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Research Article

Infrastructure and Economic Growth: Panel Analysis of Selected Asian Countries

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ABSTRACT

Effective and reliable infrastructure is considered helpful for economic growth. Particularly, transport infrastructure is an important factor in the development of countries. The infrastructure can be classified into different dimensions i.e. economic and social infrastructure. The current study uses panel analysis techniques to examine the association between infrastructure and economic growth. The panel data is used having a period from 2000-2020 for selected Asian countries. Panel unit root tests are applied to check the stationarity of the data, and findings depict that all variables are stationary at the first difference. After analyzing the unit root properties, the Pedroni cointegration technique is employed to assess the long-run association. The results indicate that all variables have an association in the long run. Furthermore, the Random effect model is employed for empirical investigations. The results concluded that transport infrastructure, energy use, and communication infrastructures positively affect the economic growth in the selected Asian countries. It is recommended that the government stress public expenditure to ensure effective infrastructure, promoting economic growth. It is also suggested that more budget may be consumed to make the roads, dams, telecommunication services, and bridges.

Key Words: Economic Growth, Infrastructure, Panel data



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INTRODUCTION

Effective and reliable infrastructure is considered helpful for GDP growth. Particularly, Transport infrastructure is essential for the development of nations. First, it connects people to employment services and links business with labor (Kirkpatrick, 2004). However, developed economies with a developed system of growth patterns must pay more attention to higher investment in inferential sectors. On the other hand, Egert et al. (2009) for developing economies should focus on investing in more infrastructure to enhance their growth and development.

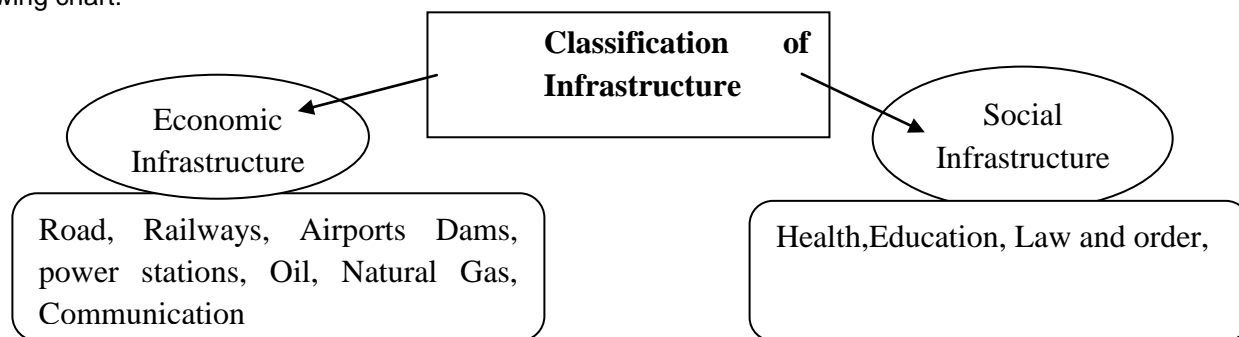
Infrastructure development is an important aspect of economic growth in many ways. Direct investment process as the agent for enhancing the level of better opportunities for the production process. It also promotes the development of a new economic growth track at the same time. It provides a facility for people to gain jobs easily and human and civilized infrastructure not only for rich people. Especially for South Asian economies, the core objective is to enhance people's living standards and minimize the poverty range. For the fulfillment of these requirements, sustainable development is necessary. In underdeveloped economies, infrastructure has a positive correlation with economic growth.

The investment in infrastructure leads to the increase of production services and economic activities. Infrastructure is a comprehensive term encompassing various elements of physical infrastructure utilized as inputs by different industries in their production processes. Broadly speaking, infrastructure can impact total output in two primary ways. First, it directly enhances GDP growth, and second, it supports the production processes of other economic sectors, contributing to overall economic development. On the other hand, it reduces the cost paid for the production inputs and ultimately increases the overall output level. In this sense, it might be considered that an indirect way increases the growth level (Chan et al., 2009).

