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Influence of Infrastructure Development with its Sub-sectors on Economic Growth in Selected Asian Countries: An Empirical Analysis using DOLS and FMOLS Approaches

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ABSTRACT

This paper exploits a dynamic ordinary least square (DOLS) and fully modified ordinary least square (FMOLS) panel data method to research the bond through infrastructure development and economic growth for four selected Asian countries viz., China, Pakistan, India and Bangladesh since 1990-2016. In this regard, the data is collected mainly from secondary resources including gross domestic product (GDP), domestic credit (DC), electric power consumption (EN), rail lines (RL), mobile subscriptions (M), health expenditures (HT), Education expenditures (ED). To attain the desired objectives, panel causality test is also used in the study to check the causal relationship among the variables. Results showed that all the variables have significant positive impact on economic growth except the variable domestic credit. Further, the findings showed that investment in all types of categories in public infrastructure have significant contribution in the development of the countries. The study concludes that an economy can robust its economic growth if regressive taxes are levied. Moreover, study recommends that the countries should have to focus on all the sectors but there is need to focus more on energy sector and telecommunication sector to accelerate economic growth.

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1. Introduction

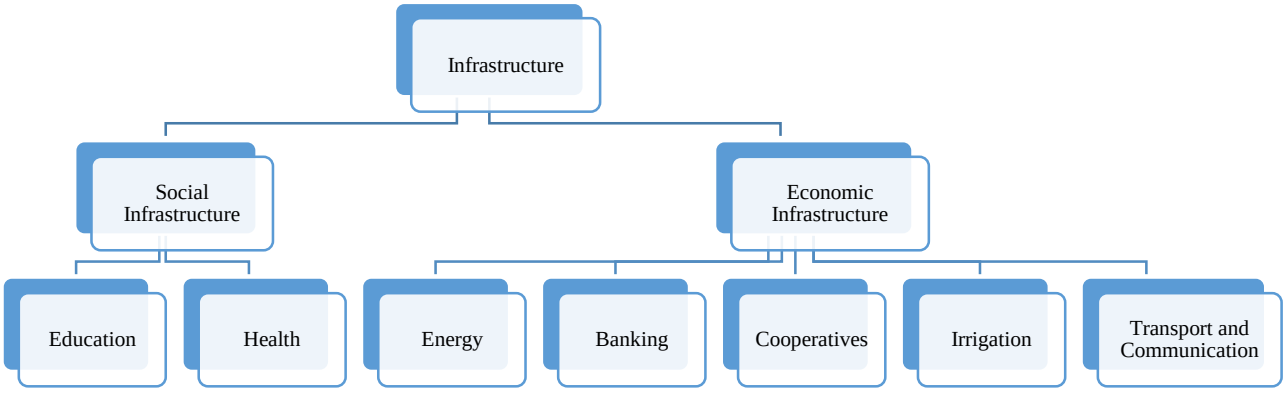
The term infrastructure has its origin in the 19th century in France, where it was basically, means military installations. Since 1927 infrastructure is being used collectively for roads, bridges, transport, telecommunication etc. Infrastructure is a combination of words: infra and structure meaning by under the structure or foundation. Hence infrastructure in an economy acts in the similar manner as a foundation does in an edifice. Public infrastructure investment has been an important part and parcel of development strategy in developed and developing economies. Public infrastructure facilitates private investment by providing a conducive environment for further expansion in investment through roads, bridges, energy, transport system etc. (Adam & Bevan, 2014; Afonso & ST. AUBYN, 2009; Jiang, He, Zhang, Qin, & Shao, 2017). Public infrastructure investment can also result in crowding out of a private investment if distortionary taxes are imposed to finance infrastructure projects or diminishes expected rate of return on private investment. Similarly, high demand of funds by the government from financial markets can also increase interest rate which is detrimental for propensity to invest (Afonso & ST. AUBYN, 2009; Phetsavong & Ichihashi, 2012).

Although many studies had been carried out related to infrastructure yet their focus was on output and growth without the relationship between infrastructure and social welfare. Infrastructure investment up to a threshold level found welfare improving and too high level of infrastructure expenditure had detrimental consequences for welfare (Rioja, 2001). Infrastructure investment affected growth, important macroeconomic variables as well as welfare. However, welfare gains through public investment in infrastructure depended on the

actual condition of infrastructure. Countries with good infrastructure available with them will enjoy greater GDP growth and welfare than those counterparts with poor infrastructure. Meanwhile, infrastructure investment could negatively affect private investment and public consumption resultantly reduced social welfare through extra tax burden (Machicado, 2007).

There is a core relationship between infrastructure and economic development and this was shown by the causal link between the regional level economic development and infrastructure. There is also the relationship between different communities in a region. It keeps much importance to show the relation between economic developments at the community level because investment on infrastructure is made at local levels (Tsaurai & Ndou, 2019). Economic development is positively affected by Human capital while heavy taxes have not good impacts on growth. The population has no positive effect at the community level. Maintenance of capital depreciation keeps the significant importance of economic development. Infrastructure also keeps high importance for business and industry (Baklanova, Petrova, & Koval, 2020).

Figure 1: Components of Infrastructure



Asia is very populous continent and half of the world's population is living in Asia. With the passage of time Asia has grown up very much and poverty has also reduced to the great extent. Approximate Gross National Product (GNP) of Asian countries has also increased from 1999 to 2014 with amount of 2390$ to 5305$[1] and it is estimated that poverty also decreased from 2004 to 2013 with 809.1 million to 633 million as per poverty line $ 1.25 daily report by Asian Development Bank 2012. The core significant of this progress is the availability of appropriate infrastructure. Physical infrastructure as well as social infrastructure keeps much importance to provide services to households and manufacturing zone. The provision of basic needs like roads, transportation, sanitation, telecommunication and safe drinking water and good health facilities improves the living standards of households. These facilities not only enhance income but also minimize poverty too. Physical and social infrastructural facilities decrease vulnerability to losses and improve nation's climatic change. Lack of the required infrastructure is core barrier in economic progress. China is a developed country and experiencing a higher economic growth rate rather than India, Pakistan and Bangladesh. However, the economic reforms in 1990s accelerate the economic growth in India and Bangladesh but Pakistan could not achieved desired economic objectives due to its internal conflicts, social security and political instability which interrupt the business environment for investment (Rehman, Khan, Khan, Pervaiz, & Liaqat, 2020).

There is no dearth of studies on infrastructure development and economic growth, but this study will add a significant contribution in the existing literature. Most of the previous studies had analyzed the relationship between infrastructure and economic growth; however, a few studies had observed this relationship. Moreover, past studies had conducted time series analysis of infrastructure impact on economic growth but this study would present more appropriate econometric techniques. Although a few studies are available on European countries yet little evidence is found that any renowned study was conducted on Asian countries through panel data

[1] $ Sign is a symbol used to represent the several currencies round the globe.

analysis. Infrastructure investment is crucial for overall socio economic development of a nation. Infrastructure attracts investment in other essential services and comes in handy in improving human development. It acts as wheel of the economy because it encompasses on vital services like telecommunication, urban development, civil aviation, transport, postal services, civil services etc. Infrastructure is an underlying structure or supporting installations which are essential for working of national or international economies. Infrastructure development plays positive role in people to people contact and bridging gaps among comity of nations. Efficient infrastructure also has a positive impact on production. In this context, the objective of study is to examine the influence of infrastructure development with its sub-components on economic growth in selected countries of Asia using FMOLS and DOLS panel data techniques. Further, the study also examines the causal relationship among the study's variables including gross domestic product, domestic credit, electric power consumption, rail lines, mobile subscriptions, health expenditures, Education expenditures and agriculture irrigated land.

The rest of the paper is divided into four sections. The brief review of literature is presented into section 2. Section 3 presents the materials and methods including data types, data sources, as well as analytical techniques which are used in the paper. Section 4 presents the empirical results of the study. At the last, conclusions and policy recommendations are presented in section 5.

2. Brief Review of Literature

The main purpose of particular interest of this study is to examine the impact of infrastructure development on economic growth. The relationship between economic growth and development of different components of infrastructure particularly physical infrastructure, a most important type of infrastructure, is widely studied in the literature. According to the knowledge of researcher, different authors empirically worked on the infrastructure development, investment, welfare and economic growth. As argued by Kumari and Sharma (2017), the relationship between physical and social infrastructure and economic development is positive and both economic and social infrastructure has a progressive relationship with economic growth. At the same time, the both types of infrastructure i.e. physical as well as social have importance in the development process however, physical infrastructure is much necessary for the development and economic growth (Hussain, Naqvi, Makhdum, & Shah, 2019). Ishida (2015) examined the effect of the development of information communication technologies (ICT) on energy consumption and economic growth and showed that ICT will subsidize both energy consumption and increase economic growth. Further, many observers stated that the development of telecommunication infrastructure is a necessary for the development of other sectors of infrastructure which are necessary for economic growth (Erumban & Das, 2016; Jorgenson & Vu, 2016; Kumar, Kumar, & Patel, 2015; Pradhan, Arvin, Norman, & Bele, 2014; Salahuddin & Alam, 2015; Shabani & Shahnazi, 2019).

Conversely, Minges (2015) examined that broadband has inverse impact on economic growth. Moreover, Zahra, Azim, and Mahmood (2008) concluded that if the infrastructure of telecommunication is good then GDP of these countries will be raised up. They also suggested that investment in telecommunication infrastructure had a positive link and had good results. Likewise, Calderón and Servén (2010) concluded that in the long run when the infrastructure is improved then service quality will be good but it has negative effect on income inequality. Findings showed that trade and infrastructure are interweaved to each other. They also observed that income inequality exists in large countries over time. Some Asian countries also had same sympathetic. In the same way, findings of Calderón and Servén (2014) showed that infrastructure growth highly operative to combat poverty. Shi (2012) empirically examined a study on economic growth of China to see the effect of infrastructure. He explored that if infrastructure increases, then employment also increase. On the other hand there are also some studies on the causality between infrastructure and economic progress as Kaur and Malhotra (2014) investigated the causality between GDP as well as many other determinants of GDP and telecommunication infrastructure development in India. The literature showed that there is causality among growth of telecommunication sector and economic growth in long run at both aggregate level and at sectorial levels. The study also indicated that there is causality between growth of telecommunication sector with other sectors of economy as like manufacturing sector and services sectors.

