European Online Journal of Natural and Social Sciences 2018; www.european-science.com
Vol. 7, No.3(s) Special Issue on Contemporary Research in Social Sciences
ISSN 1805-3602

Impact of Human Capital and Infrastructure Development on Economic Growth in Pakistan

Salma Munir[1], Ijaz Elahi[2], Irfan Hussain Khan[3]*
[1]The Islamia University of Bahawalpur, Bahawalpur, Pakistan; [2]International Islamic University, Multan; [3]Government College University Faisalabad
*Email: irfansial007@hotmail.com

Abstract

The core purpose of the analysis is to explore the influence of human capital and infrastructure on Pakistan's economic growth. The study is based on time series data covering the period from 1972 to 2013. The study has applied Johansen Cointegration technique to estimate the long run and short run relationship among variables. Results indicate that human capital and infrastructure development have positive and significant impact on economic growth. Further, Principal Component Analysis (PCA) is applied to construct infrastructure index to observe its impact on economic growth.

Keywords: Infrastructure, human capital, economic growth, Johenson Cointegration and Principal Component Analysis (PCA)

Introduction

The term human capital was firstly used in 1960's and 70's, when Mincer (1958), Goode (1959), Schultz (1961) and Becker (1975) gave the different point of view regarding the concept and formation of human capital. However, human capital accumulation got importance by the emergence of endogenous growth theory given by Lucas (1988) and Romer (1989, 1990). Mankiw*et al.* (1992) firstly used human capital in production function. It is expected that higher level of human capital leads to higher rate of economic growth. There are many ingredient of human capital *i.e.* education, health, on job trainings, skills, aptitudes and migration to better job, but education serves as the most important ingredients of human capital (Goode, 1959; Schultz, 1961; Khilji 2005). Human capital refers to the productive qualities that activate the labor force. The productive qualities are education, health and skills of the labor force. According to Michael Parkin, Human capital refers to the skill and knowledge of human beings. Human capital is the qualities of education, skills, training specialization etc. in population.

The link between investing in human capital and economic growth matters for an additional reason. A large part of the world's population continues to live in poverty, and the focus of economic researchers and policy-makers has increasingly shifted toward designing policies that benefit the poor. There is widespread agreement that economic growth is necessary to help reduce poverty, but that growth by itself is not sufficient. Pakistan is a good example of this, as despite the relatively high growth rates, its social development is weak and poverty remains widespread, with about an estimated 30 percent of the population living in poverty. Investment inhuman capital, by creating a more productive work force, will lead to higher future growth and incomes. Higher social spending on education and health care canal so benefit the poor directly by improving their current living conditions, as well as their future prospects. An important distinction between physical infrastructure and human capital investments is that the return on human capital investment are long term and continuous while return on infrastructure investments are observed in short time period.

Government of Pakistan has focused on human capital formation but still need to pay more attention to this sector. Some important factors of human capital for Pakistan are discussed here:

Increase in education is the major factor of human capital formation. Education is a major form of investment in human capital, which provides as a key input in human resource development. Education improves the quality of manpower and enables the skilled workers to manage the developing technology of the country. But Literacy rate is just 57.7 % in Pakistan, i.e., almost 100 % in developed countries while Expenditure on education sector is just 1.8 % of GDP i. e., lowest in Asia. Low literacy rate leads to low efficiency of workforce. Heavy amount of investment is needed to provide training to the on job employees. More attention is given to material capital formation rather than human capital formation in Pakistan. In fact, more concentration should be given to human capital formation because it improves the services of engineers, technicians and administrators, which cause in economic growth and development. Rapidly growing population and improper manpower planning are resulted in unemployment and under-employment. Due to improper labor market, there is brain drain in Pakistan. Availability of proper manpower planning is also a main factor of human capital formation. In Pakistan, population growth rate is 2.1 %, unemployment rate is 5.6 %, under-employment rate is 16 % and disguised-unemployment rate is 20 %. Poor population is backward in Pakistan. Rapidly growing population has not proper health and nutrition facilities. If a worker is not healthy and fully nourished then it is impossible for it to maintain the efficiency.Total expenditure on health sector is only 0.23 % of GNP in Pakistan.Death rate is 0.73 % and life expectancy is 67.2 years. One MBBS doctor is available for 1222 persons. One hospital bed is for 1701 persons. Per capita food intake is targeted at 2526 calories per day, against the required 2550 calories per day.

Infrastructure is the fundamental requirement in the functioning of any country. In today's modern era, we need electricity to power our homes and industry. We need roads to transport goods from one place to the other and then ports and airports to export our industrial products to foreign trade partners. Similarly, a modern nation requires effective water and sanitation to improve and sustain the health and cleanliness of its people. In all situations, infrastructure is such a necessity that it affects the lives of every single individual on this planet. Lack of proper infrastructure causes chaos and havoc in our lives. It also causes bottlenecks in the smooth functioning of the economy.

