çorum - İskilip	İlçe Tek. Zir. Müd.	1977-83	—	18 000	—	11 000	—	6 000
77A110080	Patates Deposu Sosyal Tes.	Bolu	Sosyal Tesisler	1977-83	—	73 500	—	36 000	—	37 500
77A110410	Atölye Bin. Tesi Prj.	Ankara	Revir. Atöl. Sos. Tes.	1977-83	—	65 160	—	37 560	—	27 600
77A110430	Tarımsal Yayım. Geliş. Proj.	Muh.	4 İlçe Müd. 1 Köy Grub. Binası	1977-83	—	85 700	—	44 000	—	41 700
79A080790	Bitkisel Arş. Komp.	Ankara - Haymana	Muhtelif	1979-83	—	104 000	—	54 000	—	50 000
79A080300	Tavukçuluk Arş. Komp.	Ankara - Haymana	Muhtelif	1979-82	—	150 000	—	71 100	—	78 900
	b) 1983'den Sonraya Kalanlar				223 735	33 991 048	—	9 226 193	100 635	6 073 250
79A110010	Hububat ve Baklagil Üret. Geliş. Proj.	Muh.	İnş. Mak. Teç. Tag. Ür. Tes.	1979-84	—	677 133	—	147 300	—	80 000
	Makina - Teçhizat Alımı		2 Ad. Kombine Mibzer				—	—	—	(600)
	Üretim Tesisleri	15 İl Buğday 15 İl Arpa 23 İl Mısır 8 İl Çeltik 16 İl K. Fasulye	1.200.000 Da. 800.000 Da. 125.000 Da. 60.000 Da. 50.000 Da.				—	—	—	(79 400)
79A110040	Mavi Küfe Dayanıklı Tüt. Toh. Üret. Projesi		İnş. Mak. Teç. Tag. Ürt. Tes.	1979-84	—	87 300	—	24 150	—	10 000
	Üretim Tesisleri	11 İl	371 Da.				—	—	—	(10 000)
79A110050	Yağlı Toh. ve Sanayi Bit. Üret. Geliş. Proj.		İnş. Mak. Teç. Tag. Ürt. Tes.	1979-84	—	794 681	—	154 080	—	60 000
	Makina - Teçhizat Alımı		3 Ad. Dikim Makinası 3 Ad. Boğ. Dol. Makinası				—	—	—	(750)
	Üretim Tesisleri	22 İl Ayçiçeği 15 İl Patates 6 İl T. Patates Bilecik Şeboiçkotu Samsun I. Or. Soya	600.000 Da. 5.000 Da. 5.000 Da. 9.171 Da. 10.000 Da.				—	—	—	(59 250)

Source: DPT (1984)

Table A.2.2.2 Public Investment per Province and per Sector, 1983, Thousand Turkish Liras (TL), Obtained from Investment Programmes that Contain Pages as in Figure A.2.2.1

No Province	Agriculture	Mining	Manufacturing	Energy	Transportation and Communication
01 Adana	26414425	1920246	1185518	20181523	2886837
02 Adiyaman	428829	0	6727812	876862	178331
03 Afyon	923093	0	3158960	1115259	1874886
04 Agri	229408	0	18732660	133447	2674965
05 Amasya	5300201	0	474207	1567390	0
06 Ankara	5138547	39618581	107606824	125440475	25349515
07 Antalya	4368754	277092	703901	50211300	5142686
08 Artvin	3838746	13574726	16012336	416509	1807419
09 Aydin	9387642	1028010	3556553	52064	108445
10Balikesir	5184553	5468683	27907973	1424900	3422028
11 Bilecik	226358	0	331945	805617	67481
12 Bingol	961745	86453	652035	98647	491615
13 Bitlis	409884	27709	11855	109608	486796
14 Bolu	3599460	1203132	9150418	2937641	775981
15 Burdur	642349	0	0	137010	274726
16 Bursa	8317237	13669724	4503485	40114784	973591
17 Canakkale	1033031	1733486	551266	1205685	8603267
18 Cankiri	1242365	0	1608155	1424900	0
19 Corum	2369002	3868201	29638	301421	250627
20 Denizli	2238397	0	3785589	17292811	766322
21 Diyarbakir	1733337	160713	20276204	99595061	935028
22 Edirne	3194642	0	3787723	942626	173511
23 Elazig	3433907	5238697	4885228	4033564	756702
24 Erzincan	3937204	22167	69056	1750983	1021798
25 Erzurum	3069653	3446190	4738662	1090597	9506215
26 Eskisehir	6924031	1912011	14522591	704230	337388
27 Gaziantep	661991	0	3135694	2246958	371121
28 Giresun	313865	2771	563121	1422160	886835
29 Gumushane	634504	0	414931	95907	9640
30 Hakkari	430038	0	385293	27402	462706
31 Hatay	3117765	16626	97261055	0	3349250
32 Isparta	2968710	179145	53348	1487925	178331
33 Icel	3075829	0	22422287	13788652	3046087
34 Istanbul	1390609	0	24982110	15701307	114710955
35 Izmir	3857214	457201	193392301	8188158	38452990
36 Kars	4756484	0	50384	65765	674766
37 Kastamonu	2097304	13889142	10900182	1909915	2506274
38 Kayseri	9238160	281248	36453184	3903405	1373626
39 Kirklareli	2017613	1327270	29638	1499982	689225
40 Kirsehir	875537	0	26851974	230176	313284
41 Kocaeli	2306292	27709	31717071	2212432	4443817
42 Konya	14194775	1569697	45865139	3649937	2838837
43 Kutahya	2546386	61455075	5305191	23850641	481971
44 Malatya	1669918	886694	4694650	2627845	1889340
45 Manisa	2381588	21808785	957305	74402821	1161562
46 Maras	5232251	127953775	3378725	172998808	2072496
47 Mardin	1153697	1559472	942486	263059	843462
48 Mugla	5061393	30676276	280102	183313443	5123407
49 Mus	1515810	0	6510981	0	713324
50 Nevsehir	285540	0	865428	2098988	265087
51 Nigde	1359645	0	30875324	287720	409679
52 Ordu	734597	0	124479	493235	510894

53 Rize	854182	304801	2845242	126049	1648357
54 Sakarya	1477535	0	4842839	2531938	269906
55 Samsun	1562299	2771	15494715	42858265	2800279
56 Siirt	424101	42253724	15837922	602842	631388
57 Sinop	372423	0	0	1074156	1108544
58 Sivas	3178984	33465758	1570811	71097052	14305026
59 Tekirdag	2524109	0	183755	871381	4820
60 Tokat	4437818	0	20227953	7952041	481976
61 Trabzon	806348	831275	3911023	665867	4173900
62 Tunceli	239175	0	177828	101387	221709
63 Urfa	35561047	0	10373338	27925309	72296
64 Usak	284870	0	0	616543	0
65 Van	6642518	96982	0	2175713	1792935
66 Yozgat	6231828	0	177828	1479704	308469
67 Zonguldak	2179339	37222292	33804779	32706946	2665326

Table A.2.2.2 Continued, Public Investment per Province and per Sector, 1983, Thousand Turkish Liras (TL), Obtained from Investment Programmes that Contain Pages as in Figure A.2.2.1

No Province	Tourism	Housing	Education	Health	City Infrastructure and Security
01 Adana	0	2548968	6025825	4435267	4295333
02 Adiyaman	411377	480970	1249316	1323224	2500313
03 Afyon	0	471062	629105	1847131	1622255
04 Agri	0	2471558	2628819	209922	785049
05 Amasya	9836	0	733821	13457	1788124
06 Ankara	802184	15457256	37202709	14537297	74693952
07 Antalya	6752747	559216	1512489	650398	2041886
08 Artvin	0	1087653	616572	2243	728922
09 Aydin	1851195	387488	1800389	0	4076758
10Balikesir	0	228970	1047161	0	5769936
11 Bilecik	20569	770573	482745	0	774694
12 Bingol	0	374278	1793111	0	809210
13 Bitlis	0	859211	1559825	103167	993296
14 Bolu	102844	35226	1287118	32206	3639527
15 Burdur	0	277406	222370	448550	717512
16 Bursa	473083	356665	4158118	2444600	12415237
17 Canakkale	954394	3333191	352558	0	3710477
18 Cankiri	0	114089	279782	0	951221
19 Corum	0	132098	454848	20633	1781708
20 Denizli	82275	361069	268866	0	1887645
21 Diyarbakir	61706	3284733	4213610	1246970	3133292
22 Edirne	0	1434279	1456322	3370857	3271249
23 Elazig	0	2228057	4536754	399210	3328499
24 Erzincan	0	877705	1152281	71768	1123690
25 Erzurum	0	2574419	6350081	1432917	5609171
26 Eskisehir	0	313557	1686374	2260694	6253544
27 Gaziantep	0	2591591	2494891	1373237	3166216
28 Giresun	90729	132098	1105786	134565	1637596
29 Gumushane	0	400038	750216	0	1035482
30 Hakkari	41138	1162200	1360804	0	421863
31 Hatay	0	2390978	2983924	2426568	3578814
32 Isparta	0	0	752015	3673180	2114700
33 Icel	61706	713331	2009518	58312	10517321
34 Istanbul	6787714	5743191	32131814	14642809	40974854
35 Izmir	1295836	3912310	9953544	2122541	16945759
36 Kars	0	1829561	2388740	0	3275191
37 Kastamonu	0	320999	778214	1586972	1654294
38 Kayseri	0	438566	3494040	4005556	2618465
39 Kirklareli	102844	953089	385711	0	2531370
40 Kirsehir	246826	0	426951	695253	642382
41 Kocaeli	0	1712874	2190952	1569927	11133103
42 Konya	41138	887260	6214435	461110	3995499
43 Kutahya	543017	361069	842985	90607	1844692
44 Malatya	0	1236131	4335408	6055	2243544
45 Manisa	61706	726540	1305515	0	3750842
46 Maras	0	1193288	717649	0	2189853
47 Mardin	20569	5268518	2319118	75132	4542034
48 Mugla	5862117	660491	747163	123351	3749607
49 Mus	0	2377020	1095678	0	2015355
50 Nevsehir	1028442	206954	616167	0	1414518
51 Nigde	61706	106559	167384	0	871722
52 Ordu	460199	187580	1159559	518076	2833524
53 Rize	246826	424916	725735	672826	2025575

54 Sakarya	0	22016	850299	0	2326801
55 Samsun	0	550409	3653945	2849417	5273288
56 Siirt	0	250987	2232393	0	1634086
57 Sinop	0	295592	304445	0	1612667
58 Sivas	0	378858	3612907	2236024	2151118
59 Tekirdag	0	22016	1366970	125594	824550
60 Tokat	47275	145308	858753	225845	2012191
61 Trabzon	219095	950711	2135157	5403508	3925662
62 Tunceli	49365	968720	1493923	75356	383512
63 Urfa	0	1987638	2504291	532878	4121748
64 Usak	0	0	198112	0	431834
65 Van	143982	1321863	3208598	201848	3271532
66 Yozgat	0	242180	760910	134565	1614585
67 Zonguldak	0	1818949	2193762	1578898	5069655

A.2.3 Robustness of the Results

In this section, the robustness of the results is firstly examined for the influential data. In the studies that use cross-sectional data, it is common practice to control for the observation or the small group of observations that may influence the results. The observation or observations that influence the results can be detected as they tend to have unusually large residuals. This type of influential data point is called an outlier. Bramati and Croux (2007) point out the fact that this problem is not addressed in panel data studies.

Secondly, the robustness of the results is examined for the issues discussed in the data section. It has been pointed out that the data were originally unbalanced, as between 1975 and 2001 the number of provinces rose from 67 to 81 as some districts became provinces. To achieve a balanced dataset, the values for the districts that later became provinces are added to the provinces they were under the administrative jurisdiction of. To see if this affects the results, regressions in the earlier section are repeated by excluding these districts and the provinces that contained these districts. Additionally, it has been pointed out that the measurement of data for private capital in the manufacturing sector changes due to the change in the scope of the census in 1986. The regression in Table 2.2.b, column (5) is repeated by excluding the variable for private capital to examine if the change in data measurement has any impact on the results.

Thirdly, the regression in Table 2.2.b, column (5) is repeated for the longer run, by replacing the dependent variable by the seven-year, ten-year and fifteen-year forward moving geometric average of the growth rate of real GDP per worker. Furthermore, the results for the five-year forward moving arithmetic and geometric average of real GDP per worker and per capita growth rates are provided. Finally, the variance inflation factors are provided and discussed to examine the robustness of the results to potential co-linearity between variables.

. The discussions for the chosen econometric technique and the issues related to standard errors are provided in the fifth chapter. The tests chosen for model specification and omitted variable bias, and unit root tests are explained and results are provided in the fifth chapter. Model misspecification tests are carried out for the model in Table 2.2.b in column (5). Overall results provide statistical evidence that the model in Table 2.2.b in column (5) does not suffer from inappropriate functional form and omitted variable bias. Unit root tests reject the null hypothesis that data for some panels contain a unit root, which is required for robust panel estimations. Hausman test suggests using the results obtained from fixed-effects technique.

Table A.2.3.1 shows the robustness of the results to the presence of potential outliers, and the change in the data due to the change in the number of provinces between 1975 and 2001. Additionally, the regression in Table 2.2.b in column (5) is repeated by excluding the observations for which the value of the five-year forward moving geometric average of the growth rate of real GDP per worker is greater than $|5\%|$.

The first column shows the results taken from Table 2.2.b, column (5). The results in columns (2), (3) and (4) remain similar in terms of signs and statistical significance of the variables, except for the coefficient of the share of public agricultural investment in GDP, which becomes statistically insignificant in columns (2), (3), and (4). The coefficient of public tourism investment is statistically insignificant in column (4). Also, the coefficient of the share of public tourism investment in GDP in column (2) is considerably higher compared to the coefficients in columns (1) and (3). The size of the coefficient for the share of public education investment in GDP is lower in column (4) too. The overall results indicate that the results in Table 2.2.b, column (5) are robust to the presence of potential outliers, and to the extreme values of the five-year forward moving geometric average of the growth rate of real GDP per worker. The technique that is used to adjust the dataset for the change in the number of provinces between 1975 and 2001 does not appear to have a noticeable impact on the results. In both columns, the size of the coefficients appears to be sensitive to the change in samples.

Table A.2.3. 1 Robustness of the Results for Outliers and the Provinces that Change Status

	(1) Original Sample	(2) Excluding Potential Outliers	(3) Excluding Provinces that change status	Excluding the observations for which the dependent variable is >│0.05│
Public Agricultural Investment	0.214	0.066	0.018	0.152
Proportion of GDP	(0.077)**	(0.076)	(0.067)	(0.091)
Public Mining Investment	-0.066	-0.070	-0.093	-0.059
Proportion of GDP	(0.017)**	(0.020)**	(0.030)**	(0.018)**
Public Manufacturing Investment	0.042	0.040	0.028	0.021
Proportion of GDP	(0.037)	(0.030)	(0.039)	(0.027)
Public Energy Investment	0.103	0.099	0.107	0.072
Proportion of GDP	(0.012)**	(0.014)**	(0.013)**	(0.011)**
Public Transportation and Com. Investment	-0.388	-0.337	-0.470	-0.287
Proportion of GDP	(0.123)**	(0.121)**	(0.145)**	(0.114)*
Public Housing Investment	-0.005	-0.015	-0.003	0.205
Proportion of GDP	(0.036)	(0.022)	(0.038)	(0.106)
Public Tourism Investment	0.337	2.590	0.380	0.010
Proportion of GDP	(0.120)**	(0.847)**	(0.115)**	(0.021)
Public Education Investment	0.644	0.572	0.611	0.273
Proportion of GDP	(0.161)**	(0.136)**	(0.208)**	(0.097)**
Public Health Investment	0.134	0.211	0.110	0.076
Proportion of GDP	(0.167)	(0.124)	(0.208)	(0.105)
Public City Infrastructure and Security Investment	0.588	0.329	0.795	0.282
Proportion of GDP	(0.368)	(0.281)	(0.400)	(0.198)
Population Growth Rate	-0.120	-0.184	-0.188	-0.091
	(0.163)	(0.148)	(0.209)	(0.133)
1975	0.003	0.000	0.008	0.003
	(0.001)*	(0.002)	(0.001)**	(0.001)*
1976	-0.012	-0.013	-0.007	-0.005
	(0.001)**	(0.002)**	(0.001)**	(0.001)**
1977	-0.019	-0.019	-0.013	-0.010
	(0.002)**	(0.002)**	(0.001)**	(0.001)**
1978	-0.011	-0.012	-0.006	-0.008
	(0.002)**	(0.002)**	(0.001)**	(0.001)**
1979	-0.000	-0.004	0.002	0.001
	(0.002)	(0.002)	(0.001)	(0.001)
1980	0.012	0.010	0.013	0.009
	(0.003)**	(0.003)**	(0.003)**	(0.002)**
1981	0.011	0.013	0.014	0.009
	(0.003)**	(0.003)**	(0.003)**	(0.002)**
1982	0.023	0.022	0.024	0.006
	(0.003)**	(0.003)**	(0.002)**	(0.002)**
1983	0.019	0.018	0.022	0.006
	(0.003)**	(0.003)**	(0.002)**	(0.002)**
1984	0.013	0.010	0.018	0.001
	(0.002)**	(0.002)**	(0.002)**	(0.002)
Private Capital	0.050	0.058	0.069	0.049
(Proportion of GDP)	(0.013)**	(0.018)**	(0.013)**	(0.017)**
1986	0.013	0.008	0.014	-0.000
	(0.001)**	(0.001)**	(0.002)**	(0.001)
1987	0.012	0.011	0.013	0.007
	(0.001)**	(0.001)**	(0.001)**	(0.001)**

1988	0.020	0.021	0.021	0.017
	(0.001)**	(0.001)**	(0.001)**	(0.000)**
1989	0.016	0.017	0.017	0.015
	(0.001)**	(0.001)**	(0.001)**	(0.001)**
1990	0.011	0.011	0.010	0.009
	(0.001)**	(0.001)**	(0.001)**	(0.000)**
1991	0.023	0.023	0.023	0.018
	(0.001)**	(0.001)**	(0.001)**	(0.000)**
1992	0.024	0.022	0.023	0.018
	(0.001)**	(0.001)**	(0.001)**	(0.000)**
1993	0.025	0.024	0.024	0.019
	(0.000)**	(0.001)**	(0.001)**	(0.001)**
1994	0.022	0.022	0.020	0.017
	(0.000)**	(0.001)**	(0.001)**	(0.000)**
1995	0.025	0.024	0.023	0.019
	(0.000)**	(0.001)**	(0.001)**	(0.001)**
Martial Law	0.003	0.002	0.003	0.002
	(0.002)	(0.002)	(0.002)	(0.002)
Constant	-0.002	0.001	-0.002	0.001
	(0.004)	(0.003)	(0.005)	(0.003)
Observations	1407	1326	1176	1190
Number of groups	67	67	56	67
F	66.95	1901737.57	37.60	19106.50
Within R-Squared	0.22	0.31	0.21	0.22

Standard Errors in parentheses.
* Significant at 5%, ** significant at 1%

The measurement of the data for private capital in the manufacturing sector changes due to the change in the scope of the industrial census that is used to obtain data between 1983 and 1993. Secondly, because there are only a few manufacturing companies in some provinces, these companies do not report any data in order to protect this information for some years. The value of the share of private capital in GDP is taken as zero for these provinces as they are the least-developed provinces in Turkey, for which the value of private capital in the manufacturing sector is expected to be dramatically low. To investigate the robustness of results for the issues related to private capital data, the share of private capital in GDP is removed from the model in Table A.2.3.2 in column (2). In column (3), the share of private capital in GDP is estimated for 1985, which is not available in the original dataset. The first column in Table A.2.3.2 shows the results from the model in Table 2.2.b, column (5). The results in columns (2) and (3) remain the same in terms of the signs and the statistical significance of the variables. There appear to be slight changes in the coefficients; but, nevertheless, it can be said that the results in Table 2.2.b, column (5) do not appear to be affected by the change in the measurement of private capital data.