Economists have classified infrastructure into two categories: economic and social infrastructure. The process in which other areas of an economy move toward progressive steps is considered the process of economic infrastructure development. When the literacy rate becomes high at a sufficient level, the availability of better health opportunities and cultural trends present in an economy is called the social infrastructural promotion concept (Fourie, 2006). Seneviratne and Sun (2013) expressed that infrastructure is an important component of GDP growth. An investment in infrastructure will increase people's living standards and growth in developing countries (OECD, 2006). The areas with low production costs and efficient infrastructure facilities have a high profit margin for investors. (Pradhan and Bagchi, 2013). Saidi et al., (2018) stated that transportation infrastructure leads toward sustainable growth after attaining the availability of new incentives. Cantarelli et al., (2010) & Locatelli et al., (2017) argued that infrastructure investments do not give satisfactory results in underdeveloped regions. Crescenzi et al., (2016) & Maparuand (2017) explained that infrastructure development had gained more importance, so it's a satisfactory condition for the new arrival of investors. International investors are attracted by the developed transport systems (Erenberg 1993 & Fernal 1999). The major determinant of production is energy consumption which might be considered the spine of the industrial and agricultural economy. The growth goals of the country may not be achieved without using energy.

Division of Infrastructure

The infrastructure can be divided into two predominant categories such as economic infrastructure and social infrastructure. Both categories are further subdivided into different types, which are explained with the help of the following chart:



Economic infrastructure includes the development of roads, railways, airports, dams, power stations, oil, natural Gas, and communication. The social infrastructure consists of health, education, and law & order.

The study aims to analyze how investment in transport infrastructure impacts economic growth in specific Asian countries i.e. Pakistan, Iran, Turkey, Malaysia, Bangladesh, and Indonesia. Finally, the economic growth of selected Asian Countries is investigated under the effect of its energy consumption and communication infrastructure. There is a lot of literature regarding the impact of infrastructure on developed and developing regions' economic growth. Nevertheless, the literature on how infrastructure influences economic growth in six specific Asian countries such as Pakistan, Turkey, Iran, Malaysia, Bangladesh, and Indonesia is lacking. To fill in the gaps in the literature, this study investigates how infrastructure affects economic growth in six emerging Asian countries. The present study also emphasizes the impact of other socioeconomic variables including gross fixed capital formation and trade openness on growth.

LITERATURE REVIEW

Boopen, S. (2006) explored the link between infrastructure and the growth level of Africa's economy with the help of a dynamic panel. This study analyzed the 38 economies of Sub-Saharan. The data span ranges from 1980 to 2000 for the SSA countries. The same analysis was also carried out for SIDS economies. Total output has been used as a

dependent, and independent variable including all the human resources of the economies, transportation, and the total available workers in the model. The study estimated the OLS regression and fixed and random effect models. GMM estimator was also employed for empirical results. The results found that transport capital is more important for the enhancement of the growth of economies. The same study also performs the process for the SIDS economies. For SIDS economies, the role of transport capital is less effective for growth encouragement as compared to SSA countries. Salahuddin M. & Alam (2016) examined the information and communication technology using short and long-run, employing panel data from 1985 to 2021. The study explored how electricity consumption relates to the level of economic growth. The study employed a cointegration test "Dumitrescu – Hurlin Causality test, a unit root test, and a pooled mean group regression test" technique. The results found an important role of electricity consumption in an economy and a significant role in the short and long period. The increase in the consumption of electricity boosted economic growth significantly.

Azam, M. et al. (2017) studied the influence of infrastructure development on Malaysia's economic growth. The time spans from 1975-2015. Foreign Direct Investment (FDI) and other human capital variables were used for analysis. The OLS method was used to obtain the estimates. The results explored that the level of growth of Malaysia's economy moves upward when new inferential investments. Other variables also have a positive relation with economic growth. The results indicate that the Malaysian government should focus on enhancing the development of the country's infrastructure. The findings depicted that infrastructure improvement enhanced growth.

Tariq M. & Ayub (2018) examined the growth level situation of 149 countries by using different ICT (Information and communication technology). Variables. The study collected data from 1980 to 2015 from a specific range of areas. The two stages Least Square Method, the "Generalized Method of moments and Ordinary least square" techniques were employed for empirical estimations. All techniques have a specific role in the explanation of different results. The study used the data to examine the economic progress situation worldwide and in geographical areas. The analysis was subdivided into advanced and under-developing economies to observe the role of ICT technology. According to the results, ICT has a more powerful and key role in developing economies despite advanced economies. However, the use of ICT is very important for both types of economies.

Sadie, S. et.al (2018) explored the significance of energy use in the transportation process and linked this transportation inferential significance with the economy. The data set was used for MENA countries in a specific range of time from 2000 to 2016. In this analysis, the panel was scattered into three subgroups. The GMM econometric method was used to examine the robustness of this analysis. The result indicated that using energy for transportation strongly impacted GDP growth for "MENA" countries. Results also indicated that more use of energy raised the growth of the economy. Findings suggested that more investment in new infrastructure will boost economic development and reduce negative externalities.