Infrastructure is a heterogeneous term, including physical structures of various types used by many industries as inputs to the production of goods and services (Chan et al., 2009). Economists and urban planners distinguish two types of infrastructure: economic infrastructure and social infrastructure. Economic infrastructure is defined as the infrastructure that promotes economic activity, such as roads, highways, railroads, airports, sea ports, electricity, telecommunications, water supply and sanitation. Social infrastructure (such as schools, libraries, universities, clinics, hospitals, courts, museums, theatres, playgrounds, parks, fountains and statues) is defined as the infrastructure that promotes the health, education and cultural standards of the population – activities that have both direct and indirect impact on the welfare. All of these institutions entail capital goods that have some public use (Fourie, 2006).

Conceptually, infrastructure may affect aggregate output in two main ways: (i) directly, considering the sector contribution to GDP formation and as an additional input in the production process of other sectors3; and (ii) indirectly, raising total factor productivity by reducing transaction and other costs thus allowing a more efficient use of conventional productive inputs. Infrastructure can be considered as a complementary factor for economic growth.

Pakistan's infrastructural situation is relatively poor by international standards and this has an acute effect on the lives of every Pakistani in the country. Everyone suffers from electricity shortages and the lack of proper water and sanitation provisions. Also as the population increases our problems become more serious. The Government of Pakistan and its people facing poor infrastructure and. It is estimated that due to insufficiency, Pakistan looses about 4 to 6 percent of its GDP (approximately $6 billion). Logistical bottlenecks increase the cost of production of our goods by about 30 percent. This has a significant impact as Pakistan is facing stiff competition from India and China in the export markets. To improve and expand infrastructure, Pakistan's needs are very large and its resources are limited. There is not only limited fiscal space but there are also huge gaps in public sector capacity to build and operate infrastructure. Tight fiscal indicators such as fiscal deficit of 4.2 per cent, trade deficit of around $ 10 billion and current account deficit of 4.4 percent of GDP does not permit to spare public sector resources for infrastructure development. As the economy is growing at the average rate of 7 percent per annum, it requires investment on infrastructure at around 7 to 9 percent of GDP.

The aim of this paper is to analyze the impact of factors of production on economic growth. With labor and physical capital, human capital and infrastructure capital is also included in production function to explore the impact of human capital accumulation and infrastructure capital on economic growth.

Literature Review

Human capital and Economic growth

The relationship between human capital and economic growth in different countries is observed through different studies. These studies suggest that human capital formation deals with such capabilities like literacy, skill development, health facilities, batter living standard and experience. Furthermore, it is said that the share of human capital in economic growth is greater than the amount of physical capital. Some important studies from developed and developing countries are included in this section.

Khan (2005) presented empirical results to support the traditional view that raising investment and improving institutions are key to achieving higher rates of economic growth. But the results also confirm that countries that invest more in their human capital do better in terms of economic growth. Higher levels of education and better health care result in a more productive work force, increasing total factor productivity, and pushing a country's production function outward. According to him, Pakistan has high growth rates but still have less development in social sector because of low investments in human capital.

Mankiw et al. (1992) investigated the impact of human capital level on subsequent economic growth using cross-country analysis. They found a significant role of human capital measured by the secondary school enrollment rates.

Bils and Klenow (2000) said that countries which have high enrollment rate in schools can achieve more growth in per capita income. High enrollment rate in education causes speedy improvements in level of productivity. The results have confirmed that education has a long run and significant relationship with growth. They suggested that progress in education standards will enhance the productivity and also affect the growth in the long run.

Rodrik (2003) argued that enhancing economic growth and maintaining it are two different things. He said that for starting the process of growth, we need only small reforms but if we want to maintain or sustain the growth, then we need continuous institutional reforms which can maintain productive dynamism. He believes that there are few principals that may help for strong growth i.e. security of property rights, competition in market and low inflation. These principals can be converted into some policy packages which further translated into institutional designs.

Akram (2008) tried to estimate the relationship between health status and economic growth. There observed a two-way relationship between improved health facilities and economic growth. Health and other types of human capital increases the per capita GDP by increasing productivity of human beings and then some part of this increased income is spent on investment in human capital which furthermore results in per capita growth.