Table A.2.3.2 Robustness of the Results for the Measurement of Private Capital

	(1)	(2)	(3)
Public Agricultural Investment	0.214	0.225	0.221
Proportion of GDP	(0.077)**	(0.095)*	(0.094)*
Public Mining Investment	-0.066	-0.062	-0.062
Proportion of GDP	(0.017)**	(0.018)**	(0.018)**
Public Manufacturing Investment	0.042	0.032	0.032
Proportion of GDP	(0.037)	(0.040)	(0.040)
Public Energy Investment	0.103	0.097	0.098
Proportion of GDP	(0.012)**	(0.010)**	(0.010)**
Public Transportation and Com. Investment	-0.388	-0.362	-0.369
Proportion of GDP	(0.123)**	(0.129)**	(0.128)**
Public Housing Investment	-0.005	-0.009	-0.008
Proportion of GDP	(0.036)	(0.031)	(0.031)
Public Tourism Investment	0.337	0.324	0.332
Proportion of GDP	(0.120)**	(0.121)**	(0.119)**
Public Education Investment	0.644	0.655	0.653
Proportion of GDP	(0.161)**	(0.183)**	(0.182)**
Public Health Investment	0.134	0.094	0.101
Proportion of GDP	(0.167)	(0.175)	(0.176)
Public City Infrastructure and Security Investment	0.588	0.635	0.639
Proportion of GDP	(0.368)	(0.394)	(0.395)
Population Growth Rate	-0.120	-0.101	-0.103
	(0.163)	(0.185)	(0.186)
1975	0.003	0.002	0.003
	(0.001)*	(0.001)	(0.001)*
1976	-0.012	-0.012	-0.012
	(0.001)**	(0.001)**	(0.001)**
1977	-0.019	-0.020	-0.019
	(0.002)**	(0.002)**	(0.002)**
1978	-0.011	-0.011	-0.011
	(0.002)**	(0.002)**	(0.002)**
1979	-0.000	-0.001	-0.000
	(0.002)	(0.002)	(0.002)
1980	0.012	0.012	0.012
	(0.003)**	(0.003)**	(0.003)**
1981	0.011	0.011	0.012
	(0.003)**	(0.003)**	(0.003)**
1982	0.023	0.023	0.023
	(0.003)**	(0.003)**	(0.003)**
1983	0.019	0.019	0.019
	(0.003)**	(0.003)**	(0.003)**
1984	0.013	0.013	0.014
	(0.002)**	(0.002)**	(0.002)**
Private Capital	0.050		
(Proportion of GDP)	(0.013)**		
1986	0.013	0.012	0.013
	(0.001)**	(0.002)**	(0.002)**
1987	0.012	0.011	0.012
	(0.001)**	(0.001)**	(0.001)**
1988	0.020	0.020	0.020
	(0.001)**	(0.001)**	(0.001)**
1989	0.016	0.015	0.016
	(0.001)**	(0.001)**	(0.001)**
1990	0.011	0.010	0.011
	(0.001)**	(0.001)**	(0.001)**
1991	0.023	0.022	0.023
	(0.001)**	(0.000)**	(0.001)**
1992	0.024	0.024	0.024
	(0.001)**	(0.001)**	(0.001)**
1993	0.025	0.025	0.025
	(0.000)**	(0.001)**	(0.001)**

1994	0.022	0.022	0.022
	(0.000)**	(0.000)**	(0.000)**
1995	0.025	0.025	0.025
	(0.000)**	(0.000)**	(0.000)**
Martial Law	0.003	0.002	0.002
	(0.002)	(0.002)	(0.002)
1985		0.018	0.018
		(0.002)**	(0.002)**
Private Capital (Estimated for 1985)			0.050
(Proportion of GDP)			(0.014)**
Constant	-0.002	-0.001	-0.003
	(0.004)	(0.005)	(0.004)
Observations	1407	1474	1473
Number of groups	67	67	67
F	66.95	32.99	300295.23
Within R-Squared	0.22	0.21	0.21

Standard Errors in parentheses.
* Significant at 5%, ** significant at 1%

In Tables 2.2.a and 2.2.b, the dependent variable is chosen as the five-year forward moving geometric average of the growth rate of real GDP per worker. In Table A.2.3.3, the results are examined for their robustness of the results for the longer run. In Table A.2.3.3., the first column shows the results for the growth rate of real GDP per worker. The results show the relationship between public investment indicators and the growth rate in the short run. In column (1), the results are less reliable to infer causality. This is because public policy may aim to increase growth rates, and particular types of public investment may be increased for this purpose. It is also possible for a type of public investment to take effect in the long run. For these reasons, the dependent variable in this thesis is calculated as the five-year forward moving geometric average of real GDP per worker. However, it is possible the relationship between government policies and economic growth persists for longer than five years. For robustness analyses, the dependent variables in columns (3), (4) and (5) are calculated as the seven-year, ten-year and fifteen-year forward moving geometric average of the growth rate of real GDP per worker.

However, calculating the dependent variable for the longer run also has disadvantages. This reduces the available sample for the model as the dependent variable only becomes available for a part of the dataset. This decreases the robustness of inferential statistics due to co-linearity. Calculating the dependent variable for the longer run also contributes to serial correlation between error terms. For example, when the dependent variable is calculated as the fifteen-year forward moving geometric average of real GDP per worker, the dependent variable between t and $t + k$ becomes correlated, which introduces serial correlation to error terms between t and $t + k$. Thus, the results become less reliable for the models in which the dependent variable is calculated for the ten-year or fifteen-year forward moving average of the growth rate.

Table A.2.3.3 shows that, in column (1), only the coefficients for public agricultural investment and public energy investment are statistically significant with a positive sign. Their coefficients remain statistically significant for the longer run. Between columns (2) and (5), the signs and the statistical significance of the coefficients for the share of public agricultural investment in GDP, the share of public mining investment in GDP, the share of public energy infrastructure investment in GDP, and the share of public transportation and communication investment in GDP remain the same for the longer run, but the size of the coefficients differ in the long run. The statistical significance of the coefficient of the share of public education investment in GDP seems to be sensitive to the change in dependent variable. The coefficient for the share of public manufacturing investment in GDP appears to become statistically significant for the longer run in columns (3) and (4). This seems to be the case for the share of public city infrastructure and security investment in GDP too. The negative sign for the coefficient of the share of public housing investment in GDP in column (1) switches signs between columns, and becomes statistically significant in the fourth column.

The results for the remaining variables remain the same in terms of statistical significance and signs, with slight changes in the size of the coefficients, with the exception of population growth rate. It appears to have a statistically significant coefficient in the fourth column, in which the dependent variable is the fifteen-year forward moving geometric average of the growth rate of GDP per worker. The overall results suggest that the relationship between the share of public agricultural investment in GDP, the share of public mining investment in GDP, the share of public energy investment in GDP, the share of public transportation and communication investment in GDP, the share of public tourism investment in GDP, and the share of public education investment in GDP and economic growth hold for the longer run.

Table A.2.3. 3 Robustness of the Results for the Longer Run

	(1)	(2)	(3)	(4)	(5)
	Dependent Variable				
	Growth Rate of real GDP per worker	Five-Year Forward Moving Geometric Average of the Growth Rate of real GDP per worker	Seven-Year Forward Moving Geometric Average of the Growth Rate of real GDP per worker	Ten-Year Forward Moving Geometric Average of the Growth Rate of real GDP per worker	Fifteen-Year Forward Moving Geometric Average of the Growth Rate of real GDP per worker
Public Agricultural Investment	0.610	0.214	0.140	0.127	0.047
Proportion of GDP	(0.299)*	(0.077)**	(0.052)**	(0.057)*	(0.018)*
Public Mining Investment	-0.089	-0.066	-0.061	-0.041	-0.003
Proportion of GDP	(0.079)	(0.017)**	(0.009)**	(0.012)**	(0.008)
Public Manufacturing Investment	0.063	0.042	0.017	0.056	0.031
Proportion of GDP	(0.085)	(0.037)	(0.021)	(0.008)**	(0.003)**
Public Energy Investment	0.121	0.103	0.081	0.070	0.033
Proportion of GDP	(0.035)**	(0.012)**	(0.008)**	(0.009)**	(0.004)**
Public Transportation and Com. Investment	-0.055	-0.388	-0.326	-0.312	-0.174
Proportion of GDP	(0.376)	(0.123)**	(0.102)**	(0.062)**	(0.022)**
Public Tourism Investment	-0.163	0.337	0.341	0.321	0.663
Proportion of GDP	(0.282)	(0.120)**	(0.053)**	(0.028)**	(0.093)**
Public Housing Investment	0.127	-0.005	-0.034	0.383	0.343
Proportion of GDP	(0.156)	(0.036)	(0.067)	(0.513)	(0.154)*
Public Education Investment	0.592	0.644	0.336	0.263	0.056
Proportion of GDP	(0.351)	(0.161)**	(0.211)	(0.125)*	(0.208)
Public Health Investment	1.215	0.134	-0.020	0.173	0.086
Proportion of GDP	(1.205)	(0.167)	(0.201)	(0.092)	(0.061)
Public City Infrastructure and Security Investment	0.324	0.588	0.503	0.715	0.575
Proportion of GDP	(0.281)	(0.368)	(0.247)*	(0.066)**	(0.041)**
Population Growth Rate	0.007	-0.120	-0.108	-0.117	-0.183
	(0.454)	(0.163)	(0.141)	(0.062)	(0.015)**
1975	0.144	0.003	-0.009	-0.006	0.000
	(0.004)**	(0.001)*	(0.001)**	(0.001)**	(0.001)
1976	0.062	-0.012	-0.020	-0.013	-0.006
	(0.003)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**
1977	0.042	-0.019	-0.021	-0.012	-0.005
	(0.004)**	(0.002)**	(0.002)**	(0.002)**	(0.002)**
1978	0.034	-0.011	-0.015	-0.009	-0.001
	(0.005)**	(0.002)**	(0.002)**	(0.001)**	(0.001)
1979	0.018	-0.000	-0.005	-0.006	0.000
	(0.004)**	(0.002)	(0.001)**	(0.001)**	(0.001)
1980	0.081	0.012	0.007	0.003	0.003
	(0.010)**	(0.003)**	(0.003)*	(0.001)**	(0.001)**
1981	0.044	0.011	0.002	-0.000	0.005
	(0.010)**	(0.003)**	(0.003)	(0.001)	(0.001)**
1982	0.077	0.023	0.000	0.005	0.008
	(0.010)**	(0.003)**	(0.003)	(0.001)**	(0.001)**
1983	0.072	0.019	0.005	0.006	0.008
	(0.011)**	(0.003)**	(0.003)	(0.001)**	(0.001)**
1984	0.081	0.013	0.006	0.004	0.007
	(0.007)**	(0.002)**	(0.002)**	(0.001)**	(0.000)**
Private Capital	0.079	0.050	0.040	0.016	0.007
(Proportion of GDP)	(0.069)	(0.013)**	(0.010)**	(0.023)	(0.004)
1986	0.112	0.013	0.006	0.003	
	(0.002)**	(0.001)**	(0.001)**	(0.001)**	
1987	0.060	0.012	-0.005	0.004	

	(0.002)**	(0.001)**	(0.001)**	(0.000)**	
1988	0.032	0.020	-0.001	0.008	
	(0.002)**	(0.001)**	(0.001)*	(0.000)**	
1989	0.114	0.016	0.009	0.005	
	(0.002)**	(0.001)**	(0.001)**	(0.000)**	
1990	0.069	0.011	0.009	0.004	
	(0.002)**	(0.001)**	(0.001)**	(0.000)**	
1991	0.101	0.023	0.014		
	(0.002)**	(0.001)**	(0.000)**		
1992	0.098	0.024	0.001		
	(0.002)**	(0.001)**	(0.000)		
1993	0.024	0.025	0.003		
	(0.002)**	(0.000)**	(0.001)**		
1994	0.084	0.022			
	(0.002)**	(0.000)**			
1995	0.115	0.025			
	(0.002)**	(0.000)**			
1996	0.112				
	(0.002)**				
1997	0.084				
	(0.001)**				
1998	0.005				
	(0.001)**				
1999	0.101				
	(0.001)**				
Martial Law	0.002	0.003	0.001	0.002	0.004
	(0.010)	(0.002)	(0.003)	(0.001)	(0.001)**
Constant	-0.066	-0.002	0.014	0.012	0.013
	(0.008)**	(0.004)	(0.004)**	(0.001)**	(0.001)**
Observations	1675	1407	1273	1072	737
Number of groups	67	67	67	67	67
F	30.74	66.95	92.12	2260.17	853.92
Within R-Squared	0.18	0.22	0.22	0.25	0.37

Standard Errors in parentheses.
* Significant at 5%, ** significant at 1%

Table A.2.3.4 shows the results when the dependent variable is calculated for the growth rate of real GDP per capita (instead of real GDP per worker), and for the arithmetic average (instead of geometric average) of the growth rate. The results remain the same in terms of the signs and statistical significance of the explanatory variables. The size of the coefficients appears to change slightly between the columns. Thus, it can be said that Table A.2.3.4 provides evidence that the results are robust to the calculation technique of the dependent variable.

Table A.2.3.4 Robustness of the Results for the Alternative Calculation of the Dependent Variable

	Dependent Variables			
	Five-year forward moving geometric average of growth rate per worker	Five-year forward moving geometric average of growth rate per capita	Five-year forward moving arithmetic average of growth rate per worker	Five-year forward moving arithmetic average of growth rate per capita
Public Agricultural Investment	0.214	0.176	0.184	0.147
Proportion of GDP	(0.077)**	(0.078)*	(0.084)*	(0.085)
Public Mining Investment	-0.066	-0.050	-0.059	-0.043
Proportion of GDP	(0.017)**	(0.016)**	(0.019)**	(0.019)*
Public Manufacturing Investment	0.042	0.022	0.041	0.021
Proportion of GDP	(0.037)	(0.028)	(0.038)	(0.028)
Public Energy Investment	0.103	0.101	0.100	0.099
Proportion of GDP	(0.012)**	(0.012)**	(0.012)**	(0.013)**
Public Transportation and Com. Investment	-0.388	-0.313	-0.359	-0.283
Proportion of GDP	(0.123)**	(0.112)**	(0.118)**	(0.108)*
Public Housing Investment	-0.005	0.002	0.006	0.013
Proportion of GDP	(0.036)	(0.037)	(0.043)	(0.045)
Public Tourism Investment	0.337	0.287	0.315	0.263
Proportion of GDP	(0.120)**	(0.120)*	(0.111)**	(0.112)*
Public Education Investment	0.644	0.621	0.649	0.627
Proportion of GDP	(0.161)**	(0.175)**	(0.174)**	(0.188)**
Public Health Investment	0.134	0.065	0.078	0.012
Proportion of GDP	(0.167)	(0.169)	(0.164)	(0.167)
Public City Infrastructure and Security Investment	0.588	0.621	0.633	0.663
Proportion of GDP	(0.368)	(0.315)	(0.374)	(0.320)*
Population Growth Rate	-0.120	-0.131	-0.040	-0.062
	(0.163)	(0.194)	(0.214)	(0.242)
1975	0.003	0.010	0.004	0.011
	(0.001)*	(0.001)**	(0.001)**	(0.001)**
1976	-0.012	-0.004	-0.011	-0.003
	(0.001)**	(0.001)**	(0.001)**	(0.001)**
1977	-0.019	-0.011	-0.018	-0.010
	(0.002)**	(0.001)**	(0.002)**	(0.002)**
1978	-0.011	-0.003	-0.009	-0.001
	(0.002)**	(0.002)	(0.002)**	(0.002)
1979	-0.000	0.007	0.000	0.008
	(0.002)	(0.001)**	(0.002)	(0.002)**
1980	0.012	0.020	0.012	0.020
	(0.003)**	(0.003)**	(0.003)**	(0.003)**
1981	0.011	0.021	0.010	0.020
	(0.003)**	(0.003)**	(0.003)**	(0.004)**
1982	0.023	0.033	0.023	0.034
	(0.003)**	(0.003)**	(0.003)**	(0.004)**
1983	0.019	0.030	0.019	0.031
	(0.003)**	(0.003)**	(0.003)**	(0.004)**
1984	0.013	0.025	0.014	0.026
	(0.002)**	(0.002)**	(0.002)**	(0.003)**
Private Capita	0.050	0.043	0.051	0.044
(Proportion of GDP)	(0.013)**	(0.014)**	(0.012)**	(0.014)**
1986	0.013	0.023	0.016	0.025
	(0.001)**	(0.001)**	(0.002)**	(0.002)**
1987	0.012	0.019	0.012	0.020
	(0.001)**	(0.001)**	(0.001)**	(0.001)**
1988	0.020	0.025	0.021	0.025
	(0.001)**	(0.001)**	(0.001)**	(0.001)**
1989	0.016	0.018	0.016	0.019
	(0.001)**	(0.001)**	(0.001)**	(0.001)**

