Infrastructure and Economic Growth in Pakistan: A Panel Data Analysis

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بِسْمِ ٱللَّهِ ٱلرَّحْمَٰنِ ٱلرَّحِيمِ

In the Name of Allāh, the Most Gracious, the Most Merciful

Declaration

Except where otherwise indicated, this thesis is my original work.

Sarnaila Sharif

Dedicated

to

My Beloved Grand Parents

Muhammad Din (Late)

Shanaq Bibi,

and

My Khala and Mamoo

Abdul-Qayyum Shaheen (Late)

Anwar Bibi

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I am very thankful for the love, support and prayers of my mother throughout my life. I really appreciate the unconditional support and guidance of my father on each and every step of my life, without his firm belief in me I would never be able to achieve this goal. All the achievements of my life are really attributed to the love and support of my brothers Muhammad Shafiq Sajid and Shafqat Sharif, and my sisters Azra Bano, Abida Sharif, Sajida Sharif, Shamaida Sharif and Shumaila Sharif, without their love, support and kindness life would never be so beautiful and successful to me.

Sarnaila Sharif

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Abstract

This study intends to explore the empirical linkages between infrastructure and economic growth in Pakistan, along with the analysis of regional disparity in infrastructure facilities and per capita GDP across the country. The empirical analysis is based on a panel of 4 provinces of Pakistan over the period of 1994-95 to 2014-15. System Generalized Method of Moment (SYS-GMM) is used for the empirical estimation of the model. In our analysis, we have divided infrastructure into physical infrastructure (transport, electricity and irrigational facilities) and social infrastructure (education and health facilities). The study concludes that both physical and social infrastructure have positive and significant impact on economic growth while two-way causality is also confirmed between infrastructure and economic growth. The regional disparity analysis describes that regional disparity is increasing in Pakistan on the grounds of public infrastructure facilities and per capita income. The analysis also shows that along with the increase in public investment in infrastructure facilities, we need to pay more attention to the quality of infrastructure services, effective policy enforcement mechanism and equity in the distribution of infrastructure facilities across the country. Furthermore under- developed regions must be given priority for the provision of infrastructure facilities to speed up the pace of economic development and social betterment there.

Chapter 1

Introduction

Infrastructure is the backbone of every competitive economy, and leads to the goal of high and sustainable economic growth, industrialization, capital formation and high standard of living (Rosenstein-Rodan, 1943; Ekstein, 1957; Nurkse, 1953; Rostow, 1959). Public investment in infrastructure is an integral part of economic development process (Ali and Pernia, 2003; Fan et. al., 2000, 2004; Kwon, 2005; Seethanah et. al., 2009; Khandker and Koolwal, 2010; Ahmad, 2013). Infrastructure plays significant role in economic growth through increased productivity, reduced cost, better economic conditions with more employment opportunities, investment friendly environment and global competitiveness (Hulten and Schwab, 1993; Salinas-Jimenez, 2003; Sahoo et. al., 2010; Fan et. al., 2004; Macdonald, 2008).

Infrastructure provides the base over which, the structure of the economy is formed and all other economic activities are established. The initial concept of infrastructure was elaborated by Fleming (1955), Myrdal (1957) and Hirschman (1958). Hirschman divided the economic activities into Direct Productive Activities (DPA) and Social Overhead Capital (SOC); he demarcated SOC as "those basic services without which primary, secondary and tertiary productive activities cannot function." Infrastructure services can be decomposed into two main components: physical and social infrastructure. Physical infrastructure includes transport (roadways, railways, airways and waterways), electricity, irrigation and telecommunication, whereas social infrastructure includes health and education facilities (World Bank, 1994). Public spending on physical infrastructure enhances economic growth by more production opportunities, productivity growth with reduction in cost, and employment, output and income opportunities (Sahoo et. al. 2010 and Fan et. al. 2004). In developing countries like Pakistan physical infrastructure also contributes significantly in the growth of agriculture sector and in enhancement of social infrastructure services (Ahmed and Donovan, 1992). On the other hand, social infrastructure performs a better role in human capital formation through education, health and housing facilities that propagate productivity of labor and standard of living of the people (Ghosh and De, 2004; Majumdar, 2005).

The contributions of infrastructure in the economic development were specified by the pioneers of Development Economics (Fleming 1955, Hirschman 1958, Myrdal 1958). In this respect the major research work was generated in the 1980s to explain the slowdown in productivity in the developed countries, especially USA (Ascheur 1989). Several studies confirmed the positive impact of infrastructure on economic development, employment growth and quality of life (Ascheur 1989a, b; Looney and Frederiksen 1981; Munnell 1990; Eberts et al 1991; Easterly and Rebelo 1993; Canning et al 1993, 1999, 2004; Cutanda and Paricio 2003; Esfahani and Ramirez 2003, Majumdar 2012). There is also a school of thought that considered the relation between infrastructure and economic growth as spurious and questioned the validity of this relation (Aaron 1991; Tatom 1991, 1993; Eisner 1991; Munnell 1992; Gramlich 1994).One major concern in this respect is the endogeneity and the direction of causation between infrastructure and growth: since infrastructure plays an essential role in the growth of productivity and output, but on the other hand economic growth also affects the determinants of infrastructure, and if problem of endogeneity is not addressed properly it will result in biasness of results. Some studies found no evidence of such biasness as (Flores de Frutos and Pereira 1993; Fernald 1999), while other researchers concluded on the basis of state level panel data, that long run fixed effects were unable to show positive association between infrastructure and economic growth (Holtz Eakin 1994; Holtz Eakin and Schwartz 1995; Gracia Mila et al 1996).

Canning and Pedroni 1999 confirmed two way relations in most countries, keeping in view short run heterogeneity in infrastructure and output growth association.

1.1. Motivation of the Study

Infrastructure plays significant role in the development of every country, but the returns to public investment differs from country to country, while according to World Bank Report (2007) Pakistan must increase public expenditures in deficient categories of Infrastructure; power, water, irrigation and transport sector. The role of public expenditures in infrastructure facilities is highly controversial in case of Pakistan, in some studies the role of infrastructure in propagation of economic development is extensively acknowledged while some studies concluded that there is no significant impact of public investment in Infrastructure on economic development, however it is admitted that public investment attracts private investment and increases pace of economic activities in the economy (Naqvi, N. H., 2002). Infrastructure deficiency is also categorized an important cause of low rate of economic development in Pakistan (Samad and Ahmed 2011). Pakistan is facing not only problems of shortage of public expenditures, but the inefficient usage of resources and corruption in infrastructure projects are also posing a great obstacle in the way to progress (Pasha 2011).

Public investment in infrastructure has increased significantly in the last 50 years in Pakistan, but the rate of growth is low as compared to other developing countries as Sri Lanka, Malaysia and Egypt. Since the tendency and expected rate of economic growth is low in Pakistan, it is assessed that by enhancing power, telecommunication and transport sectors the per capita GDP growth rate can be incrementally improved by 3.7 % with varying contributions from different sectors; 1.9 % power sector, 0.6% transportation, 1.2 % telecommunication (Loayza and Wada, 2012). There are also found wide differences over the availability of infrastructure facilities in the provinces of the country, as Punjab can be classified as most developed region, KPK and Sindh as intermediate regions and Balochistan as lagging region with respect to provision of infrastructure facilities; this situation will result in further widening of regional disparities and slowdown of economic growth rate.

A lot of studies are conducted in Pakistan to analyze the effects of infrastructure on economic growth, but most of them are concerned either with time series data or cross country analysis. The countries like India and China have extensively used panel data to explain the linkage between infrastructure and economic growth and the resulting regional disparities due to infrastructure imbalance, however there is hardly found any study that uses panel of provinces for confirmation of this relation in Pakistan. The main concern of this study is to estimate the relation between infrastructure and economic growth in Pakistan and to check whether regional differences are going to be wider in infrastructure facilities and per capita income, so this study fills the gap by using panel of four provinces to investigate the relation between infrastructure facilities and economic growth in Pakistan and the regional disparities in the provision of infrastructure facilities and income inequality.

1.2. Objectives of the Study

This study is specifically designed to examine the linkage between infrastructure facilities and the economic growth pattern in Pakistan. We can classify the objectives of the study as under:

- To investigate the relationship between infrastructure and economic growth in Pakistan
- To analyze the regional disparity in infrastructure facilities and regional income inequality

1.3. Organization of the Study

This study is organized in the following pattern: Chapter 1 consists upon introduction and objectives of the study. Chapter 2 deals with the analysis of infrastructure development in Pakistan along with policy analysis in this respect. Chapter 3 provides an extensive theoretical and empirical literature review. Chapter 4 encompasses the empirical model, econometric methodology and the data description. In chapter 5, the empirical results of the study are explained and Chapter 6 comprises conclusion of the study and policy recommendations.

Chapter 2

Trends of Infrastructure Services in Pakistan

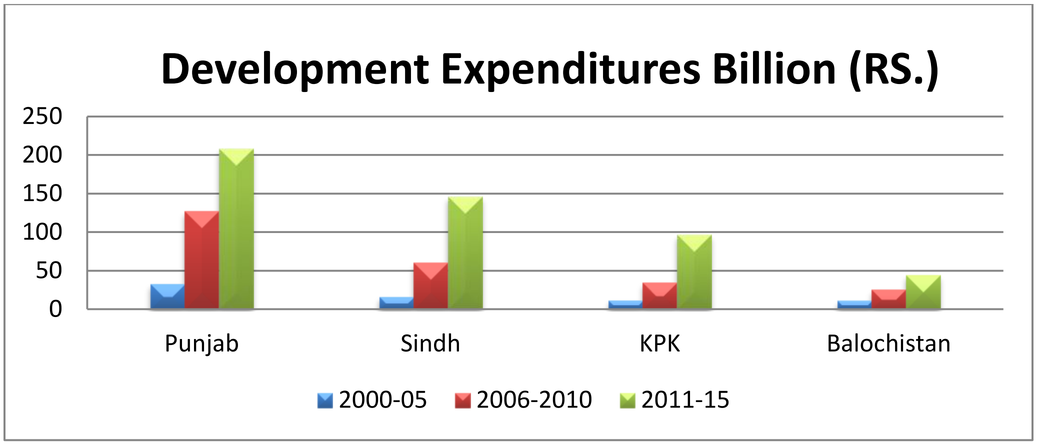
Infrastructure provides a structure over which the foundation of economic development is established. In this chapter we are going to provide an overview of infrastructure services in the provinces of Pakistan, this description will not only inform us about the status of infrastructure facilities but also about the prevalent disparity in infrastructure services across the country.

2.1. Development Expenditure – Trends and Issues

Public spending in the social sector is characterized with much inefficiency in Pakistan, such as a major portion of the resources are reserved for the current expenditures. In addition, a major part of public expenditures are devoted to the tertiary services without regard for primary services, towards urban areas at the cost of rural areas, and for the development of one geographical region causing damage to the others. As a result of these shortcomings the increase in public expenditures remained unable to bring sizeable improvement in the performance of the social indicators. Since social spending is crucial for economic development of the provinces, so there is dire need to increase public investment in education, health, transportation, power and telecommunication sectors.

Keeping in view enormous potential and future challenges provincial governments have enhanced public investments in infrastructure, however at the same time proficiency in resource allocations and competence in operations must be provided through good governance. On average, provincial development expenditures increased much faster during the last three decades it shows availability of more financial resources to the provinces due to favorable changes in revenue sharing formula and the responsiveness of provincial governments towards the development needs of the people. The scenario of development expenditures is increasing in all provinces except in Balochistan where tight fiscal condition prohibited the province from making any significant upsurge in development expenditures.

Figure 2.1 Development Expenditures – A Provincial Comparison



Source: Office of the Accountant General Punjab

The development preferences of the provinces are a key to ascertain the provision of basic necessities of life such as education, health, social protection, housing, environment protection program etc. in the provinces. The information given in the table 2.1 shows that Punjab is going to invest more proportion of its GDP for development expenditures as compared to other provinces, while the rate of growth of development expenditures in significant in all provinces except Balochistan. However the rate of growth of provincial development expenditures is less than that of current expenditures and this refers that major part of fiscal resources are devoted towards the current expenditures, such as in Punjab during the fiscal year 2006-07 the development expenditures were 39 percent of total expenditures, while this proportion declined to 26 percent in 2011-12, so there is utmost need to allocate more financial resources towards development expenditure.