Ali et al (2010) examined the role of human capital formation in economic growth in Pakistan by using the secondary data for the period of 1972-73 to 2010-11. The results implied that education enrollment (proxy for human capital), health and physical capital are important to boost the economic growth in Pakistan. Human capital, fixed capital and employed labor force affect the GDP and result in unidirectional and non-unidirectional causality. After estimating the model, we concluded that education enrollment index, gross fixed capital formation and Gini coefficient have positive and significant impact on gross domestic product, while head count ratio, infant mortality rate, CPI inflation and investment growth rate have negative and significant impact on gross domestic product in Pakistan.

Mustaf, Rizov and Kernohan (2011) investigated the links between openness, economic growth and human development for 12 Asian economies between 1970 and 2011. their empirical strategy allows us to test the interrelationships running between these three variables. Their findings suggest that openness, economic growth, and human development are indeed interrelated. They find that trade openness has a positive impact on both economic growth and human development. Their results demonstrate that higher levels of human capital stimulate economic growth and improve human development. Therefore, human capital accumulation is important in enhancing economic growth as well as human development.

Jesus and Seren (2001) analyzed the empirical relationship between human capital and economic growth across countries. They provide empirical evidence on the so-called level effect, through the simultaneous dependence between human capital and economic growth. They used benchmark model for this study proposed by Mankiv, Romer and Weil (MRW). In this model human capital is incorporated in Cobb-Douglas production function.

Infrastructure development and Economic growth

Many studies have been carried out to investigate the relationship between infrastructure development and economic growth in different countries. These studies suggest positive impact of infrastructure development on economic growth. Some important studies are presented here.

Prud'homme (2004), Baldwin and Dixon (2008) agree that infrastructure is very long lasting, space specific, infrastructure assets involve long gestation periods, infrastructure assets have few substitutes in short run periods, infrastructure services are very capital intensive and usually associated with market failures. Baldwin and Dixon (2008) according to these features classify infrastructure into three groups: machinery and equipment, buildings and engineering construction.

Bristow and Nellthorp (2000) define three main impacts of infrastructure, describing, that infrastructure has not only visible effect on environment but also directly impacts welfare (by time and cost savings, increasing safety, information network development) and economics (employment, economic growth).

Nijkamp (1986) argues that infrastructure is one of the instruments to improve development of a region. Though it can influence in a direct or an indirect way socio-economic activities and other regional potentiality as well as production factors. The author stresses that infrastructure policy is conditional policy for regional development: it does not guarantee regional competiveness but it creates necessary conditions for the achievement of regional development goals.

Macdonald (2008) analysed the impact of public infrastructure on private production level that has been overlooked in other researches and found out that a private infrastructure provided a vital input for private sector production. Companies view public capital as an unpaid factor of production when maximizing profit.

Aschauer (1998) argues that public infrastructure underpins the quality of life: better roads reduce accidents and improve public safety, water systems reduce the level of diseases, waste management improves health and aesthetics of environment.

Calculations of Mamatzakis (2008) provide evidence that justifies recent scientific trends in infrastructure investment, as it is a crucial component of economic performance in Greece. The estimations show that public infrastructure is a cost saving input in most manufacturing industries, as it enhances their productivity growth.

Straub (2008) distinguishes additional channel through which infrastructure investments may cause growth effect: economies of scale and scope. The author argues that better transport infrastructure lowers the costs of transportation and leads to economies of scale and better management.

Li and Li (2008) argue that infrastructure investment is very important to boost national economic growth and prove this with the results of infrastructure investment and the GDP in China from 1997 to 2006.

Snieska and Simkunaite (2009) explored the relationship between infrastructure development and economic growth. They faced the problem of data availability and the results of causal relationship estimations between growth and infrastructure variables in different countries are presented for the period 1995-2007. Statistical measurement of relationship between infrastructure and economic growth determinants in the Baltic States proved that several variables are not enough to evaluate the impact of infrastructure on development. The full-scale method is a must in order to measure this relationship. Empirical test also proved that the direction of relationship differs in Lithuania and Latvia which are attributed to the same level development and these results contradict the findings in scientific literature. For this reason it is important to acknowledge that the model of infrastructure impact evaluation must involve determinants of regional peculiarity.

Canning and Pedroni (2004), in the paper on the Effects of Infrastructure on Long Run Economic Growth, investigate the long run consequences of infrastructure provision on per capita in a panel data of countries from 1950 to 1992. The paper develops simple panel based tests which enable us to isolate the sign and direction of long run effect of infrastructure on income in a manner that is robust to the presence of unknown heterogeneous short run causal relationships. The results show clear evidence that in majority of the cases the development of infrastructure induces long run growth effects.

Imran and Niazi (2010) find out the determinants of the total factor productivity (TFP). Their focus is on the public infrastructure stock as an important determinant of TFP. Second, to determine how infrastructure impacts on growth, specifically, to determine which types of infrastructure, that is, roads highways, power, telecommunications, irrigation, etc., are more effective from the viewpoint of raising the growth rate of the economy as a whole.