1990	0.011	0.011	0.010	0.011
	(0.001)**	(0.001)**	(0.001)**	(0.001)**
1991	0.023	0.023	0.022	0.022
	(0.001)**	(0.001)**	(0.001)**	(0.001)**
1992	0.024	0.024	0.024	0.024
	(0.001)**	(0.001)**	(0.001)**	(0.001)**
1993	0.025	0.025	0.024	0.024
	(0.000)**	(0.001)**	(0.001)**	(0.001)**
1994	0.022	0.022	0.021	0.021
	(0.000)**	(0.000)**	(0.000)**	(0.000)**
1995	0.025	0.025	0.025	0.025
	(0.000)**	(0.000)**	(0.000)**	(0.000)**
Martial Law	0.003	0.002	0.004	0.003
	(0.002)	(0.002)	(0.003)	(0.003)
Constant	-0.002	-0.010	-0.001	-0.009
	(0.004)	(0.004)*	(0.005)	(0.005)
Observations	1407	1407	1407	1407
Number of groups	67	67	67	67
F	66.95	81.42	64.19	89.85
Within R-Squared	0.22	0.21	0.20	0.20

Standard Errors in parentheses. * Significant at 5%, ** significant at 1%

Co-linearity diagnostics are provided for the model in Table 2.2.b, column (5) in Table A.2.3.5. The values of variance inflation factors are reported as an indicator. The minimum value the variance inflation factor can take is “1”, which indicates that there is no co-linearity between the variables. The mean for the variance inflation factor for the model in Table 2.2.b, column (5) is 1.42, which is considered to be at an acceptable level. The highest value appears to be for martial law which is 3.45. The value of the variance inflation factor for the remaining variables varies between 1.5 and 2.5, which indicates that co-linearity is unlikely to be a problem in the results.

Table A.2.3. 5 Co-linearity Diagnostics for the Regression in Table 2.2.b, Column (5)

Variable	VIF	1/VIF
Martial Law	3.45	0.289722
Proportion of Public Investment in GDP	2.24	0.447124
Population Growth Rate	2.23	0.449138
Energy (Proportion of GDP)	2.22	0.450011
Transportation and Communication (Proportion of GDP)	1.75	0.572665
1981	1.58	0.632838
1982	1.58	0.633113
1983	1.57	0.634973
1980	1.55	0.644074
Private Capital (Proportion of GDP)	1.32	0.754885
1984	1.29	0.773258
1985	1.25	0.798447
1987	1.24	0.808048
1988	1.22	0.821687
1986	1.20	0.833585
1989	1.20	0.833781
1990	1.16	0.861607
1993	1.15	0.872101
1986	1.15	0.872912
1988	1.14	0.873378
1990	1.14	0.878771
1994	1.14	0.879156
1987	1.13	0.885057
1995	1.11	0.899991
1991	1.08	0.925980
1992	1.07	0.933729
Mean VIF	1.47	

Finally, for the robustness analyses, Table A.2.3.6 is provided to investigate the relationship between long-run economic growth, infant mortality rates and the gross enrolment rates. In columns (5), (6) and (7) the dependent variables in the third and the fourth chapter are included to examine the possible linkages between the five-year forward moving averages of economic growth rate, the infant mortality rates, and the gross enrolment rates. However, none of the variables for health and education in Table A.2.3.6 appear to be statistically related to the five-year forward moving geometric average of the growth rate of GDP per worker. The results for public investment indicators seem to remain similar between columns.

Table A.2.3. 6 The Relationship between Long-Run Economic Growth, the Gross Enrolment Rates, and the Infant Mortality Rates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Dependent Variable: Five-Year Forward Moving Geometric Average of the Growth Rate of Real GDP per worker						
Public Agricultural Investment	0.214	0.218	0.208	0.212	0.205	0.213	0.205
Proportion of GDP	(0.077)**	(0.077)**	(0.093)*	(0.093)*	(0.083)*	(0.077)**	(0.083)*
Public Mining Investment	-0.066	-0.066	-0.066	-0.066	-0.066	-0.066	-0.066
Proportion of GDP	(0.017)**	(0.017)**	(0.016)**	(0.016)**	(0.016)**	(0.016)**	(0.016)**
Public Manufacturing Investment	0.042	0.041	0.043	0.042	0.042	0.042	0.042
Proportion of GDP	(0.037)	(0.037)	(0.038)	(0.038)	(0.038)	(0.038)	(0.038)
Public Energy Investment	0.103	0.103	0.102	0.103	0.103	0.102	0.103
Proportion of GDP	(0.012)**	(0.012)**	(0.012)**	(0.012)**	(0.012)**	(0.011)**	(0.011)**
Public Transportation and Com. Investment	-0.388	-0.385	-0.385	-0.381	-0.381	-0.389	-0.381
Proportion of GDP	(0.123)**	(0.125)**	(0.118)**	(0.119)**	(0.117)**	(0.125)**	(0.119)**
Public Tourism Investment	0.337	0.338	0.337	0.338	0.339	0.337	0.339
Proportion of GDP	(0.120)**	(0.121)**	(0.122)**	(0.123)**	(0.125)**	(0.119)**	(0.125)**
Public Housing Investment	-0.005	-0.004	-0.000	0.000	0.007	-0.005	0.007
Proportion of GDP	(0.036)	(0.036)	(0.050)	(0.050)	(0.043)	(0.036)	(0.043)
Public Education Investment	0.644	0.638	0.656	0.651	0.662	0.645	0.661
Proportion of GDP	(0.161)**	(0.157)**	(0.149)**	(0.147)**	(0.150)**	(0.156)**	(0.147)**
Public Health Investment	0.134	0.133	0.132	0.131	0.134	0.134	0.134
Proportion of GDP	(0.167)	(0.167)	(0.176)	(0.176)	(0.171)	(0.167)	(0.171)
Public City Infrastructure and Security Investment	0.588	0.596	0.579	0.587	0.568	0.586	0.568
Proportion of GDP	(0.368)	(0.357)	(0.343)	(0.334)	(0.353)	(0.356)	(0.342)
Population Growth Rate	-0.120	-0.117	-0.109	-0.105	-0.090	-0.121	-0.090
	(0.163)	(0.163)	(0.139)	(0.138)	(0.144)	(0.164)	(0.142)
1975	0.003	0.002	0.003	0.002	0.004	0.003	0.004
	(0.001)*	(0.002)	(0.001)**	(0.001)	(0.003)	(0.002)	(0.004)
1976	-0.012	-0.013	-0.012	-0.013	-0.010	-0.012	-0.010
	(0.001)**	(0.002)**	(0.001)**	(0.001)**	(0.003)**	(0.002)**	(0.004)*
1977	-0.019	-0.020	-0.019	-0.020	-0.018	-0.019	-0.018
	(0.002)**	(0.002)**	(0.001)**	(0.002)**	(0.004)**	(0.003)**	(0.004)**
1978	-0.011	-0.012	-0.011	-0.012	-0.009	-0.011	-0.009
	(0.002)**	(0.002)**	(0.002)**	(0.002)**	(0.004)*	(0.003)**	(0.005)*
1979	-0.000	-0.001	-0.000	-0.001	0.001	-0.000	0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.004)
1980	0.012	0.011	0.012	0.011	0.013	0.012	0.013
	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.004)**	(0.003)**	(0.004)**
1981	0.011	0.011	0.011	0.011	0.012	0.012	0.012
	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.003)**	(0.004)**
1982	0.023	0.022	0.023	0.022	0.024	0.023	0.024
	(0.003)**	(0.002)**	(0.003)**	(0.002)**	(0.003)**	(0.003)**	(0.003)**
1983	0.019	0.018	0.019	0.018	0.020	0.019	0.020
	(0.003)**	(0.002)**	(0.003)**	(0.002)**	(0.003)**	(0.003)**	(0.003)**
1984	0.013	0.013	0.013	0.012	0.014	0.013	0.014
	(0.002)**	(0.002)**	(0.002)**	(0.001)**	(0.002)**	(0.002)**	(0.003)**
Private Capital	0.050	0.051	0.050	0.051	0.050	0.050	0.050
(Proportion of GDP)	(0.013)**	(0.013)**	(0.012)**	(0.012)**	(0.013)**	(0.013)**	(0.013)**
1986	0.013	0.013	0.013	0.012	0.014	0.013	0.014
	(0.001)**	(0.001)**	(0.004)**	(0.003)**	(0.001)**	(0.001)**	(0.001)**
1987	0.012	0.012	0.012	0.011	0.013	0.012	0.013
	(0.001)**	(0.001)**	(0.004)**	(0.003)**	(0.001)**	(0.001)**	(0.001)**
1988	0.020	0.020	0.020	0.019	0.021	0.020	0.021
	(0.001)**	(0.001)**	(0.003)**	(0.002)**	(0.001)**	(0.001)**	(0.002)**
1989	0.016	0.015	0.016	0.015	0.017	0.016	0.017
	(0.001)**	(0.001)**	(0.002)**	(0.002)**	(0.002)**	(0.001)**	(0.002)**
1990	0.011	0.010	0.010	0.010	0.012	0.011	0.012
	(0.001)**	(0.001)**	(0.002)**	(0.002)**	(0.002)**	(0.001)**	(0.002)**
1991	0.023	0.023	0.023	0.022	0.024	0.023	0.024
	(0.001)**	(0.001)**	(0.002)**	(0.002)**	(0.002)**	(0.001)**	(0.002)**
1992	0.024	0.024	0.024	0.024	0.025	0.024	0.025

	(0.001)**	(0.001)**	(0.002)**	(0.002)**	(0.002)**	(0.001)**	(0.002)**
1993	0.025	0.025	0.025	0.024	0.026	0.025	0.026
	(0.000)**	(0.001)**	(0.001)**	(0.001)**	(0.002)**	(0.001)**	(0.003)**
1994	0.022	0.022	0.022	0.022	0.023	0.022	0.023
	(0.000)**	(0.001)**	(0.001)**	(0.001)**	(0.002)**	(0.001)**	(0.002)**
1995	0.025	0.025	0.025	0.025	0.026	0.025	0.026
	(0.000)**	(0.001)**	(0.000)**	(0.000)**	(0.001)**	(0.000)**	(0.001)**
Martial Law	0.003	0.002	0.002	0.002	0.002	0.003	0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)
Infant Mortality Rate		0.085		0.088			
		(0.121)		(0.113)			
Gross Enrolment Ratio			0.010	0.011			
			(0.056)	(0.056)			
Five-Year Forward Moving Average of the Gross Enrolment Rate					0.028		0.029
					(0.044)		(0.042)
Five-Year Forward Moving Average of the Infant Mortality Rate						-0.012	0.007
						(0.170)	(0.156)
Constant	-0.002	-0.003	-0.009	-0.010	-0.023	-0.002	-0.023
	(0.004)	(0.004)	(0.037)	(0.036)	(0.032)	(0.004)	(0.029)
Observations	1407	1407	1407	1407	1407	1407	1407
Number of groups	67	67	67	67	67	67	67
F	66.95	83.57	76.58	88.12	63.01	80.56	76.49
Within R-Squared	0.22	0.22	0.22	0.22	0.22	0.22	0.22

Standard Errors in parentheses.
* Significant at 5%, ** significant at 1%

APPENDIX: CHAPTER 3

A.3.1 Robustness of the Results

As in the appendices for the earlier chapter, the chosen econometric technique, methods for robust standard errors, tests for model specification and omitted variable bias, and unit root tests are discussed in the fifth chapter. The tests for model specification and omitted variable bias fail to reject the null hypothesis that the model in Table 3.2, column (6) in the third chapter is correctly specified. The unit root tests reject the null hypothesis that all panels are non-stationary except for the adult education indicator. When the adult education indicator is removed from the regression, this does not change the results, but the Ramsey regression specification error test rejects that the model in Table 3.2 is correctly specified.

In this section, the robustness of the results in Table 3.2, column (6) will be investigated for the presence of potential outliers. The technique used to examine the robustness of the results to outliers is explained in more detail in the second chapter in the section on the robustness of the results. Outliers are the observations that have significantly larger residuals compared to the rest of the sample, which may bias the results. To detect observations that may bias the results, the regression in Table 3.2, column (6) is repeated by excluding observations that have Studentized residuals higher than the absolute value of 2. The results are provided in Table 3.3, column (2). In column (2), the positive coefficient for the logarithm of GDP per capita becomes statistically significant. The results for the rest of the variable remain the same in terms of the signs and statistical significance, with slight changes in the size of the coefficients.

It has been stated in the second chapter, in the section for data, that in reality, the number of provinces rose from 67 to 81 between 1975 and 2001. For the regressions in the thesis, in order to achieve a balanced dataset, the data are adjusted for former districts and provinces that contained those districts. In order to examine if the change in data due to the change in provinces affects results, in Table A.3.1.1, column (3), the regression in Table 3.2, column (6) is repeated by excluding these areas from the observations. There does not appear to be any change in the sign and statistical significance of the variables in column (3). In short, it can be said that the change in data due to the change in the number of provinces does not have a considerable effect on the results in Table 3.2, column (6).

Table A.3.1.1 Robustness of the Results for Outliers and the Provinces that Change Size and Status

	(1)	(2)	(3)
	Original Sample	Excluding Potential Outliers	Excluding Provinces that Change Size and Status
Public Energy Investment	-0.001	0.001	-0.000
Proportion of GDP	(0.015)	(0.011)	(0.016)
Public Transportation and Com. Investment	-0.364	-0.242	-0.386
Proportion of GDP	(0.200)	(0.138)	(0.216)
Public Education Investment	0.121	0.040	0.111
Proportion of GDP	(0.190)	(0.111)	(0.342)
Public Health Investment	-0.266	-0.266	-0.322
Proportion of GDP	(0.459)	(0.313)	(0.644)
Public City Infra. and Security Investment	0.992	1.402	0.957
Proportion of GDP	(0.173)**	(0.117)**	(0.255)**
Population Growth Rate	-1.014	-0.923	-0.999
	(0.238)**	(0.175)**	(0.223)**
1975	-0.166	-0.155	-0.161
	(0.025)**	(0.015)**	(0.027)**
1976	-0.166	-0.151	-0.161
	(0.024)**	(0.015)**	(0.025)**
1977	-0.161	-0.148	-0.157
	(0.023)**	(0.014)**	(0.025)**
1978	-0.157	-0.143	-0.152
	(0.022)**	(0.013)**	(0.024)**
1979	-0.139	-0.125	-0.134
	(0.020)**	(0.012)**	(0.022)**
1980	-0.134	-0.118	-0.132
	(0.021)**	(0.013)**	(0.022)**
1981	-0.119	-0.103	-0.117
	(0.020)**	(0.012)**	(0.021)**
1982	-0.109	-0.095	-0.107
	(0.019)**	(0.012)**	(0.020)**
1983	-0.098	-0.084	-0.096
	(0.018)**	(0.011)**	(0.019)**
1984	-0.085	-0.072	-0.081
	(0.016)**	(0.010)**	(0.017)**
1985	-0.080	-0.074	-0.075
	(0.014)**	(0.010)**	(0.014)**
1986	-0.089	-0.080	-0.085
	(0.014)**	(0.009)**	(0.014)**
1987	-0.091	-0.082	-0.087
	(0.013)**	(0.009)**	(0.014)**
1988	-0.092	-0.082	-0.089
	(0.012)**	(0.008)**	(0.013)**
1989	-0.092	-0.083	-0.090
	(0.012)**	(0.007)**	(0.012)**
1990	-0.097	-0.087	-0.095
	(0.010)**	(0.007)**	(0.011)**
1991	-0.100	-0.090	-0.097
	(0.009)**	(0.006)**	(0.010)**
1992	-0.103	-0.092	-0.101
	(0.009)**	(0.005)**	(0.009)**
1993	-0.106	-0.095	-0.105
	(0.007)**	(0.005)**	(0.007)**
1994	-0.091	-0.079	-0.090
	(0.005)**	(0.003)**	(0.006)**
1995	-0.066	-0.054	-0.067
	(0.004)**	(0.002)**	(0.004)**
1996	-0.035	-0.018	-0.035
	(0.002)**	(0.003)**	(0.002)**
Ln(GDP per capita)	0.026	0.029	0.030
	(0.017)	(0.014)*	(0.018)
Infant Mortality Rate	-0.299	-0.284	-0.278
	(0.065)**	(0.040)**	(0.108)*

Martial Law	0.019	0.015	0.021
	(0.005)**	(0.003)**	(0.005)**
Adult Education Indicator	-0.666	-0.652	-0.649
	(0.203)**	(0.117)**	(0.213)**
Constant	0.517	0.456	0.447
	(0.229)*	(0.194)*	(0.248)
Observations	1541	1474	1288
Number of groups	67	67	56
F	33.92	6095048.56	92.09
Within R-Squared	0.49	0.55	0.47

Standard Errors in parentheses.
* Significant at 5%, ** significant at 1%

In the third chapter, the dependent variable is calculated as the five-year forward moving arithmetic average of the gross enrolment rate. This is because, in the short run, policy makers may take the gross enrolment rates as an indicator by which to determine the level of public infrastructure, health and education investment, which would lead to reverse causality between the explanatory variable and the outcome variable. Additionally, calculating the dependent variable for the longer run allows a lag for public investment to take effect on gross enrolment rates. In this section, for robustness analyses, the results for shorter and longer run are presented in Table A.3.1.2. In column (1), the dependent variable is the gross enrolment rate. In columns (2), (3), (4) and (5), the dependent variable is the five-year, seven-year, ten-year, and fifteen-year forward moving arithmetic average of the gross enrolment rate.