Table 2.1 Development Expenditures – A Provincial Comparison (% of Provincial GDP)

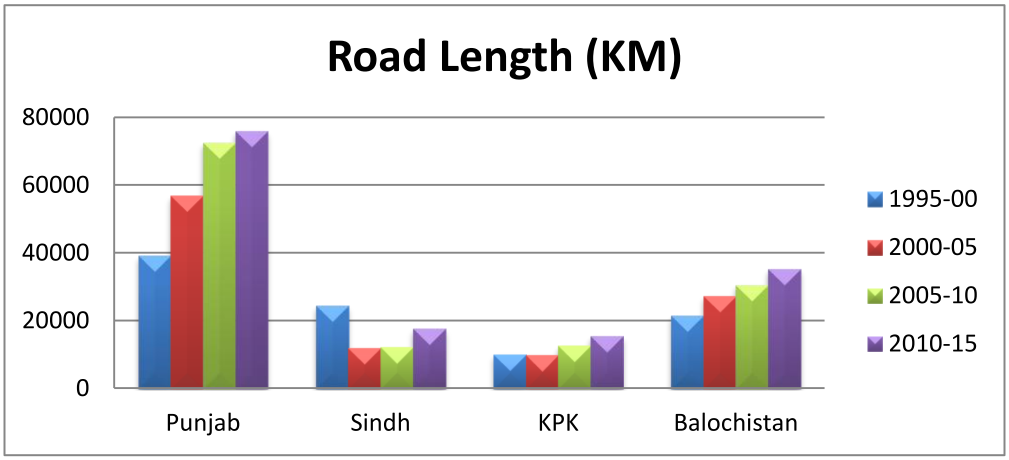
Province	FY01-FY06	FY07-FY12
Punjab	0.6%	0.9%
Sindh	0.3%	0.6%
KPK	0.2%	0.4%
Balochistan	0.2%	0.2%

Source: Ministry of Finance, Government of Pakistan

2.2. Provincial Transportation Facilities

Infrastructure is the backbone of every economy; it determines the economic growth rate and standard of life of the people. From the indicators of Infrastructure the most important one that is responsible for decline in cost of production and enhancement of productivity; is the transportation sector. We represent the transportation facility of the provinces by the total road length in KM and we see that Punjab is the most advanced area with respect to transportation facilities. An interesting indication about road infrastructure is that although Balochistan is the most backward province of Pakistan, yet the road structure of Balochistan is better than that of Sindh and KPK. Balochistan is the largest province of Pakistan with respect to area so the total road length here is better than that of Sindh and KPK, but if we consider the road density then it is observed that the road density in Balochistan is the lowest among all other provinces, which describes the deplorable condition of Balochistan with respect to transportation facilities.

Figure 2.2 Total Road Length in the Provinces



Source: Provincial Development Statistics

The transport sector of Pakistan is characterized with low road density, a miserable quality of railroads with only satisfactory quality of seaports. The description of road density in table 2.2 shows that road density is highest in Punjab and lowest in Balochistan, while lack of communication resources in Balochistan are further responsible for less road connectivity with other areas of the country and less economic activities in the province. Let we have a brief description of road density;

Table 2.2 Provincial Road Density

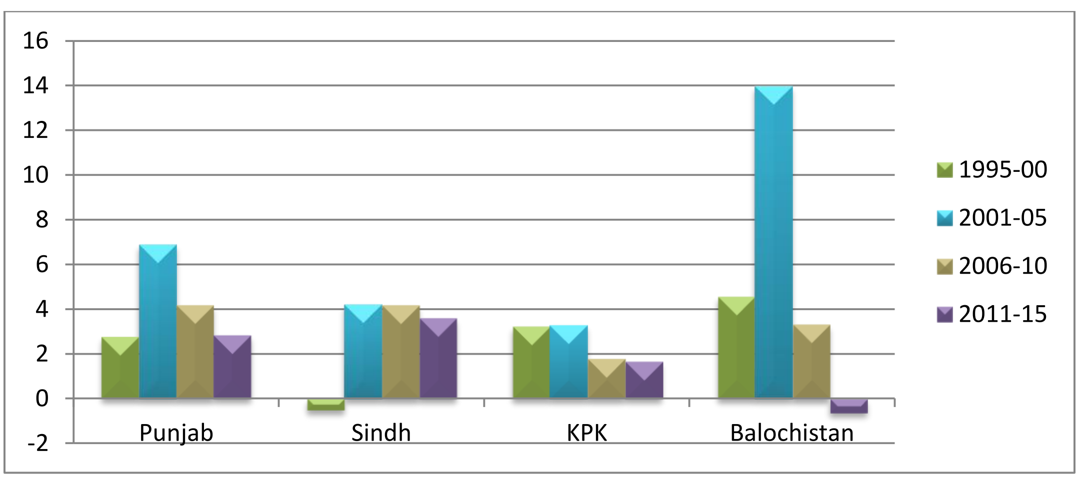
Year	Punjab	Sindh	KPK	Balochistan
1994-95	0.174	0.166	0.131	0.055
1999-00	0.206	0.178	0.146	0.068
2004-05	0.340	0.081	0.136	0.085
2009-10	0.362	0.097	0.201	0.093
2014-15	0.376	0.129	0.214	0.108

Source: Provincial Development Statistics

2.3. Electricity consumption

The electricity infrastructure of Pakistan is considerably lower than the other developing countries which show miserable electricity generating capacity of our country. Moreover, in Pakistan only 62% of population has access to electricity and this is the second lowest percentage among the group of other developing countries like Malaysia, India, Sri Lanka, Thailand, Brazil, Egypt and Bangladesh. The growth rate of electricity consumption remained positive during the last two decades, although major proportion of generated electricity is consumed in Punjab on the household and commercial level, but we see in the figure 2.3 that the growth rate of electricity consumption was consistent in Punjab, Sindh and KPK while the highest growth rate with respect to electricity consumption is witnessed in Balochistan in the first half of last decade, later on the growth rate in Balochistan remained low and even negative in 2011-15.

Figure 2.3 Electricity Consumption Growth Rate (%)



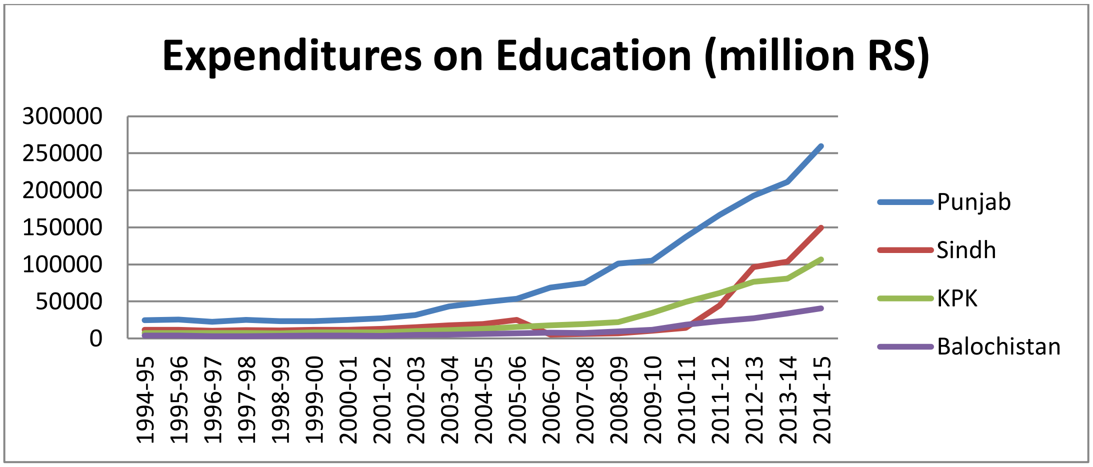
Source: Pakistan Energy Yearbook (Various Issues)

One of the most binding constraints on Pakistan's economic growth and productivity has been its energy deficit. There is dire need to increase public investment in power sector to help the economic activities as well as standard of life of the people, it is also referred that among the infrastructure indicators the major contributions in the economic growth enhancement are generatd from the energy sector development.

2.4. Education: Status, Progress, and Remaining Challenges

Over the last two decades, extensive efforts have been done to bring significant reforms in the education sector of Pakistan, these reforms are intended to establish new institutions, improve the managing structure and increase the level of government expenditures in the education sector. There are still many issues in our education sector that must be addressed such as gender and regional disparities, low rate of growth of real expenditures in education, increasing irregularities in expenditure composition, and the incapability of the government to deal these deep-rooted issues that slowdown the rate of improvement in the education sector. It is evident from the figure 2.4 that the public spendings on education sector has increased in all provinces during the last two decades, however the major changes in spendings on education increased after 2006 when after NFC Award the proportion of share of provinces incresed in federal resources and this has led to a sharp increase in education expenditure.

Figure 2.4 Provincial Public Expenditures on Education

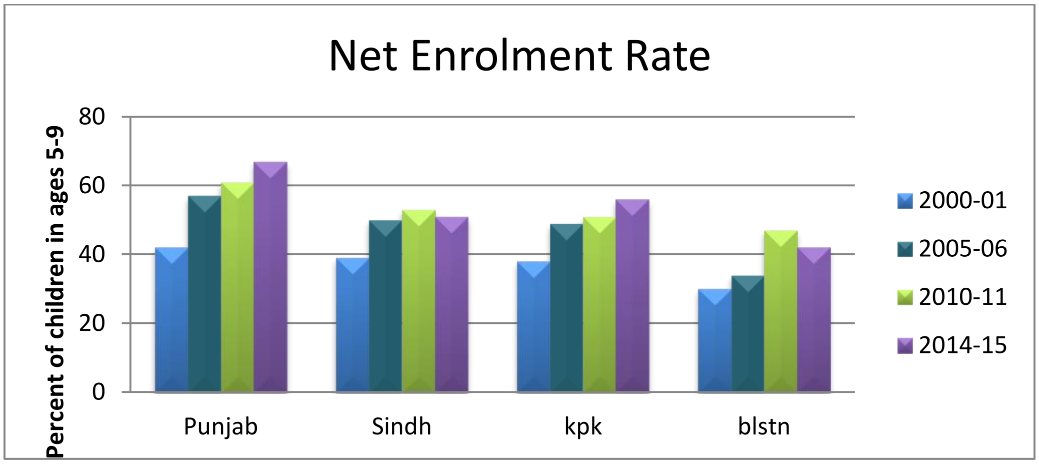


Source: Provincial Budget Statements

However, despite increasing share of budget allocations for education sector, poor enrolment rates across the provinces are a clear sign that our education sector is incapable to fulfill the needs of the people. Insufficient resources for education sector, poor governance and ineffective management are partly responsible for poor quality of education. The net enrolment rate in Punjab is highest and is also constantly increasing among the other provinces but it is still less than most of other developing countries as India and Sri Lanka, the NER in Sindh showed some improvement in the last decade but this initial impetus was temporary due to bad economic conditions and famine there. The NER is increasing at low but persistent rate in KPK, but still NER in KPK is less than that of national level and Punjab and one of the major causes of this slow improvement is the security issue. The performance of Balochistan is very miserable in the education sector with the lowest NER among the provinces, mainly due to meagre allocation of resources to the education sector, poor management, less priority given to education sector among the other development projects, political instability and security problems. Since the population growth rate in Pakistan is higher than that of most South Asian countries, so extensive efforts must be carried to attain desired level of education indicators ; enrolment rate, literacy rate etc.

Literacy rate is an important indicator of education while high literacy rate in a country is an indication of better quality of education, high standard of life and sound economic conditions. According to the latest Pakistan Social and Living Standards Measurement (PSLM) Survey 2015, the literacy rate in Pakistan of the population (10 years and above) is 60 percent as compared to 58 percent in 2014, while the literacy rate for men is 70 percent against 49 percent for women which indicates a gap of 21 percent of female literacy rate that must be addressed to remove gender inequality in the education sector. Literacy rate of provinces specify that Punjab leads with 63 percent followed by Sindh with 60 percent, Khyber Pakhtunkhwa with 53 percent and Balochistan with 44 percent. It is a fact that in this competitive world the goal of sustainable economic growth can be achieved only through productive human capital and innovation, and for this we must give preference to the education sector in the development policies.