Theoretical framework

Human capital and economic growth

In the traditional neoclassical growth models developed by Robert Solow and Trevor Swan in the 1950s, the output of an economy grows in response to larger inputs of capital and labor (all physical inputs). Non-economic variables such as human capital or human health variables have no function in these models. Furthermore, the economy under such a model conforms to the *law of diminishing returns to scale*. With these assumptions, the neoclassical growth models afford some implications to the economy; particularly that as the capital stock increases, growth of the economy slows down, and in order to keep the economy growing it must use capital with technological progress. It is well known that technological progress in this model is considered as exogenous. But with the passage of time it was observed that there are some other factors which are not included in this model are effecting economic growth. Addressing the above issues, in the mid 1980s, a new paradigm was developed in the literature, mostly due to the Paul Romer (1986), which is now commonly known as *"endogenous growth models"*. By broadening the concept of capital to include *human capital*, the new endogenous growth model argues that the law of diminishing returns to scale phenomenon may not be true as is the case for East Asian economies. In simple terms, what this means is that if the firm which invests in capital also employs educated and skilled workers who are also healthy, then not only will the labor be productive but it will also be able to use the capital and technology more efficiently. This will lead to a so called "Hicks neutral" shift in the production function and thus there can be *increasing* rather than *decreasing* returns to investments. In other words, technology and human capital are both "*endogenous*" to the system.

Indeed, the advent of "endogenous growth models" with human capital have certainly enhanced the understanding of the mysteries of rapid and long sustainable high growth performances of East Asian economies. However, in order to establish the point whether healthy human capital was one of the important factors in explaining the economic development for the Asian countries in the region, it will be useful to analyze the actual data on these variables across the countries considered earlier. Although there are many variables that can represent human capital and health conditions of the people of a nation.

Infrastructure and economic growth

The theoretical analysis of the effect of infrastructure on growth and on development outcomes is mostly found in growth theory and the new economic geography literature. Authors (Agénor and Moreno-Dodson, 2006, Fourier, 2006) argue that infrastructure impacts on economic growth primarily in several ways:

Infrastructure lowers the cost of input factors in production process. This effect is called the direct productivity effect.

Infrastructure improves the productivity of workers, and this effect is known as the indirect effect.

Impact of infrastructure on growth is obtained through the initial building and construction period: working places are created in construction and related industries. As infrastructure investments require maintenance, it further boosts the long-term creation of jobs.

Infrastructure also has positive effect on education and health outcomes: good health and high education of labor force induce economic growth.

Data and methodology

Model

In this section main objective is to examine the effects of infrastructure and human capital on overall growth in the economy. To achieve this objective we use an aggregate production function called Cobb-Douglas production function, which can be written in the form:

$Y = A^* f(L, K, H)$

Where A* is the factor productivity represented by the state of technology, K is the stock of capital, L is the labor force, H is human capital. To observe the impact of infrastructure on economic growth we include infrastructure capital. Now Cobb-Douglas production function is:

$Y = A^* f(L, K, H, I)$

Using the Cobb-Douglas form:

$Y = A^* L^{\alpha} K^{\beta} H^{\gamma} I^{\delta} e^{\mu}{}_{t}$

Now write this equation in log form:

$\text{Log } Y = \log A + \alpha \log L + \beta \log K + \gamma \log H + \delta \log I + \mu_t$

Where α, β, γ and δ are production elastisities. As it is assumed that $\alpha+\beta=1$, $\gamma>0$ and $\delta>0$ according to endogenous growth theory and then $\alpha + \beta + \gamma + \delta > 1$, it means return to scale are increasing.

Human capital accumulation cannot be directly observable. If human beings are more educated and enjoying good health then they will be more productive. Two proxies are used for human capital: education enrolment index and health expenditures. Now model is as follows:

$\text{Log } GDP = \log A + \alpha \log EMPL + \beta \log GFCF + \gamma \log(EEI + healthexp) + \delta \log INFRA + \mu_t$

$\text{Log } GDP = \log A + \alpha \log EMPL + \beta \log GFCF + \gamma_0 \log EEI + \gamma_1 \log healthexp + \delta \log INFRA + \mu_t$

Infrastructure is defined as a complex of capital goods which are not consumed directly; they provide services only in combination with labor and other inputs. This description allows to distinguish a wide range of components and to analyze their direct impact on development issues and emphasizes the need of specification of infrastructure sector in order to measure its impact. We include trade openness in this model as control variable. Then model becomes in following form:

$\ln GDP = C + \beta_0 \ln EMPL + \beta_1 \ln GFCF + \beta_2 \ln INFRA + \beta_3 \ln EEI + \beta_4 \ln healthexp + \beta_5 Opp + \mu_t$

Where EMPL is employed labor force, EEI is education enrolment index, healthexp is health expenditures, INFRA is infrastructure index, GFCF is gross fixed capital formation and Opp is trade openness.