In the first column, there appears to be a negative relationship between public education investment, public transportation investment and the gross enrolment rate. However, as pointed out earlier, this is likely to be a result of public policy that aims to improve the gross enrolment rate. It is possible that the government invests more in provinces in which the gross enrolment rates are low, which would create a negative link between public education investment and the gross enrolment rate. For the same reason, it is less reliable to infer a causal relationship between public transportation and communication investment and the long-run gross enrolment rate.

As pointed out in the appendices for the second chapter, calculation of the dependent variable for the longer run has the disadvantage of reducing the size of the sample of the estimations, which increases co-linearity. Accordingly, the results in Table A.3.1.2 appear to display its symptoms. The logarithm of GDP per capita switches signs between columns, and becomes statistically significant with a negative sign in the fifth column. This appears to be the case for the share of public city infrastructure and security investment in GDP. While it has a positive and statistically significant sign in the second column, it switches sign in the fourth column, and appears to have a negative and statistically significant sign in the fifth column. The coefficient of health investment in GDP is statistically insignificant, but its sign changes in the fourth column.

In summary, although the relationship between the explanatory variables and the gross enrolment rate appears to change in the long run, the results in Table A.3.1.2 show symptoms of co-linearity in the fourth and fifth columns. Increasing co-linearity is likely to be due to the reduction in the size of the available sample when the dependent variable is calculated for the longer run.

Table A.3.1.2 Robustness of the Results for the Longer Run

	(1)	(2)	(3)	(4)	(5)
			Dependent Variable		
	Gross Enrolment Rates	Five-Year Forward Moving Arithmetic Average of the Gross Enrolment Rate	Seven-Year Forward Moving Arithmetic Average of the Gross Enrolment Rate	Ten-Year Forward Moving Arithmetic Average of the Gross Enrolment Rate	Fifteen-Year Forward Moving Arithmetic Average of the Gross Enrolment Rate
Public Energy Investment	0.013	-0.001	-0.000	-0.000	-0.007
Proportion of GDP	(0.016)	(0.015)	(0.007)	(0.008)	(0.006)
Public Transportation and Com. Investment	-0.556	-0.364	-0.214	-0.112	0.171
Proportion of GDP	(0.244)*	(0.200)	(0.130)	(0.101)	(0.088)
Public Education Investment	-0.818	-0.266	-0.364	-0.290	-0.140
Proportion of GDP	(0.389)*	(0.459)	(0.322)	(0.156)	(0.061)*
Public Health Investment	0.380	0.121	0.017	-0.064	0.195
Proportion of GDP	(0.312)	(0.190)	(0.197)	(0.199)	(0.092)*
Public City Infra. and Security Investment	0.196	0.992	0.561	-0.067	-0.325
Proportion of GDP	(0.228)	(0.173)**	(0.212)*	(0.258)	(0.126)*
Population Growth Rate	-1.319	-1.014	-0.831	-0.523	-0.332
	(0.166)**	(0.238)**	(0.260)**	(0.209)*	(0.106)**
1975	-0.259	0.351	-0.115	-0.065	-0.036
	(0.019)**	(0.229)	(0.023)**	(0.013)**	(0.002)**
1976	-0.259	0.351	-0.111	-0.058	-0.030
	(0.018)**	(0.230)	(0.022)**	(0.012)**	(0.002)**
1977	-0.266	0.356	-0.100	-0.050	-0.027
	(0.018)**	(0.231)	(0.021)**	(0.011)**	(0.001)**
1978	-0.264	0.361	-0.094	-0.046	-0.027
	(0.017)**	(0.228)	(0.020)**	(0.011)**	(0.002)**
1979	-0.258	0.379	-0.082	-0.039	-0.026
	(0.016)**	(0.228)	(0.018)**	(0.009)**	(0.002)**
1980	-0.266	0.384	-0.079	-0.039	-0.029
	(0.016)**	(0.226)	(0.018)**	(0.010)**	(0.002)**
1981	-0.249	0.399	-0.066	-0.032	-0.026
	(0.016)**	(0.227)	(0.017)**	(0.009)**	(0.002)**
1982	-0.238	0.408	-0.059	-0.028	-0.026
	(0.016)**	(0.226)	(0.016)**	(0.009)**	(0.002)**
1983	-0.199	0.419	-0.054	-0.025	-0.026
	(0.015)**	(0.227)	(0.016)**	(0.008)**	(0.002)**
1984	-0.192	0.433	-0.045	-0.021	-0.022
	(0.014)**	(0.226)	(0.013)**	(0.006)**	(0.001)**
1985	-0.183	0.437	-0.041	-0.018	-0.014
	(0.013)**	(0.226)	(0.010)**	(0.004)**	(0.001)**
1986	-0.183	0.428	-0.048	-0.025	-0.007
	(0.012)**	(0.227)	(0.011)**	(0.005)**	(0.000)**
1987	-0.173	0.427	-0.051	-0.030	
	(0.012)**	(0.228)	(0.010)**	(0.004)**	
1988	-0.182	0.426	-0.056	-0.035	
	(0.011)**	(0.227)	(0.009)**	(0.003)**	
1989	-0.182	0.425	-0.057	-0.031	
	(0.011)**	(0.227)	(0.008)**	(0.003)**	
1990	-0.188	0.421	-0.063	-0.024	
	(0.010)**	(0.228)	(0.007)**	(0.002)**	
1991	-0.184	0.418	-0.066	-0.013	
	(0.009)**	(0.227)	(0.006)**	(0.001)**	
1992	-0.181	0.414	-0.060		

	(0.009)**	(0.228)	(0.005)**		
1993	-0.194	0.412	-0.047		
	(0.008)**	(0.227)	(0.004)**		
1994	-0.191	0.427	-0.023		
	(0.007)**	(0.227)	(0.002)**		
1995	-0.192	0.451			
	(0.006)**	(0.227)			
1996	-0.192	0.483			
	(0.006)**	(0.228)*			
1997	-0.181	0.517			
	(0.005)**	(0.229)*			
1998	-0.120				
	(0.004)**				
1999	-0.062				
	(0.002)**				
2000	-0.015				
	(0.002)**				
Log(GDP per capita)	0.022	0.026	0.022	0.013	-0.014
	(0.008)**	(0.017)	(0.018)	(0.017)	(0.006)*
Infant Mortality Rate	-0.375	-0.299	-0.348	-0.366	-0.164
	(0.133)**	(0.065)**	(0.099)**	(0.129)**	(0.052)**
Martial Law	0.017	0.019	0.017	0.013	0.007
	(0.008)*	(0.005)**	(0.005)**	(0.005)**	(0.002)**
Adult Education Indicator	-0.746	-0.666	-0.499	-0.314	-0.060
	(0.089)**	(0.203)**	(0.216)*	(0.156)*	(0.021)**
Constant	0.691	0.000	0.506	0.586	0.916
	(0.122)**	(0.000)	(0.238)*	(0.224)*	(0.090)**
Observations	1809	1541	1407	1206	871
Number of groups	67	67	67	67	67
F	37.20	61.15	37.60	93.35	82.39
Within R-Squared	0.60	0.49	0.40	0.29	0.26

Standard Errors in parentheses.
* Significant at 5%, ** significant at 1%

The co-linearity indicator used in the chapter is the variance inflation factor, as in the earlier chapters. The minimum value of the variance inflation factor is 1, which indicates that there is no co-linearity between the variables. In Table A.3.1.3, it can be seen that the value of the variance inflation factor for the logarithm of GDP per capita is 66.58, and for the adult education indicator it is 21.33; these are considerably high. The severity of co-linearity is likely to increase in models in which the dependent variable is calculated for the longer run, as this reduces the available sample for the regressions. Thus, the inferential statistics in Table A.3.1.2 do not appear to be reliable in the fourth and fifth columns.

In Table A.3.1.4, the results for the five-year forward moving geometric average of the gross enrolment rate are provided. The size of the coefficients of the public city infrastructure and security investment, and the population growth rate slightly change between the first and second columns. Nevertheless, the rest of the results in column (2) remain similar to those in column (1).

Table A.3.1.3 Co-linearity Diagnostics for the Regression in Table 3.2, Column (6)

Variable	VIF	1/VIF
Logarithm of GDP per capita	66.58	0.015019
Adult Education Indicator	21.33	0.046888
Infant Mortality Rate	4.00	0.250215
Martial Law	3.49	0.286332
1975	3.40	0.293809
1976	3.33	0.300710
1977	3.24	0.308375
1980	3.15	0.317571
1981	3.11	0.321204
1978	3.11	0.321421
Public City Infra. & Sec. Investment	3.07	0.325710
1982	3.05	0.327587
1983	3.02	0.331269
1979	2.92	0.342486
1984	2.63	0.380469
Public Education Investment	2.55	0.392405
Population Growth Rate	2.52	0.396736
1985	2.49	0.401430
1986	2.48	0.402740
1987	2.42	0.413844
1988	2.34	0.427613
1989	2.28	0.439118
1990	2.24	0.446745
1991	2.17	0.460706
1992	2.11	0.473020
1993	2.11	0.473280
1994	2.04	0.490140
1995	2.01	0.497751
1996	1.99	0.503036
Public Trans. & Com. Inv	1.73	0.577813
Public Health Investment	1.37	0.727323
Public Energy Investment	1.14	0.874975
Mean VIF	5.17	

Table A.3.1.4 Robustness of the Results for the Alternative Calculations of the Dependent Variable

	Chapter 3	
	Five-year forward moving arithmetic average of gross enrolment rate	Five-year forward moving geometric average of gross enrolment rate
Public Energy Investment	-0.001	-0.002
Proportion of GDP	(0.015)	(0.015)
Public Transportation and Com. Investment	-0.364	-0.349
Proportion of GDP	(0.200)	(0.197)
Public Education Investment	-0.266	-0.310
Proportion of GDP	(0.459)	(0.439)
Public Health Investment	0.121	0.113
Proportion of GDP	(0.190)	(0.190)
Public City Infrastructure and Security Investment	0.992	1.010
Proportion of GDP	(0.173)**	(0.172)**
Population Growth Rate	-1.014	-1.009
	(0.238)**	(0.236)**
1975	-0.166	-0.163
	(0.025)**	(0.025)**
1976	-0.166	-0.163
	(0.024)**	(0.023)**
1977	-0.161	-0.158
	(0.023)**	(0.023)**
1978	-0.157	-0.153
	(0.022)**	(0.022)**
1979	-0.139	-0.136
	(0.020)**	(0.020)**
1980	-0.134	-0.130
	(0.021)**	(0.020)**
1981	-0.119	-0.116
	(0.020)**	(0.020)**
1982	-0.109	-0.106
	(0.019)**	(0.019)**
1983	-0.098	-0.095
	(0.018)**	(0.018)**
1984	-0.085	-0.081
	(0.016)**	(0.016)**
1985	-0.080	-0.077
	(0.014)**	(0.014)**
1986	-0.089	-0.086
	(0.014)**	(0.014)**
1987	-0.091	-0.088
	(0.013)**	(0.013)**
1988	-0.092	-0.089
	(0.012)**	(0.012)**
1989	-0.092	-0.089
	(0.012)**	(0.011)**
1990	-0.097	-0.094
	(0.010)**	(0.010)**
1991	-0.100	-0.098
	(0.009)**	(0.009)**
1992	-0.103	-0.100
	(0.009)**	(0.008)**
1993	-0.106	-0.103
	(0.007)**	(0.007)**
1994	-0.091	-0.089
	(0.005)**	(0.005)**
1995	-0.066	-0.065
	(0.004)**	(0.004)**
1996	-0.035	-0.035
	(0.002)**	(0.002)**
Ln(GDP per capita)	0.026	0.026
	(0.017)	(0.017)
Infant Mortality Rate	-0.299	-0.305
	(0.065)**	(0.067)**

Martial Law	0.019	0.019
	(0.005)**	(0.005)**
Adult Education Indicator	-0.666	-0.657
	(0.203)**	(0.200)**
Constant	0.517	0.503
	(0.229)*	(0.228)*
Observations	1541	1541
Number of groups	67	67
F	33.92	34.54
Within R-Squared	0.49	0.48

Standard Errors in parentheses.
* Significant at 5%, ** significant at 1%

In Table A.3.1.5, the robustness of results is investigated by altering the estimated model. This practice is carried out as the infant mortality in the regression model in Table 3.2, column (6) is likely to be correlated with public investment indicators because of the short-run relationship between public investment and the infant mortality rate. The infant mortality rate is included in the regressions in Table 3.2 as a proxy for school-age children's health. Table A.3.1.5 shows that removing this indicator from the regression does not change the statistical significance of the coefficient of the share of public city infrastructure and security investment, but does increase the size of the coefficient.

Additionally, in columns (3), (4) and (5) in Table A.3.1.5, the adult education indicator, the variable for martial law, and then the logarithm of GDP per capita are excluded from the regressions. Removing these variables appears to reduce the size of the coefficient for public city infrastructure and security investment, but the variable remains statistically significant with a positive sign in all columns.

Table A.3.1.5 Alternative Specification of the Regression Model in Table 3.2, Column (6)

	(1)	(2)	(3)	(4)	(5)
	Dependent Variable: Five-Year Forward Moving Arithmetic Average of the Gross Enrolment Rate				
Public Energy Investment	-0.001	0.001	0.002	0.008	0.001
Proportion of GDP	(0.015)	(0.015)	(0.013)	(0.012)	(0.017)
Public Transportation and Com. Investment	-0.364	-0.355	-0.412	-0.419	-0.387
Proportion of GDP	(0.200)	(0.197)	(0.215)	(0.215)	(0.218)
Public Education Investment	-0.266	-0.286	-0.405	-0.376	-0.430
Proportion of GDP	(0.459)	(0.459)	(0.433)	(0.447)	(0.381)
Public Health Investment	0.121	0.122	-0.006	-0.075	-0.131
Proportion of GDP	(0.190)	(0.190)	(0.193)	(0.174)	(0.259)
Public City Infra. and Security Investment	0.992	1.036	0.757	0.663	0.605
Proportion of GDP	(0.173)**	(0.169)**	(0.240)**	(0.289)*	(0.253)*
Population Growth Rate	-1.014	-1.006	-1.099	-1.141	-1.127
	(0.238)**	(0.240)**	(0.283)**	(0.305)**	(0.296)**
1975	-0.166	-0.170	-0.080	-0.079	-0.085
	(0.025)**	(0.026)**	(0.008)**	(0.009)**	(0.003)**
1976	-0.166	-0.170	-0.082	-0.085	-0.090
	(0.024)**	(0.025)**	(0.007)**	(0.007)**	(0.003)**
1977	-0.161	-0.165	-0.081	-0.084	-0.088
	(0.023)**	(0.024)**	(0.005)**	(0.005)**	(0.002)**
1978	-0.157	-0.160	-0.083	-0.079	-0.084
	(0.022)**	(0.023)**	(0.007)**	(0.008)**	(0.002)**
1979	-0.139	-0.142	-0.071	-0.068	-0.073
	(0.020)**	(0.021)**	(0.008)**	(0.008)**	(0.002)**
1980	-0.134	-0.136	-0.074	-0.058	-0.064
	(0.021)**	(0.021)**	(0.010)**	(0.009)**	(0.002)**
1981	-0.119	-0.122	-0.060	-0.044	-0.049
	(0.020)**	(0.020)**	(0.009)**	(0.009)**	(0.003)**
1982	-0.109	-0.112	-0.052	-0.036	-0.041
	(0.019)**	(0.019)**	(0.009)**	(0.009)**	(0.003)**
1983	-0.098	-0.101	-0.043	-0.027	-0.032
	(0.018)**	(0.018)**	(0.009)**	(0.009)**	(0.003)**
1984	-0.085	-0.087	-0.033	-0.026	-0.031
	(0.016)**	(0.016)**	(0.009)**	(0.009)**	(0.003)**
1985	-0.080	-0.083	-0.031	-0.030	-0.034
	(0.014)**	(0.014)**	(0.008)**	(0.008)**	(0.003)**
1986	-0.089	-0.092	-0.041	-0.040	-0.044
	(0.014)**	(0.014)**	(0.006)**	(0.006)**	(0.002)**
1987	-0.091	-0.092	-0.044	-0.044	-0.047
	(0.013)**	(0.014)**	(0.005)**	(0.005)**	(0.002)**
1988	-0.092	-0.093	-0.048	-0.048	-0.051
	(0.012)**	(0.013)**	(0.005)**	(0.006)**	(0.002)**
1989	-0.092	-0.094	-0.052	-0.053	-0.056
	(0.012)**	(0.012)**	(0.005)**	(0.005)**	(0.001)**
1990	-0.097	-0.098	-0.060	-0.060	-0.062
	(0.010)**	(0.011)**	(0.004)**	(0.004)**	(0.002)**
1991	-0.100	-0.101	-0.068	-0.068	-0.071
	(0.009)**	(0.010)**	(0.004)**	(0.005)**	(0.001)**
1992	-0.103	-0.104	-0.076	-0.076	-0.077
	(0.009)**	(0.009)**	(0.003)**	(0.003)**	(0.001)**
1993	-0.106	-0.106	-0.084	-0.083	-0.085
	(0.007)**	(0.007)**	(0.004)**	(0.004)**	(0.002)**
1994	-0.091	-0.091	-0.074	-0.073	-0.076
	(0.005)**	(0.005)**	(0.003)**	(0.004)**	(0.001)**
1995	-0.066	-0.067	-0.056	-0.055	-0.057
	(0.004)**	(0.004)**	(0.003)**	(0.003)**	(0.001)**
1996	-0.035	-0.035	-0.029	-0.029	-0.030
	(0.002)**	(0.002)**	(0.002)**	(0.002)**	(0.001)**
The Logarithm of GDP per capita	0.026	0.027	0.018	0.014	
	(0.017)	(0.017)	(0.018)	(0.019)	

Infant Mortality Rate	-0.299				
	(0.065)**				
Martial Law	0.019	0.018	0.019		
	(0.005)**	(0.004)**	(0.005)**		
Adult Education Indicator	-0.666	-0.669			
	(0.203)**	(0.208)**			
Constant	0.517	0.503	0.503	0.562	0.756
	(0.229)*	(0.231)*	(0.262)	(0.274)*	(0.006)**
Observations	1541	1541	1541	1541	1541
Number of groups	67	67	67	67	67
F	33.92	34.71	55.02	36.25	39.80
Within R-Squared	0.49	0.49	0.46	0.44	0.44

Standard Errors in parentheses.
* Significant at 5%, ** significant at 1%

APPENDIX: CHAPTER 4

A.4.1 Robustness of the Results

As in the appendices for the previous chapters, the chosen econometric technique, the method to obtain robust standard errors, the tests for model specification and omitted variable bias, and unit root tests are explained, and results are provided in the fifth chapter. Although the Ramsey regression specification error test rejects the null hypothesis that the model in Table 4.2, column (6) in the fourth chapter is correctly specified, the Lagrange multiplier test provides results that show the results are robust to inappropriate functional form and omitted variable bias. Similar to the earlier chapter, the unit root tests provide results that indicate that data for variables are stationary, except for the adult education indicator. Excluding the adult education indicator from the regression model does not alter the results.