Parikh, Fu, Parikh, McRobie, and George (2015) observed the association between infrastructure establishment and poverty mitigation by evaluating five hundreds interviews led in examined then non-serviced favelas of India. The study established that poverty can be lessened by gender sensitive infrastructure interventions. The study also established that by the investment in infrastructure, employment opportunities will be increased and these opportunities will help to improve the lives of slums residents. Along with, another study by Oladipo and Olomola (2015) investigated the nature and way of fundamental association between development of highway transport infrastructure, economic progress and deficiency in Nigeria. The study results showed that in short run poverty can be reduced by the progress of road transport infrastructure and economic growth and both could affect one another. It was concluded by the study that to mitigate and overcome on poverty development of transport infrastructure and economic growth contributes bit. Musibau, Mahmood, and Hammed (2017) explored the effect of infrastructure as well as foreign capital inflows, and corruption on economic growth among ECOWAS member's countries. It was estimated that there is an inverse link between foreign direct investments, Infrastructure also real progress rate while on the other side, real economic growth positively affected by ODA, corruption, political stability among ECOWAS members.

Wan and Zhang (2018) estimated the straight besides indirect special effects of infrastructure off firm output and proposed analytical framework for estimating both types of effects. They find out that both effects were significant and positive. The study moreover established that administering the infrastructure accumulation connection indications towards overestimation of the through results. Oladipo (2017) examined the impact between development of road infrastructure, poverty level and economic growth in Nigeria. The result indicated that an unanticipated rise in the development of road infrastructure transport increased economic growth. It was determined that development of road infrastructure has significant effect on economic progress while helps in reduction of poverty in Nigeria. Overall previous literature clearly showed that still there is a special need to work on infrastructure development in large economies of Asia. Moreover, in recent years, Asian economies are investing large amount of their revenues on improving their physical as well as social infrastructure.

3. Materials and Methods

3.1. Data and Empirical Model

Literature review and theoretical framework have made it clear that infrastructure is essential for economic growth. A set of countries as China, India, Pakistan and Bangladesh are selected from Asia and annual secondary data is used to estimate the results. The study explored the empirical relationship between infrastructure development with its sub-components and economic growth for selected countries of Asia over the period of 1990 to 2016. Data is collected mainly from the World development indicators (WDI). The description of variables is presented in Table 1.

Table 1: Description of Variables

Variables	Signs	Definition (Measurement)	Data Source
Gross domestic product	GDP	Gross Domestic Product (Current US$)	World Development Indicators
Domestic credit	DC	Domestic credit provided by financial sector (% of GDP)	World Development Indicators
Electric power consumption	EN	Electric power consumption (kwh per capita)	World Development Indicators
Total health expenditures	HT	Health expenditure total (% of GDP)	World Development Indicators
Agricultural irrigated land	IRN	Agricultural irrigated land (% of total agriculture land)	World Development Indicators
Government expenditures on education	ED	Government expenditure on education total (% of GDP)	World Development Indicators
Mobile cellular or subscriptions	M	Mobile cellular or subscriptions (per 100 people)	World Development Indicators
Rail lines	RL	Rail lines (Total route-km)	World Development Indicators

To analyse the interrelationship among gross domestic product, domestic credit, energy, health, irrigation, education, mobile and rail lines the equation (1) is estimated as.

$$GDP_{i,t} = \beta_{\circ} + \beta_1 DC_{i,t} + \beta_2 EN_{i,t} + \beta_3 HT_{i,t} + \beta_4 IRN_{i,t} + \beta_5 ED_{i,t} + \beta_6 M_{i,t} + \beta_7 RL_{i,t} + \mu_{i,t} \quad (1)$$

In the above equation.1, (GDP) is taken as dependent variable that is used in US Dollar. GDP is important because it measures economic activity in a country. The variable Domestic credit (DC) is proxy by the credit provided by the commercial zone (% of GDP), the capitalization of domestic companies (current US $), total reserve, including gold (current US $). Another independent variable is energy Consumption (EN). Electric power consumption is used for a proxy of energy infrastructure which is an important part of the physical infrastructure and crucial for economic growth. Health expenditure (HT) is another important independent variable and is an important part of the infrastructure and helps to provide better health facilities. The variable Agricultural irrigated land (IRN) is used as proxy of irrigation infrastructure whereas (ED) represents the total government expenditure on education. Moreover, variable (M) and (RL) represents the mobile cellular subscription and rail lines, respectively. Rail line is an important sub-component of transport infrastructure. All the variables were transformed into natural logarithm and so the equation 1 is written as follows;

$$LNGDP_{i,t} = \beta_{\circ} + \beta_1 LNDC_{i,t} + \beta_2 LNEN_{i,t} + \beta_3 LNHT_{i,t} + \beta_4 LNIRN_{i,t} + \beta_5 LNED_{i,t} + \beta_6 LNM_{i,t} + \beta_7 LNRL_{i,t} + \mu_{i,t} \quad (2)$$

Where β_0 represents the intercept term, *LN* denotes the natural logarithm, β_1 - β_7 indicate the elasticity of variables whereas μ_{it} represents the error term.

3.2. Panel Unit Root Tests

To check the stationary among the variables and to investigate the degree of integration among the variables in panel data, panel unit root tests are used. So for this purpose, we used several unit root tests in this study that contain PP test that is recommended by Hadri (2000), Maddala and Wu (1999), Choi (2001), and Breitung (2001). ADF using in fisher test, Im, Pesaran, and Shin (2003) proposed IPS test and Levin, Lin, and Chu (2002) introduced LLC test. Across the cross-section, the Fisher-PP, IPS tests and Fisher-ADF tests undertake that there are different unit root procedures. There is unit root in variables is the null hypothesis of these three tests although there is no unit root of some cross-sections contains an alternative hypothesis. It is revealed that individual values of panel series have explicit inclinations that are the chunk of LLC and IPS, this is because the correction is biased which moreover eradicates mean in the sequence of a local substitute (Breitung, 2001). The author advocates a test that is not used as a preconception alteration with the extraordinary power of IPS or LLC tests. Breitung's statistics null hypothesis is the panel set validates non-stationary transformation however alternative hypothesis reveals that the panel series is stationary. Lagrange Multiplier (LM) test is proposed by Hadri (2000). Where no unit root in panel set becomes a null hypothesis and there is a unit root in panel set is alternative hypothesis.

3.3. Panel Co-Integration Test

In command to evaluate the long run association in panel series Panel co-integration test is used among variables of the study. Co-integration test has two types: group tests and panel tests (Pedroni, 2004). Pedroni tests bases on assessed residuals of long run model given below:

$$GDP_{it} = \alpha_i + \sum_{k=1}^{r} \beta_{ki} G_{kit} + \varepsilon_{it} \quad (4)$$

Where is i= 1, N for all in data series and t= 1… T states time period in data series α_i stricture let for freedom of fixed effects of section-specifics. ε_{it} Signify long-run association aberration. No cointegration of null hypothesis H_i=1 is measured through the unit root test on residuals of data series for this the equation is as follows:

$$\varepsilon_{it} = H_i \varepsilon_{i(t-1)} + P_{it} \quad (5)$$

Three methods of Co-integration is used in the study. Two-step procedures of enforcing homogeneity and Engle-Granger and on units of data series explanation in Dickey-Fuller test framework was established first by (Kao, 1999). The Fisher's test pooled the p-values of specific possibility Johansen maximum co-integration test statistics (Maddala & Wu, 1999). Nonparametric tests do not undertake similarity in coefficients of Fisher's test. All seven test's

alternative hypothesis is that the co-integration exists between study variables and null hypothesis states that no co-integration occurs between the study's variables.

3.4. Panel FMOLS and DOLS techniques

To estimate the long run relationship between variables, panel FMOLS and DOLS estimation techniques were used. In long-run equation the OLS estimator leads to preconception estimators of parameter until repressors are firmly exogenous; therefore, OLS estimators are unable to for effective inference. FMOLS is proposed by Pedroni (2001) and DOLS is introduced by (Kao & Chiang, 2001; Mark & Sul, 2003) as substitute approach for panel co-integration estimation. The FMOLS is considered as a non-parametric method and accounts for the potential association between the first difference and error term of the regressor along with because of the occurrence of a relentless term, to handling amendment for serial association (Maddala & Wu, 1999). The assessment of FMOLS and DOLS allow us to contemplate the subsequently mounted results of panel regression:

$$GDP\ it = \alpha i\ +\ G\_it\ \beta + \varepsilon\_it\ \ i\ =\ \ N, t\ =\ 1, \dots, T \tag{6}$$

Here $GDP_{it}$is a matrix (1,1) ,β is slopes of vector (k,1) measurement, individual fixed effect is *ai* , stationary disturbance terms are ε_{it} . It is supposed that Z_{it}(k, 1) direction is assimilated methods of order one for all *i*, where:

$$G_{it}\ =\ G_{it-1}\ +\ \mu_{it} \tag{7}$$

Below these stipulations, Eq (3) designates a system of integrated regressions, i.e. $GDP_{it}$is co-integrated with Z_{it} . By investigative the restrictive circulation of the FMOLS and DOLS estimators in co-integrated regressions Kao and Chiang (2001) indicated that they're asymptotically traditional. The FMOLS reckoner is made by creating corrections for endogeneity and sequential correlation to the OLS reckoner and is outlined such as;

$$\bar{Y}_{FM} = [\sum_{i=1}^{N}\sum_{t=1}^{T}(G_{it} - \bar{g}_{it})]^{-1}[\sum_{i=1}^{N}(\sum_{t-1}^{T}(G_{it} - \bar{g}_{it})\hat{h}_{it}^{+} + T\Delta_{\varepsilon\mu}^{+})] \tag{8}$$