Toader, E. et al. (2018) explored how Information and Communication Technology infrastructure is connected to economic growth. EU economies from 2000 to 2017 were used as panel data. The independent variable served as ICT infrastructure and the proxy variable was GDP per Capita to represent economic progress. Control variables included other variables such as government expenditures, inflation rate, foreign direct investments, unemployment rate, and degree of trade openness. Empirical outcomes were obtained from the applied GMM, random effect, and fixed effect models. The study establishes strong and economically meaningful ICT infrastructure effects on EU member state level's economic growth. The results show that EU countries' GDP per Capita is positively affected by the inflation rate, foreign direct investments, unemployment rate, government expenditures, and the degree of trade openness.

THEORETICAL FRAMEWORK

The study is based on neoclassical growth models proposed by two Economists R. Solow and T. Swan in 1956. The models argued that the economy boosts with a huge amount of capital and labor which are considered constant in the model. The law of diminishing return to scale is discussed in this law.

This model is further elaborated with the help of assumptions, with some economic implications. The model assumes that a capital stock increase will raise the economy slowly. For moving the economy faster, the technological progress added with capital will push the economy. Some variables are not included in the model, pushing economic growth over time. In this study, other factors i.e. transport, energy, and communication infrastructure, are included to examine the growth of the economy rapidly.

According to Paul Romer (1986), the law of decreasing return to scale dilemma may not be explained by giving the model (Endogenous growth model). Due to the influence of other factors, this law may change. With the help of assumptions, some economic implications are discussed under the neoclassical growth model. It is important that if the capital stock increases, then economic growth decreases. Technological progress adds to the capital if an economy wants to grow. The technological progress in the model is used as an exogenous variable.

DATA AND METHODOLOGY

The data was extracted from different sources i.e. World Development Indicators, Trading Economics, and Pakistan Economic Survey for the period of 2000-2020.

Table 1. Variable Description

Variables	Label	Description	Unit of Measurement
Gross domestic product	GDP	GDP is utilized as a measure of economic growth. It represents the total value added by all resident producers in an economy, including product taxes, while excluding subsidies not incorporated in product values.	Per Capita
Transport Infrastructure	INFO	It includes road network length (Km) which is used as a proxy for transport infrastructure.	Total
Mobile subscription	Cellular MCS	It is used as a proxy variable for the communication sector. (mobile cellular subscription per 100 People)	% Percentage
Energy Use	EU	It is used as a proxy for the energy sector.	Total
Gross Fixed Capital Formation,	GFCF	Physical capital is employed in the production process	% of GDP
Trade Openness	TO	It is also used as a control variable.	% of GDP

Source: WDI, Trading Economics, Pakistan Economic Survey

The variables employed in this study are outlined in the table above. Gross domestic product per capita was employed as a measure of economic growth and extracted data from (WDI) World Development Indicator. The GDP per Capita is in total form. For this reason, the natural logarithmic form is applied in the study. The road length is described in Km for selected Asian countries. It is a proxy for the transport sector of the economy. The data on road length was extracted from WDI and different statistical yearbooks.

The data was also collected from WDI and the proxy for the communication sector was Mobile Cellular Subscription per 100 people. The data is used in percentage form. The next variable is the energy used, which represents the energy sector and is also used in ratio form after taking logarithmics. The study includes trade openness and gross fixed capital formation as control variables.

Model Specification

Many empirical studies have employed dynamic panel Cointegration analysis to explore the link between economic growth and infrastructure, however, the current study uses the basic framework of Munir, S., et al (2018) and Gohar Badyan (2014). By following the functional form presented by Munir, S., et al., (2018), the current study, The Cobb-Douglas Production Function (CDPF) is employed as a model for aggregate production and can be formulated as:

$$Y = A^* f(L, K) \quad (1)$$

In this equation, A^* stands for total factor productivity, which reflects technological progress, K represents the capital stock, and L denotes the labor force.

The Cobb-Douglas form of the above model can be described below.

$$Y = A^* L^\alpha K^\beta I^\delta \mu_t \quad (2)$$

Now write this equation in natural logarithm form:

$$\ln Y_{it} = \ln A + \alpha \ln L_{it} + \beta \ln K_{it} + \delta \ln I_{it} + \mu_t \quad (3)$$

Where α , β , and δ are production elasticities. As it is assumed that $\alpha + \beta = 1$, and $\delta > 0$. The current study used panel data of all variables ranging from 2000-2020 for selected Asian countries. This long-run association between economic growth and infrastructure is then estimated by the following model for selected Asian economies.

$$\ln\text{GDP}_{it} = C + \beta_1 \ln\text{MCS}_{it} + \beta_2 \ln\text{RL}_{it} + \beta_3 \ln\text{EU}_{it} + \beta_4 \ln\text{GFCF}_{it} + \beta_5 \ln\text{TO}_{it} + \mu_i \quad (4)$$

All the variables are in natural logarithmic form. GDP indicates gross domestic product per Capita. Mobile cellular subscription used proxy for communication infrastructure is represented by MCS and road length proxy for transport infrastructure is represented by RL. GFCF stands for gross fixed capital formation and TO stands for trade openness.