In this section, the robustness of results is analysed for the presence of potential outliers, change in data due the change in the number of provinces between 1975 and 2001, and for the dependent variables for the longer run.

The technique to detect observations that may potentially be outliers is the same technique used in the earlier chapters. The regression in Table 4.2, column (6) is repeated by excluding the observations that have Studentized residuals that are higher than the absolute value of 2. The results are reported in Table 4.3, column (2), and they remain very similar to those in Table 4.2, column (6).

As explained in detail in the earlier chapters, data for some provinces display change as these provinces originally contained districts that later became new provinces. To control for the effect of this change on the results, these provinces and districts are excluded from the observations and the regression in Table 4.2, column (6) is repeated. The results are reported in Table A.4.1.1, column (3). It appears that the negative coefficients of the share of public transportation and communication investment in GDP and the logarithm of GDP per capita become statistically significant in column (3). The coefficient of public city infrastructure and security investment becomes statistically insignificant in the third column in Table A.4.1.1. The results for the remaining variables remain similar to those in Table 4.2, column (6).

Table A.4.1.1 Robustness of the Results for Outliers and the Provinces that Change Size and Status

	(1)	(2)	(3)
	Original Sample	Excluding Potential Outliers	Excluding Provinces that Change Size and Status
Public Energy Investment	-0.009	-0.008	-0.008
Proportion of GDP	(0.002)**	(0.002)**	(0.002)**
Public Transportation and Com. Investment	-0.027	-0.024	-0.029
Proportion of GDP	(0.024)	(0.023)	(0.013)*
Public Education Investment	0.007	0.011	0.020
Proportion of GDP	(0.028)	(0.027)	(0.038)
Public Health Investment	0.078	0.085	0.073
Proportion of GDP	(0.045)	(0.050)	(0.046)
Public City Infrastructure and Security Investment	-0.158	-0.154	-0.052
Proportion of GDP	(0.076)*	(0.077)*	(0.032)
Population Growth Rate	-0.047	-0.048	-0.026
	(0.027)	(0.027)	(0.025)
1975	0.012	0.012	0.008
	(0.001)**	(0.001)**	(0.001)**
1976	0.013	0.013	0.009
	(0.002)**	(0.001)**	(0.001)**
1977	0.013	0.013	0.009
	(0.001)**	(0.001)**	(0.001)**
1978	0.012	0.012	0.009
	(0.001)**	(0.001)**	(0.001)**
1979	0.011	0.011	0.009
	(0.001)**	(0.001)**	(0.001)**
1980	0.009	0.009	0.007
	(0.001)**	(0.001)**	(0.001)**
1981	0.009	0.009	0.007
	(0.001)**	(0.001)**	(0.001)**
1982	0.008	0.008	0.007
	(0.001)**	(0.001)**	(0.001)**
1983	0.007	0.007	0.006
	(0.001)**	(0.001)**	(0.001)**
1984	0.007	0.007	0.006
	(0.000)**	(0.001)**	(0.001)**
1985	0.008	0.008	0.006
	(0.001)**	(0.001)**	(0.001)**
1986	0.007	0.007	0.005
	(0.001)**	(0.001)**	(0.001)**
1987	0.006	0.006	0.004
	(0.001)**	(0.001)**	(0.001)**
1988	0.005	0.005	0.004
	(0.001)**	(0.001)**	(0.000)**
1989	0.004	0.005	0.003
	(0.001)**	(0.001)**	(0.000)**
1990	0.004	0.004	0.002
	(0.001)**	(0.001)**	(0.000)**
1991	0.003	0.003	0.002
	(0.000)**	(0.000)**	(0.000)**
1992	0.002	0.002	0.001
	(0.000)**	(0.000)**	(0.000)**
1993	0.002	0.002	0.002
	(0.000)**	(0.000)**	(0.000)**
1994	0.001	0.002	0.001
	(0.000)**	(0.000)**	(0.000)**
1995	0.001	0.001	0.001
	(0.000)**	(0.000)**	(0.000)**
1996	0.000	-0.000	0.000
	(0.000)**	(0.000)*	(0.000)**
Ln(GDP per capita)	-0.002	-0.001	-0.003
	(0.001)	(0.001)	(0.001)**
Martial Law	0.003	0.003	0.002

	(0.001)*	(0.001)*	(0.001)*
Adult Education Indicator	0.008	0.004	-0.002
	(0.014)	(0.013)	(0.009)
Constant	0.032	0.023	0.046
	(0.010)**	(0.013)	(0.010)**
Observations	1541	1474	1288
Number of groups	67	67	56
F	41.52	44932519.18	84.79
Within R-Squared	0.49	0.50	0.50

Standard Errors in parentheses.
* Significant at 5%, ** significant at 1%

As in the sections for robustness analyses in the appendices for earlier chapters, the results are also presented for the infant mortality rate, and the five-year, seven-year, ten-year, fifteen-year forward moving arithmetic average of the infant mortality rate. The dependent variable in the fourth chapter is calculated as the five-year forward moving arithmetic average of the infant mortality rate to reduce the possibility of reverse causality in the results, and allow for a lag in the effect of public investment on the outcome indicator.

The change in results between columns (2), (3), (4) and (5) in Table A.4.1.2 appears to be in the same pattern that is reported in the appendix for the third chapter in Table A.3.1.2. The positive coefficient for the logarithm of GDP per capita switches signs in column (4), and becomes statistically significant in column (5). The coefficient for the share of public city infrastructure and security investment in GDP is negative and statistically significant in columns (1) and (2), but it is positive and statistically significant in column (5). These can be interpreted as the symptoms of co-linearity, which reduces the reliability of the results in columns (4) and (5).

Table A.4.1.2 Robustness of the Results for the Longer Run

	(1)	(2)	(3)	(4)	(5)
	Dependent Variable				
	Infant Mortality Rate	Five-year Forward Moving Arithmetic Average of the Infant Mortality Rate	Seven-year Forward Moving Arithmetic Average of the Infant Mortality Rate	Ten-year Forward Moving Arithmetic Average of the Infant Mortality Rate	Fifteen-year Forward Moving Arithmetic Average of the Infant Mortality Rate
Public Energy Investment	-0.004	-0.009	-0.009	-0.008	-0.005
Proportion of GDP	(0.002)*	(0.002)**	(0.002)**	(0.001)**	(0.001)**
Public Transportation and Com. Investment	-0.029	-0.027	-0.035	-0.052	-0.063
Proportion of GDP	(0.020)	(0.024)	(0.025)	(0.018)**	(0.005)**
Public Education Investment	0.046	0.078	0.076	0.078	0.062
Proportion of GDP	(0.035)	(0.045)	(0.044)	(0.034)*	(0.018)**
Public Health Investment	-0.018	0.007	0.018	0.010	-0.022
Proportion of GDP	(0.029)	(0.028)	(0.023)	(0.020)	(0.011)
Public City Infra. and Security Investment	-0.084	-0.158	-0.119	-0.060	0.044
Proportion of GDP	(0.024)**	(0.076)*	(0.067)	(0.039)	(0.006)**
Population Growth Rate	-0.006	-0.047	-0.055	-0.066	-0.067
	(0.018)	(0.027)	(0.027)*	(0.019)**	(0.011)**
1975	0.015	0.044	0.012	0.010	0.007
	(0.002)**	(0.011)**	(0.001)**	(0.000)**	(0.000)**
1976	0.015	0.045	0.012	0.011	0.007
	(0.002)**	(0.011)**	(0.001)**	(0.000)**	(0.000)**
1977	0.015	0.045	0.012	0.010	0.006
	(0.002)**	(0.011)**	(0.001)**	(0.000)**	(0.000)**
1978	0.015	0.043	0.011	0.009	0.006
	(0.002)**	(0.011)**	(0.000)**	(0.000)**	(0.000)**
1979	0.013	0.043	0.011	0.008	0.005
	(0.002)**	(0.011)**	(0.000)**	(0.000)**	(0.000)**
1980	0.012	0.040	0.008	0.006	0.004
	(0.002)**	(0.010)**	(0.001)**	(0.001)**	(0.000)**
1981	0.013	0.040	0.008	0.006	0.004
	(0.002)**	(0.010)**	(0.001)**	(0.001)**	(0.000)**
1982	0.011	0.040	0.007	0.005	0.003
	(0.002)**	(0.010)**	(0.001)**	(0.001)**	(0.000)**
1983	0.011	0.039	0.006	0.004	0.003
	(0.002)**	(0.010)**	(0.001)**	(0.001)**	(0.000)**
1984	0.011	0.039	0.006	0.005	0.003
	(0.002)**	(0.010)**	(0.000)**	(0.001)**	(0.000)**
1985	0.013	0.039	0.006	0.005	0.002
	(0.002)**	(0.011)**	(0.000)**	(0.000)**	(0.000)**
1986	0.010	0.038	0.006	0.004	0.001
	(0.002)**	(0.011)**	(0.001)**	(0.000)**	(0.000)**
1987	0.009	0.037	0.005	0.003	
	(0.002)**	(0.011)**	(0.001)**	(0.000)**	
1988	0.008	0.037	0.004	0.002	
	(0.001)**	(0.011)**	(0.000)**	(0.000)**	
1989	0.008	0.036	0.003	0.002	
	(0.001)**	(0.011)**	(0.000)**	(0.000)**	
1990	0.007	0.035	0.003	0.001	
	(0.001)**	(0.011)**	(0.000)**	(0.000)**	
1991	0.006	0.034	0.002	0.001	
	(0.001)**	(0.010)**	(0.000)**	(0.000)**	
1992	0.005	0.034	0.001		
	(0.001)**	(0.010)**	(0.000)**		
1993	0.005	0.034	0.001		

	(0.001)**	(0.010)**	(0.000)**		
1994	0.004	0.033	0.000		
	(0.001)**	(0.010)**	(0.000)**		
1995	0.004	0.032			
	(0.001)**	(0.010)**			
1996	0.003	0.032			
	(0.001)**	(0.010)**			
1997	0.003				
	(0.001)**				
1998	0.003				
	(0.000)**				
1999	0.002				
	(0.000)**				
2000	0.001				
	(0.000)**				
Log (GDP per capita)	-0.003	-0.002	-0.000	0.000	0.002
	(0.001)**	(0.001)	(0.001)	(0.001)	(0.001)*
Martial Law	0.002	0.003	0.002	0.002	0.001
	(0.001)*	(0.001)*	(0.001)*	(0.001)**	(0.000)**
Adult Education Indicator	0.017	0.008	0.003	-0.007	-0.021
	(0.013)	(0.014)	(0.008)	(0.005)	(0.007)**
Constant	0.047	0.032	0.015	0.005	-0.013
	(0.011)**	(0.010)**	(0.010)	(0.011)	(0.010)
Observations	1809	1541	1407	1206	871
Number of groups	67	67	67	67	67
F	47.97	51.73	117.57	162.82	276.95
Within R-Squared	0.41	0.49	0.51	0.55	0.56

Standard Errors in parentheses.
* Significant at 5%, ** significant at 1%

The co-linearity diagnostics can be carried out using the variance inflation factor presented in Table A.4.1.3. As in the earlier chapter, the logarithm of GDP per capita has a considerably high value for the variance inflation factor: 61.14. The value of the variance inflation factor for the adult education indicator has the second highest value: 16.33. These statistics imply that the results in Table 4.4 may suffer from co-linearity, as calculating the dependent variable for the longer run reduces the size of the available sample for the estimation, which contributes to the severity of co-linearity.

Table A.4.1.3 Co-Linearity Diagnostics for the Regression in Table 4.2, Column (6)

Variable	VIF	1/VIF
Chapter 4		
Logarithm of GDP per capita	61.14	0.016356
Adult Education Indicator	16.33	0.061225
Martial Law	3.48	0.287765
Public City Infrastructure and Security Investment	3.06	0.327045
1975	2.96	0.337860
1980	2.92	0.341884
1981	2.89	0.346041
1976	2.89	0.346356
1982	2.87	0.348141
1983	2.84	0.352050
1977	2.82	0.354536
1978	2.75	0.363624
1979	2.63	0.380703
Public Education Investment	2.53	0.394856
1984	2.47	0.404142
Population Growth Rate	2.34	0.427038
1986	2.34	0.427520
1985	2.33	0.429599
1987	2.30	0.434799
1988	2.25	0.444223
1989	2.19	0.456640
1990	2.18	0.458265
1991	2.13	0.469457
1993	2.10	0.476816
1992	2.09	0.479425
1994	2.03	0.492205
1995	2.00	0.498918
1996	1.99	0.503053
Public Transportation and Communication Investment	1.73	0.578300
Public Health Investment	1.37	0.727324
Public Energy Investment	1.14	0.875928
Mean VIF	4.75	

Table A.4.1.4 shows the results for the five-year forward moving geometric average of the infant mortality rate. The results in column (2) remain almost identical to those in column (1), showing that the results hold for both arithmetic and geometric mean of the outcome variable.

Table A.4.1.4 Robustness of the Results for the Alternative Calculation of the Dependent Variable

	Five-year forward moving arithmetic average of infant mortality rate	Five-year forward moving geometric average of infant mortality rate
Public Energy Investment	-0.009	-0.008
Proportion of GDP	(0.002)**	(0.002)**
Public Transportation and Com. Investment	-0.027	-0.026
Proportion of GDP	(0.024)	(0.023)
Public Education Investment	0.078	0.078
Proportion of GDP	(0.045)	(0.044)
Public Health Investment	0.007	0.002
Proportion of GDP	(0.028)	(0.027)
Public City Infrastructure and Security Investment	-0.158	-0.159
Proportion of GDP	(0.076)*	(0.073)*
Population Growth Rate	-0.047	-0.047
	(0.027)	(0.027)
1975	0.012	0.012
	(0.001)**	(0.001)**
1976	0.013	0.013
	(0.002)**	(0.002)**
1977	0.013	0.013
	(0.001)**	(0.001)**
1978	0.012	0.012
	(0.001)**	(0.001)**
1979	0.011	0.011
	(0.001)**	(0.001)**
1980	0.009	0.008
	(0.001)**	(0.001)**
1981	0.009	0.008
	(0.001)**	(0.001)**
1982	0.008	0.008
	(0.001)**	(0.001)**
1983	0.007	0.007
	(0.001)**	(0.001)**
1984	0.007	0.007
	(0.000)**	(0.000)**
1985	0.008	0.007
	(0.001)**	(0.001)**
1986	0.007	0.007
	(0.001)**	(0.001)**
1987	0.006	0.006
	(0.001)**	(0.001)**
1988	0.005	0.005
	(0.001)**	(0.001)**
1989	0.004	0.004
	(0.001)**	(0.001)**
1990	0.004	0.004
	(0.001)**	(0.001)**
1991	0.003	0.003
	(0.000)**	(0.000)**
1992	0.002	0.002
	(0.000)**	(0.000)**
1993	0.002	0.002
	(0.000)**	(0.000)**
1994	0.001	0.001
	(0.000)**	(0.000)**
1995	0.001	0.001
	(0.000)**	(0.000)**
1996	0.000	0.000
	(0.000)**	(0.000)**
Ln(GDP per capita)	-0.002	-0.002
	(0.001)	(0.001)
Martial Law	0.003	0.003
	(0.001)*	(0.001)*

Adult Education Indicator	0.008	0.009
	(0.014)	(0.013)
Constant	0.032	0.031
	(0.010)**	(0.010)**
Observations	1541	1541
Number of groups	67	67
F	41.52	39.44
Within R-Squared	0.49	0.49

Standard Errors in parentheses.
* Significant at 5%, ** significant at 1%

Finally, Table A.4.1.5 shows the results for alternative regression models. As mentioned before, the adult education indicator is the share of high school and university graduates in the population who are aged over 17. The adult education indicator is used in regression to proxy for the adult literacy rate. Alternatively, the gross enrolment rates could be used to proxy for the adult literacy rates, assuming that, in the long run, literate parents are those who were enrolled in primary school for a period of time. Thus, in column (2), the adult education indicator is replaced by the gross enrolment rate in time t. It must be noted that both the Ramsey regression specification error test and the Lagrange multiplier test reject the null hypothesis that the model in column (2) is correctly specified[8]. Nevertheless, the results are presented in Table A.4.1.5. It can be seen that the results remain similar when the adult education indicator is replaced by the gross enrolment rate. The coefficient for the gross enrolment rate is statistically significant with a negative sign, indicating that this variable might be more suitable as a proxy for the adult literacy rates. However, because the Ramsey regression specification error test and the Lagrange multiplier test show that the results suffer from model misspecification and omitted variable bias, the gross enrolment rate is not included in the regression model in the fourth chapter in Table 4.2 column (6)

Additionally, in columns (3), (4) and (5), the results show that, excluding the adult education indicator for the overall population, the variable for martial law, and the logarithm of GDP per capita does not make a significant change in the results for the coefficients of public energy infrastructure investment and public city infrastructure and security investment, but the coefficient of the logarithm of GDP per capita becomes statistically significant when the adult education indicator and the variable for martial law are excluded from the regression model in columns (2),

[8] Ramsey regression specification and error test statistics are F (3, 66) = 21.05, Prob > F = 0.0000, and the Lagrange multiplier statistics are $n * R^2_{Within} = 8.733 > \chi^2_{3,,\alpha=0.05.} = 7.805$. For the explanations of the tests, see Chapter 5.