Here $\Delta\varepsilon\mu+\hat{}$ is the serialized correlation alteration term and $\check{h}^{+}_{it}$ remains the converted variable of *hit* ian direca tion to attain the endogeneity adjustment. In serialized association and the endogeneity would be modified through using DOLS estimator. Now in direca tive to attain an balanced estimator of the long-run factors, DOLS estimator uses parametric adjustment to the errors by counting the previous and the upcoming values of the differenced I(1) regressors. From the following equation of DOLS, results can be obtained.

$$GDP_{it}\ =\ \alpha_j +\ BiG_{it} + \sum_{Q=w}^{w} c_{ik}\ \ \Delta G_{it+k}\ + \varepsilon_{it} \qquad t = 1, \dots \dots . T\ i = 1, \dots \dots . N \tag{8}$$

Here *ai* specifies the country-specific result and *cik*is constant of an indication or gap of firstly differenced descriptive variables. Term ε_{it} represents the disruption positions behind the I(0) method. A predictable figure of DOLS is given by.

$$\bar{Y}_{DOLS} = \sum_{i=1}^{N}(\sum_{t=1}^{T} k_{it}k_{it}')^{-1}(\sum_{i=1}^{T} k_{it}k_{it}^{+} + y_{it}^{+}) \tag{9}$$

3.5. Panel VECM

A panel vector error correction model is predicated for observe the causal relationship (Pesaran, Shin, & Smith, 1999). Two-step technique is expected for first approximating the long-run model identified the Engle and Granger (Engle & Granger, 1987).

Eq. (3) obtained the expected residuals. Afterward, describing the lagged residuals from Eq. (3) because the error modification term, the subsequent dynamic error correction model is predictable

$$lnGDP_{it} = \varepsilon_{ij} + \sum_{k=1}^{q}\psi_{1ik}lnGDP_{it-k} + \sum_{k=1}^{q}\psi_{2ik}lnDC_{it-k} + \sum_{k=1}^{q}\psi_{3ik}lnEN_{it-k} + \sum_{k=1}^{q}\psi_{4ik}lnHT_{it-k} + \sum_{k=1}^{q}\psi_{5ik}lnIRN_{it-k} + \sum_{k=1}^{q}\psi_{6ik}lnED_{it-k} + \sum_{k=1}^{q}\psi_{7ik}lnM_{it-k} + \sum_{k=1}^{q}\psi_{8ik}lnRL_{it-k} + \gamma_{1i}\varepsilon_{it-1} + \mu_{1it} \quad (10)$$

$$lnDC_{it} = \varepsilon_{2j} + \sum_{k=1}^{q}\psi_{11ik}lnGDP_{it-k} + \sum_{k=1}^{q}\psi_{12ik}lnDC_{it-k} + \sum_{k=1}^{q}\psi_{13ik}lnEN_{it-k} + \sum_{k=1}^{q}\psi_{14ik}lnHT_{it-k} + \sum_{k=1}^{q}\psi_{15ik}lnIRN_{it-k} + \sum_{k=1}^{q}\psi_{16ik}lnED_{it-k} + \sum_{k=1}^{q}\psi_{17ik}lnM_{it-k}\psi_{18ik}lnRL_{it-k} + \gamma_{2i}\varepsilon_{it-1} + \mu_{2it} \quad (11)$$

$$lnEN_{it} = \varepsilon_{3j} + \sum_{k=1}^{q}\psi_{21ik}lnGDP_{it-k} + \sum_{k=1}^{q}\psi_{22ik}lnDC_{it-k} + \sum_{k=1}^{q}\psi_{23ik}lnEN_{it-k} + \sum_{k=1}^{q}\psi_{24ik}lnHT_{it-k} + \sum_{k=1}^{q}\psi_{25ik}lnIRN_{it-k} + \sum_{k=1}^{q}\psi_{26ik}lnED_{it-k} + \sum_{k=1}^{q}\psi_{27ik}lnM_{it-k} + \sum_{k=1}^{q}\psi_{28ik}lnRL_{it-k} + \gamma_{3i}\varepsilon_{it-1} + \mu_{3it} \quad (12)$$

$$lnHT_{it} = \varepsilon_{4j} + \sum_{k=1}^{q}\psi_{31ik}lnGDP_{it-k} + \sum_{k=1}^{q}\psi_{32ik}lnDC_{it-k} + \sum_{k=1}^{q}\psi_{33ik}lnEN_{it-k} + \sum_{k=1}^{q}\psi_{34ik}lnHT_{it-k} + \sum_{k=1}^{q}\psi_{35ik}lnIRN_{it-k} + \sum_{k=1}^{q}\psi_{36ik}lnED_{it-k} + \sum_{k=1}^{q}\psi_{37ik}lnM_{it-k} + \sum_{k=1}^{q}\psi_{38ik}lnRL_{it-k} + \gamma_{4i}\varepsilon_{it-1} + \mu_{4it} \quad (13)$$

$$lnIRN_{it} = \varepsilon_{5j} + \sum_{k=1}^{q}\psi_{41ik}lnGDP_{it-k} + \sum_{k=1}^{q}\psi_{42ik}lnDC_{it-k} + \sum_{k=1}^{q}\psi_{43ik}lnEN_{it-k} + \sum_{k=1}^{q}\psi_{44ik}lnHT_{it-k} + \sum_{k=1}^{q}\psi_{45ik}lnIRN_{it-k} + \sum_{k=1}^{q}\psi_{46ik}lnED_{it-k} + \sum_{k=1}^{q}\psi_{47ik}lnM_{it-k} + \sum_{k=1}^{q}\psi_{48ik}lnRL_{it-k} + \gamma_{5i}\varepsilon_{it-1} + \mu_{5it} \quad (14)$$

$$lnED_{it} = \varepsilon_{6j} + \sum_{k=1}^{q}\psi_{51ik}lnGDP_{it-k} + \sum_{k=1}^{q}\psi_{52ik}lnDC_{it-k} + \sum_{k=1}^{q}\psi_{53ik}lnEN_{it-k} + \sum_{k=1}^{q}\psi_{54ik}lnHT_{it-k} + \sum_{k=1}^{q}\psi_{55ik}lnIRN_{it-k} + \sum_{k=1}^{q}\psi_{56ik}lnED_{it-k} + \sum_{k=1}^{q}\psi_{57ik}lnM_{it-k} + \sum_{k=1}^{q}\psi_{58ik}lnRL_{it-k} + \gamma_{6i}\varepsilon_{it-1} + \mu_{6it} \quad (15)$$

$$lnM_{it} = \varepsilon_{7j} + \sum_{k=1}^{q}\psi_{61ik}lnGDP_{it-k} + \sum_{k=1}^{q}\psi_{62ik}lnDC_{it-k} + \sum_{k=1}^{q}\psi_{63ik}lnEN_{it-k} + \sum_{k=1}^{q}\psi_{64ik}lnHT_{it-k} + \sum_{k=1}^{q}\psi_{65ik}lnIRN_{it-k} + \sum_{k=1}^{q}\psi_{66ik}lnED_{it-k} + \sum_{k=1}^{q}\psi_{67ik}lnM_{it-k} + \sum_{k=1}^{q}\psi_{68ik}lnRL_{it-k} + \gamma_{7i}\varepsilon_{it-1} + \mu_{7it} \quad (16)$$

$$lnRL_{it} = \varepsilon_{8j} + \sum_{k=1}^{q}\psi_{71ik}lnGDP_{it-k} + \sum_{k=1}^{q}\psi_{72ik}lnDC_{it-k} + \sum_{k=1}^{q}\psi_{73ik}lnEN_{it-k} + \sum_{k=1}^{q}\psi_{74ik}lnHT_{it-k} + \sum_{k=1}^{q}\psi_{75ik}lnIRN_{it-k} + \sum_{k=1}^{q}\psi_{76ik}lnED_{it-k} + \sum_{k=1}^{q}\psi_{77ik}lnM_{it-k} + \sum_{k=1}^{q}\psi_{78ik}lnRL_{it-k} + \gamma_{8i}\varepsilon_{it-1} + \mu_{8it} \quad (17)$$

Here Δ is the first-difference, k is that the lag length set at one supported chance quantitative relation tests, and μ is that the serially unrelated error term. From (A) to (H), the short-term relation is set by the applied mathematics consequence of the fractional F-statistic related to the corresponding variables. The semi-permanent relation is discovered by the applied mathematics significance of the individual error correction terms employing a t-test. The short-term relation is set by the applied mathematics impact of the F-statistic. In the occurrence of long-run connection would be recognized by investigative the importance usage the t-statistic on the coefficient λ, of the error correction term, εit-1 in (A)-(H) equations.

4. Results and Discussion

4.1. Descriptive results

In order to examine the relationship between infrastructure development and economic growth, we begin our results by performing descriptive statistics of entire variables used in the study. Table 1 presents the descriptive statistics of all variables of study for nominated Asian countries. The GDP has the mean and S.D value is 26.48±1.06, which indicates that GDP is a sensitive phenomenon. Standard deviation is a measure of volatility, greater the S.D greater is the dispersion and volatility. In the same manner, Domestic Credit has the mean and S.D value is 4.101±0.51.