Figure 2.5 Provincial Primary Net Enrolment Rate

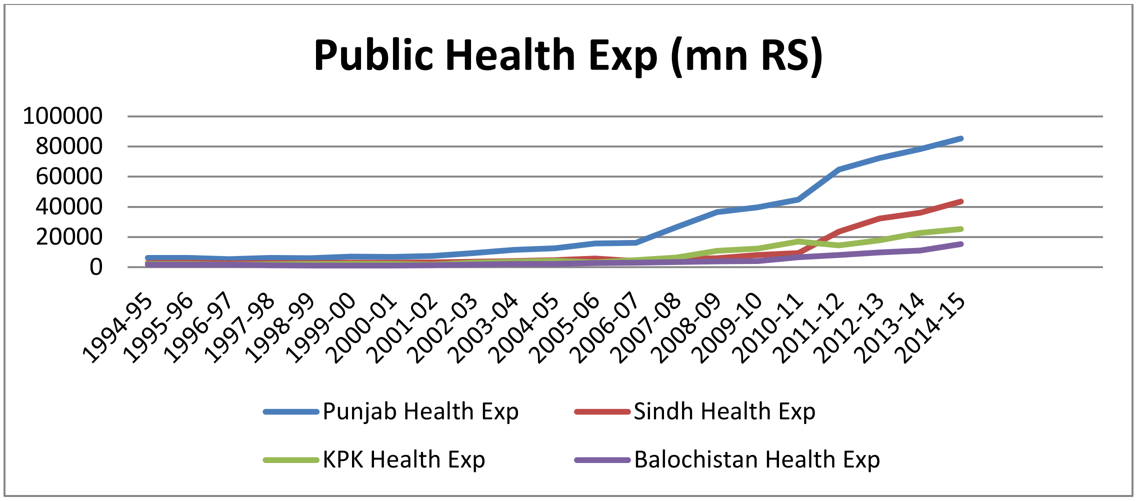


Source: PSLMS (Various Issues)

2.5. Health Sector: Need for Reprioritization

The status of Pakistan with respect to health services is very poor as compared to other developed and developing countries; there is dire need to increase public expenditures on health services as well as these health facilities must be expanded in such a way that the poorest segment of the population got maximum benefit from health subsidies and quality health facilities are provided to all segments of the society. The issues of poverty, rapid population growth rate and urbanization affect health system intensely, so concrete efforts are required to improve structure of health services in Pakistan.

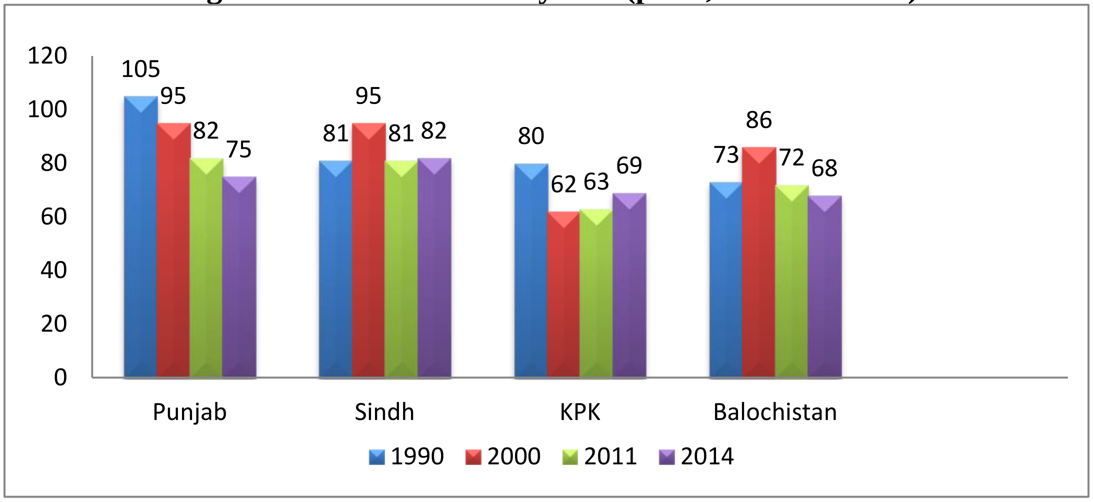
Figure 2.6 Provincial Public Health Expenditures



Source: Office of the Accountant General, Punjab

Although during the last three decades the proportion of health expenditures has increased in the provincial budget allocations but still the provinces are away from the track to accomplish MDGs (Millennium Development Goals) regarding the health status, since the MDG for child mortality in Pakistan is to lessen the under –five child mortality rate to 52 deaths per 1,000 live births by the year 2015 but keeping in view current rate of progress, it is anticipated that even Punjab would take another 20 years to realize this goal. The improvement in the provincial health services in Punjab is evident from the decline in the Infant Mortality Rate (IMR) , but still the IMR and under five mortality rate in Punjab are double than the rates of Nepal and Bangladesh where rapid decline has witnessed in the same period. The health status of Sindh is representing more deplorable condition where even after two decades the IMR is still on the same point. The health sector of KPK represented very gloomy picture over the last three decades, showing no improvement in the public health services with increased IMR. Balochistan health statistics show that the overall situation of health facilities is quite unsatisfactory there mainly due to poor public health facilities which are provided in far-flung areas, security concerns and low per capita income of the people.

Figure2.7 Infant mortality rate (per 1,000 live births)



Source: PSLMS (Various Issues)

Immunization is one of the key components that lead to the reduction of under-five child mortality, although the immunization rate for the children aged 12-23 months has improved in all the provinces and the major improvement is seen in the first half of last decade later on there has been found no significant improvement in the immunization coverage. The immunization rate provides the same picture as by the IMR where immunization coverage is increasing in Punjab, Sindh and KPK but the pace of growth in the latter two is less than that of Punjab. The more deplorable condition is witnessed in Balochistan where half population of the children aged 12-23 months has no access to immunization facilities. The immunization coverage is very poor in Pakistan still away from the goal of fully immunization of children of all age groups. It is a bitter reality that Pakistan is struggling to achieve the status of Polio-free country even in 21st century, primarily due to less public health spending, security concerns, low literacy rate and irregularities and inefficiencies in the public health management sector. Provision of public health facilities must be the foremost priority of provincial and national authorities, to actualize the goals of sustainable economic growth with productive and innovative human capital.

Table 2.3	Percentage of Children aged 12-23 months that have been fully immunized			
Year	**Punjab**	**Sindh**	**KPK**	**Balochistan**
1994-95	44	42	36	49
1999-00	54	40	52	28
2004-05	84	73	76	62
2009-10	87	72	74	51
2014-15	89	73	78	51

Source: PSLMS (Various Issues)

2.6. The Way Forward

Although the level of infrastructure in Pakistan is less or more stable, yet there are also many factors that are responsible for competitiveness of a country such as productivity and management of infrastructure, as indicated in Framework for Economic Growth (2011). It is also estimated that low productivity of transport infrastructure becomes a cause of loss of about 5% of GDP in Pakistan per year, while the ranking of Connectivity Scorecard (2010), which assesses physical connectivity and productively utilization level of infrastructure in the countries, Pakistan was rated 25th out of 25 developing countries. The issue of lack of infrastructure in specific sectors and areas can be solved by more public investment in infrastructure services, efficient utilization of resources and effective management of infrastructure facilities. Our current approach towards economic growth is mainly stimulated towards construction of physical infrastructure while the poor ranking of Pakistan in the Human Development Index (2015) shows that we are lagging behind the developed world with respect to provision of basic necessities of life such as health, education and social protection facilities ; so we must adopt balanced approach by increasing investment in physical as well as social infrastructure to increase productivity and efficiency in all sectors of economy.

Chapter 3

Literature Review

3.1. Introduction

Economic growth of regions differs mostly on basis of provided public capital stock and regional development policies, and these are responsible for not only cross country economic growth differences but also for regional growth disparity within the same country. A large no of studies have been conducted worldwide, to study the impact of infrastructure on economic growth, although research work in Pakistan is very scanty in this field. In this section of literature review, we have discussed national and international studies for understanding of the relation between infrastructure and economic growth. For expositional purposes, we are going to divide this literature into two categories. First there are studies that are conducted to gauge the relationship between infrastructure and economic growth. In the second strand of literature, it is analyzed that how infrastructure facilities become cause of regional economic growth disparity.

3.2. Infrastructure and Economic Growth

Infrastructure is a tool by which government can play its role in the betterment of the people, and this involvement of government in public projects is not naval in history. Adam Smith had acknowledged this effect in the "Wealth of Nations" by suggesting that state must play its role in the economic activities, by production and maintenance of public works. Later on the debate among economists got started about role of public expenditures in the economic growth, in form of classical and neoclassical economics. Neoclassical economists were not in favor of active role of public expenditures in the economy, according to them public expenditures can affect economic growth patterns only, during the transition phase to steady state, and have no role in economic growth of a country. Then the works of Barro (1990) can be considered a new shift in the endogenous growth models, in which the role of public expenditures in economic growth explanation was analyzed through, research and development expenditures and human capital investment.

Singer (1951) started to categorize infrastructure in overhead capital and directly productive activities, and furthermore Nurkse (1961) considered overhead capital as an important tool for the development of backward regions. Infrastructure and regional economic growth were studied extensively by Myrdal (1958), Hirschman (1958), Hansen (1965), and Mera (1973). Looney and Frederiksen (1981) and Biehl (1986) showed the significant impact of infrastructure on regional economic development. Eberts (1985, 1986) concluded that public capital had a positive and significant contribution to manufacturing production, but elasticity of public capital to output was very small (0.03); the study also suggested that labor and public capital were complementary inputs, while public capital and private capital were substitutes. Costa et al. (1987) declared that labor and public capital are complementary inputs, and public capital is subject to diminishing returns. It was also examined that there the reverse relation was found between output elasticity of public capital and ratio of public to private capital, as indicated by Hansen (1965).Similar study was conducted by Garcia-Mila and McGuire (1987) to measure the effect of transportation and educational facilities on the production process, and concluded that these public expenditures had positive and significant effect on economic growth. But the findings of Hulten and Schwab (1984, 1991) contradicted this and examined that public infrastructure had no role in explanation of regional growth differences and furthermore stated that productivity did not grow faster in those regions, where public capital was provided intensively.

The series of articles by Ascheur (1989a 1989b) are majorly responsible for revival of infrastructure in economic growth explanations. The slowdown of productivity in private sector of the USA in 1970-1985 was tried to be explained, by oil price shocks, high energy prices and decline in expenditures on research and development, but none of them can be considered as the dominant factor for the explanation of this productivity decline, then Ascheur came with the explanations that decline in public capital expenditures were the sole cause for this productivity slowdown. The positive contributions of infrastructure to economic growth were confirmed by Eberts and Deno (1989), even when impact of infrastructure was considered in three different dimensions: a consumption commodity, an input into the production function and a public works activity.

Following the research pattern of Ascheur, the empirical conducted by Munnell (1990, 1992) found positive and significant relationship between public capital stock (Education, hospital, water supply facilities and other buildings) and productivity of labor. Later on researchers criticized this approach on basis of econometric problems such as, Aaron (1990) and Tatom (1991) criticized the work of Munnell on basis of non-stationarity of time series data, and identified that this may result in spurious relation between public capital stock and output growth. Aaron and Musgrave (1990) criticized the work of Ascheur for not considering the fact, that most of services of public capital had no effect on output and productivity. Even if the problem of non-stationarity is solved, the results of various studies were contradicting the results of Ascheur findings; Aaron (1990) and Finn (1993) find lower elasticities of output with respect to public capital such as 0.09 and 0.16, respectively. While Tatom (1991), Harmatuck (1996), Hulten and Schwab (1991b) and Sturm and De Haan (1995) investigated that the impact of public capital in statistically non-significant. Kro1 (1998), Ford and Poret (1991) were unable to find significant impact of infrastructure on economic growth for the OECD countries. These authors also questioned the direction of causality and suggested that output also become cause of infrastructure development.

The direction of causality between public capital and output was discussed by Eisner (1991) and Hulten and Schwab (1991a, 1993) with the confirmation that causality may run output to public capital. Eisner (1991) negated the work of Munnell and proved that there was found no statistically significant relation between public capital and output growth, when he used Munnell's (1990, b) data to show the time series evidence for the 48 states in Munnell's sample. He also criticized the research of Munnell for not considering the fact, that the increase in public capital would affect the conventional output after variable lags. In the same way Tatom (1993) considered the results of Munnell spurious and unrelated, and considered that the causality runs in the reverse direction. He proved that infrastructure stock consisting upon highways, streets, education facilities, health facilities may affect output and productivity but at the same time economic growth also determines the demand and supply of infrastructure, and this endogeneity problem must be addressed to remove upward biasness in the estimated returns to infrastructure. The studies conducted by Flores de Frutos and Pereira (1993), and Fernald (1999) revealed that this upward biasness is not large enough and confirmed the positive contribution of infrastructure towards economic growth and productivity, furthermore Fernald (1999) argued that although growth of road infrastructure influenced productivity significantly in vehicle-intensive industries yet road-building explained much of the productivity slowdown.

Transport infrastructure has normal impact on growth of developed countries, very high impact on economic growth of industrializing countries and moderate rate of return in under developed countries; furthermore these significant results are intense in the long run (Canning and Fay, 1993). However, a number of studies estimated that in presence of long run fixed effects infrastructure had no role in explanation of growth patterns of states in the United States (Holtz Eakin, 1994; Holtz Eakin and Schwartz, 1995; Garcia Mila et al., 1996). Public capital has significant effect on industrial location, trade and development, the study by Martin and Roger (1995) showed that after trade integration the industries would be located in those countries which had better domestic infrastructure facilities, to ripe the economies of scale.