Data sources

This study is based on the secondary sources of data. The data is collected for the period of 1972 to 2013. The data for this study are obtained from Pakistan Economic Survey (of various years), State Bank of Pakistan and World Development Indicators.

Table 1: Description of variables

Variables/ symbols	Description	Indicators
Economic growth/GDP	It shows the size of an economy of country.	Gross domestic product , GDP
Labor/EMPL	Labor force in a country.	Total employment
Human capital/ EEI, healthexp	Human capital is accumulated if human beings are more educated and healthier. It has positive impact on economic growth.	Education Enrolment Index, Health expenditures
Capital stock	Physical capital which is used in production process.	Gross fixed capital formation, GFCF
Trade openess	It is used as control variable.	(Export+import)/GDP
Infrastructure index	It includes no. of hospitals, length of roads, no. of ports, no. of vehicles (registered), no of post offices, telephone line no. and electricity generation. It has positive impact on economic growth.	Principal Component Analysis (PCA) is used to construct index of infrastructure.

Description of variables used in this study

Economic growth is dependent variable while labor, human capital and infrastructure capital are independent variables in this study. Table 1 provides description of the variables.

Construction of Education Enrolment Index

Different indicators of education are being used in literature to measure the effect of education e.g. school enrollment, college enrollment, university enrollment, total enrollment in all educational institutions and total expenditures on education. These measures do not capture the whole effect of education. So, the present research work uses a more comprehensive measure of education i.e. education enrollment index. Education Enrolment index is constructed by using UNDP methodology developed in 1999-2000 for the period of 1972 to 2013. In education enrolment index, adult enrolment with two-thirds weighting and the combined primary, middle and secondary, enrollment with one-third weighting are added together.

EEI = 2/3 (adult education) + 1/3 (primary + middle + secondary)

Construction of Infrastructure Index

PCA (principal component analysis) is used to construct infrastructure index.

Principal Component Analysis (PCA)

To construct infrastructure index, PCA (principal component analysis) has been used on the following variables:

1) no. of hospitals
2) Road length (Km)
3) Ports
4) no. of universities
5) Post Offices
6) Telephone lines
7) Electricity generation (gha)

PCA requires that there should be some correlations greater than 0.30 between the variables of concern, which is satisfied as observed from the correlation matrix of variables in Table 2.

Table 2: Correlation Matrix

	Hospitals	roadL	Ports	postoff	TPlines	Elecgen	GDP	Universities
Hospitals	1							
roadL	0.96	1						
Ports	0.94	0.90	1					
Postoff	0.72	0.72	0.58	1				
TPlines	0.93	0.91	0.92	0.49	1			
Elecgen	0.94	0.97	0.95	0.62	0.95	1		
GDP	0.87	0.81	0.96	0.42	0.90	0.90	1	
Universities	0.87	0.83	0.94	0.38	0.94	0.92	0.96	1

Observing the positive correlations in the table it is evident that each of these sectors is interrelated, and an increase in growth because of an increase in investment in any particular sector might not be solely because of that sector. PCA enables us to transform this data into non-correlated data by creating eigenvectors from which we can avoid the problem of correlation in data.

A further analysis compares the change in GDP with the change in each of the parameters by calculating eigenvalues and corresponding eigenvectors. All the components whose eigenvalues are greater than 1.0 are significant. In our sample there are two components having eigenvalues greater than 1.0 (Table 3), which explains more than 90% of the total variance of the data, when the criteria is only 60%. The higher the eigenvalue of a component, the higher its importance, as it explains most of the variance in the data. The component loadings of each of the components are analyzed to see the individual importance of sectors, and the absolute value of the component loading of a sector explains its own importance to growth.

Table 3: Components (42 years)

Component	Eigenvalue	Difference	Proportion	Cumulative variance
Comp 1	6.04	5.31	0.86	0.86
Comp 2	1.01	0.62	0.10	0.97

Finally we consider each of the components individually to identify the significance of each parameter. Table 4 shows all the components with the component loading values that explain the significance of each parameter.

Table 4: Principal Components (Eigenvectors)

Variables	Comp 1	Comp 2	Unexplained
Hospitals	0.399	0.103	.030
Road length	0.396	0.124	.043
Ports	0.394	-0.131	.050
Post offices	0.275	0.853	.012
TP lines	0.389	-0.243	.041
Electricity generation	0.401	-0.063	.024
Universities	0.375	-0.408	.027

Now infrastructure index is constructed by using first component loading values. These component loading values are used as weights to construct index.