Table 2: Descriptive Analysis

	ln_GDP	ln_DC	ln_ED	ln_EN	ln_HT	ln_IRN	ln_M	ln_RL
Mean	26.486	4.100	0.861	6.118	1.243	3.818	0.750	9.753
Median	26.333	3.965	0.785	6.065	1.223	3.908	1.386	10.014
Maximum	30.047	5.371	1.470	6.789	1.745	4.042	4.573	11.139
Minimum	24.156	3.020	0.354	5.610	0.811	3.325	-8.411	7.903
Std. Dev.	1.608	0.517	0.261	0.317	0.252	0.207	3.490	1.343
Skewness	0.462	0.254	0.595	0.582	0.101	-1.096	-0.716	-0.228
Kurtosis	2.259	2.872	2.532	2.440	1.799	2.721	2.466	1.304
Jarque − Bera	6.318	1.235	7.354	7.499	6.676	21.982	10.518	13.870
Probability	0.042	0.539	0.025	0.024	0.036	0.000	0.005	0.001
Sum	2860.478	442.766	93.008	660.761	134.279	412.324	81.005	1053.290
Sum Sq. Dev.	276.704	28.595	7.295	10.749	6.795	4.567	1303.566	192.943
Observations	108	108	108	108	108	108	108	108

Further Education has the mean and value of S.D is 0.86±0.26. Moreover, energy has the mean and value of S.D is 6.11±0.31. In the same manner, Health has the mean and S.D value is 1.24 ±0.25. Further irrigation has the mean an S.D value is 3.81±0.20. Moreover, mobile cellular has the mean and S.D value is 0.75±3.49. In the same manner rail lines have the mean and S.D value is 9.75±1.34. Skewness shows that ln GDP, ln domestic credit (DC), ln education (ED), ln energy (EN) and ln health (HT) are positively skewed whereas ln irrigation (IRN), ln mobile (M) and ln rail lines (RL) are negatively skewed. Moreover, jarque-Bera values indicate the normality of data. The graphical representation of the trend of all variables for China, India, Pakistan and Bangladesh also presented (see Appendix Table 2).

4.2. Unit root results

The first phase involves in establishing the order of integration of every variable where FMOLS and DOLS is appropriate for variables which are integrated at level or first difference. The analysis of the study starts by investigating variables using Breitung Unit Root Test, Fisher Chi Unit Root Test, PP Fisher Unit Root Test and Hadri Z-Stat Unit Root Test. Table 3 indicates that the Breitung unit root is tested for GDP, DC, EN, HT, IRN, ED, M, and RL. At level our results is not significant, at first difference these are significant. GDP is Significant at p<0.05 on 0.028. Domestic credit (Dc) is significant at Significant at p<0.01on 0.0016. Energy (EN) is also a significant factor at p<0.01 0n 0.0096. Health (HT) is significant at p<0.05 on 0.0451. Irrigation (IRN) is also significant at p<0.01 0n 0.0009. Education (ED) is significant at p<0.01 0n 0.0096. Mobile subscriptions (M) is significant p<0.10 on 0.0638. Rail lines (RL) is not significant at all the level of significance.

Table 3: Breitung Unit Root Test

	Level		First Difference	
Variables	**Breitung Statistic**	**Prob.**	**Statistics**	**Prob.**
GDP	1.44435	0.9257	-1.90784	0.0282**
Dc	-0.20026	0.4206	-2.94114	0.0016***
EN	0.73692	0.7694	-2.34308	0.0096***
HT	-0.91045	0.1813		
IRN	-1.01247	0.1557	-3.13606	0.0009***
ED	-0.22379	0.4115	-2.34308	0.0096***
M	2.19835	0.986	-1.5233	0.0638*
RL	4.37716	1	1.37403	0.9153

*** Significant at p < 0.01 ** Significant at p < 0.05 * Significant at p < 0.10

Table 4 indicates that Fisher Chi Unit Root is tested for GDP, DC, EN, HT, IRN, ED, M, and RL. At level our results are not significant; at first difference these are significant. GDP is significant at p<0.05 on 0.017. Domestic credit (DC) is significant at p<0.01 on 0.006. Energy (EN) is also significant factor at p<0.05 on 0.033. Health (HT) is strongly significant at p<0.01on 0.000. Irrigation (IRN) is significant at p< 0.01 on 0.000. Education (ED) is also significant at p<0.01 on 0.003. Mobile (M) is significant at p<0.01 on 0.000. Rail lines (RL) is also significant at p<0.01 on 0.001.

Table 4: Fisher Chi Unit Root Test

	Level				First Difference			
Variables	**Fisher Chi Statistic**	**Prob**	**Choi-Z Statistic**	**Prob**	**Fisher Chi Statistic**	**Prob**	**Choi-Z Statistic**	**Prob**
GDP	3.499	0.899	1.093	0.863	16.698	0.033**	-2.119	0.017*
DC	4.534	0.806	0.627	0.735	21.362	0.006*	-2.535	0.006*
EN	2.395	0.966	1.784	0.963	15.321	0.053*	-1.833	0.033**
HT	19.277	0.013	-1.917	0.028	26.013	0.001***	-3.362	0.000***
IRN	13.971	0.083	-1.373	0.085	49.808	0.000***	-5.116	0.000***
ED	7.350	0.499	-0.305	0.380	22.937	0.003**	-2.773	0.003**
M	37.062	0.000	-2.681	0.004	275.664	0.000***	-9.630	0.000***
RL	6.151	0.630	2.635	0.996	26.286	0.001***	-3.129	0.001***

*** $Significant\ at\ p < 0.01$ ** $Significant\ at\ p < 0.05$ * $Significant\ at\ p < 0.10$

Table 5 indicates that PP Fisher Unit Root Test is tested for GDP, DC, EN, HT, IRN, ED, M, and RL. At level our results are not significant; at first difference these are significant. GDP is significant at p<0.01 on 0.000. Domestic credit (DC) is significant at p<0.01 on 0.000. Energy

(EN) is also significate factor at p<0.01 on 0.000. Health (HT) is strongly significant at p<0.01 on 0.000. Irrigation (IRN) is significant at p<0.01 on 0.000. Education (ED) is also significant at p<0.01 on 0.000. Mobile (M) is significant at p<0.01 on 0.000. Rail lines (RL) is also significant 01 on 0.000.

Table 5: PP Fisher Unit Root Test

Variables	Level PP Fisher Statistics	Prob	pp Choi z Statistics	Prob	First Difference PP Fisher Statistics	Prob	pp Choi z Statistics	Prob
GDP	5.880	0.661	0.768	0.779	30.140	0.000***	-3.613	0.000***
DC	3.467	0.902	0.979	0.836	35.628	0.000***	-4.478	0.000***
EN	2.054	0.979	2.323	0.990	27.199	0.001***	-3.635	0.000***
HT	4.283	0.831	0.573	0.717	37.694	0.000***	-4.243	0.000***
IRN	11.916	0.155	-1.303	0.096	135.851	0.000***	-9.263	0.000***
ED	6.602	0.580	0.219	0.587	27.199	0.001***	-3.635	0.000***
M	19.771	0.011	-1.318	0.094	30.969	0.000***	-3.499	0.000***
RL	7.124	0.523	4.000	1.000	255.281	0.000***	-11.124	0.000***

$*** Significant\ at\ p < 0.01\ ** Significant\ at\ p < 0.05\ * Significant\ at\ p < 0.10$

Table 6 indicates that Hadri Z-stat Unit Root is tested for GDP, DC, EN, HT, IRN, ED, M, and RL. At level our results are not significant; at first difference these are significant. GDP is significant at p<0.05 on 0.031. Domestic credit (DC) is significant at p<0.05 on 0.031. Energy (EN) is also significant factor at p<0.05 on 0.015. Health (HT) is strongly significant at p<0.01on 0.000. Irrigation (IRN) is significant at p< 0.01 on 0.001. Education (ED) is also significant at p<0.05 on 0.033. Mobile (M) is significant at p<0.01 on 0.001. Rail lines (RL) is also significant at p<0.01 on 0.000.

Table 6: Hadri Z-Stat Unit Root Test

Variables	Level Hadri Z-Stat	Prob	Hetro	Prob	First Difference Hadri Z-Stat	Prob	Hetro	Prob
GDP	3.653	0.000***	3.729	0.000***	2.266	0.012**	1.867	0.031**
DC	3.064	0.001***	3.064	0.001***	3.064	0.001***	1.867	0.031**
EN	4.721	0.000***	4.590	0.000***	1.638	0.051*	2.161	0.015**
HT	3.737	0.000***	3.290	0.001***	0.424	0.33**	5.259	0.000***
IRN	2.051	0.020	2.514	0.006*	0.322	0.37**	3.301	0.001***
ED	2.479	0.007*	3.332	0.000***	0.201	0.42**	1.843	0.033**
M	3.185	0.001***	3.524	0.000***	3.038	0.001***	3.199	0.001***
RL	5.250	0.000***	3.173	0.001***	2.285	0.011*	7.411	0.000***

$*** Significant\ at\ p < 0.01\ ** Significant\ at\ p < 0.05\ * Significant\ at\ p < 0.10$

The correlation matrix depicted in Table 7 which is used to predict the level of relationship between two or more variables of this study. Its value is extending from -1 to +1. The positive or negative sign with the coefficient directs the power of the association. There is a positive or negative relationship between the said variables. As in our analysis, Independent variables as ln domestic credit (DC), ln_education (ED), ln_energy (ENG), ln_health (HT), and ln_mobile are positively related with ln_GDP that is the dependent variable. While ln_irrigation (IRN), and ln_rail lines (RL) are negatively correlated to our dependent variable.