Canning and Pedroni (1999, 2004) found that in presence of heterogeneous infrastructure in the short run, two way associations between infrastructure and economic growth is detected in most of the countries, while long run economic growth can be stimulated by infrastructure development even if the economy was operating below efficient infrastructure level. Moreover the public facilities of telephone and roads were provided at the growth maximizing level on average in most of the countries while electricity generating capacity is under provided on average. Infrastructure facilities provide a common set of characteristics that are essential for the success of an economic system; these features are significant enough that they can explain most of cross country economic growth differences (Hulten, 1996), while the cross country income differences are partially explained by physical capital and educational attainment hence the impact of social infrastructure in the explanation of these differences is significant (Hall and Jones 1996, 1999).

Economic growth depends on the productivity of components of public expenditures as well as their share in investment decision; the excessive use of public expenditures at the expense of current expenditures can make them unproductive as in case of most of developing countries (Devarajan et al., 1996). Fox and Smith (1990) stressed that public infrastructure policy must be formulated keeping in view regions' economic development requirements and their locations, so that they benefit more from infrastructure expansion, in this respect intermediate regions are likely to benefit more from advanced infrastructure services. D'emurger (2001) estimated that infrastructure endowment in the sectors of transport, telecommunication and education explained growth differences substantially among the regions along with reforms, openness and geographical location, furthermore transport infrastructure plays central role in explanation of growth differences among the Chinese provinces. Shioji (2001) estimated the effect of public capital growth on the per capita income growth in Japan and the USA and found positive and modest contribution of infrastructure towards economic growth, while the cross regional analysis conducted by De La Fuente (2000) for the comparison of infrastructure facilities in the USA and Spain concluded that causality runs from infrastructure development to economic growth, but once the saturation point is reached the returns to infrastructure investment decreases.

Esfahani and Ramı´rez (2003) brought into light the role of institutional factors along with economic factors, to explain the interaction between infrastructure and economic growth through endogenous growth model. They confirmed the significant contributions of transport and telecommunication services on economic growth that exceed the cost of provision of these facilities. Zhao and Kanamori (2007) argued that most of endogenous growth models dealing with public infrastructure, fail to consider the impact of these public services on household consumption and utility level. So in the study they emphasized on the external effects of roads, telecommunication, electricity and education services on consumption and production that leads to long run economic growth, along with structural changes in consumption and income. Infrastructure is considered a key consumption object to households mainly consisting upon water, transportation, electricity and telecommunications facilities; generally it is examined that between about one-third and one half of infrastructure facilities are used as consumption products by the households (Prud'homme, 2005; Fay and Morrison, 2007).

Infrastructure has significant impact on economic growth, employment and income equality, income inequality declines due to sound infrastructure quality and quantity in the transport, telecommunication and power sectors, since these services increase the income level of the poor more proportionally (Calderon et al., 2004). Ali and Pernia (2003, 2013) examined that infrastructure facilities such as roads, electricity and irrigation play their role in poverty reduction through income distribution directly and economic growth indirectly. The income distribution channel works through enhancement of employment and income opportunities in the non-agriculture sector and by increasing productivity in agriculture and non-agriculture sector. And if economics activities are further developed, the economic growth process is established on the initiative of infrastructure services. Public investment in physical infrastructure (rural roads, village electrification and irrigation) and social infrastructure (rural education and rural health services) enhance the development process in rural areas through productivity growth in agriculture and reduction in rural poverty rate (Nadeem et al, 2011).

Infrastructure investment in fields of transport and communication has positive impact upon regional economic growth furthermore the positive externalities created due to cumulative expenditures of other states also contribute in these benefits (Lall, 2006). The supplies of roads, telecommunications and electric power play significant role in industrial productivity and output at domestic level as well as in determination of comparative advantage and specialization in trade among the world nations (Yeaple and Golub, 2007). Sahoo and Dash (2010, 2011) defined that investment in infrastructure facilities (roads, telecommunication and energy) has significant effect on productivity and growth than both public and private investment, because areas well equipped with infrastructure facilities are more attractive to investors.

Ghani and Din (2006) indicated that public consumption and public investment had no association with economic growth in Pakistan and output growth was mostly explained by private investment, while Ahmed and Malik (2012) indicated positive and significant role of public expenditures on rural development and irrigation on economic growth but it was still less significant than the other determinants of economic growth as labor and private capital. Iqbal and Nadeem (2006) examined that a long run relation is found among social, real, monetary and infrastructure development in Pakistan. They examined that infrastructure development leads to social development but it had no significant impact on real economic growth and monetary growth.

Kamps (2004) investigated that public capital has positive and significant impact on economic growth but hardly examined any sign of positive impact on employment opportunities, furthermore among most of OECD countries public capital and private capital are observed as complements in the long run, while they may be complements or substitutes in the short run. Jalilian and Weiss (2004) conducted the study to examine the impact of road infrastructure on poverty reduction and economic growth using a sample of developed and developing countries. The study investigated that the human capital development is the prerequisite for the positive relation between infrastructure and economic growth; furthermore the complementary relation between road infrastructure and human capital development is established. Development of road infrastructure alone may "exert an adverse impact on the poor through such channels as factor-market and political economy processes", so for the positive impact on welfare road infrastructure must be coupled with human capital development (Balisacan and Pernia, 2002).

Zhang and Fan (2004) examined that presence of sound physical infrastructure facilities (roads, irrigation, electricity, and telecommunication) in a region bring more opportunities for development and trade than the landlocked economies. Investment in physical infrastructure can be used as a tool for reduction in regional disparity, among all the indicators considered that can promote regional development; education is the best equalizing factor, while Gemmell (2012) revealed for the OECD countries that reallocation of public expenditures on infrastructure and education leads to long run economic growth. Infrastructure development specifically in the field of energy is crucial for economic growth and arrival of more FDI in the country, as it provides more opportunities to the domestic and foreign investors (Friday, 2016). Public expenditures on infrastructure affect the economy through reduction in cost of production, and also influence the relative price level, output level, and degree of specialization and pattern of international trade (Anwar, 2001).

Physical infrastructure (transportation, energy and telecommunication) has positive and significant effect on the long run economic growth in Pakistan and furthermore one percent increase in infrastructure services leads to 0.47 percent increase in the aggregate level of GDP (Jan et al., 2012). Nannan and Jianing (2012) investigated positive and significant impact of public infrastructure investment on economic growth in China; furthermore examined that infrastructure investment increases the level of economic growth in the long run. Telecommunication infrastructure had positive and significant impact on economic development (Waverman et al, 1996; Hashmi, 2009), since growth of transportation and telecommunication infrastructure is prerequisite for regional economic growth (Weiguo Lu, 1996; Faridi et al, 2011), but the improper use of communication services can also become cause of negative impact of telecommunication facilities on economic development (Faridi et al 2011).

Straub and Hagiwara (2011) analyzed the impact of infrastructure on economic growth in 102 developing countries including Pakistan and described the positive impact of infrastructure on economic growth, while Haider et al, (2012) defined infrastructure as per capita health expenditure and electricity generation and confirmed positive and significant impact of infrastructure on economic growth in the short run but fail to find any long run relation between them in case of Pakistan. Infrastructure investment has positive association with economic development and productivity growth, so a substantial accumulation infrastructure stock is required to speed up economic growth rate (Estache and Fay, 2009; Agarwala, 2011; Imran and Niazi, 2012).

Bertrand and Mamatzaki (2001) examined the effects of public infrastructure (transport, sewage, electricity, water and gas) on cost structure and productivity differences between two key consecutive periods, and investigated that infrastructure facilities reduces the cost of production thereby productivity rises in the second period. The relation between infrastructure and non-infrastructure capital is invisible in the first period but complementary in the second period, in the same way infrastructure capital and labor are found to be substitutes in the first period but no relation in the second period. Nedozi (2014) examined the vital role played by telecommunication and transport infrastructure in the economic growth of Nigerian economy and considered infrastructure as an intermediate product for real sector and as finished product for the consumers, so to promote the real sector of the economy infrastructure must be given priority in the investment decisions.

Public infrastructure indicators affect different industries in the different way; precisely public spending in highways, sewerage system and public buildings affect growth of manufacturing industries in the positive way. Pereira and Andraz (2003) investigated that public investment in infrastructure changes the pattern of employment toward construction and transportation, and the configuration of private investment towards manufacturing sector, public utilities, and communications. In contrast to the earlier studies, the impact of infrastructure investment in transportation, communication, electricity generation and gas distribution has negative impact on the manufacturing sector in Pakistan and this is mainly due to political instability and bad economic conditions in the country (Soneta et al, 2012).

Infrastructure development leads to the goal of high and sustainable economic growth (Alexander and Estache, 1999), but still there are also many factors that influence regional infrastructure development such as governance and institutions. Countries with sound institutions, good governance, higher economic growth level and open economies tend to have higher infrastructure level (Prabir De, 2010). National competitiveness is determined by institutional effectiveness and infrastructure development in the region so keeping in view these arguments economic policies must be formulated to bring institutional reforms and more infrastructure investment in the economy (Palei, 2015). Inadequacy of public infrastructure is a big constraint over a nation's ability to sustain high economic growth level, so public-private partnership must be encouraged in the public infrastructure projects (Mishra, 2012).

3.3 Infrastructure Imbalance and Regional Economic Disparity

Generally infrastructure imbalance can become cause of regional economic disparity (Rao, 1977; Elhance and Lakshmanan, 1988; Ghosh and De, 1998, 2004; Sahoo and Saxena, 1999), and this situation is seen mostly in those areas which are heterogeneous in nature and where development policy is devised not keeping in view comprehensive and equal economic growth opportunities. The impact of this unequal distribution of infrastructure services is so pervasive that the operation of law of diminishing returns is negated as indicated by the neoclassical model (Kaldor, 1972). Salvatore (1976) and Biehl (1980) considered the lack of infrastructure in the lagging regions, as one of the main factors, responsible for regional income divergence and economic growth disparities. It is also seen that relation between infrastructure and development vary from country to country, and in this scenario the role of other economic indicators is also needed to be considered.

The study of regional economic disparity was evolved very soon in history, along with study of classification of different categories of infrastructure (Fleming 1955; Hirschman 1958; Myrdal 1958). In this respect the study of Hirschman (1958) is remarkable, while discussing development strategies in "The Strategy of Economic Development", he stressed upon the availability of electric power and transportation, as preconditions for economic development. He emphasized that for elimination of growth imbalances we must start different projects according to the requirements of the sectors, and for this he proposed the strategy of "Big Push" or "Minimum Critical Effort" in the lagging regions.

Another important work in this respect is submitted by Hansen (1965), he classified the regions into three types (a) Congested (b) Intermediate and (c) lagging and public capital into (a) Economic Overhead Capital (EOC) and (b) Social Overhead Capital (SOC). EOC consists on public works projects like roads, bridges, water and sanitation conditions, irrigation system etc., while SOC is designed to enhance human abilities and consists upon health, education and other welfare facilities. The study showed that impact of public expenditures is different on different regions according to their specific requirements, so for balanced growth it is suggested that EOC should be provided in the intermediate regions where more opportunities exist, and the best investment in the lagging regions is that of SOC.

Mera (1973) conducted his study in Japan to see the impact of infrastructure on economic activities and further included the communication system in Hansen's concept of EOC and supported the findings of Hansen study, while the comparative study of developed and developing countries concluded that developed regions were experiencing economic growth due to public infrastructure projects and lagging regions due to technological progress Mera (1975). The results of Hansen study were also proved by Looney and Frederiksen (1981) when they conducted their study to examine the regional growth pattern in Mexico, and confirmed that EOC had significant effect on the growth of intermediate regions and SOC on the growth patterns of lagging regions.

Infrastructure endowment explain regional economic growth differences significantly where major share of public capital stock is bestowed to the industrialized and densely populated areas than that of backward and agricultural regions (Nijkamp, 1981). DeRooy (1978) conducted the study to calculate the multipliers of different types of social overhead capital in the Sunbelt and Snowbelt regions of the USA and found large multipliers only for investment in human capital (Education), public sector employment and size of infrastructure stock, while the values of these multipliers were not much different in both regions. Regional economic disparity can be reduced by the supply side measures as investment in infrastructure and education, since about one third of regional disparity is explained by differences in human capital and public investment, however the definite impact of investment on regional disparity depends upon the volume and allocation of resources according to regional requirements (Fuente et al, 1995). Public investment in education and health facilities play an important role in reduction of regional disparities, specifically the education infrastructure facilities for women in the lagging regions are essential for the development of backward areas and comprehensive growth program (Dadabhavi and Bagalkoti, 1994; Chaudhry, 2008).