(3) and (4). In column (2), the coefficient for the population growth rate becomes statistically significant with a negative sign.

Table A.4.1.5 Alternative Specifications of the Regression Models in Table 4.2, Column (6)

	(1)	(2)	(3)	(4)	(5)
	Dependent Variable: Five-Year Forward Moving Arithmetic Average of the Infant Mortality Rate				
Public Energy Investment	-0.009	-0.008	-0.009	-0.008	-0.007
Proportion of GDP	(0.002)**	(0.002)**	(0.002)**	(0.002)**	(0.002)**
Public Transportation and Com. Investment	-0.027	-0.034	-0.026	-0.027	-0.032
Proportion of GDP	(0.024)	(0.026)	(0.024)	(0.024)	(0.024)
Public Education Investment	0.078	0.058	0.079	0.083	0.091
Proportion of GDP	(0.045)	(0.038)	(0.045)	(0.045)	(0.046)
Public Health Investment	0.007	0.012	0.009	-0.001	0.008
Proportion of GDP	(0.028)	(0.027)	(0.027)	(0.030)	(0.031)
Public City Infrastructure and Security Investment	-0.158	-0.140	-0.155	-0.168	-0.159
Proportion of GDP	(0.076)*	(0.069)*	(0.070)*	(0.078)*	(0.079)*
Population Growth Rate	-0.047	-0.065	-0.046	-0.052	-0.054
	(0.027)	(0.027)*	(0.028)	(0.028)	(0.029)
1975	0.012	0.011	0.011	0.011	0.012
	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.000)**
1976	0.013	0.012	0.012	0.011	0.012
	(0.002)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
1977	0.013	0.012	0.012	0.011	0.012
	(0.001)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
1978	0.012	0.011	0.011	0.011	0.012
	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.000)**
1979	0.011	0.010	0.010	0.011	0.011
	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.000)**
1980	0.009	0.008	0.008	0.010	0.011
	(0.001)**	(0.002)**	(0.002)**	(0.001)**	(0.001)**
1981	0.009	0.008	0.008	0.010	0.011
	(0.001)**	(0.002)**	(0.002)**	(0.001)**	(0.001)**
1982	0.008	0.007	0.007	0.009	0.010
	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.000)**
1983	0.007	0.007	0.006	0.009	0.009
	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.000)**
1984	0.007	0.007	0.006	0.007	0.008
	(0.000)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**
1985	0.008	0.008	0.007	0.007	0.008
	(0.001)**	(0.001)**	(0.001)**	(0.000)**	(0.000)**
1986	0.007	0.007	0.006	0.006	0.007
	(0.001)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
1987	0.006	0.006	0.005	0.005	0.006
	(0.001)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
1988	0.005	0.005	0.004	0.004	0.005
	(0.001)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
1989	0.004	0.004	0.004	0.004	0.004
	(0.001)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
1990	0.004	0.004	0.003	0.003	0.003
	(0.001)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
1991	0.003	0.003	0.002	0.002	0.003
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
1992	0.002	0.002	0.002	0.002	0.002
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
1993	0.002	0.002	0.002	0.002	0.002
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
1994	0.001	0.001	0.001	0.001	0.001
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
1995	0.001	0.001	0.001	0.001	0.001
	(0.000)**	(0.000)*	(0.000)	(0.000)*	(0.000)**

1996	0.000	0.000	0.000	0.000	0.000
	(0.000)**	(0.000)	(0.000)	(0.000)	(0.000)**
Log (GDP per capita)	-0.002	-0.001	-0.002	-0.002	
	(0.001)	(0.001)*	(0.001)*	(0.001)**	
Martial Law	0.003	0.003	0.003		
	(0.001)*	(0.001)*	(0.001)*		
Adult Education Indicator	0.008				
	(0.014)				
Gross Enrolment Rates		-0.016			
		(0.004)**			
Constant	0.032	0.040	0.032	0.040	0.010
	(0.010)**	(0.009)**	(0.010)**	(0.011)**	(0.001)**
Observations	1541	1541	1541	1541	1541
Number of groups	67	67	67	67	67
F	41.52	60.12	44.68	28.34	27.17
Within R-Squared	0.49	0.50	0.49	0.48	0.48

Standard Errors in parentheses.
* Significant at 5%, ** significant at 1%

APPENDIX: CHAPTER 5

A.5.1 Correlation Tables for the Residuals

Table A.5.1. 1 Correlation Table for the Residuals from the Model in Table 2.2.b, Column (5)

	$\hat{e}_t$	$\hat{e}_{t-1}$	$\hat{e}_{t-2}$	$\hat{e}_{t-3}$	$\hat{e}_{t-4}$	$\hat{e}_{t-5}$	$\hat{e}_{t-6}$
$\hat{e}_t$	1.0000						
$\hat{e}_{t-1}$	0.5960	1.0000					
$\hat{e}_{t-2}$	0.4206	0.5960	1.0000				
$\hat{e}_{t-3}$	0.1858	0.4206	0.5960	1.0000			
$\hat{e}_{t-4}$	0.0092	0.1858	0.4206	0.5960	1.0000		
$\hat{e}_{t-5}$	-0.2842	0.0092	0.1858	0.4206	0.5960	1.0000	
$\hat{e}_{t-6}$	-0.2403	-0.2842	0.0092	0.1858	0.4206	0.5960	1.0000
$\hat{e}_{t-7}$	-0.2614	-0.2403	-0.2842	0.0092	0.1858	0.4206	0.5893
$\hat{e}_{t-8}$	-0.2648	-0.2614	-0.2403	-0.2842	0.0092	0.1858	0.4084
$\hat{e}_{t-9}$	-0.2948	-0.2648	-0.2614	-0.2403	-0.2842	0.0092	0.1695
$\hat{e}_{t-10}$	-0.2914	-0.2948	-0.2648	-0.2614	-0.2403	-0.2842	0.0026
$\hat{e}_{t-11}$	-0.2427	-0.2914	-0.2948	-0.2648	-0.2614	-0.2403	-0.2993
$\hat{e}_{t-12}$	-0.2026	-0.2427	-0.2914	-0.2948	-0.2648	-0.2614	-0.2478
$\hat{e}_{t-13}$	-0.1910	-0.2026	-0.2427	-0.2914	-0.2948	-0.2648	-0.2752
$\hat{e}_{t-14}$	-0.1166	-0.1910	-0.2026	-0.2427	-0.2914	-0.2948	-0.2828
$\hat{e}_{t-15}$	-0.1415	-0.1166	-0.1910	-0.2026	-0.2427	-0.2914	-0.3283
$\hat{e}_{t-16}$	-0.1203	-0.1415	-0.1166	-0.1910	-0.2026	-0.2427	-0.3027
$\hat{e}_{t-17}$	-0.1865	-0.1203	-0.1415	-0.1166	-0.1910	-0.2026	-0.2427
$\hat{e}_{t-18}$	-0.1546	-0.1865	-0.1203	-0.1415	-0.1166	-0.1910	-0.2126
$\hat{e}_{t-19}$	-0.1509	-0.1546	-0.1865	-0.1203	-0.1415	-0.1166	-0.1569
$\hat{e}_{t-20}$	-0.1634	-0.1509	-0.1546	-0.1865	-0.1203	-0.1415	-0.0546
	$\hat{e}_{t-7}$	$\hat{e}_{t-8}$	$\hat{e}_{t-9}$	$\hat{e}_{t-10}$	$\hat{e}_{t-11}$	$\hat{e}_{t-12}$	$\hat{e}_{t-13}$
$\hat{e}_{t-7}$	1.0000						
$\hat{e}_{t-8}$	0.5756	1.0000					
$\hat{e}_{t-9}$	0.3999	0.5741	1.0000				
$\hat{e}_{t-10}$	0.1604	0.4010	0.5704	1.0000			
$\hat{e}_{t-11}$	-0.0103	0.1555	0.3928	0.5628	1.0000		
$\hat{e}_{t-12}$	-0.3135	-0.0073	0.1467	0.3942	0.5684	1.0000	
$\hat{e}_{t-13}$	-0.2587	-0.3240	-0.0119	0.1476	0.4028	0.5738	1.0000
$\hat{e}_{t-14}$	-0.2892	-0.2714	-0.3298	-0.0074	0.1636	0.4122	0.5816
$\hat{e}_{t-15}$	-0.3068	-0.3133	-0.2837	-0.3283	0.0053	0.1720	0.4226
$\hat{e}_{t-16}$	-0.3139	-0.2950	-0.3054	-0.2634	-0.3106	0.0203	0.1912
$\hat{e}_{t-17}$	-0.3027	-0.3139	-0.2950	-0.3054	-0.2634	-0.3106	0.0203
$\hat{e}_{t-18}$	-0.2074	-0.2824	-0.3053	-0.2665	-0.2912	-0.2779	-0.3258
$\hat{e}_{t-19}$	-0.1452	-0.1602	-0.2524	-0.2854	-0.2542	-0.3038	-0.3018
$\hat{e}_{t-20}$	-0.0605	-0.0636	-0.1032	-0.2249	-0.2790	-0.2857	-0.3288
	$\hat{e}_{t-14}$	$\hat{e}_{t-15}$	$\hat{e}_{t-16}$	$\hat{e}_{t-17}$	$\hat{e}_{t-18}$	$\hat{e}_{t-19}$	$\hat{e}_{t-20}$
$\hat{e}_{t-14}$	1.0000						
$\hat{e}_{t-15}$	0.5830	1.0000					
$\hat{e}_{t-16}$	0.4439	0.6102	1.0000				
$\hat{e}_{t-17}$	0.1912	0.4439	0.6102	1.0000			
$\hat{e}_{t-18}$	0.0133	0.1843	0.3659	0.6102	1.0000		
$\hat{e}_{t-19}$	-0.3519	0.0052	0.0499	0.3659	0.5838	1.0000	
$\hat{e}_{t-20}$	-0.3306	-0.3976	-0.1655	0.0499	0.2923	0.5321	1.0000

$\hat{e}_t$: residual term in time t

Table A.5.1. 2 Correlation Table for the Residuals from the Model in Table 3.2, Column (6)

	$\hat{e}_{t}$	$\hat{e}_{t-1}$	$\hat{e}_{t-2}$	$\hat{e}_{t-3}$	$\hat{e}_{t-4}$	$\hat{e}_{t-5}$	$\hat{e}_{t-6}$
$\hat{e}_{t}$	1.0000						
$\hat{e}_{t-1}$	0.9029	1.0000					
$\hat{e}_{t-2}$	0.7538	0.9029	1.0000				
$\hat{e}_{t-3}$	0.5624	0.7538	0.9029	1.0000			
$\hat{e}_{t-4}$	0.3508	0.5624	0.7538	0.9029	1.0000		
$\hat{e}_{t-5}$	0.1603	0.3508	0.5624	0.7538	0.9029	1.0000	
$\hat{e}_{t-6}$	0.0084	0.1603	0.3508	0.5624	0.7538	0.8974	1.0000
$\hat{e}_{t-7}$	-0.1136	0.0084	0.1603	0.3508	0.5624	0.7474	0.8945
$\hat{e}_{t-8}$	-0.2015	-0.1136	0.0084	0.1603	0.3508	0.5572	0.7461
$\hat{e}_{t-9}$	-0.2652	-0.2015	-0.1136	0.0084	0.1603	0.3534	0.5641
$\hat{e}_{t-10}$	-0.3270	-0.2652	-0.2015	-0.1136	0.0084	0.1463	0.3497
$\hat{e}_{t-11}$	-0.3626	-0.3270	-0.2652	-0.2015	-0.1136	-0.0197	0.1279
$\hat{e}_{t-12}$	-0.3758	-0.3626	-0.3270	-0.2652	-0.2015	-0.1474	-0.0408
$\hat{e}_{t-13}$	-0.3846	-0.3758	-0.3626	-0.3270	-0.2652	-0.2515	-0.1814
$\hat{e}_{t-14}$	-0.4071	-0.3846	-0.3758	-0.3626	-0.3270	-0.3330	-0.2994
$\hat{e}_{t-15}$	-0.4446	-0.4071	-0.3846	-0.3758	-0.3626	-0.4023	-0.3893
$\hat{e}_{t-16}$	-0.5002	-0.4446	-0.4071	-0.3846	-0.3758	-0.4394	-0.4573
$\hat{e}_{t-17}$	-0.5409	-0.5002	-0.4446	-0.4071	-0.3846	-0.4586	-0.5035
$\hat{e}_{t-18}$	-0.6070	-0.5409	-0.5002	-0.4446	-0.4071	-0.4626	-0.5166
$\hat{e}_{t-19}$	-0.6924	-0.6070	-0.5409	-0.5002	-0.4446	-0.4667	-0.5045
$\hat{e}_{t-20}$	-0.7400	-0.6924	-0.6070	-0.5409	-0.5002	-0.4772	-0.4811
$\hat{e}_{t-21}$	-0.7723	-0.7400	-0.6924	-0.6070	-0.5409	-0.5083	-0.4637
$\hat{e}_{t-22}$	-0.7463	-0.7723	-0.7400	-0.6924	-0.6070	-0.5451	-0.4901
	$\hat{e}_{t-7}$	$\hat{e}_{t-8}$	$\hat{e}_{t-9}$	$\hat{e}_{t-10}$	$\hat{e}_{t-11}$	$\hat{e}_{t-12}$	$\hat{e}_{t-13}$
$\hat{e}_{t-7}$	1.0000						
$\hat{e}_{t-8}$	0.8913	1.0000					
$\hat{e}_{t-9}$	0.7468	0.8903	1.0000				
$\hat{e}_{t-10}$	0.5605	0.7435	0.8883	1.0000			
$\hat{e}_{t-11}$	0.3378	0.5540	0.7415	0.8871	1.0000		
$\hat{e}_{t-12}$	0.1142	0.3351	0.5620	0.7519	0.8995	1.0000	
$\hat{e}_{t-13}$	-0.0579	0.1118	0.3520	0.5784	0.7657	0.9057	1.0000
$\hat{e}_{t-14}$	-0.2039	-0.0595	0.1349	0.3760	0.5989	0.7798	0.9074
$\hat{e}_{t-15}$	-0.3306	-0.2149	-0.0458	0.1521	0.3933	0.6173	0.7842
$\hat{e}_{t-16}$	-0.4153	-0.3364	-0.1991	-0.0281	0.1707	0.4135	0.6217
$\hat{e}_{t-17}$	-0.4830	-0.4134	-0.3155	-0.1795	-0.0082	0.2202	0.4369
$\hat{e}_{t-18}$	-0.5293	-0.4811	-0.3891	-0.2894	-0.1554	0.0319	0.2381
$\hat{e}_{t-19}$	-0.5346	-0.5323	-0.4650	-0.3705	-0.2737	-0.1370	0.0303
$\hat{e}_{t-20}$	-0.5030	-0.5310	-0.5267	-0.4505	-0.3539	-0.2649	-0.1395
$\hat{e}_{t-21}$	-0.4579	-0.4867	-0.5327	-0.5234	-0.4384	-0.3506	-0.2641
$\hat{e}_{t-22}$	-0.4309	-0.4314	-0.4902	-0.5335	-0.5136	-0.4387	-0.3361
	$\hat{e}_{t-14}$	$\hat{e}_{t-15}$	$\hat{e}_{t-16}$	$\hat{e}_{t-17}$	$\hat{e}_{t-18}$	$\hat{e}_{t-19}$	$\hat{e}_{t-20}$
$\hat{e}_{t-14}$	1.0000						
$\hat{e}_{t-15}$	0.9090	1.0000					
$\hat{e}_{t-16}$	0.7853	0.9117	1.0000				
$\hat{e}_{t-17}$	0.6374	0.8004	0.9245	1.0000			
$\hat{e}_{t-18}$	0.4463	0.6481	0.8108	0.9354	1.0000		
$\hat{e}_{t-19}$	0.2294	0.4420	0.6495	0.8251	0.9406	1.0000	
$\hat{e}_{t-20}$	0.0226	0.2263	0.4472	0.6791	0.8379	0.9433	1.0000
$\hat{e}_{t-21}$	-0.1412	0.0249	0.2375	0.4912	0.7047	0.8505	0.9456
$\hat{e}_{t-22}$	-0.2517	-0.1261	0.0439	0.2815	0.5340	0.7405	0.8688
	$\hat{e}_{t-21}$	$\hat{e}_{t-22}$					
$\hat{e}_{t-21}$	1						
$\hat{e}_{t-22}$	0.9545	1					

$\hat{e}_{t}$: residual term in time

Table A.5.1. 3 Correlation Table for the Residuals from the Model in Table 4.2, Column (6)