Table 7: Correlation Matrix

	ln_DC	Ln_ED	Ln_ENY	Ln_GDP	Ln_HT	Ln_IRN	Ln_M	Ln_RL
ln_DC	1							
ln_EDU	0.17	1						
ln_ENG	0.45	0.37	1					
lN_GDP	0.87	0.35	0.54**	1				
ln_HT	0.70**	0.36	0.39	0.89**	1			
ln_IRN	0.17	-0.58	0.22	-0.096	-0.275	1		
ln_M	0.49**	0.289	0.78**	0.56**	0.399	0.207	1	
ln_RL	0.69**	0.43	0.09	0.83**	0.82**	-0.491	0.196	1

4.3. Panel Co-Integration Test Results

To check the robustness we used panel co-integration tests, i.e. Johansen's Fisher panel co-integration tests, Kao (1999) and Pedroni (2004). Table 8 indicates, the results of Pedroni (2004) heterogeneous panel tests specify that the null of no co-integration cannot be rejected at

p<0.01, p<0.05 and p<0.10 significance levels except for the group pp-statistic, the group rho-statistic the panel pp-statistic and panel rho-statistics.

Table 8: Pedroni Residual Co-Integration Test Results

	Statistic	**Prob.**	**Statistic**	**Prob.**
$Panel\ v-Statistic$	-0.24848	0.59	-0.20597	0.58
$Panel\ rho-Statistic$	1.229729	0.89	1.213885	0.88
$Panel\ PP-Statistic$	-0.76418	0.22	-0.89173	0.18
$Panel\ ADF-Statistic$	0.142853	0.55	0.214138	0.58
$\boldsymbol{Alternative\ hypothesis: individual\ AR\ coefs.\ (between-dimension)}$				
	Statistic	Prob.		
$Group\ rho-Statistic$	1.762661	0.96		
$Group\ PP-Statistic$	-1.15947	0.12		
$Group\ ADF-Statistic$	0.304493	0.61		
Cross section specific results				

$***\ Significant\ at\ p<0.01\ **\ Significant\ at\ p<0.05\ *\ Significant\ at\ p<0.10$

Table 9 shows the results of Kao (1999) residual panel co-integration tests, which reject the null of no co-integration at the p<0.01 significance level.

Table 9: Kao's Residual Co-Integration Test Results

ADF	**t-Statistic**	**Prob.**
	-3.55***	0.0002

$Note: The\ ADF\ is\ the\ residual-based\ ADF\ statistic\ (Kao, 1999).$ *** Specifies that the parameters are momentous at the 0.01% level.

As a final point, the consequences of Johansen's Fisher panel integration test are described in Table 10. The results of Fisher's test (trace test statistics or maximum eigenvalue test statistics) are in favour of the occurrence of a co-integrated relationship among the eight variables at the 1% level.

Table 10: Panel Co-integration Test Results of a Fisher-type Test using an Underlying Johansen Methodology

$\boldsymbol{Hypothesized\ No.\ of\ CE(s)}$	$\boldsymbol{Fisher\ Stat.*\ (from\ trace\ test)}$	$\boldsymbol{Prob.}$	$\boldsymbol{Fisher\ Stat.*\ (from\ max-eigen\ test)}$	$\boldsymbol{Prob.}$
$None$	606.6	0.00***	116.2	0.00***
$At\ most\ 1$	237.1	0.00***	191.6	0.00***
$At\ most\ 2$	176.5	0.00***	82.29	0.00***
$At\ most\ 3$	113.8	0.00***	57.32	0.00***
$At\ most\ 4$	67.86	0.00***	33.41	0.001***
$At\ most\ 5$	40.98	0.00***	27.94	0.005***
$At\ most\ 6$	21.41	0.006*	20.17	0.097*
$At\ most\ 7$	11.17	0.19**	11.17	0.19

$***\ Significant\ at\ p<0.01\ **\ Significant\ at\ p<0.05\ *\ Significant\ at\ p<0.10$

We identified in Table 10 that variables are integrated in long-term period implication that variables of growth, infrastructure's investment and infrastructure development (GDP, DC, EN, HT, ED, M, RL and IRN) change together in the long run. Dickey, Jansen, and Thornton (1994) explain that there are seven co-integrated factors. Being of more than one integrating vector specifies that the system under inspection is fixed in more than one direction.

4.4. Panel Estimation Results

Hence, the results of all unit root tests did not suggests the occurrence of second difference and for the long run results, validates the use of FMOLS and DOLS.

It's important to notice that the DOLS method has the drawback when no. of degree freedom reducing by containing clues and gaps, this prominent to less robust estimations. Such as our sample size is not small in both the number of countries and, dimensions of time, less robust results may be yield by DOLS estimation. However, the DOLS estimation method confirms the general trend and trend of the causality attained by the FMOLS method. Table 11 and Table 12 present the long run estimates of FMOLS and DOLS. The results of Table 11 shows that the

estimated coefficients are positive or negative LN_DC or LN_IRN are negative coefficient and statistically significant at p<0.01 and p<0.05 levels excluding LN_HT and LN_IRN variables.

Table 11: Panel FMOLS Long-run Estimates

Variables	Coefficient	Std. Error	t-Statistic	Prob.
LN_DC	-0.919279	0.165122	-5.567284	0.00***
LN_ED	0.414607	0.184129	2.251723	0.02**
LN_EN	1.840091	0.222018	8.28803	0.00***
LN_HT	0.271917	0.232075	1.171678	0.24
LN_IRN	-0.370529	0.876576	-0.422701	0.67
LN_M	0.082895	0.014068	5.892293	0.00***
LN_RL	3.500865	0.55914	6.261165	0.00***
$R-squared$	0.989301	$Mean\ dependent\ var$		26.52688
$Adjusted\ R-squared$	0.988151	$S.D.dependent\ var$		1.609679
$S.E.of\ regression$	0.175219	$Sum\ squared\ resid$		2.855246
$Durbin-Watson\ stat$	0.712351	$Long-run\ variance$		0.039*8

$*** Significant\ at\ p < 0.01\ ** \ Significant\ at\ p < 0.05 * Significant\ at\ p < 0.10$

Generally, the outcomes of this study indicate that there is a strong long-run relationship between LN_GDP, LN_DC, LN_EN, LN_HT, LN_IRN, and LN_RL. The results specify that a 1% increase in LN_DC may have significantly negative impact on GDP by -0.91%. The finding supports the fact that unproductive utilization of domestic credit may lead to credit boom and therefore have negative influence on output growth of an economy. The finding is in line with the finding of (Pham & Nguyen, 2020). The coefficient of LN_ED shows that when 1% increases in education then GDP increased by 0.41%. This result supports the fact that education improves the quality of human capital which raises the labour productivity and output of an economy. This result is consistent with the findings of (Artekin & Konya, 2020). The coefficient of LN_EN indicates that GDP is positively affected 1.84 with 1% increase in electricity consumption. This result supports the fact that energy leads to the creation of new projects, business and new markets and thus provides opportunities for peoples to earn more incomes. The result is also consistent with the finding by (Yu et al., 2019). Moreover, the result of FMOLS also showed that the variables LN_HT and LN_IRN have insignificant impact on economic growth and the findings is consistent with the study by (Saad & Kalakech, 2009).

The coefficient of LN_M is positively correlated when 1% increase in mobile phones then our economy will grow by 0.08% and the result is consistent with (Andrianaivo & Kpodar, 2012; Haftu, 2019). The coefficient of LN_RL shows that rail lines are positively associated with GDP and the result implies that a 1% increase in rail lines leads to increase in GDP by 3.50 %. The finding is consistent with the study by Wang, Lim, Zhang, Zhao, and Lee (2020). In the same way, Table 12 represents the long run results of DOLS. The estimated coefficients are positive or negative LN_DC, LN_ED or LN_HT are negative coefficients and statistically significant at p<0.01 and p<0.05 levels except for LN_ED and LN_M variables. These results are consistent with the findings by (Ejemeyovwi & Osabuohien, 2018; Kouassi, 2018). Generally, the outcomes of this study indicate that there is a strong long-run relationship between LN_GDP, LN_DC, LN_EN, LN_HT, LN_IRN, and LN_RL. The results specify that a 1% increase in LN DC then our GDP is significantly negatively affected by -1.12%.

Table 12: Panel DOLS Long-run Estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_DC	-1.125456	0.02486	-45.27186	0.00***
LN_ED	-0.053306	0.050024	-1.065602	0.29
LN_EN	1.843631	0.029791	61.88472	0.00***
LN_HT	-0.15444	0.052311	-2.95235	0.005**
LN_IRN	1.842818	0.111294	16.55813	0.00***
LN_M	0.00444	0.003503	1.267515	0.21
LN_RL	6.293567	0.167649	37.54018	0.00***

$*** Significant\ at\ p < 0.01\ ** \ Significant\ at\ p < 0.05 * Significant\ at\ p < 0.10$

The coefficient of LN_EN indicates that 1% increase in Energy then our GDP is positively affected by an increase in1.84%. The coefficient of LN_HT indicates that 1% increase in health facilities then our GDP is significantly negatively affected by -0.15 and the result is in line with (Kouassi, 2018). The coefficient of LN_IRN indicates that when 1% increases in agriculture

irrigated land leads to increase in GDP by 1.84%. The coefficient of LN_RL shows that rail lines and GDP are positively correlated with an increase 6.29 %.

Table 13 (see Appendix Table 13) indicates the causal and dynamic linkages between the GDP and other infrastructure variables. The result indicates that GDP leads to the domestic credit at p<0.05 on 0.01significantly. Then education leads to GDP at p<0.10 on 0.08 significantly. The energy leads to GDP at p<1.01 on 0.004 significantly. GDP leads to health at p<0.05 0n 0.03 significantly. Moreover, GDP also leads to rail lines at p<0.10 0n 0.072 significantly. Domestic credit leads to health at p<0.05 on 0.03 significantly. Domestic credit also leads to mobile at p<0.10 0n 0.071 significantly. Irrigation leads to education at p<0.10 0n 0.068. Energy leads to mobile at p<0.01 on 0.003. Health leads to mobile at p<0.01 0n 0.001. Mobile leads to rail lines at p<0.10 on 0.09.