Infrastructure index = w_1 Hospitals + w_2 Road lengths + w_3 Ports + w_4 post offices + w_5 TP lines + w_6 Electricity generation + w_7 Universities

Methodology

The stationarity properties of the variables in a time series data are judged by unit root test. If the mean, variance and auto – covariance of the variable remain constant, the variable is called Stationer. There is no shortage of tests for judging the existence of the unit root problem in the literature of econometrics. Dickey and Fuller (1979, 1981) developed a technique for formal testing of non stationarity, names DF test. The DF test is appropriate, if the disturbance term is uncorrelated. This test becomes inappropriate when error terms (u_t) are correlated. Dickey and Fuller have suggested an extended form of testing procedure by incorporating an additional lagged term of explained variable for tackling the problem of autocorrelation when there is white noise error. This test procedure is Augmented Dickey Fuller (ADF) test. Lag length is determined based on Akaike Information Criterion (AIC) and or Schwartz Bayesian Criterion (SBC).

If we have found that the time series data on economic variables are non – stationary at level I(0) and have the order of integration one i.e. I(1) based on the Augmented Dickey – Fuller test, then we have to apply co-integration technique that was first introduced by Granger (1981). Co – integration is the most useful technique for finding the long run relationship among variables. Johansen (1981) and Johansen – Juselius (1990) approach is used in order to examine the cointegration in multiple equations. The two main statistics like the value of LR test which depends on the Maximum Eigen – value and the trace value of the stochastic matrix are the result of Johansen procedure of co-integration.

In order to trace out the short run relationship of the model, we have used ECM technique. The rate of adjustment from short-run to the long run equilibrium is interpreted by the ECM term

Results

First of all, descriptive analysis is discussed here then we will discuss time series econometric analysis.

Descriptive analysis

The descriptive analysis comprises on descriptive statistics of selected variables and zero order correlation matrix. Table 5 provides the descriptive statistics of variables used in the analysis.

Table 5: Descriptive Statistic Analysis (1972-2013)

	GDP	EMPL	GFCF	INFRA	EEI	HEALTH EXP	OPP
Mean	3514183	33.863	625977.4	934599.3	6.576781	24080.52	0.35
Std. Dev.	2783848	11.158	840144.3	791736.3	1.228	36735.29	0.052
Skewness	1.180	0.606	1.441	0.616045	1.067	2.709	0.582
Kurtosis	3.007	2.289	3.696	2.037422	3.919	11.088	2.768
Jarque-Bera	9.759	3.455	15.379	4.278052	9.452	165.877	2.462
Probability	0.007	0.178	0.000	0.117	0.008	0	0.292

The degree of association among the variables is reported in table 6. It is observed in the study that all variables have high degree of relationship among the variables. All the variables are positively correlated.

Table 6: Correlation Matrix

	GDP	EMPL	GFCF	INFRA	EEI	HEALTH EXP	OPP
GDP	1						
EMPL	0.96	1					
GFCF	0.98	0.93	1				
INFRA	0.89	0.94	0.87	1			
EEI	0.77	0.79	0.69	0.79	1		
HEALT HEXP	0.87	0.83	0.92	0.79	0.50	1	
OPP	0.78	0.73	0.77	0.68	0.64	0.70	1

Econometric Analysis

Step 01: Unit Root Test

The problem of spurious regression has occurred when we have applied OLS regression technique. In order to avoid the problem of spurious regression, we use unit root test to examine the stationarity of the variables for determining the order of integration. Augmented Dickey Fuller test is employed to measure the unit roots of all the variables. Results are discussed in table 7.

Table 7: Result of Augmented Dickey Fuller Test (ADF) for Unit root

Variables	Level	1st diff	Conclusion
lnGDP	0.1006	-3.964	I(1)
lnEMPL	-0.146	-6.414	I(1)
lnEEI	-2.065	-4.458	I(1)
Lnhealthexp	-2.027	-4.361	I(1)
lnINFRA	-0.864	-4.533	I(1)
Lngfcf	-0.587	-4.578	I(1)
Opp	-1.231	-5.072	I(1)

Note: The Null hypothesis is that the series is non-stationary or contains a unit root. The rejection of null hypothesis for ADF test is based on the Mackinnon Critical values at 5%.

Results showed that all variables are stationer at first difference so Simple OLS method is not suitable method for further analysis.

Step 02: Optimal lag length

In order to select lag length, we have used vector autoregressive test (VAR) based on the values of Akaike Information Criterion (AIC) and Schwarz Criterion (SBC). The optimal lag length in our study is 1.