	$\hat{e}_{t}$	$\hat{e}_{t-1}$	$\hat{e}_{t-2}$	$\hat{e}_{t-3}$	$\hat{e}_{t-4}$	$\hat{e}_{t-5}$	$\hat{e}_{t-6}$
$\hat{e}_{t}$	1.0000						
$\hat{e}_{t-1}$	0.9271	1.0000					
$\hat{e}_{t-2}$	0.8093	0.9271	1.0000				
$\hat{e}_{t-3}$	0.6536	0.8093	0.9271	1.0000			
$\hat{e}_{t-4}$	0.4594	0.6536	0.8093	0.9271	1.0000		
$\hat{e}_{t-5}$	0.2557	0.4594	0.6536	0.8093	0.9271	1.0000	
$\hat{e}_{t-6}$	0.0686	0.2557	0.4594	0.6536	0.8093	0.9244	1.0000
$\hat{e}_{t-7}$	-0.0928	0.0686	0.2557	0.4594	0.6536	0.8015	0.9218
$\hat{e}_{t-8}$	-0.2191	-0.0928	0.0686	0.2557	0.4594	0.6385	0.7942
$\hat{e}_{t-9}$	-0.3013	-0.2191	-0.0928	0.0686	0.2557	0.4363	0.6258
$\hat{e}_{t-10}$	-0.3582	-0.3013	-0.2191	-0.0928	0.0686	0.2280	0.4186
$\hat{e}_{t-11}$	-0.4155	-0.3582	-0.3013	-0.2191	-0.0928	0.0339	0.2037
$\hat{e}_{t-12}$	-0.4682	-0.4155	-0.3582	-0.3013	-0.2191	-0.1346	-0.0009
$\hat{e}_{t-13}$	-0.5204	-0.4682	-0.4155	-0.3582	-0.3013	-0.2659	-0.1782
$\hat{e}_{t-14}$	-0.5837	-0.5204	-0.4682	-0.4155	-0.3582	-0.3531	-0.3204
$\hat{e}_{t-15}$	-0.6415	-0.5837	-0.5204	-0.4682	-0.4155	-0.4166	-0.4149
$\hat{e}_{t-16}$	-0.6870	-0.6415	-0.5837	-0.5204	-0.4682	-0.4801	-0.4883
$\hat{e}_{t-17}$	-0.7235	-0.6870	-0.6415	-0.5837	-0.5204	-0.5291	-0.5495
$\hat{e}_{t-18}$	-0.7679	-0.7235	-0.6870	-0.6415	-0.5837	-0.5837	-0.6001
$\hat{e}_{t-19}$	-0.7892	-0.7679	-0.7235	-0.6870	-0.6415	-0.6353	-0.6392
$\hat{e}_{t-20}$	-0.7882	-0.7892	-0.7679	-0.7235	-0.6870	-0.6788	-0.6735
$\hat{e}_{t-21}$	-0.7803	-0.7882	-0.7892	-0.7679	-0.7235	-0.7126	-0.7031
$\hat{e}_{t-22}$	-0.7454	-0.7803	-0.7882	-0.7892	-0.7679	-0.7481	-0.7315
	$\hat{e}_{t-7}$	$\hat{e}_{t-8}$	$\hat{e}_{t-9}$	$\hat{e}_{t-10}$	$\hat{e}_{t-11}$	$\hat{e}_{t-12}$	$\hat{e}_{t-13}$
$\hat{e}_{t-7}$	1.0000						
$\hat{e}_{t-8}$	0.9188	1.0000					
$\hat{e}_{t-9}$	0.7881	0.9176	1.0000				
$\hat{e}_{t-10}$	0.6170	0.7848	0.9169	1.0000			
$\hat{e}_{t-11}$	0.4057	0.6126	0.7825	0.9169	1.0000		
$\hat{e}_{t-12}$	0.1825	0.3964	0.6083	0.7818	0.9174	1.0000	
$\hat{e}_{t-13}$	-0.0310	0.1666	0.3891	0.6072	0.7817	0.9187	1.0000
$\hat{e}_{t-14}$	-0.2218	-0.0608	0.1479	0.3809	0.6017	0.7788	0.9196
$\hat{e}_{t-15}$	-0.3757	-0.2660	-0.0905	0.1347	0.3727	0.5994	0.7812
$\hat{e}_{t-16}$	-0.4797	-0.4326	-0.3099	-0.1134	0.1187	0.3643	0.6005
$\hat{e}_{t-17}$	-0.5521	-0.5366	-0.4819	-0.3429	-0.1371	0.1064	0.3636
$\hat{e}_{t-18}$	-0.6145	-0.6116	-0.5870	-0.5195	-0.3693	-0.1471	0.1118
$\hat{e}_{t-19}$	-0.6498	-0.6585	-0.6476	-0.6103	-0.5361	-0.3761	-0.1428
$\hat{e}_{t-20}$	-0.6703	-0.6771	-0.6782	-0.6580	-0.6113	-0.5341	-0.3682
$\hat{e}_{t-21}$	-0.6888	-0.6830	-0.6829	-0.6752	-0.6451	-0.5986	-0.5211
$\hat{e}_{t-22}$	-0.7124	-0.6939	-0.6763	-0.6676	-0.6493	-0.6179	-0.5765
	$\hat{e}_{t-14}$	$\hat{e}_{t-15}$	$\hat{e}_{t-16}$	$\hat{e}_{t-17}$	$\hat{e}_{t-18}$	$\hat{e}_{t-19}$	$\hat{e}_{t-20}$
$\hat{e}_{t-14}$	1.0000						
$\hat{e}_{t-15}$	0.9210	1.0000					
$\hat{e}_{t-16}$	0.7823	0.9248	1.0000				
$\hat{e}_{t-17}$	0.6018	0.7862	0.9274	1.0000			
$\hat{e}_{t-18}$	0.3750	0.6162	0.8006	0.9343	1.0000		
$\hat{e}_{t-19}$	0.1276	0.3927	0.6365	0.8120	0.9430	1.0000	
$\hat{e}_{t-20}$	-0.1145	0.1629	0.4346	0.6691	0.8353	0.9481	1.0000
$\hat{e}_{t-21}$	-0.3315	-0.0632	0.2302	0.4946	0.7175	0.8551	0.9522
$\hat{e}_{t-22}$	-0.4796	-0.2751	0.0223	0.3194	0.5732	0.7566	0.8666
	$\hat{e}_{t-21}$	$\hat{e}_{t-22}$					
$\hat{e}_{t-21}$	1						
$\hat{e}_{t-22}$	0.9535	1					

$\hat{e}_{t}$: residual term in time

A.5.2 Probability Distribution of the Residuals

Figure A.5.2.1 Histogram for the Residuals obtained from Table 2.2.b, Column (5)

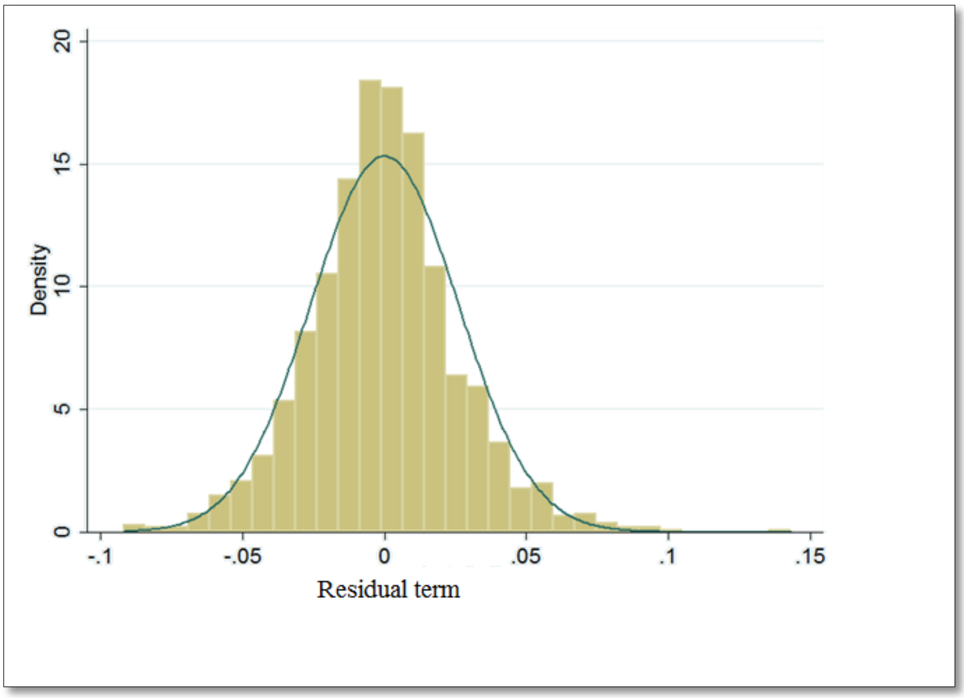


Figure A.5.2.2 Histogram for the Residuals obtained from Table 3.2, Column (6)

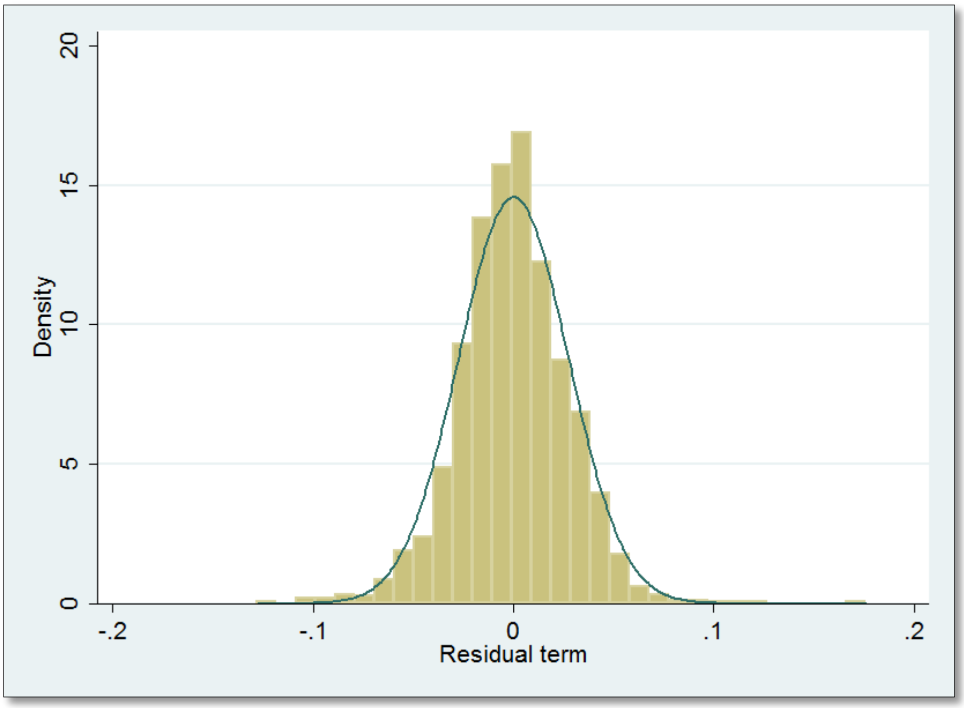


Figure A.5.2.3 Histogram for the Residuals obtained from Table 4.2, Column (6)

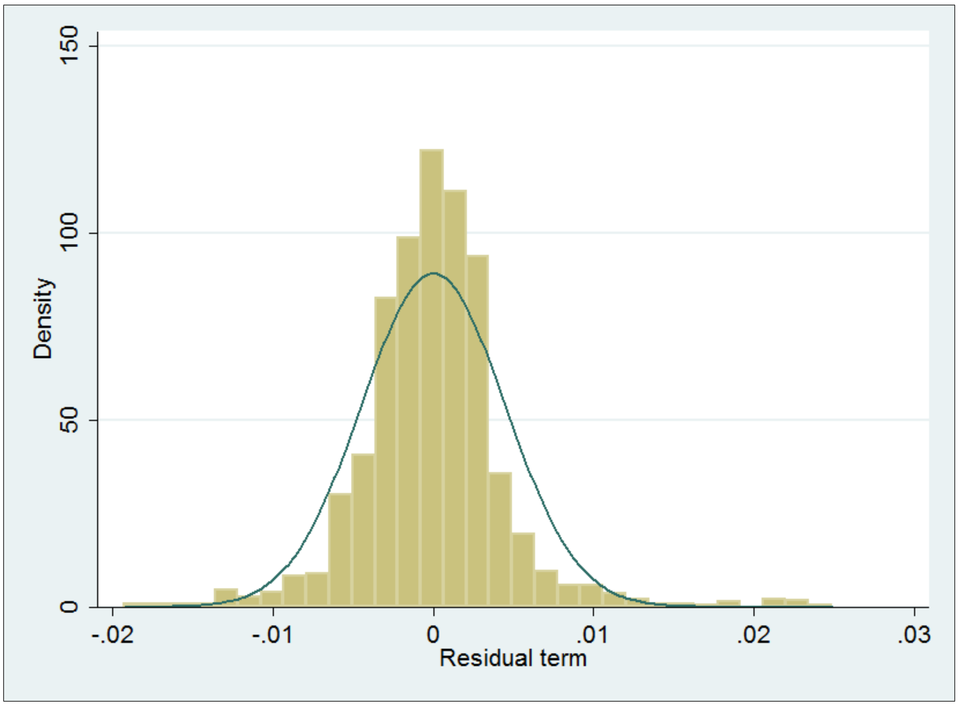


Figure A.5.2.4 Probability Distribution of the Residuals obtained from Table 2.2.b, Column (5)

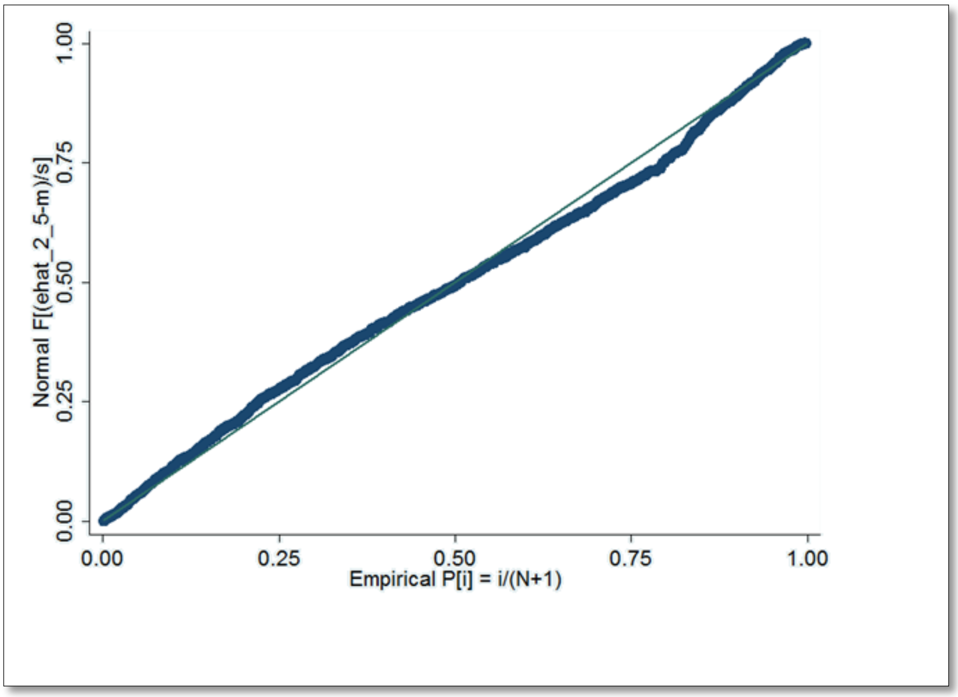


Figure A.5.2.5 Probability Distribution of the Residuals obtained from Table 3.2, Column (6)

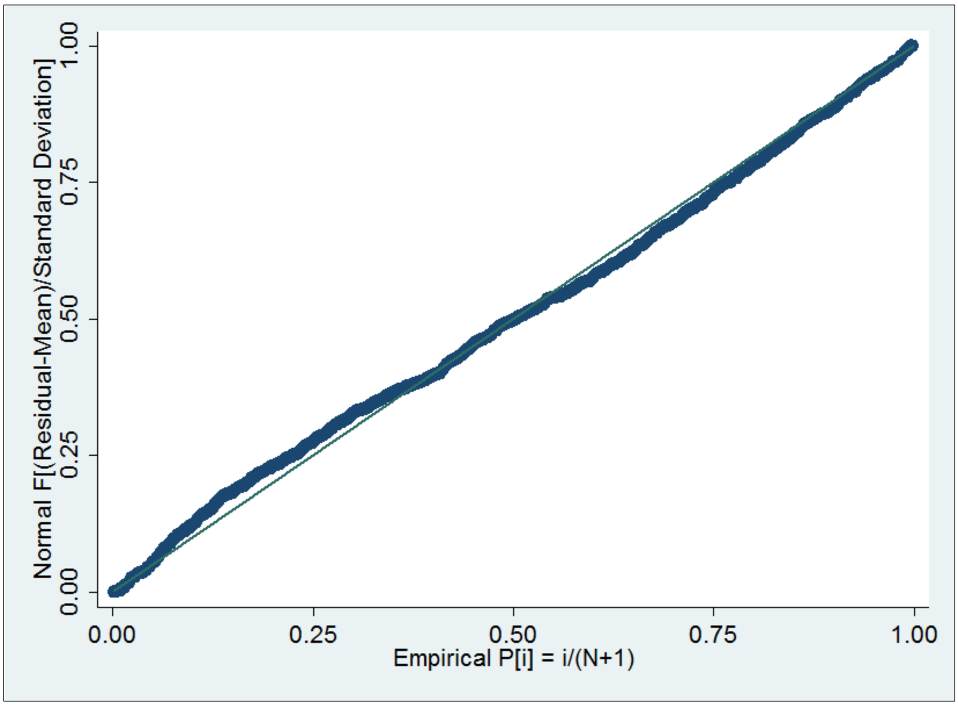


Figure A.5.2.6 Probability Distribution of the Residuals obtained from Table 4.2, Column (6)