Qutub studied the investigated the relation between output per capita and provided infrastructure intensity at district level in Pakistan; the study described that initially the availability of infrastructure facilities in underdeveloped districts remain unable to stimulate growth of per capita output. But after the maintenance of basic infrastructure "at a level of half the national average" per capita output increases at the high speed, yet no significant increase in industrial or agricultural production is witnessed whenever the infrastructure stock crosses the maximum limit "1.7 times the national average". Bagchi and Kurian (2005) estimated the regional disparities in India across the pre-reform and post-reform periods, the results pointed out that investment level and welfare level in the backward regions can be increased by enhancing the competence of the backward states to escalate public spending in social and economic services. The analysis of pre and post reform periods in India described that regional disparities has increased to a greater extent and a positive relation is found between advanced level of infrastructure, per capita income, and capital flows (Dev, 2008), while Kaushiva (2007) estimated that even after various policies in the Indian states the economic growth level, poverty reduction and human development rate is very miserable and even after reforms the percentage share of total foreign direct investment also decreased. Public spending in health infrastructure is responsible for disparity in health facilities among the Indian states, furthermore a direct linkage is also found between per capita health expenditures and economic development (Malhotra and Shweta, 2008). Chotia and Rao (2015) conducted the analysis using the indicators from the sectors of health, education, transport, agriculture, and energy to give a comprehensive view of the overall Infrastructure, the results revealed that infrastructure growth and economic growth move together in the same direction, while states with well-defined infrastructure facilities attract major proportions of private investment. Acharya (2011) investigated that development of infrastructure facilities such as roads, telecommunication, electricity and communication has positive impact on economic growth and negative impact on poverty, furthermore infrastructure facilities should be provided to reduce the regional disparity, poverty and to enhance economic growth level.

3.4. Conclusion

This chapter has provided an overview of the theoretical and empirical literature on infrastructure and economic growth linkage. Generally the preceding literature concludes that development of infrastructure facilities leads to economic growth. However empirical literature is also available which describes either negative or insignificant impact of infrastructure facilities development on economic growth, these conflicting results are seen specifically in the presence of weak institutional structure, corruption and political instability in the countries. The analysis of infrastructure imbalance and regional disparity explains that imbalance in provision of infrastructure facilities leads to regional disparity and slowdown of economic growth. Due to mix results about the relation between infrastructure and economic growth, there is need to further explore the issue. Such exploration may take care of these shortcomings by making aggregated and disaggregated analysis and by employing appropriate econometric method (GMM).

Chapter 4

Data and Methodology

This chapter is divided into three parts; theoretical framework, data and variable description, and econometric model specification and estimation technique.

4.1. Theoretical Framework

In this section we develop an analytical framework for the study that helps us to diagnose the impact of infrastructure development on economic growth in Pakistan. This model is formulated along the lines of Esfahani and Ramirez (2003), however in contrast to their specified model this study uses infrastructure services in cumulative form and do not confine it to some specific sectors. This is a simultaneous equations model which is designed to see the mutual relation between infrastructure indicators and economic growth.

4.2. A model of output and infrastructure growth

Economic growth is generated by the joint efforts of many factors, which enhance economic output and standard of living of the people. For the analysis of the role played by infrastructure in economic growth, the process is started by the evaluation of production function that takes into account all factors into the output level. In our analysis, we will confine our subject to four factors: Labor, L, Infrastructure, I, non-infrastructure capital, K and all those elements that can affect productivity are represented by P. We assume Cobb Douglas production function with constant returns to scale and define labor productivity by P:

$$Y = K^{\alpha} I^{\beta} (PL)^{1-\alpha-\beta} \qquad (4.1)$$

While α and β represents output elasticity with respect to private capital and infrastructure respectively and both of these parameters are positive. We take labor supply, L and P as exogenous variables.

Infrastructure is different from other types of capital and is subject to government intervention and institutional characteristics. An important imperfection in infrastructure is found in the form of economies of scale due to network externalities (World Bank). For estimation of impact of infrastructure, it is preferred to estimate production function in log-level, in first difference or growth form. We transform the model into per capita form as:

$$\log y = \alpha \log k + \beta \log i + (1-\alpha-\beta) \log P \tag{4.2}$$

We compute the growth rate of output as:

$$\theta_y = (1-\alpha-\beta)p + \alpha\theta_k + \beta\theta_i \tag{4.3}$$

Where p is growth rate of P and θ_y, θ_k and θ_i are growth rates of per capita output, per capita capital and per capita infrastructure respectively. Private capital is difficult to be incorporated and it contains elements that may be missing or correlated with infrastructure. In order to deal with this problem of endogeneity and simultaneity, we incorporate infrastructure demand equation in the model that also combines growth of output and infrastructure.

4.3. The Dynamics of the Model

The dynamics of the economy are created due to divergence of economy from steady state level. Esfahani and Ramirez (2003) defined that output is divided between consumption and investment, and a specific fraction of output is devoted to the accumulation of capital and infrastructure. One unit of output reserved for capital and infrastructure produces one new unit of capital, in addition the existing capital also depreciates at rate δ. We assume that depreciation rate is same for both assets.

4.3.1. The dynamics of Capital

We consider capital per unit of labor in our analysis, as k=K/L so by using chain rule

$$k^{\bullet} = K^{\bullet}/L - (K/L)(L^{\bullet}/L) \qquad (4.4)$$

Since $L^{\bullet}/L$ =n and K/L=k, and $K^{\bullet} = s_k Y - \delta K$, so we can write the expression as

$$k^{\bullet} = s_k y - \delta k - nk \qquad (4.5)$$

We can compute the growth rate of per capita capital as

$$\theta_k = s_k y / k - \delta - n \qquad (4.6)$$

This shows that growth rate of capital per capita depends upon allocation of resources to accumulation of capital and is affected negatively by depreciation rate and population growth rate.

4.3.2. The dynamics of Infrastructure

In the same way we calculate growth rate of infrastructure, let consider the per capita infrastructure services, i=I/L and $i^{\bullet} = s_i Y - \delta I$

$$i^{\bullet} = s_i y - \delta i - ni \qquad (4.7)$$

While the growth rate of infrastructure capital per capita:

$$\theta_i = s_i y / i - \delta - n \qquad (4.8)$$

The derivation shows that infrastructure growth is determined by investment in this sector and the rate of growth declines due to depreciation and population growth rate. Households want to increase proportion of output devoted to K and I to maximize their long term expected level of consumption, but there are also many factors that influence these accumulation rates as government policies, market imperfections, institutional elements, preferences and production possibilities in the economy.

4.4. The balanced growth path

The steady state level is the optimal situation where saving rate, the growth rates of y, k and i, and fractions of output devoted to k and i are constant. According to (4.6) and (4.8) k/y and i/y are constant and endogenous variables grow at same rate which must be equal to "p" as indicated by eq. (4.3). We indicate steady state values by *:

$$s_{k*} y^* / k^* = s_{i*} y^* / i^* = p^* + \delta + n \qquad (4.9)$$

We denote long run growth rate of P by p* assumed to be constant over all regions, then steady state *k*/y** and *i*/y** are confirmed by (p*+ δ+ n) and other factors that determine long run investment in capital and infrastructure. Due to economic shocks actual output growth rate may be different from the steady state rate and growth rate of capital and infrastructure may also deviate from p*, due to deviation of k/y and i/y from optimal point . We can define situation as:

$$\theta_j - p^* = s_j y / j - (p^* + \delta + n) \qquad (4.10)$$

Where j=k, i since at steady state level (p*+ δ+ n) $= s_{j^*} y^* / j^*$. So we write as:

$$\theta_j - p^* = (p^* + \delta + n)\left(\frac{s_j y / j}{s_{j^*} y^* / j^*} - 1\right)$$
$$\theta_j - p^* = (p^* + \delta + n)\left(\frac{s_j}{s_{j^*}}\right)\left[X_j + \frac{s_j - s_{j^*}}{s_j}\right] \qquad (4.11)$$

Where $X_j = \frac{i^*/y^*}{i/y}$- 1 is the difference between actual and optimal asset-output ratio. The models like Solow Swan model work with fixed investment rates and assume that $s_j = s_{j^*}$, then the growth rate of assets can be defined as $\theta_j = p^* + (p^* + \delta + n)X_j$, j=k, i, and the convergence rate of the assets towards steady state is *(p*+ δ+ n)* and it explains that how the asset j adjusts in each period due to deviations of *j/y* from the steady state level.

In the short run s_j may deviate from s_{j^*}, then speed of adjustment differs due to joint operation of X_j and $(s_j - s_{j^*})/s_j$. This is presented as the second order effect in the neighborhood of steady state where s_j can be defined approximately equal to s_{j^*}, in the applications of neoclassical growth models. The asset imbalance greatly affects the investment rates in these sectors and special policies are formulated to deal these imbalances. As the first order approximation we can write

$$(s_j - s_{j^*})/s_j = g_j(Z)X_j, \qquad \text{where} \quad \text{j=k, i} \qquad (4.12)$$

Where $g_j(.), j = k, i$ represents a function consisting upon vector of variables, Z, that influence the response of investment rates to asset imbalance. We substitute eq. (4.12) into eq. (4.11), in the neighborhood of steady state:

$$\theta_j = p* + (p* + \delta + n)\left[1 + g_j(Z)\right]X_j, \qquad \text{j=k, i} \qquad (4.13)$$

This defines that when investment rate responds to asset imbalance relative to steady state level, the adjustment rate for the asset j is formulated as $(p* + \delta + n)\left[1 + gj(Z)\right]$, which is specified by country conditions. Since at steady state level $s_{j*}y*/j* = q* + \delta + n$ so we can write the expression for deviation from steady state level as:

$$X_j = \log(j*/y*) - \log(j/y)$$
$$X_j = \log(s_{j*}) - \log(p* + \delta + n) - \log(j/y) \qquad \text{Where j=k, i} \qquad (4.14)$$

The gap for asset j can be explained in form of initial asset-output ratio and factors determining investment rate for the asset. Non infrastructure capital consists on a large number of productive activities, and there is no well-defined method for its estimation, so we include θ_k as defined by eq. (4.13) into eq. (4.3), to formulate growth pattern of per capita output:

$$\theta_y = (1-\beta)p* + (1-\alpha-\beta)(p-p*) + \beta\theta_i + (p* + \delta + n)\left[1 + g_k(Z)\right]\alpha X_k \qquad (4.15)$$

X_k Can be defined by the terms other than k from the production function:

$$\alpha X_k = \alpha\log(s_{k*}) - \alpha\log(p* + \delta + n) - (1-\alpha)\log y + (1-\alpha-\beta)\log P + \beta\log n \qquad (4.16)$$

However this eq. still contains terms as s_{j*} and P that cannot be estimated easily so we have to substitute them with other relevant variables that determine them. The eq. (4.15) describes higher productivity P is combined with higher growth of per capita GDP, and it works through lowering capital-output ratio and by enhancing capital stock, the initial infrastructure stock also has a positive impact on economic growth due to same reasons. A parametric increase in initial per capita income tends to lower economic growth.