Panel Unit Root Tests

The stationarity of the data is confirmed using panel unit root tests. This research applies two types of panel unit root tests: Levin, Lin, and Chu (LLC) and Im, Pesaran, and Shin (IPS). The LLC test assumes a shared unit root process across all cross-sections, while the IPS test permits unique unit root processes for each cross-section.

Ho: Unit Root

H1: No Unit Root

If the p-value is below 0.05, the null hypothesis of no unit root is rejected, indicating that the data is stationary.

Panel Cointegration Analysis

The cointegration test is for testing to assess the existence of a long-term equilibrium among the variables. Given distributed variables that deviate significantly, the robustness of variables is checked based on the basic rule of cointegration testing. (Abadir & Taylor, 1999).

If the variables are cointegrated, that is, if they move in combination with each other over time then. Long-term solutions exist to long-term problems. Then, if the sample data has no unit root panel, cointegration tests are performed. The current study uses the most famous panel cointegration technique devised by Pedroni (1999). In the case of Pedroni's, the null and alternative hypotheses are;

Ho: No Cointegration

H1: Cointegration Exists

This cointegration technique is comprised of seven statistics. These seven statistics are divided into between and within the dimension. Four within statistics are named Panel-v, panel-ADF, panel-rho, and panel-PP statistics, while between-dimension statistics are group-PP, group-ADF, and Group-rho.

The result of cointegration depends upon the majority of the outcome. If half or more outcomes declare the p-value below five percent, then the null hypothesis of no cointegration is rejected.

Random Effect Model

A panel data procedure is more efficient than that of cross-section and time series data in econometric handling. Among social scientists, panel data estimation has better performance. Although the panel data can be balanced or unbalanced. An unbalanced panel is characterized by unequal time observations across variables and individuals, while a balanced panel maintains the same number of time observations for each variable and individual. The major cause of the data not being handled is not unbalanced data but rather the panel being computed.

The relationship among the variables is studied with fixed and random effects. It develops a Hausman test for choosing between fixed and random effect models. Based on panel data analysis, the fixed effect model doesn't apply to the constructed test. If the p-value is above 5 percent, we do not support the null hypothesis that the fixed effects model is more suitable than the random effects model.

Hausman's hypothesis is;

Ho: The random effect model is appropriate

H1: The fixed effect model is appropriate

RESULTS AND DISCUSSION

Table 2. Descriptive Analysis

	GPCA	RLENGTH	MCS	EU	INV	TO
MEAN	5332.47	218621.5	68.7366	1314.99	24.4949	63.8736
MEDIAN	4621.868	241211.5	72.9175	880.4986	25.3277	47.6358
MAX.	15225.61	544917.0	164.4406	3060.386	35.7994	220.4068
MIN	524.9459	20782.00	0.2153	122.7029	12.5206	25.3062
S.D.	4288.910	159475.7	45.0359	970.0542	5.6817	48.4685

Note. Author own calculation

Table 3. Correlation Matrix

	LNGDP	LNRL	MCS	LNEU	INV	TO
LNGDP	1.0000	0.3962	0.5043	0.8483	0.3299	-0.4987
LNRL	0.3962	1.0000	0.2004	0.3574	-0.2053	-0.0146
MCS	0.5043	0.2404	1.0000	0.3638	0.2758	0.2461
LNEU	0.8483	0.3575	0.3638	1.0000	0.1109	0.5344
INV	0.3299	-0.2053	0.2758	0.1109	1.0000	-0.0105
TO	-0.4987	-0.0146	0.2461	0.5344	-0.0105	1.0000

Note. Author own calculation

Table 4. Panel Unit Root Test Results

Variables	LLC		IPS	
	Level	1st difference	Level	1st difference
GDPPC	-0.2940 (0.6165)	-1.9413 (0.0261)**	1.8321 (0.9665)	-3.2883 (0.0005)*
RL	-0.1501 (0.4403)	-1.8647 (0.0311)**	2.5178 (0.9941)	-4.9818 (0.0000)*
EU	-0.0826 (0.15896)	-1.7645 (0.0388)**	-0.8256 (0.2045)	-2.2569 (0.0120)*
MCS	-1.0053 (0.8426)	-0.9327 (0.0175)*	0.8512 (0.8027)	-1.3599 (0.0869)**
GFCF	-0.7360 (0.2308)	-2.8756 (0.0020)*	-0.0433 (0.4827)	-3.1800 (0.0007)*
TO	-0.3499 (0.3699)	-5.994 (0.0000)*	0.1609 (0.5639)	-5.3945 (0.0000)*

Note. ***& ** reveals the significance level at 1%, 5% & 10 %.