5. Conclusions and Policy Implications

The relationship between infrastructure development and economic growth is a dynamic phenomenon. The results of this study reveal that investment in all types of categories in public infrastructure has significant contribution in the development of the economies. The findings of FMOLS represents that the variables including domestic credit, energy, rail lines, mobile subscriptions and education expenditures have significant impact on economic growth in the selected Asian countries. However, the impact of variable domestic credit on economic growth is negative. In parallel, the variables such as agriculture irrigated land and health expenditures have insignificant impact on economic growth in these selected countries.

Likewise, the findings of DOLS showed that the variables including domestic credit, energy, health expenditures, rail lines and agriculture irrigation land have significant association with economic growth. However, along the variable domestic credit the impact of health expenditures on economic growth is also found negative. In comparative to FMOLS, the variable agriculture irrigated land is found significant by performing DOLS. Moreover, estimations of DOLS showed that the variable mobile subscriptions and health expenditures have insignificant impact on economic growth. However, the results of both techniques showed that the signs of coefficients remained same for variable domestic credit but magnitude value is higher in FMOLS. Further, the results of granger causality test showed a unidirectional causal relationship among the variables from GDP to domestic credit, energy to GDP, GDP to health, GDP to rail lines, domestic credit to health, domestic credit to mobile subscriptions, agriculture irrigated land to education, energy to mobile and rail lines to health. Except these relationships, there is found neither unidirectional nor bidirectional causality among the variables.

It is concluded that an economy can robust its economic growth if regressive taxes are levied. However, there is need of crowding out of private investment if distortionary taxes are imposed on financing the infrastructure projects. Marginal propensity to investment should increase each year in infrastructure development. Our results are in line with (Hussain et al., 2019; Phetsavong & Ichihashi, 2012) Srinivasu *et al*. 2013). Our study emphasized on the long run and short run dynamics of relationship between the proxy of economic growth and the infrastructure proxies. The results indicate significant impact of infrastructure growth and economic growth during this study period.

The policy recommendations of these findings are very straightforward. If the economies wished to accelerate long run economic growth, attention must be paid jointly toward all the segments of infrastructure including physical as well as social infrastructure including transport, energy telecommunication, agriculture, health, education and banking sector as well. But there is a dire need to additional focus on productive infrastructure as transport, telecommunication and energy. Moreover, domestic credit must be provided to the small entrepreneur who is engaged in productive activities as well as to increase the productivity level of human capital, there is a need of investment in technical education. From recent years, Pakistan is facing electricity shortage, budget deficit, political instability and insecure business environment which interrupt in the economic growth of the country. So, there is a dire need of huge investment in these countries to accelerate economic growth through the channel of infrastructure development.

References

Adam, M. C., & Bevan, M. D. (2014). *Public Investment, Public Finance, and Growth: The Impact of Distortionary Taxation, Recurrent Costs, and Incomplete Appropriability*: International Monetary Fund.

Afonso, A., & ST. AUBYN, M. (2009). Macroeconomic rates of return of Public and Private investment: Crowding-in and Crowding-out effects. *The Manchester School, 77*, 21-39. doi:https://doi.org/10.1111/j.1467-9957.2009.02117.x

Andrianaivo, M., & Kpodar, K. (2012). Mobile phones, financial inclusion, and growth. *Review of Economics and Institutions, 3*(2), 30. doi:https://doi.org/10.22598/pi-be/2020.14.1.77

Artekin, A. Ö., & Konya, S. (2020). Health expenditure and economic growth: Is the healthled growth hypothesİs supported for selected OECD countries? *Poslovna izvrsnost, 14*(1), 77-89. doi:https://doi.org/10.22598/pi-be/2020.14.1.77

Baklanova, O., Petrova, M., & Koval, V. (2020). INSTITUTIONAL TRANSMISSION IN ECONOMIC DEVELOPMENT. *Economic Studies, 29*(1).

Breitung, J. (2001). The local power of some unit root tests for panel data. In *Nonstationary panels, panel cointegration, and dynamic panels* (pp. 161-177): Emerald Group Publishing Limited.

Calderón, C., & Servén, L. (2010). Infrastructure and economic development in Sub-Saharan Africa. *Journal of African Economies, 19*(suppl_1), i13-i87. doi:https://doi.org/10.1093/jae/ejp022

Calderón, C., & Servén, L. (2014). Infrastructure, growth, and inequality: An overview. *World Bank Policy Research Working Paper*(7034).

Choi, I. (2001). Unit root tests for panel data. *Journal of international money and Finance, 20*(2), 249-272. doi:https://doi.org/10.1016/S0261-5606(00)00048-6

Dickey, D. A., Jansen, D. W., & Thornton, D. L. (1994). A Primer on Cointegration with an Application to Money and Income. In *Cointegration: For the Applied Economist* (pp. 9-45): Springer.

Ejemeyovwi, J. O., & Osabuohien, E. S. (2018). Investigating the relevance of mobile technology adoption on inclusive growth in West Africa. *Contemporary Social Science*.

Engle, R., & Granger, C. (1987). Co-integration and error correction: Representation estimation, and testing. Econometrica, 55, 251–76. *Margin—The Journal of Applied Economic Research 6: 3 (2012)*, 361-383. doi:https://doi.org/10.2307/1913236

Erumban, A. A., & Das, D. K. (2016). Information and communication technology and economic growth in India. *Telecommunications Policy, 40*(5), 412-431. doi:https://doi.org/10.1016/j.telpol.2015.08.006

Hadri, K. (2000). Testing for stationarity in heterogeneous panel data. *The Econometrics Journal, 3*(2), 148-161. doi:https://doi.org/10.1111/1368-423X.00043

Haftu, G. G. (2019). Information communications technology and economic growth in Sub-Saharan Africa: A panel data approach. *Telecommunications Policy, 43*(1), 88-99. doi:https://doi.org/10.1016/j.telpol.2018.03.010

Hussain, B., Naqvi, S. A. A., Makhdum, M. S. A., & Shah, S. A. R. (2019). Influence of infrastructure development on economic growth in BRICS countries. *Management Theory and Studies for Rural Business and Infrastructure Development, 41*(3), 305-317. doi:https://doi.org/10.15544/mts.2019.25

Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of econometrics, 115*(1), 53-74. doi:https://doi.org/10.1016/S0304-4076(03)00092-7

Ishida, H. (2015). The effect of ICT development on economic growth and energy consumption in Japan. *Telematics and Informatics, 32*(1), 79-88. doi:https://doi.org/10.1016/j.tele.2014.04.003

Jiang, X., He, X., Zhang, L., Qin, H., & Shao, F. (2017). Multimodal transportation infrastructure investment and regional economic development: A structural equation modeling empirical analysis in China from 1986 to 2011. *Transport Policy, 54*, 43-52. doi:https://doi.org/10.1016/j.tranpol.2016.11.004

Jorgenson, D. W., & Vu, K. M. (2016). The ICT revolution, world economic growth, and policy issues. *Telecommunications Policy, 40*(5), 383-397.

Kao, C. (1999). Spurious regression and residual-based tests for cointegration in panel data. *Journal of econometrics, 90*(1), 1-44. doi:https://doi.org/10.1016/S0304-4076(98)00023-2