We estimate the model on the basis of Eq. (3.16) and Eq. (3.18) with j= i, the former allows us to estimate infrastructure growth equation and this will in turn helps in explaining the growth path of per capita GDP. Thus the model can be specified as:

$$\theta_y = \beta_i\theta_i + (1-\beta_i)q^* + (1-\alpha-\beta_i)(q-q^*) + (q^*+\delta+n)\left[1+g_i(Z)\right]\alpha X_k \quad (4.17)$$

With $\alpha X_k = \beta \log i - (1-\alpha)\log y + (1-\alpha-\beta)\log Q + \alpha \log s_{k*} - \alpha \log(q^*+\delta+n)$ and the equation for infrastructure growth is formulated as:

$$\theta_i = q^* + (q^*+\delta+n)\left[1+g_i(Z)\right]\left[\log(s_{i*}) - \log(i/y) - \log(q^*+\delta+n)\right] \quad (4.18)$$

4.5. The Econometric Model

After the discussion of the theoretical framework of the study, now we focus upon derivation of econometric model to measure the impact of infrastructure on economic growth and vice versa. For the empirical estimation of the model, we divide infrastructure into two categories; social infrastructure and physical infrastructure and our econometric model consists upon three equations; physical infrastructure growth equation, social infrastructure growth equation and economic growth equation. We theorize that the growth rate of physical infrastructure and social infrastructure depends upon population density, tax-GDP ratio, investment-GDP ratio in respective infrastructure sector and per capita GDP growth. The equation of physical infrastructure growth can be written as;

$$PHYINFg_{i,t} = \alpha_1 + \alpha_2 \ln popdens_{i,t} + \alpha_3 taxratio_{i,t} + \alpha_4 invratio_{i,t} + \alpha_5 PGDPg_{i,t} + \varepsilon_{1i,t} \quad (4.19)$$

In the above equation $PHYINFg_{it}$ is physical infrastructure growth, *popden* is population density, *taxratio* is tax to GDP ratio, *invratio* is investment in physical infrastructure to GDP ratio, $PGDPg_{it}$ is per capita GDP growth and ε_1 is the error term. The second equation is of social infrastructure growth and has been evolved on the same lines as physical infrastructure growth equation. Following is the empirical form of social infrastructure growth.

$$SOCINFg_{i,t} = \beta_1 + \beta_2 \ln popden_{i,t} + \beta_3 \ln taxratio_{i,t} + \beta_4 invratio_{i,t} + \beta_5 PGDPg_{i,t} + \varepsilon_{2i,t} \qquad (4.20)$$

The equation about social infrastructure growth is defined as $SOCINFg_{it}$ is social infrastructure growth, *popden* is population density, *taxratio* is tax to GDP ratio, *invratio* is investment in social infrastructure to GDP ratio, while $PGDPg_{it}$ is per capita GDP growth and ε_2 is the error term. The empirical equation to quantify the impact of physical and social infrastructure on economic growth can be written as;

$$PGDPg_{i,t} = \theta_1 + \theta_2 PHYINF_{i,t} + \theta_3 SOCINF_{i,t} + \theta_4 POPg_{i,t} + \theta_5 \ln popden_{i,t} + \theta_6 PGDPg_{i,t-1} + \varepsilon_{3i,t} \qquad (4.21)$$

Where $POPg_{it}$ is population growth rate and $PGDPg_{i,t-1}$ is the growth rate of per capita GDP in the previous year.

4.6. Estimation Methodology

Since our study is concerned with the measurement of the relation between infrastructure and economic growth, and the disparities in infrastructure services and economic growth in the Pakistan, we employ a panel of four provinces of Pakistan over period of 1994-95 to 2014-15. The panel data estimation is an efficient analytical method, since it provides us opportunity to deal with different cross sections and time periods, and efficient estimation results can be calculated by increasing the sample size. Through panel data approach, we can deal with the problems of omitted variables biasness and heterogeneity. The fixed effect and random effect methods are commonly used for exploration of panel data. The fixed model is a linear model technique with the assumption that the constant to be cross-sectional specific. While random effect model do not consider intercept as a fixed value but as a random parameter. The selection between the fixed effect model and random effect model is made on the basis of Hausman test. But we do not use these techniques in our study because it might be affected e.g. omitted variable biasness, which can rise if we do not specify the model correctly and also due to endogeneity problem; when independent variables are not truly exogenous but they correlate with the error term.

There are several studies that have used OLS for estimation of the relation between infrastructure and economic growth. The OLS estimates are best, efficient and unbiased as long as explanatory variables are exogenous with no Multicollinearity, and error terms are independent and homoscedastic. In literature, there always exists a controversy about exact nature and direction of relation between infrastructure and economic growth (Cadot et al, 2002). There are a number of studies that confirmed the two way causation and endogeneity between infrastructure and economic growth (Canning and Pedroni, 1999; Batina (1997); Cullison (1993); Crowder and Himarios (1997); Lau and Sin (1997); McMillin and Smyth (1994); Pereira and Flores (1999); Pereira (2000, 2001a, 2001b).Thus in the presence of endogeneity the OLS estimates become inconsistent and biased. To address the problem of endogeneity, the instrumental variables (IV) methods are used for the consistent empirical estimations.

Generalized Method of Moment (GMM) is considered an efficient econometric technique to tackle the problems of potential endogeneity, two-way causality and missing variable biasness.

GMM is basically an extension of IV method the key benefit of GMM approach is that the conditions of homoscedasticity and serially independence are no more required (Blundell and Bond, 1999). Another advantage is that it finds the parameters estimates by maximizing the objective function which includes the moment restriction that the correlation between the error term and lagged regressors is zero. Moreover, Binder et al. (2005) showed that system GMM does not break down in the presence of a unit root while the standard GMM breaks down when the data is not stationary. Under the GMM estimation technique the objective function is maximized under the moment restriction that the correlation between error term and lagged independent variables is zero. The GMM considers the characteristics of the time-series data, non-observable country specific attributes, presence of lagged dependent variables as explanatory variables in the model and the problem of endogeneity (Caselli et al., 1996; Bond et al., 2001). The GMM estimates are constant and efficient even in the presence of heteroscedasticity (Pereira and Lee 2013).

Anderson and Hsiao (1982) proposed a strategy to solve the problem of endogeneity by using instruments. Anderson and Hsiao (1982) submitted to transform the model into first difference, and then to apply IV technique with lagged difference or level, to address the problem of endogeneity. Anderson and Hsiao (1982) suggested use of simple IV estimation technique with one instrument for each endogenous variable. While a general specification of this is the GMM in which the number of instruments must be greater than the number of endogenous variables. Arellano and Bond (1991) permitted the use of all valid lags of the independent variables as instruments. The estimation results of GMM become more accurate and efficient in the presence of valid moment conditions and instruments.

Therefore, the proposed technique of Arellano and Bond (1991) estimator should be more useful than that of Anderson and Hsiao (1982), but its usefulness decreases when the panel consists upon shorter time period. To tackle this issue, Arellano and Bover (1995) and Blundell and Bond (1998), assuming stationarity explained additional zero-moment conditions that can be used in a model with levels and lagged differences as instruments. System-GMM is an estimation technique that consists upon moment conditions proposed by Arellano and Bond (1991) along with some additional restrictions, in which GMM is applied to a system of two equations: an equation in difference form with lagged level instruments and the other equation in level form with lagged difference values as instruments. Arellano and Bover (1995) and Blundell and Bond (1998) reformed the difference GMM estimation technique by adding the original level equation to the system with their own lagged first differences as instruments.

Furthermore, the accuracy of GMM estimates is determined by the validity of instruments. A valid instrument must have strong correlation with the endogenous variable and zero correlation with the error term. The higher the number of valid instruments, the higher the accuracy of GMM estimates. Sargan (1958, 1975, and 1988) proposed a test, known as Sargan J-statistics, to test the overall validity of the instruments. In order to address the issues of endogeneity and reverse causality, we use system-GMM as the estimation technique, since System-GMM is the most efficient technique to solve these problems along with autocorrelation non stationary process of the data. It is also stated that 2SLS technique cannot be applied in this case, since 2SLS is used for estimation of simultaneous equations however to deal with the problems of endogeneity and autocorrelation 2SLS is not as effective as system GMM.

4.7. Construction of Infrastructure Development Indices

We have formulated physical infrastructure development index (PIDI) and social infrastructure development index (SIDI). The basic advantage of derivation of an index is that it consists upon key indicators and an aggregate representation is formed from various indicators. For composition of index, we assign specific weight to all indicators under each category; the main issue with conventional method of indexation is that it assigns ad hoc and fixed weights to all indicators that may differ over time and space. To tackle this limitation, we have employed Principal Component Analysis (PCA) for development of infrastructure indices. PCA allocates weight according to the variance of the variable. In PCA one factor or component consists upon variables that are strongly correlated with one another. In this technique the maximum amount of variation in the data is explained by the first component and last factor explains very small portion of variation in the data, due to this fact it is preferred to use first component information for the further analysis. Each indicator is normalized first by using the following formula;

$$Indicator = \frac{\text{Actual Value} - \text{Minimum Value}}{\text{Maximum Value} - \text{Minimum Value}}$$

For formulation of the index the "unit-free" values of infrastructure indicators are multiplied by assigned weights from "factor loading". Thus, infrastructure index is a linear combination of unit free values of the individual facilities such that

$$InfrastructureIndex_{ij} = \Sigma W_{k\,j} Y_{kij}$$

Where $Index_{ij}$ = infrastructure development index of the i-th province in j-th time, W_{kj} = weight of the k-th facility in j-th time, and Y_{kij} = unit free value of the k-th facility for the i-th province in j-th time point.

4.8. Physical Infrastructure Development Index

In this study, we have formulated an index for the description of state of physical infrastructure in the provinces of Pakistan. We have constructed Physical infrastructure using three indicators; electricity consumption, gross irrigation facility (Gross irrigated area refers to irrigated area as % of total cultivated area) and availability of roads (KM). Ghosh and De (2004) have used these variables to formulate the physical infrastructure index with an additional indicator that is telephone mainline. We have not used telephone mainline facility in case of Pakistan since the data is not available for all provinces for the required time period.

4.9. Social Infrastructure Development Index

We have estimated social infrastructure index using two variables to represent education and health facilities; literacy rate and immunization rate (Children aged 12-23 months). Ghosh and De (2004) had included residential houses facility for formation of social infrastructure index. Khandker and Koolwal (2010) had used police stations (Thana) in explanation of the determinants of social infrastructure along with health and education facilities.

4.10. Definition of Variables

Definitions of the variables that are used in the study:

Table 4.1: Definition of the variables

Variable	*Definition*
. GDP per capita	GDP per capita is gross domestic product divided by population. GDP is defined as the sum of all goods and services produced in a country within a year. Generally economic growth of a country is calculated by the growth rate of GDP per capita. We have used Gross Value Added at constant factor cost 1999-00 as a proxy for provincial GDP.
Population growth	Population growth rate is defined as the increase in a country's population during a specific period of time. It is calculated as a percentage of the population at the start of the period, usually one year. It describes the birth rate and the death rate, and the number of people migrating to and from the country.
Tax –GDP ratio	The tax to GDP ratio is the ratio of collected taxes to GDP. It tells about the financial capability of the countries and most of the countries want to increase it to control their budget deficit and to finance their development projects
Population density	Population density is the number of people living per unit of area, usually per square km or per square mile.
Investment-GDP ratio	It is defined as the share of GDP allocated to investment in physical and social infrastructure. Investment is essential for development process, and this investment-GDP ratio describes that how much resources are devoted for growth of social infrastructure and physical infrastructure.

Table.4.2. Summary of the variables that are used to formulate infrastructure indices

Physical Infrastructure:	• Transport Facility • Gross Irrigated Area • Consumption of Electricity	• Transport facility consists upon total road length (high type and low type) in KM. • Gross irrigated area refers to irrigated area as % of total cultivated area while cultivated area is defined as the area that is sown at least during a year or the preceding year. Irrigated facility means availability of water for farming from canals (public and private), tube wells, tanks etc. • Consumption of electricity means the total consumption of electricity by a province in million kilowatt hour (MKVH).
Soft Infrastructure	• Literacy rate • Immunization rate	• Literacy rate is defined as the % of people (10 years and above) that can read and write with understanding of a simple sentence out of total population. • By the immunization rate we mean the percentage of all children aged 12-23 months that have been fully immunized, and fully immunization means the children that have got BCG, DPT, POLIO and Measles vaccination.

4.11. Sample Selection

Since, we want to diagnose the relation between infrastructure and economic growth and the regional disparities in the availability of infrastructure facilities and per capita income in Pakistan, so we have formulated a sample consisting upon four provinces of Pakistan. The sample period is taken from 1994-95 to 2014-15; the basic reason for using this time period is availability of data.

4.12. Data

The data used in this study are physical infrastructure index, social infrastructure index, population density, population growth, per capita GDP growth, tax-GDP ratio, investment in infrastructure-GDP ratio, while the physical infrastructure index is further composed by consumption of electricity, irrigation facility and road length, and social infrastructure index is generated by literacy rate and percentage of children immunized. Gross Value Added at constant factor cost 1999-00 is used as a proxy for provincial GDP. The provincial GDP data for the period 1994-95 to 1998-99 is taken from Bengali and Sadaqat (2005) while data for the remaining time period is extracted from World Bank Report (2013), although the data base of both studies is different yet through splicing the data is converted into same base. The data of population, irrigation facility and road length is taken from Development Statistics of Punjab, Sindh, KPK and Balochistan. The data about literacy rate, tax rate and investment in infrastructure facilities is taken from Economic Survey of Pakistan and annual budget statement of the respective provinces. Consumption of electricity data is derived from Pakistan Energy Yearbook and that of immunization rate from PSLM.

Chapter 5

Empirical Results, Interpretation and Discussion

After transformation of the model in suitable format and explanation of empirical methodology in the previous chapter, we now estimate the empirical relation between infrastructure and economic growth using System-GMM. We divide infrastructure in two categories: Physical Infrastructure and Social Infrastructure and then their individual impact is examined on economic growth. This chapter consists upon four sections. Section 5.1 of the chapter describes the descriptive statistics while section 5.2 deals with significance of the model. In the section 5.3 physical infrastructure growth equation is empirically estimated while section 5.4, deals with the social infrastructure demand relation. In the section 5.5, we evaluate the growth effects of physical and social infrastructure on economic growth while the section 5.6, deals with the analysis of regional disparity in infrastructure facilities and per capita GDP. Section 5.7, deals with infrastructure development indices, furthermore the analysis of regional disparity in infrastructure facilities and per capita income is done in sections 5.8 and 5.9, respectively.