The findings from the panel unit root find that none of the variables are stationary at the level. Unit root tests are less than 0.05 at 1st difference P-value for the data in both panels, implying that the null hypothesis of the presence of a unit root is rejected (stationary data at 1st difference).

Table 5. Cointegration Test Results

Within Dimension Statistics		
	Statistics	Prob- Value
Panel -v- Statistic	8.5006	(0.0000)*
Panel -rho- Statistic	1.5915	0.9443
Panel -PP- Statistic	-1.4045	(0.0801)***
Panel -ADF- Statistic	-1.4984	(0.0670)**
Between Dimension Statistics		
Group - rho- Statistic	2.5627	0.9948
Group - PP- Statistic	-1.3528	(0.0881)***
Group - ADF- Statistic	-1.9936	(0.0231)**

Note.***& ** reveals the significance level at 1%,5%.&10 %

The result of cointegration depends upon the majority of the outcome. If half or more outcomes declare the p-value below five percent, then the null hypothesis is rejected. In the above table, Panel - v-, and Group - ADF statistics show a value of less than 5 percent, but Panel - PP- Statistics, ADF - Statistics, and Group - PP - Statistics show a probability value of less than ten percent. It is concluded that five outcomes reject the H₀. It means that there exists cointegration in the model. To find the link between the variables random effect model is used in the current study. It is important to choose between random and fixed effect models before the application of the random effect model. The results in the following table are presented for this purpose using the Hausman test.

Table 6. Hausman Test Results

Hausman Test (GDP Per Capita is the Dependent variable)

Test Summary	Results
Chi-Sq- Statistics	7.2820
Probability value	

Note. The three asterisks ******* & ****** reveal the significance level at 1%, 5% & 10 %.

The above results distinguish between the application of fixed and random effect models. The first column demonstrates the test summary, while 2nd column shows the results accordingly. The Chi-Sq-Statistics is 7.2820, and the P- value is 0.2005, which is above 5 percent. The final comment is that the P-value is above 5%, which rejects the alternative statement and shows that the random effect model is appropriate for the above model.

Table 7. Random Effect Model Results

Variables	Coefficients/ P- Value
MCS	0.0027 (0.0104)**
EU	0.6880 (0.0000)*
TO	0.0030 (0.0062)
RL	0.1987 (0.0000)*
GFCF	0.0500 (0.0000)*
A_R ²	0.82

Note. ******* & ****** reveals the significance level at 1%, 5% & 10 %.

In the random effect model, the relationship between dependent and independent variables is analyzed. Mobile cellular subscription has a positive sign and this indicates that there is an encouraging and significant correlation with economic growth. The economic growth variable positively correlates with the length of road per km. Moreover, roads are important in promoting economic growth and therefore the governments of these countries should concentrate on investing in infrastructure such as new roads. Energy use is also shown to have a considerable positive impact on economic growth. But energy should be used efficiently, not harmful to the economy and environment. So, the government should relax taxes and provide subsidies in the energy sector. People should use alternative methods of energy rather than non-modern energy sources. To save energy and environmental pollution, people should use public transport instead of their vehicles and use less energy in homes, offices, and institutions. Even CNG may be used instead of other fuels, and less consuming energy vehicles may be designed. People should not excessively use energy and should adopt modern methods of energy like biogas and solar to save energy. The other two variables also demonstrate a positive relationship with GDP growth, indicating that the contribution of transport infrastructure to selected Asian countries' economic growth is both significant and positive. In addition, energy, information, and communication technology are also identified as positive contributions to economic growth. The selected Asian country is found to have a positive correlation among economic growth, trade openness, and gross fixed capital formation.

This research suggests that the Government can encourage economic growth by promoting investment in ICT to help facilitate easy access to ICT. As communications and information technologies reduce trade costs, they may contribute to economic development. Therefore, increasing investment in this area can be an effective strategy for promoting economic growth.

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