Step 03: Cointegration Test

Once we have selected suitable lag length, we have used the LR test which based on the Eigen values of the stochastic matrix of the Johanson (1991) procedure for finding the number of co-integrating vectors. The results of co-integration tests are given in the table 8. In this present analysis, three co-integrating vectors are observed at 5 percent level of significance based on likelihood ratio test (LR). The null hypothesis of zero co-integrated vectors is rejected against the alternative of one co-integrating vector. Similarly, the null hypothesis of At most 1and At most 2co-integrating vectors are also rejected against the alternative hypothesis.

Table 8: Unrestricted Co integration Rank test (Maximum Eigen Value)

Eigenvalue	Likelihood Ratio	5% Critical Value	1% Critical Value	Hypothesized No. of CE(s)
0.763728	175.0257	124.24	133.57	None **
0.68264	117.3149	94.15	103.18	At most 1 **
0.587776	71.40608	68.52	76.07	At most 2 *
0.294348	35.95859	47.21	54.46	At most 3
0.274527	22.01328	29.68	35.65	At most 4
0.201098	9.176022	15.41	20.04	At most 5
0.004872	0.195355	3.76	6.65	At most 6

Note: *(**) denotes rejection of the hypothesis at 5%(1%) significance level.
L.R. test indicates 3 cointegrating equation(s) at 5% significance level

Table 9 presents the findings of the coefficients of β matrices in the form of normalized co-integrating coefficients of the equation. We have found long run relationships among variables in the current study. The results of the study are highly significant. Employment and trade openess have positive impact on economic growth in the long run. Health expenditures have positive impact on economic growth. 1% increase in health expenditure leads to increase in 0.78% economic growth. Human capital accumulation is done by increasing human productivity and more healthy and educated labor can be more productive. Results showed that human capital in terms of healthier workers has positive impact on economic growth in long run. If labor is healthier then it will be more productive and efficient. But education has negative impact on economic growth because in Pakistan, mostly people are unemployed with higher degrees because of less job opportunities and the biased nature of the system is a big hurdle for active participation of educated person for the development process. Infrastructure capital has positive impact on economic growth, 1% increase in infrastructure capital leads to increase in 20.3% economic growth. Gross fixed capital formation has negative but insignificant effect on economic growth.

Table 9: Normalized Co-integrating Coefficients: 1 Co-integrating equation(s)

Variables	coefficients	Standard error	t-statistics
LNEMPL	0.008223	-0.14569	-0.056442
LNGFCF	-0.001289	-0.09052	0.01424
LNINFRA	0.203623	-0.09183	-2.217391
LNEXP	0.078178	-0.02734	-2.859473
LNEEI	-0.738262	-0.25865	2.85429
OPP	0.290815	-0.13249	-2.194996

Step 04: Estimation of Short Run Dynamics

Table 10: Results of Error Correction model for Short run dynamics

Variables	Coefficients	Standard Errors	t-statistics
CointEq1	-0.327496	-0.09332	(-3.50936)
D(LNGDP(-1))	0.236779	-0.20277	-1.1677
D(LNEMPL(-1))	0.015851	-0.15154	-0.1046
D(LNGFCF(-1))	0.071419	-0.0559	-1.2776
D(LNINFRA(-1))	0.007728	-0.0501	-0.15424
D(LNEXP(-1))	0.017128	-0.02637	-0.64958
D(LNEEI(-1))	0.073494	-0.07668	-0.9584
D(OPP(-1))	-0.057958	-0.05331	(-1.08728)
C	0.00445	-0.00383	-1.16226
R-squared	0.4474		
Adj. R-squared	0.3047		
F-statistic	3.1373		
Schwarz SC	-5.9798		
Akaike AIC	-6.1778		

In the previous analysis, we have explored the long run relationship among variables. The short run relationship of the variables may be found through ECM approach. The ECM permits the introduction of last disequilibrium as an explanatory variable in the model. Thus, error correction model is beneficial in controlling the short run as well as long run association among the variables. The short run behavior of the model is given in the table 10. The error correction model correlates the changes in the log of real gross domestic product to the changes in other relevant variables and the error term of lagged period. The error correction term ECt-1 indicates the rate of adjustment. The coefficient of the error correction term is significant at 1 percent level and shows inverse relationship which is correct sign. In the present analysis, we have found 32 % speed of adjustment which is meant that movement of the short run towards long run would occur almost 32 % per year. In addition, we have observed that infrastructure, health expenditure, education, employment and gross fixed capital formation have positive influence on GDP while trade openness has negative influence on GDP.