5.1. Descriptive Statistics

In this section, the the descriptive statistics are presented that gives the information about the two measures of central tendency i.e. mean and median, the maximum and minimum values of the variables and the standard deviation to represent the dispersion of data. The results of the descriptive statistics are presented in table 5.1 in appendix A.1.

5.2. Overall Significance of the Model

The results of System-GMM applied on the model given by equations 3.10, eq. 3.30 and eq. 3.32 are given in tables 5.1, 5.2 and 5.3. We will use J-static as primary statistic for diagnosis of overall significance of the model while J-statistic follows Chi-square distribution. The J-stat in this case is 0.272 and when multiplied with 84 (number of observation for 4 provinces) which is 22.85 which is clearly below the tabulated value (26.757) of chi square for 11 degrees of freedom (number of instruments minus the total number of variables used in the whole system). Since the calculated value of chi-square is less than the tabulated value so we fail to reject null hypothesis regarding the validity of instruments. Here the value of J-statistic proves that the instruments used for estimation are valid and they are not correlated with the error term. We have used three years lag values of the explanatory variables as instruments in this analysis.

5.3 Physical Infrastructure Growth Equation

Table 5.1 presents the empirical estimation of physical infrastructure growth equation; all the explanatory variables have the expected signs and are statistically significant. In the physical growth equation, population density has a positive and significant coefficient. The estimated coefficient is 0.13 and it shows that 1 percent increase in population density leads to 0.13 percent increase in availability of physical infrastructure services in the region. The population density is important indicator for estimation of economies of scale of infrastructure networks that shows as population density increases the returns to investment in infrastructure also increases (Esfahani and Ramirez, 2003). Keeping all other indicators constant, high population density leads to low per capita cost of construction for a common facility for instance roads, and if benefits for all persons are same at variant population densities and per capita cost is low due to high population density then population density leads to high benefit/cost ratio (Glover and Simon, 1975).

The coefficient of investment in physical infrastructure-GDP ratio is positive and statistically significant, since the investment in physical infrastructure is also considered a form of “complementary capital”, that is essential for the private capital formulation (Reinkka and

Svensson, 1999). The trend of returns from investment in physical infrastructure is positive in Pakistan with estimated coefficient 0.164 while in case of other countries we see that this impact is greater than one (Esfahani and Ramirez, 2003). Here we see that the returns to public investment are minor in Pakistan and due to this the physical infrastructure facilities do not grow at the rapid speed. This result is in line with Pasha (2011) and Planning Commission (2010) that described that in Pakistan due to inefficient use of resources, corruption in public investment projects and poor administration the returns to public investment are very poor, so at one hand we are facing problem of less public investment while on the other hand due to above mentioned weaknesses our physical infrastructure remains unable to cope with the needs of the people.

We have used GDP to tax ratio to show the financial compatibility of the regions and a tool for financing of infrastructure investment. In case of physical infrastructure the impact of tax ratio-GDP ratio is positive and significant this implies that higher the tax to GDP ratio; the higher the rate of investment in physical infrastructure which ultimately leads to significant growth of physical infrastructure facilities. Moreover in case of Pakistan, financing of public infrastructure by taxes has negative effect on economic growth in the short run, but in the long run the financing of public infrastructure projects by taxes has positive impact on economic growth (Ahmed V et al, 2013).

The physical infrastructure growth also depends on per capita GDP growth, the estimated coefficient is positive and highly significant which shows that 1 unit change in per capita GDP growth leads to 0.21 unit change in physical infrastructure facilities. This result also confirms two-way causality between physical infrastructure and economic growth that economic growth itself becomes a cause of increase in physical infrastructure facilities. The simultaneous relation between infrastructure and economic growth is also examined in literature by (Deno and Eberts, 1991: Canning and Pedroni, 1999; Batina, 1997; Cullison, 1993; Crowder and Himarios, 1997; Lau and Sin, 1997; McMillin and Smyth, 1994; Pereira and Flores, 1999; Pereira,(2000, 2001a, 2001b; Iqbal and Nadeem, 2006).

Table 5.1: Effects of Public Investment, Tax-GDP ratio etc. on Physical Infrastructure Growth: Dependent Variable is Physical Infrastructure Growth

Variables	**GMM**
Log of Population Density	0.129
	(0.0330)***
Investment in physical Infrastructure-GDP ratio	0.163 (0.0161)***
Per capita GDP Growth	0.206
	(0.0113)***
Tax-to-GDP ratio	0.102
	(0.0146)***
Constant	-0.831
	(0.01046)***

Note: Standard Errors in parenthesis. *, **, *** correspond to significance at 10%, 5% and 1 % respectively.

5.4 Social Infrastructure Growth Equation

The results of the social infrastructure growth equation are presented in table 5.2 where all the explanatory variables have same impact on social infrastructure growth as indicated by literature. The coefficient of population density is positive and significant that shows that population density plays very important role in the growth of social infrastructure facilities or in other words we can say that social infrastructure grows at high rate in the densely populated areas and sparely populated areas have less facilities of social infrastructure. This result is quite in accordance with the availability of social infrastructure facilities across the provinces in Pakistan, as we see that Punjab is most densely populated province and at the same time social infrastructure indicators perform very well there, while Balochistan is least densely populated region with deplorable situation of health and education sectors. Stambler (2016) found a strong correlation between infrastructure density for different infrastructure indicators such as roads, health facilities, power transmission etc. and population density. In case of Pakistan we examine that the impact of population density is higher for the availability of social infrastructure services as compared to physical infrastructure services.

The coefficient of investment in social infrastructure-GDP ratio is positive but insignificant this depicts that the public investment in social infrastructure has insignificant impact on the growth of social services in Pakistan. Since the ratio of investment in social infrastructure is higher than that of physical infrastructure in Pakistan, but due to inefficient management, ineffective implementation of public policies, corruption and security concerns the rate of return of public investment in social infrastructure is insignificant. So there is utmost need to bring improvement in health, education and social protection sectoral governance, strengthening the management structures, allocation of more financial resources and effective utilization of these resources with proper policy implementation procedure.

The impact of GDP-tax ratio on social infrastructure growth is positive and significant, the coefficient value describes that one unit change in tax-GDP ratio will result in enhancement of social infrastructure facilities at the rate of 0.07 unit change. Taxes are an important tool of financing of public infrastructure projects but in case of social infrastructure the impact of tax revenue on social infrastructure growth is minor specifically due to fewer rates of returns from investment in social infrastructure services.

The impact of economic growth on social infrastructure growth is positive and significant the estimated coefficient is 0.11 which shows that one unit change in economic growth leads to 0.11 unit change in growth of social infrastructure services in Pakistan. This result is in line with findings of Iqbal and Nadeem (2006) that economic development leads to social development in Pakistan.

Table 5.2: Effects of Public Investment, Tax-GDP ratio etc. on Social Infrastructure Growth: Dependent Variable is Social Infrastructure Growth

Variables	**GMM**
Log of Population Density	0.598
	(0.0644)***
Investment in Social Infrastructure-	0.004
GDP ratio	(0.0082)
Per capita GDP Growth	0.114
	(0.0127)***
Tax-to-GDP ratio	0.0703
	(0.0325)**
Constant	-1.721
	(0.1539)***

Note: standard error in parenthesis *, **, *** correspond to significance at 10%, 5% and 1% respectively.

5.5 Economic Growth Equation

In the economic growth equation we investigate the impact of physical and social infrastructure along with other variables on per capita GDP growth. The estimated coefficient of physical infrastructure shows positive and significant impact of physical infrastructure growth on economic growth. The estimated coefficient value is 0.89 which shows that one unit change in physical infrastructure leads to 0.89 unit change in economic growth. This result is in line with the findings of Zhang and Fan (2004), Ghosh and De (2004) and Jan et al, (2012). Their empirical investigations also suggested that physical infrastructure has positive and significant contributions in the accomplishment of goal of economic growth.

As for as, the impact of social infrastructure growth is concerned, it has the sign according to theory and is also highly significant. This clearly reveals that social infrastructure has positive impact on economic growth in Pakistan while the positive contributions of social infrastructure in economic growth are also diagnosed by Ghosh and De (2004), Sahoo et al (2012), Nadeem et al (2011) and Majumdar (2012). In case of Pakistan we examine that the impact of social infrastructure on economic growth is less as compared to the impact of physical infrastructure on economic growth. One possibility of this contradiction is that social infrastructure investment itself is less productive as well as the rate of improvement in the social infrastructure indicators is also very slow as indicated in chapter 2, so this might be one of the possible reasons due to which social infrastructure does not contribute effectively in the economic growth process.

The impact of population growth on economic growth is controversial; some studies are in favor of positive impact of population growth on economic growth while some witnessed their negative relation. In this study, we find positive and significant impact of population growth which describes that population growth stimulates economic growth in Pakistan. Various empirical studies also provide evidence that population growth promotes economic growth such as Thuku et al (2013) and Ali et al. (2013). The impact of population density on economic growth is positive and highly significant. The estimated coefficient of population density is greater than one and shows large impact of population density on economic growth, since we examine that in developing countries like Pakistan population density leads to economic growth through the channels of technological advancement, communication facilities, innovation and economies of scale (Owusu, 2012; Simon and Gobin, 1980).

Table 5.3: Effects of Physical and Social Infrastructure Growth on Economic Growth: Dependent Variable is Per Capita GDP Growth

Variables	GMM
Physical Infrastructure Growth	0.892
	(0.0633)***
Social Infrastructure Growth	0.345
	(0.0461)***
Population Growth	0.450
	(0.0403)***
Log of Population Density	1.223
	(0.1064)***
Per Capita GDP Growth (t-1)	0.1552
	(0.0257)***
Constant	-2.626
	(0.3127)***

Note: Standard Errors in parenthesis. *, **, *** correspond to significance at 10%, 5% and 1 % respectively

5.6. Regional Disparity in Infrastructure and Income

We have divided infrastructure into two broad categories of physical infrastructure and social infrastructure. We have formulated physical infrastructure development index (PIDI) from the indicators of total road length (KM), gross irrigated area (irrigated area as a percentage of total cultivated area) and consumption of electricity (MKVH), while social infrastructure development index (SIDI) is formulated from the indicators of literacy rate and percentage of children that have been fully immunized (aged 12-23 months).

There is found a great degree of association among the indicators of infrastructure and each one of them leads to the propagation of other, such as the advanced transport facilities lead to faster mobility of labor and capital inputs and thus reduces cost of production. In a country like Pakistan where literacy rate is 58 per cent and most of the areas have no basic education facilities, so provinces with better transportation facilities may lead to higher literacy rate. On the other hand better transportation facilities and higher literacy rate may result in lower infant mortality rate and higher immunization rate of the children. The individual infrastructure indicators are selected in such a way that each factor plays a very important role in the economic development process.

5.7. Infrastructure Development Indices

Infrastructure services are calculated in the form of composite indices over an average period of five years namely physical infrastructure development index (PIDI) and social infrastructure development index (SIDI), and then infrastructure development index (IDI) is formulated consisting on both physical and social infrastructure indicators. We have derived each index by the Principal Component Analysis (PCA) by assigning specific weight to each indicator. The weighing mechanism is formulated to explain the maximum variance for all infrastructure indicators taken together across the provinces at a point in time. The unit free values of the infrastructure indicators are multiplied by the weights derived from PCA and finally an index is derived after adding all these values corresponding to each category.

We are going to analyze the situation in three different formats first we analyze the physical infrastructure of the provinces succeeded by social infrastructure description and then in the last we analyze the overall infrastructure situation of the provinces consisting on both physical and social infrastructure while infrastructure services are analyzed over an average period of five years. The weights of the infrastructure indicators are given in appendix A.2 along with the percentage of total variance explained corresponding to three categories of infrastructure over four different average time periods. The weights of physical infrastructure indicators indicate that gross irrigated area comes as most powerful infrastructure factor in all time periods except in 1995-2000 for explanation of cross provincial variance in physical infrastructure facilities followed by road length. After 2000 all indicators of physical infrastructure played almost proportionately same role in explanation of variance across provinces. In the weight analysis of social infrastructure we see that immunization rate got to produce negative weight in 1995-2000 and interestingly the weights of all social infrastructure indicators are same in remaining three time periods and they explained the highest variance across provinces except in 1995-2000.