Kao, C., & Chiang, M.-H. (2001). On the estimation and inference of a cointegrated regression in panel data. In *Nonstationary panels, panel cointegration, and dynamic panels* (pp. 179-222): Emerald Group Publishing Limited.
Kaur, K., & Malhotra, N. (2014). Telecommunications and economic growth in India: Causality analysis. *International Journal of Research in Business Management, 2*(5), 31-46.
Kouassi, K. B. (2018). Public spending and economic growth in developing countries: a synthesis.
Kumar, R. R., Kumar, R. D., & Patel, A. (2015). Accounting for telecommunications contribution to economic growth: A study of Small Pacific Island States. *Telecommunications Policy, 39*(3-4), 284-295. doi:https://doi.org/10.1016/j.telpol.2014.08.005
Kumari, A., & Sharma, A. K. (2017). Physical & social infrastructure in India & its relationship with economic development. *World Development Perspectives, 5*, 30-33. doi:https://doi.org/10.1016/j.wdp.2017.02.005
Levin, A., Lin, C.-F., & Chu, C.-S. J. (2002). Unit root tests in panel data: asymptotic and finite-sample properties. *Journal of econometrics, 108*(1), 1-24. doi:https://doi.org/10.1016/S0304-4076(01)00098-7
Machicado, C. G. (2007). *Macroeconomic and Welfare Effects of Public Infrastructure Investment in Five Latin American Countries*. Retrieved from
Maddala, G. S., & Wu, S. (1999). A comparative study of unit root tests with panel data and a new simple test. *Oxford Bulletin of Economics and statistics, 61*(S1), 631-652. doi:https://doi.org/10.1111/1468-0084.0610s1631
Mark, N. C., & Sul, D. (2003). Cointegration vector estimation by panel DOLS and long-run money demand. *Oxford Bulletin of Economics and statistics, 65*(5), 655-680. doi:https://doi.org/10.1111/j.1468-0084.2003.00066.x
Minges, M. (2015). Exploring the relationship between broadband and economic growth.
Musibau, H. O., Mahmood, S., & Hammed, A. Y. (2017). The impact of foreign capital inflows, infrastructure and role of institutions on economic growth: an error correction model. *Academic Journal of Economic Studies, 3*(4), 35-49.
Oladipo, S. (2017). Dynamic interactions among road transport infrastructure development, economic growth and poverty level in Nigeria.
Oladipo, S., & Olomola, P. (2015). A multivariate causal relationship among road transport infrastructure development, economic growth and poverty level in Nigeria. *International Journal of Economics and Financial Research, 1*(4), 57-64.
Parikh, P., Fu, K., Parikh, H., McRobie, A., & George, G. (2015). Infrastructure provision, gender, and poverty in Indian slums. *World Development, 66*, 468-486. doi:https://doi.org/10.1016/j.worlddev.2014.09.014
Pedroni, P. (2001). Fully modified OLS for heterogeneous cointegrated panels. In *Nonstationary panels, panel cointegration, and dynamic panels* (pp. 93-130): Emerald Group Publishing Limited.
Pedroni, P. (2004). Panel cointegration: asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. *Econometric theory, 20*(3), 597-625. doi:https://doi.org/10.1017/S0266466604203073
Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled mean group estimation of dynamic heterogeneous panels. *Journal of the American statistical Association, 94*(446), 621-634. doi:https://doi.org/10.1080/01621459.1999.10474156
Pham, H., & Nguyen, P. (2020). Empirical research on the impact of credit on economic growth in Vietnam. *Management Science Letters, 10*(12), 2897-2904. doi:http://dx.doi.org/10.5267/j.msl.2020.4.017
Phetsavong, K., & Ichihashi, M. (2012). The impact of public and private investment on economic growth: Evidence from developing Asian countries. *Hiroshima University*.
Pradhan, R. P., Arvin, M. B., Norman, N. R., & Bele, S. K. (2014). Economic growth and the development of telecommunications infrastructure in the G-20 countries: A panel-VAR approach. *Telecommunications Policy, 38*(7), 634-649. doi:https://doi.org/10.1016/j.telpol.2014.03.001
Rehman, F. U., Khan, M. A., Khan, M. A., Pervaiz, K., & Liaqat, I. (2020). The causal, linear and nonlinear nexus between sectoral FDI and infrastructure in Pakistan: Using a new global infrastructure index. *Research in International Business and Finance, 52*, 101129. doi:https://doi.org/10.1016/j.ribaf.2019.101129
Rioja, F. K. (2001). Growth, welfare, and public infrastructure: A general equilibrium analysis of Latin American economies. *Journal of Economic Development, 26*(2), 119-130.

Saad, W., & Kalakech, K. (2009). The nature of government expenditure and its impact on sustainable economic growth. *Middle Eastern Finance and Economics, 1*(4), 39-47.

Salahuddin, M., & Alam, K. (2015). Internet usage, electricity consumption and economic growth in Australia: A time series evidence. *Telematics and Informatics, 32*(4), 862-878. doi:https://doi.org/10.1016/j.tele.2015.04.011

Shabani, Z. D., & Shahnazi, R. (2019). Energy consumption, carbon dioxide emissions, information and communications technology, and gross domestic product in Iranian economic sectors: A panel causality analysis. *Energy, 169*, 1064-1078. doi:https://doi.org/10.1016/j.energy.2018.11.062

Shi, Y. (2012). *The Role of Infrastructure Capital in China's Regional Economic Growth*. Retrieved from

Tsaurai, K., & Ndou, A. (2019). Infrastructure, human capital development and economic growth in transitional countries.

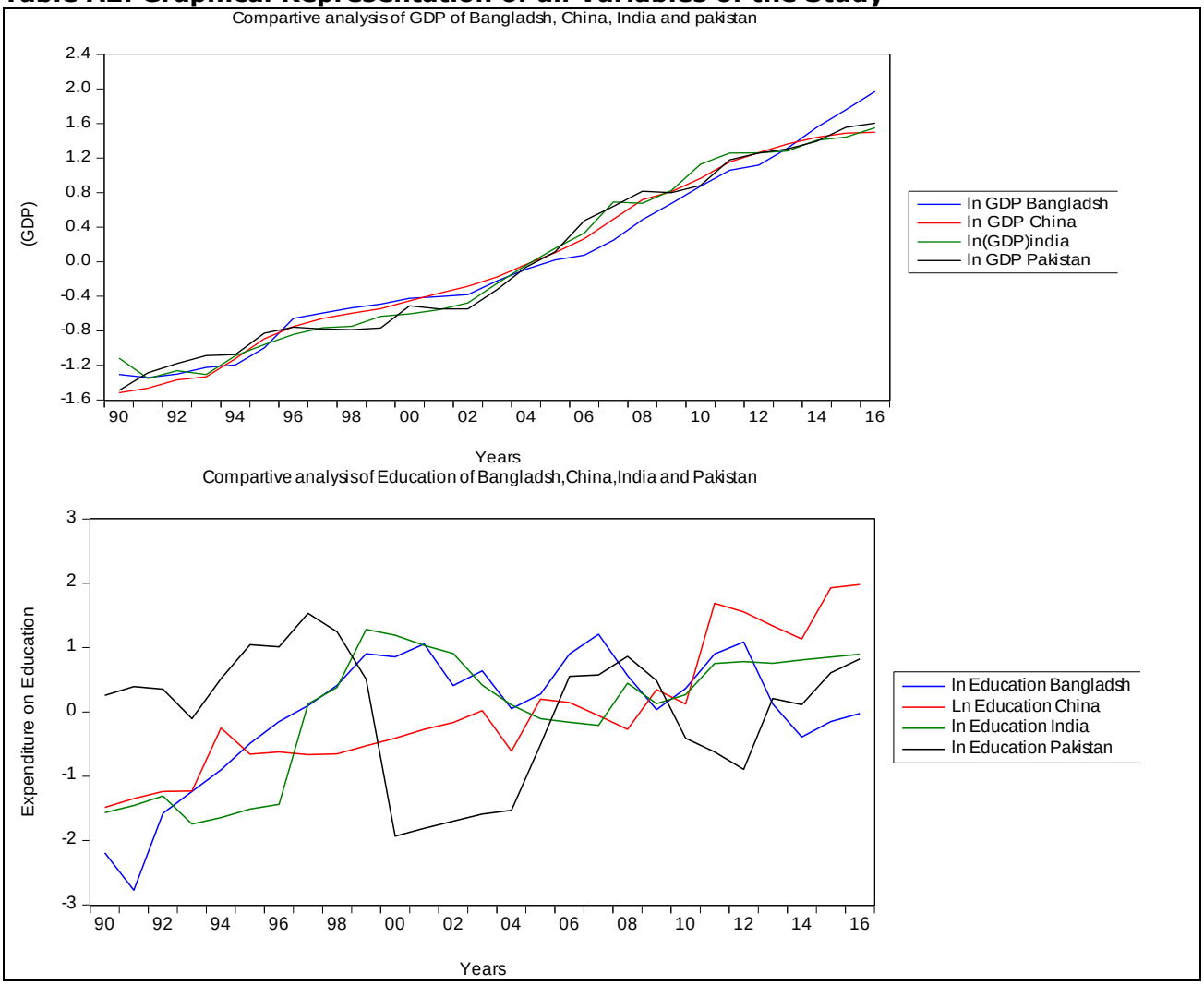
Wan, G., & Zhang, Y. (2018). The direct and indirect effects of infrastructure on firm productivity: Evidence from Chinese manufacturing. *China Economic Review, 49*, 143-153. doi:https://doi.org/10.1016/j.chieco.2017.04.010

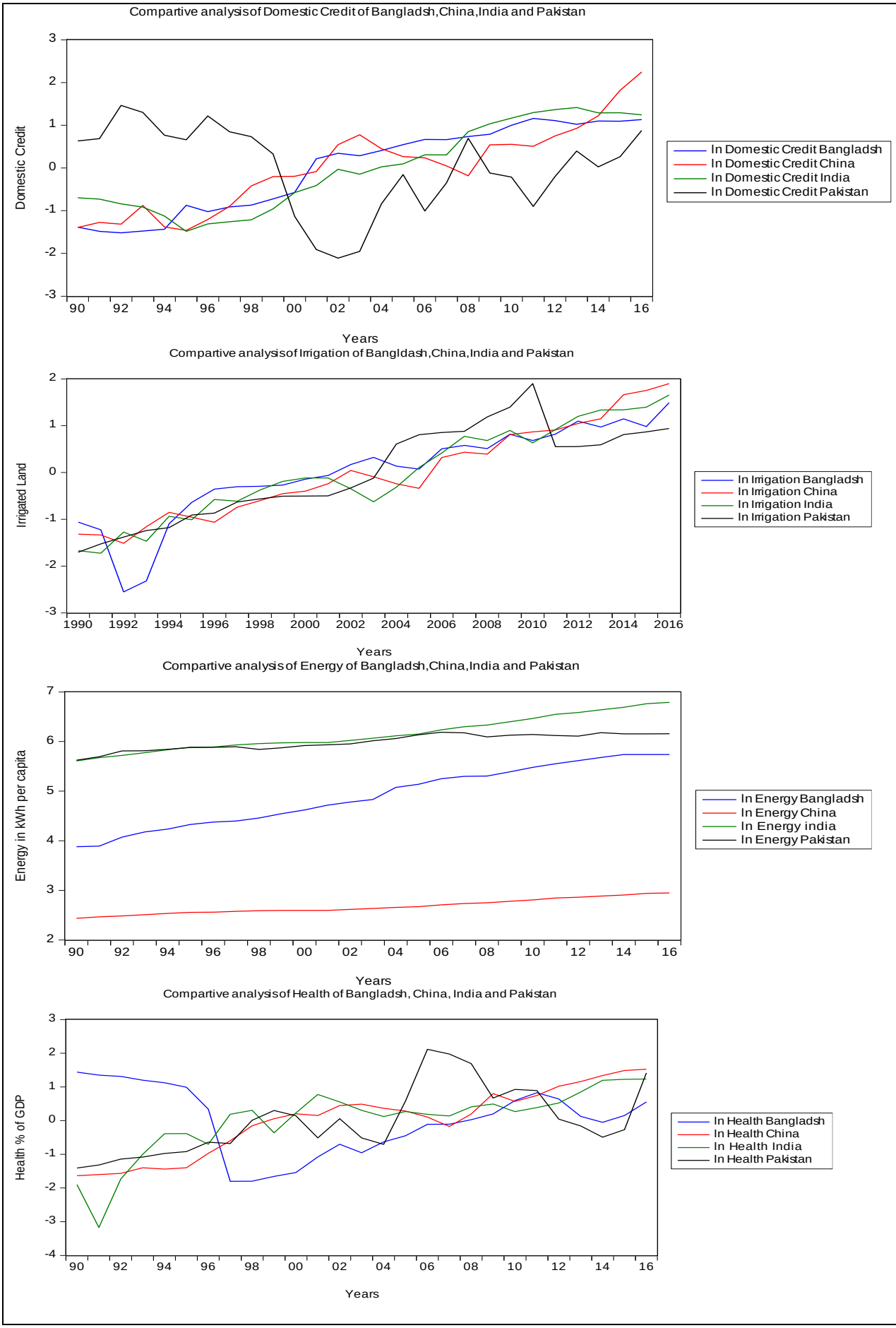
Wang, C., Lim, M. K., Zhang, X., Zhao, L., & Lee, P. T.-W. (2020). Railway and road infrastructure in the Belt and Road Initiative countries: Estimating the impact of transport infrastructure on economic growth. *Transportation Research Part A: Policy and Practice, 134*, 288-307. doi:https://doi.org/10.1016/j.tra.2020.02.009