Conclusion

The study has made an attempt to provide empirical evidence on the relationship among human capital, infrastructure and economic growth. The empirical analysis is based on Johanson's cointegration, Error Correction Model (ECM) and Principal Component Analysis (PCA) for Pakistan's time series data from 1972 to 2013. The key and significant results of the time series econometric analysis are stated as follows:

The unit root test based on ADF indicates that all variables are non-stationary at their level form and become stationary at their first difference and all variables are integrated of same order I(1).

Johanson's Cointegration test indicates that there exist a long run relationship between human capital, infrastructure and economic growth.

The results of short run dynamics by using ECM suggests that infrastructure has positive short run impact on economic growth and human capital has also positive impact on economic growth.

PCA is used to construct infrastructure index by including road lengths, number of ports, number of hospitals, number of universities, electricity generated, number of post offices and telephone lines.

Finally it is suggested that policy makers should pay more attention to generate more human capital and for this purpose it is necessary to make sensible and credible policies to facilitate health and education sector because healthier and more educated labor is efficient and more productive. It is also suggested that there should make some infrastructure development plans to improve infrastructure to achieve high growth levels.

References

Agénor, P. R., & Moreno-Dodson, B. (2006). Public Infrastructure and Growth: New Channels and Policy Implications. *The World Bank Policy Research Working Paper 4064*.

Akram, N. and Khan, M. (2008).The Long Term Impact of Health on Economic Growth in Pakistan. *The Pakistan Development Review*, 47(4), 487-500.

Ali etal (2012). *Human capital formation and economic growth in Pakistan,* Pakistan Journal of Social Sciences,vol.32, pp. 229-240.

Aschauer, D. A. (1989). Is public expenditure productive? *Journal of Monetary Economics* (23), 177-200.

Baldwin J. R., & Dixon, J. (2008). Infrastructure Capital: What Is It? Where Is It? How Much of It Is There? *Research Paper Research Paper Series* (16).

Bils, M. and Peter, J.K. (2000). Does Schooling cause Growth?.*American Economic Review*, 90(5), 1160-1183

Bristow, A. L., &Nellthorp, J. (2000). Transport project appraisal in the European Union. *Journal of the World Conference on Transport Research Society* (1).

Canning, David and Pedroni, Peter (2004). *The Effect of Infrastructure on Long Run Economic Growth*

Chan, C., Forwood, D., H. Roper, and C. Sayers (2009) 'Public Infrastructure Financing: An International Perspective', Productivity Commission Staff Working Paper.

Fourie, J. (2006). Economic infrastructure: a review of definitions, theory and empirics**.** *South African Journal of Economics* (74), 530-556.

Imran and Niazi (2010).*Infrastructure and Growth*.

Jesus and Seren (2001).*Human capital accumulation and economic growth*, investigation economics. Vol. xxv (3), 585-602.

Khan (2005).*Human Capital and Economic Growth in Pakistan*, The Pakistan Development Review, pp. 455-478.

.Li, Y., & Li, Z. (2008). Grey Relational Analysis between Infrastructure Investment and Economical Growth in China from 1997 to 2006. *Proceedings of 2008 International Conference on Construction & Real Estate Management* (1) and (2), 564-56

Macdonald, R. (2008). An Examination of Public Capital's Role in Production. *Research Paper Economic Analysis (EA) Research Paper Series* (50).

Mamatzakis, E. C. (2008). Economic performance and public infrastructure: an application to Greek manufacturing. *Bulletin of Economic Research* (60), 307-326.

Mankiw, N, G., Romar, D.and Weil, D,N.(1992). A Contribution to the Empirics of Economic Growth. *The Quarterly Journal of Economics*, 107(2), 407-437.

Mishra, Narendra and Kar (2013). *Growth and Infrastructure investment in India: Achievements, Challenges and Opportunities*, Economic Annals.

Nijkamp, P. (1986). Infrastructure and Regional development: A multidimensional policy analysis. *Empirical Economics* (1), 1-21.

Prud'homme, R. (2005). Infrastructure and Development. Lessons of Experience. *Proceedings of the 2004 Annual Bank conference on Development Economics*.153-181.

Rodrik, D. (2003).Growth Strategies. *Working Paper 10050, National Bureau of Economic Research*, JEL NO.01, 04.

Stewart, J. (2010) 'The UK National Infrastructure Plan 2010', European Investment Bank Papers: Public and Private Financing of Infrastructure.

Straub, S. (2008). Infrastructure and Development: A Critical Appraisal of the Macro Level Literature. *The World Bank Policy Research Working Paper 4590*.

The Pakistan Infrastructure Report by State Bank of Pakistan.

Todaro, M. (2002).Economic Development.8th edition, Longman, New York London.