5.8. Imbalance in Infrastructure: Space and Time

In this section we have formulated infrastructure development indices and then the provinces are ranked according to these indices to represent the relevant position of the provinces with respect to basic infrastructure facilities. A comprehensive scrutiny of individual rankings of the provinces bears a very interesting analysis towards regional imbalance in basic infrastructure services; in this regard we also have to keep in mind the geographical realities of Pakistan. Pakistan in consisting upon four provinces and each one of them belongs to different geographical belt and economic growth pattern, since Punjab is the most developed province with respect to infrastructure facilities, KPK and Sindh can be considered as intermediate regions and Balochistan as lagging region with respect to economic development and infrastructure facilities.

When we analyze the data over the period of five years, we examine that Punjab has consolidated its position in physical infrastructure services in all time periods, while most amazing changes occur in case of other provinces as Sindh that had attained position of second developed province with respect to physical infrastructure in 1995-2000 declined to the fourth position in remaining three periods, and this sharp decline in position of Sindh is due to depreciation of transport facilities in Sindh in 2001-02, while KPK has improved and performed moderately in physical infrastructure by moving from fourth position in 1995-00 to third position in remaining three periods. Physical infrastructure has provided very strange scenario in case of Balochistan, since Balochistan is the most underdeveloped region of Pakistan but it has attained second position in physical infrastructure services in the periods except 1995-2000. Here we see that the strange situation occurs in case of Balochistan because it is the largest province of Pakistan with respect to area and due to this reason the total road length (KM) in this province is better than that of KPK and Sindh, we have also examined that transport facility attains the highest weight in PCA after irrigation facility and due to the dominant role of transport facilities in the physical infrastructure indicators, it has influenced the rankings of the provinces with respect to physical infrastructure.

Table 5.4: Physical Infrastructure Development Index (PIDI)

Provinces	1995-00		2000-05		2005-10		2010-15	
	PIDI	Rank	PIDI	Rank	PIDI	Rank	PIDI	Rank
Punjab	2.75	1	2.86	1	2.89	1	2.91	1
Sindh	-0.56	2	- 1.16	4	-1.13	4	-1.02	4
KPK	-1.20	4	-1.01	3	-1.11	3	-1.00	3
Balochistan	-0.99	3	-0.69	2	-0.66	2	-0.87	2

The description of social infrastructure development index (SIDI) is going to depict more real picture across the provinces. Punjab has outperformed in all four time periods due to the sound situation of education facilities and health improvement indicators. Although literacy rate in Sindh is better than the national level, yet due to poor health facilities its ranking with respect to social infrastructure facilities has deteriorated from top in 1995-00 to the miserable third position in remaining three time periods, while KPK has improved in both indicators of social infrastructure by acquiring second position after Punjab in all time periods except 1995-00. The situation of Balochistan depicted the more deplorable situation over the whole period as it remained the most backward province with respect to social infrastructure facilities, it is also indicated from the analysis of chapter 2 that the health sector and education system perform very poor in Balochistan with very minor improvement rate.

Table 5.5: Social Infrastructure Development Index (SIDI)

Provinces	1995-00		2000-05		2005-10		2010-15	
	SIDI	Rank	SIDI	Rank	SIDI	Rank	SIDI	Rank
Punjab	-0.133	2	1.586	1	1.839	1	1.807	1
Sindh	1.652	1	0.056	3	0 .095	3	-0.102	3
KPK	-0.412	3	0.572	2	0.169	2	0.388	2
Balochistan	-1.107	4	-2.215	4	-2.103	4	-2.093	4

Let we move towards more comprehensive picture of infrastructure facilities in Pakistan by combining indicators of physical and social infrastructure in composite development index by referring it Infrastructure Development Index (IDI), while IDI represents more realistic description of infrastructure facilities across the provinces. Punjab has achieved higher level of infrastructure services in all four periods since it is also indicated from the earlier analysis that Punjab has substantially consolidated its position in both physical and social infrastructure. The most dramatic change has occurred in case of Sindh that has attained the position of second most developed province in 1995-00 has declined to third position in all remaining time periods. The availability of infrastructure services has improved very much in KPK in all periods showing sound situation of physical infrastructure and social infrastructure except in 1995-2000. On the other hand the availability of infrastructure facilities has depicted miserable condition of Balochistan in all time periods. It is depicted from the description of these three indices for all four periods that Punjab is the most stable province and KPK has improved with significant speed in each category of infrastructure facility while Sindh has showed tendency of decline in each infrastructure facility. Balochistan is the largest province with respect to area and it has been connected with rest of the country with an effective transport system and this has helped him to attain good position in physical infrastructure but in case of social infrastructure and overall infrastructure facilities the situation of Balochistan is very miserable. The overall description of infrastructure facilities depicted deep sense of regional disparity among the provinces with no sign of convergence. It is also examined that the relative positions of provinces remained unchanged in terms of both physical infrastructure and social infrastructure facilities, representing an alarming high degree of inequality in infrastructure facilities and regional disparity in the country during the last two decades.

. Table 5.6: Infrastructure Development Index (IDI)

Provinces	1995-00		2000-05		2005-10		2010-15	
	IDI	Rank	IDI	Rank	IDI	Rank	IDI	Rank
Punjab	2.938	1	3.239	1	3.418	1	3.394	1
Sindh	-0.712	2	-0.852	3	-0.806	3	-0.855	3
KPK	-1.502	4	-0.458	2	-0.777	2	-0.541	2
Balochistan	-0.725	3	-1.929	4	-1.834	4	-1.988	4

5.9. Regional Disparity in Per Capita Income

To examine the nature and trend of interstate disparity in per capita income, we have carried out the test of Coefficient of Variation, which is a cardinal test for measurement of dispersion of per capita income at a point in time among different cross-sections of economies. According to standard definition of convergence, “a group of economies are converging in the sense of σ if the dispersion of their real per capita GDP levels tends to decrease over time (Barro and Sala-i-Martin, 1995)."Let examine the relative positions of the provinces in the terms of per capita income or sigma-convergence. The values of CV from 1994-95 to 2014-15 are presented in table 5. The value of CV shows that regional disparity is increasing in terms of per capita income at a fast speed during this period although there are ups and downs but the trend shows consistent increase in regional disparity.

According to standard literature of convergence, although there exist differences in institutions, technology and preferences among regions within a country but these differences are found to be smaller than that of across countries and this applies that in presence of a common central government and constitutional structure the goal of absolute convergence can be achieved more readily across regions within a country than across countries. According to Barro and Sala-i-Martin (1995) among the 48 states of the USA dispersion of per capita income decreased from 0.24 in 1950 to 0.21 in 1960 and 0.19 in 1988. In the same way among 47 Japanese prefectures disparity decreased from 0.29 in 1950 to 0.14 in 1988. But in case of dispersion of per capita income for provinces in Pakistan a very gloomy picture has been derived, we observe that disperse of per capita income for provinces in Pakistan has increased from 0.213 in 1994-95 to 0.270 and 0.300 in 2014-15 through 0.287 in 2010-11 and this depicts a high level of disparity among provinces of a country according to any standard definition of convergence.

Thus the cardinal measure of income disparity bears sufficient testimony to the fact that in terms of levels of per capita income the provincial economies are diverging during the last two decades. On the other hand we see that provinces in Pakistan are also representing regional disparity with respect to infrastructure facilities, so it can be concluded from this analysis that the relative positions of the provinces have remained unchanged in terms of any definition of development showing deep sense of regional disparity with respect to infrastructure facilities and income inequality.

Table 5.7: Non-Parametric Test on Provincial Disparity

Years	Coefficient of Variation in Provincial Per Capita Income
1994-95	0.213
1995-96	0.205
1996-97	0.226
1997-98	0.227
1998-99	0.225
1999-00	0.238
2000-01	0.243
2001-02	0.230
2002-03	0.256
2003-04	0.270
2004-05	0.298
2005-06	0.276
2006-07	0.254
2007-08	0.264
2008-09	0.262
2009-10	0.276
2010-11	0.287
2011-12	0.306
2012-13	0.305
2013-14	0.304
2014-15	0.300

Chapter 6

Conclusion and Policy Recommendations

6.1. Summary and Conclusion

The main objective of this study was to estimate the relation between infrastructure and economic growth in Pakistan, furthermore to examine the regional disparity in infrastructure facilities and per capita income in the country. For this purpose, we have employed panel of four provinces of Pakistan, infrastructure facilities are divided in two components; physical and social infrastructure. Principal Component Analysis (PCA) is used to construct Physical and Soft Infrastructure Development Indices, while Generalized Method of Moment (GMM) is used for the empirical estimation of the study. In this study apart from infrastructure indicators and per capita GDP growth analysis, the impact of public investment in infrastructure facilities to GDP ratio, tax to GDP ratio and population density is also examined while discussing infrastructure demand equations. The empirical results show that a simultaneous relation is found between infrastructure and economic growth; furthermore both physical infrastructure and social infrastructure have positive and significant impact on economic growth. The social infrastructure investment is less efficient in case of Pakistan; as a result of this the impact of public investment on social infrastructure growth is very small and insignificant which ultimately leads to small proportion of economic growth that is explained by social infrastructure growth as compared to physical infrastructure. The analysis of regional disparity shows that regional disparity in increasing in both infrastructure facilities and per capita income. The regional disparity analysis shows that during the last three decades the rankings of the provinces with respect to infrastructure services remained same showing no improvement or spread of infrastructure facilities among the provinces, so a deep sense of regional disparity is found among the provinces with respect to provision of infrastructure facilities, in the same way the Coefficient of Variation described increasing rate of disparity or divergence among the provinces with respect to per capita GDP.

6.2. Policy Recommendations

Comprehensive growth policy should be devised to achieve sustainable economic growth through increased investment in physical and social infrastructure. Physical infrastructure in Pakistan is in satisfactory condition but the performance of health and education indicators in Pakistan is very alarming; so there is dire need to bring structural reforms in the social infrastructure sector for the proper enforcement of social development policies and effective utilization of resources. The extensive emphasis on the increase in productive social infrastructure investment will enhance the productivity of labor and innovation in the economy. In order to address regional disparity, the infrastructure development projects must be established in the lagging regions as Balochistan; we have seen through the descriptive statistics and rank analysis that Balochistan is lagging behind other provinces in both social and physical infrastructure services, while the status of Sindh is worsening so it is bitterly required that infrastructure development policy must be devised keeping in view the needs of the provinces along with equity in provision of infrastructure facilities. Since taxes are an important tool to finance the infrastructure development projects so we must increase the provincial tax revenues, to make the provinces financially independent and to provide more resources for the public investment projects.

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Appendix

Appendix A.1

Table 5.1: Descriptive Statistics

Variables/Statistics	Mean	Median	Maximum	Minimum	Std. Dev.
Literacy Rate	48.34	50.69	62.98	26.79	9.907
Ln Population Density	2.213	2.45	2.697	1.23	0.507
Per capita GDP Growth	1.493	1.429	8.234	-4.50	2.508
Population Growth	2.805	2.800	7.009	-2.55	1.657
Phy inv-GDP ratio	1.111	0.686	5.101	0.219	1.109
Soc inv-GDP ratio	3.191	2.174	17.86	0.370	3.186
Tax-GDP ratio	0.586	0.392	2.938	0.150	0.549
PIDI Growth	0.0008	-0.013	7.950	-5.605	1.312
SIDI Growth	-0.589	-0.069	4.946	-37.138	4.221

Where Phy inv-GDP ratio stands for physical infrastructure expenditure –GDP ratio, and Soc inv-GDP ratio stands for social infrastructure expenditure to GDP ratio, PIDI Growth stands for physical infrastructure development index growth rate and SIDI Growth stands for social infrastructure development index growth rate.

Appendix A.2

Table 5.2: Weights of Infrastructure Variables: PCA

Infrastructure Variables	1995-00	2000-05	2005-10	2010-15
Physical Infrastructure				
Road Length	0.596	0.579	0.584	0.574
Consumption of Electricity	0.597	0.565	0.562	0.572
Gross Irrigated Area	0.567	0.587	0.584	0.586
Eigen Value	2.088	2.750	2.827	2.789
Variance Explained (per cent)	70	92	94	93
Social Infrastructure				
Net Enrolment Rate	0.707	0.707	0.707	0.707
Immunization Rate	-0.707	0.707	0.707	0.707
Eigen Value	1.036	1.938	1.961	1.952
Variance Explained (per cent)	52	97	98	98
Combined Infrastructure (Physical and Social)				
Road Length	0.54	0.411	0.429	0.409
Consumption of Electricity	0.53	0.503	0.490	0.479
Gross Irrigated Area	0.34	0.464	0.449	0.471
Net Enrolment Rate	0.38	0.456	0.458	0.469
Immunization Rate	0.40	0.394	0.404	0.403
Eigen Value	2.983	3.787	4.073	4.133
Variance Explained (per cent)	60	85	82	83