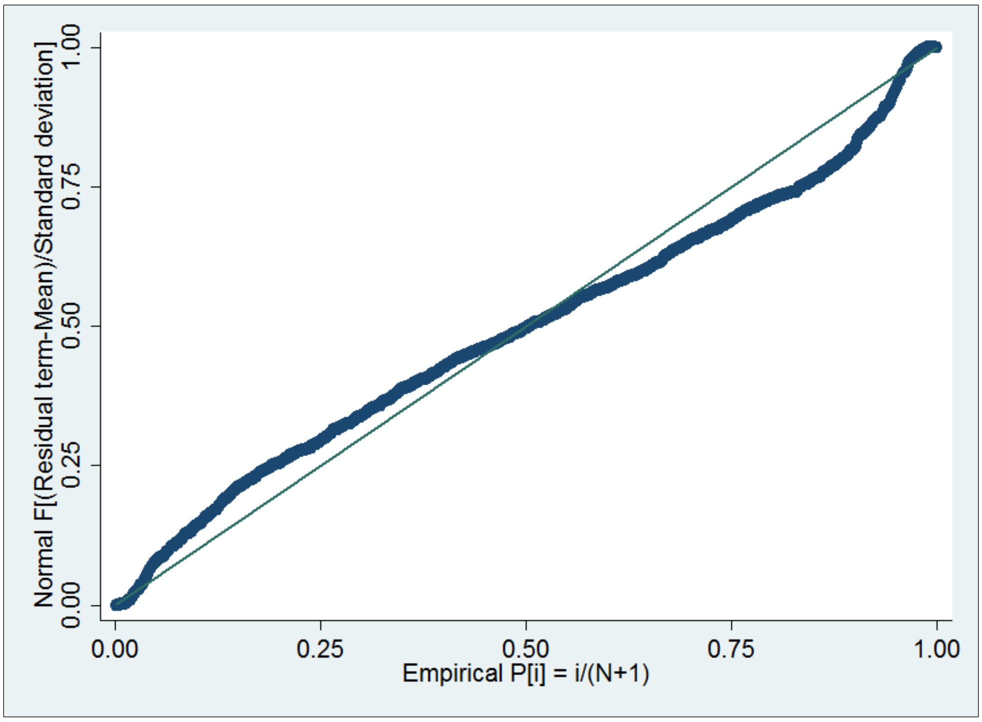


Figure A.5.2.7 Quartile Distribution of the Residuals obtained from Table 2.2.b, Column (5)

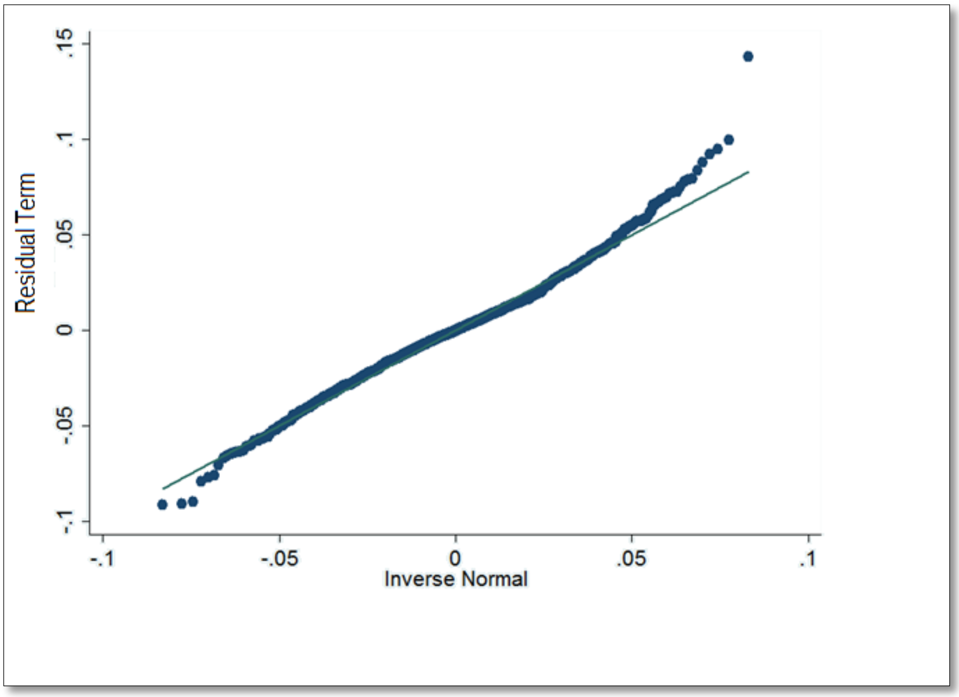


Figure A.5.2.8 Quartile Distribution of the Residuals obtained from Table 3.2, Column (6)

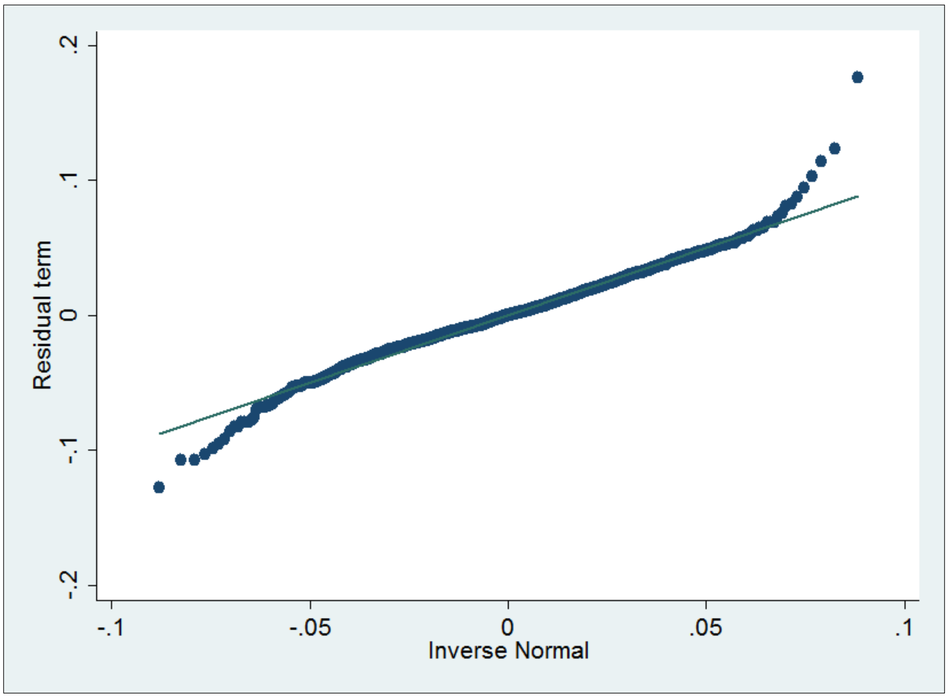
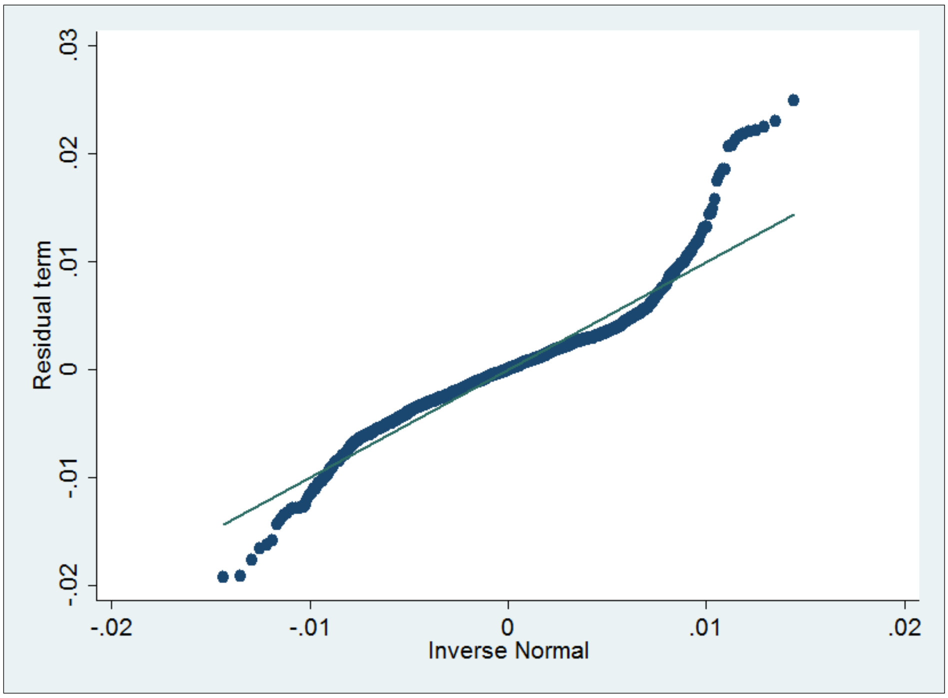


Figure A.5.2.9 Quartile Distribution of the Residuals obtained from Table 4.2, Column (6)



A.5.3 Results According to Pooled Ordinary Least Squares

Table A.5.3.1 The Results according to Pooled OLS and the Fixed Effects for the Second Chapter

Chapter 2	(1)	(2)
	Dependent Variable: Five-Year Forward Moving Geometric Average of the Growth Rate of real GDP per worker	
	Fixed Effects	Pooled OLS
Public Agricultural Investment	0.214	0.094
Proportion of GDP	(0.077)**	(0.133)
Public Mining Investment	-0.066	-0.034
Proportion of GDP	(0.017)**	(0.016)*
Public Manufacturing Investment	0.042	0.020
Proportion of GDP	(0.037)	(0.031)
Public Energy Investment	0.103	0.090
Proportion of GDP	(0.012)**	(0.011)**
Public Transportation and Com. Investment	-0.388	-0.396
Proportion of GDP	(0.123)**	(0.108)**
Public Housing Investment	0.337	0.373
Proportion of GDP	(0.120)**	(0.259)
Public Tourism Investment	-0.005	-0.034
Proportion of GDP	(0.036)	(0.039)
Public Education Investment	0.644	0.379
Proportion of GDP	(0.161)**	(0.195)
Public Health Investment	0.134	0.320
Proportion of GDP	(0.167)	(0.232)
Public City Infrastructure and Security Investment	0.588	0.357
Proportion of GDP	(0.368)	(0.275)
Population Growth Rate	-0.120	-0.200
	(0.163)	(0.097)*
1975	0.003	0.004
	(0.001)*	(0.002)
1976	-0.012	-0.010
	(0.001)**	(0.002)**
1977	-0.019	-0.015
	(0.002)**	(0.003)**
1978	-0.011	-0.010
	(0.002)**	(0.003)**
1979	-0.000	0.000
	(0.002)	(0.003)
1980	0.012	0.012
	(0.003)**	(0.002)**
1981	0.011	0.012
	(0.003)**	(0.003)**
1982	0.023	0.024
	(0.003)**	(0.003)**
1983	0.019	0.020
	(0.003)**	(0.002)**
1984	0.013	0.013
	(0.002)**	(0.002)**
Private Capital	0.050	0.111
(Proportion of GDP)	(0.013)**	(0.049)*
1986	0.013	0.015
	(0.001)**	(0.001)**
1987	0.012	0.014
	(0.001)**	(0.001)**
1988	0.020	0.021
	(0.001)**	(0.001)**
1989	0.016	0.017
	(0.001)**	(0.001)**
1990	0.011	0.012
	(0.001)**	(0.000)**
1991	0.023	0.023

	(0.001)**	(0.001)**
1992	0.024	0.024
	(0.001)**	(0.001)**
1993	0.025	0.024
	(0.000)**	(0.000)**
1994	0.022	0.021
	(0.000)**	(0.001)**
1995	0.025	0.025
	(0.000)**	(0.000)**
Martial Law	0.003	0.003
	(0.002)	(0.002)
Aegean		0.002
		(0.002)
Black Sea		-0.005
		(0.005)
Central		-0.005
		(0.002)*
East Anatolia		-0.019
		(0.003)**
South East Anatolia		-0.002
		(0.010)
Mediterranean		-0.003
		(0.001)*
Constant	-0.002	0.007
	(0.004)	(0.004)*
Observations	1407	1407
Number of groups	67	67
F	66.95	4143.89
R-Squared	0.22	0.24

Standard Errors in parentheses.
* Significant at 5%, ** significant at 1%

Table A.5.3.2 The Results according to Pooled OLS and the Fixed Effects for the Third Chapter

Chapter 3	(1)	(2)
	Dependent Variable: Five-Year Forward Moving Arithmetic Average of the Gross Enrolment Rate	
	Fixed Effects	Pooled OLS
Public Energy Investment	-0.001	-0.001
Proportion of GDP	(0.015)	(0.001)
Public Transportation and Com. Investment	-0.364	0.008
Proportion of GDP	(0.200)	(0.011)
Public Education Investment	-0.266	0.009
Proportion of GDP	(0.459)	(0.015)
Public Health Investment	0.121	0.056
Proportion of GDP	(0.190)	(0.045)
Public City Infra. and Security Investment	0.992	-0.030
Proportion of GDP	(0.173)**	(0.011)**
Population Growth Rate	-1.014	0.010
	(0.238)**	(0.006)
1975	-0.166	0.005
	(0.025)**	(0.001)**
1976	-0.166	0.005
	(0.024)**	(0.001)**
1977	-0.161	0.006
	(0.023)**	(0.001)**
1978	-0.157	0.004
	(0.022)**	(0.001)**
1979	-0.139	0.005
	(0.020)**	(0.001)**
1980	-0.134	0.003
	(0.021)**	(0.000)**
1981	-0.119	0.002
	(0.020)**	(0.000)**
1982	-0.109	0.003
	(0.019)**	(0.000)**
1983	-0.098	0.001
	(0.018)**	(0.000)**
1984	-0.085	0.002
	(0.016)**	(0.000)**
1985	-0.080	0.001
	(0.014)**	(0.001)
1986	-0.089	0.002
	(0.014)**	(0.000)**
1987	-0.091	0.002
	(0.013)**	(0.000)**
1988	-0.092	0.002
	(0.012)**	(0.000)**
1989	-0.092	0.001
	(0.012)**	(0.000)*
1990	-0.097	0.001
	(0.010)**	(0.000)**
1991	-0.100	0.002
	(0.009)**	(0.000)**
1992	-0.103	0.001
	(0.009)**	(0.000)**
1993	-0.106	0.001
	(0.007)**	(0.000)**
1994	-0.091	0.001
	(0.005)**	(0.000)**
1995	-0.066	-0.000
	(0.004)**	(0.000)
1996	-0.035	0.000
	(0.002)**	(0.000)**
Ln(GDP per capita)	0.026	0.001
	(0.017)	(0.000)*
Infant Mortality Rate	-0.299	0.832

	(0.065)**	(0.024)**
Martial Law	0.019	0.001
	(0.005)**	(0.001)
Adult Education Indicator	-0.666	0.019
	(0.203)**	(0.005)**
Aegean		0.000
		(0.000)
Black Sea		0.000
		(0.000)
Central		0.000
		(0.000)
East Anatolia		0.000
		(0.000)
South East Anatolia		0.001
		(0.001)
Mediterranean		-0.000
		(0.000)
Constant	0.517	-0.011
	(0.229)*	(0.004)**
Observations	1541	1541
Number of groups	67	67
F	33.92	5241.18
R-Squared	0.49	0.94

Standard Errors in parentheses.
* Significant at 5%, ** significant at 1%

Table A.5.3.3 The Results according to Pooled OLS and the Fixed Effects for the Fourth Chapter

Chapter 4	(1)	(2)
	Dependent Variable: Five-Year Forward Moving Arithmetic Average of the Infant Mortality Rate	
	Fixed Effects	Pooled OLS
Public Energy Investment	-0.009	-0.004
Proportion of GDP	(0.002)**	(0.003)
Public Transportation and Com. Investment	-0.027	-0.032
Proportion of GDP	(0.024)	(0.043)
Public Education Investment	0.078	0.098
Proportion of GDP	(0.045)	(0.090)
Public Health Investment	0.007	0.139
Proportion of GDP	(0.028)	(0.139)
Public City Infra. and Security Investment	-0.158	-0.088
Proportion of GDP	(0.076)*	(0.053)
Population Growth Rate	-0.047	0.101
	(0.027)	(0.025)**
1975	0.012	0.035
	(0.001)**	(0.004)**
1976	0.013	0.035
	(0.002)**	(0.005)**
1977	0.013	0.034
	(0.001)**	(0.004)**
1978	0.012	0.032
	(0.001)**	(0.004)**
1979	0.011	0.030
	(0.001)**	(0.003)**
1980	0.009	0.027
	(0.001)**	(0.002)**
1981	0.009	0.026
	(0.001)**	(0.002)**
1982	0.008	0.025
	(0.001)**	(0.002)**
1983	0.007	0.023
	(0.001)**	(0.002)**
1984	0.007	0.022
	(0.000)**	(0.002)**
1985	0.008	0.021
	(0.001)**	(0.003)**
1986	0.007	0.020
	(0.001)**	(0.003)**
1987	0.006	0.018
	(0.001)**	(0.003)**
1988	0.005	0.017
	(0.001)**	(0.002)**
1989	0.004	0.015
	(0.001)**	(0.002)**
1990	0.004	0.013
	(0.001)**	(0.002)**
1991	0.003	0.012
	(0.000)**	(0.002)**
1992	0.002	0.010
	(0.000)**	(0.001)**
1993	0.002	0.009
	(0.000)**	(0.002)**
1994	0.001	0.007
	(0.000)**	(0.001)**
1995	0.001	0.005
	(0.000)**	(0.001)**
1996	0.000	0.002
	(0.000)**	(0.000)**
Ln(GDP per capita)	-0.002	0.002
	(0.001)	(0.001)**
Martial Law	0.003	0.002

	(0.001)*	(0.002)
Adult Education Indicator	0.008	0.168
	(0.014)	(0.033)**
Aegean		-0.000
		(0.001)
Black Sea		-0.004
		(0.002)*
Central Anatolia		-0.003
		(0.001)**
East Anatolia		-0.002
		(0.002)
South East Anatolia		0.007
		(0.001)**
Mediterranean		-0.006
		(0.002)**
Constant	0.032	-0.049
	(0.010)**	(0.007)**
Observations	1541	1541
Number of groups	67	67
F	41.52	2581.80
R-Squared	0.49	0.51

Standard Errors in parentheses.
* Significant at 5%, ** significant at 1%