Zahra, K., Azim, P., & Mahmood, A. (2008). Telecommunication infrastructure development and economic growth: A panel data approach. *The Pakistan Development Review*, 711-726.

Appendix

Table A2: Graphical Representation of all Variables of the Study




Compartive analysisof Domestic Credit of Bangladsh,China,India and Pakistan
Domestic Credit
Years
In Domestic Credit Bangladsh
In Domestic Credit China
In Domestic Credit India
In Domestic Credit Pakistan
Compartive analysisof Irrigation of Bangldash,China,India and Pakistan
Irrigated Land
Years
In Irrigation Bangladsh
In Irrigation China
In Irrigation India
In Irrigation Pakistan
Compartive analysis of Energy of Bangladsh,China,India and Pakistan
Energy in kWh per capita
Years
In Energy Bangladsh
In Energy China
In Energy india
In Energy Pakistan
Compartive analysisof Health of Bangladsh, China, India and Pakistan
Health % of GDP
Years
In Health Bangladsh
In Health China
In Health India
In Health Pakistan

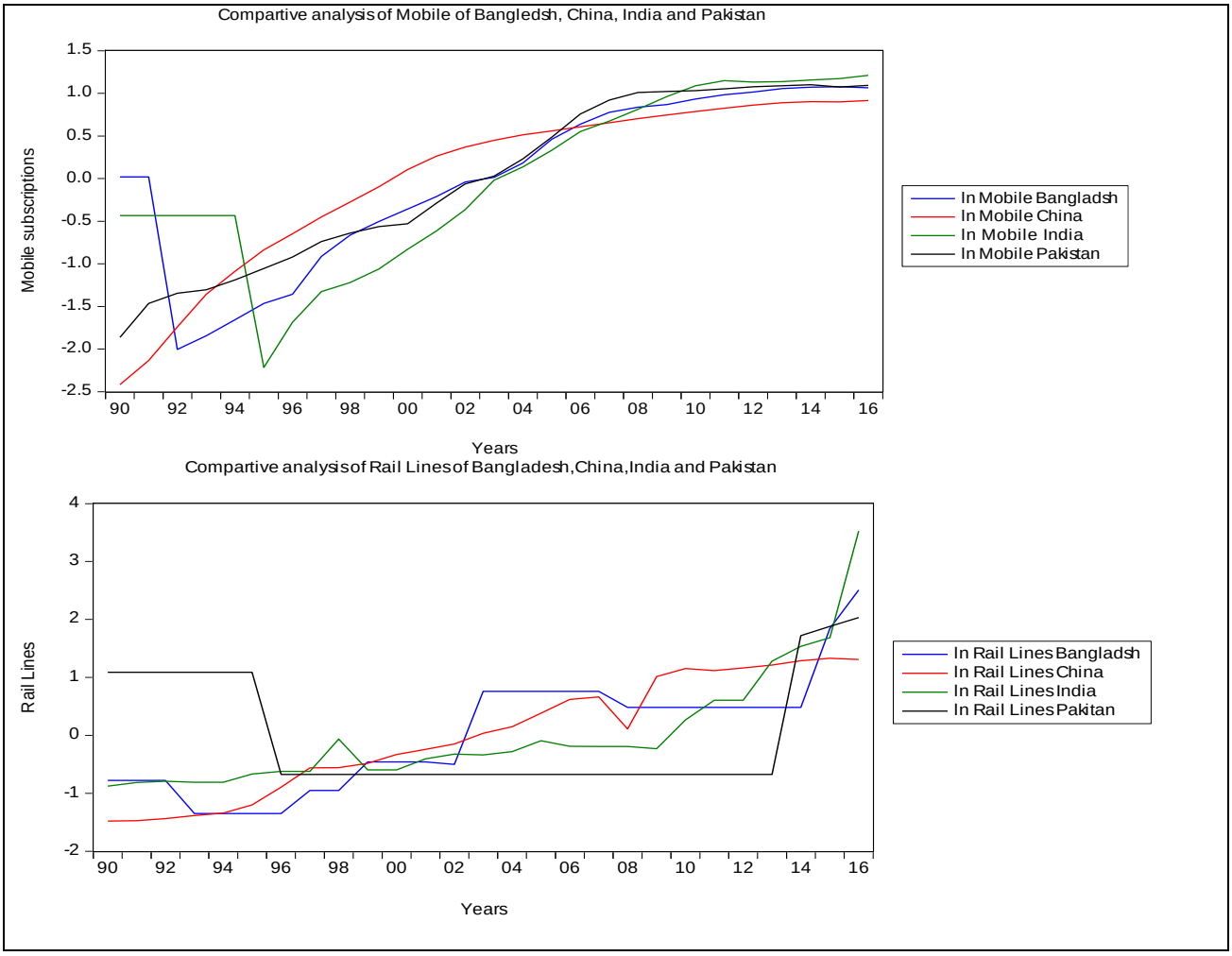


Table A13: Panel Causality Test Results

Null Hypothesis	Obs	F-Statistic	Prob.
LN_DOMESTIC_CREDIT → LN_GDP	100	1.42757	0.24
LN_GDP → LN_DOMESTIC_CREDIT		4.5805	0.01**
LN_EDUCAT → LN_GDP	100	2.55283	0.08*
LN_GD LN_ → EDUCATION		1.14776	0.32
LN_ENERGY → LN_GDP	100	5.67994	0.004***
LN_GDP → LN_ENERGY		0.4884	0.61
LN_HEALTH → LN_GDP	100	0.22008	0.80
LN_GDP → LN_HEALTH		11.5498	0.03**
LN_IRRIGATION → LN_GDP	100	0.80242	0.45
LN_GDP → LN_IRRIGATION		0.00917	0.99
LN_MOBILE → LN_GDP	100	0.22979	0.79
LN_GDP → LN_MOBILE		1.61111	0.20
LN_RAIL_LINES → LN_GDP	100	1.33717	0.26
LN_GDP → LN_RAIL_LINES		2.70015	0.072*
LN_EDUCATION → LN_DOMESTIC_CREDIT	100	0.54686	0.58
LN_DOMESTIC_CREDIT → LN_EDUCATION		0.22984	0.79
LN_ENERGY → LN_DOMESTIC_CREDIT	100	1.02936	0.36
LN_DOMESTIC_CREDIT → LN_ENERGY		0.85996	0.42
LN_HEALTH → LN_DOMESTIC_CREDIT	100	0.34403	0.70
LN_DOMESTIC_CREDIT → LN_HEALTH		3.49466	0.03**
LN_IRRIGATION → LN_DOMESTIC_CREDIT	100	0.3747	0.68
LN_DOMESTIC_CREDIT → LN_IRRIGATION		0.45449	0.63
LN_MOBILE → LN_DOMESTIC_CREDIT	100	0.05135	0.95
LN_DOMESTIC_CREDIT → LN_MOBILE		2.71606	0.071*
LN_RAIL_LINES → LN_DOMESTIC_CREDIT	100	0.0141	0.98
LN_DOMESTIC_CREDIT → LN_RAIL_LINES		0.53656	0.58
LN_ENERGY → LN_EDUCATION	100	0.17508	0.83
LN_EDUCATION → LN_ENERGY		1.19621	0.30
LN_HEALTH → LN_EDUCATION	100	1.55783	0.21
LN_EDUCATION → LN_HEALTH		0.23278	0.79

LN_IRRIGATION	→	LN_EDUCATION	100	2.76647	0.068*
LN_EDUCATION	→	LN_IRRIGATION		1.90992	0.15
LN_MOBILE	→	LN_EDUCATION	100	0.13826	0.87
LN_EDUCATION	→	LN_MOBILE		0.98689	0.37
LN_RAIL_LINES	→	LN_EDUCATION	100	1.73539	0.18
LN_EDUCATION	→	LN_RAIL_LINES		0.48325	0.61
LN_HEALTH	→	LN_ENERGY	100	0.70663	0.49
LN_ENERGY	→	LN_HEALTH		0.73577	0.48
LN_IRRIGATION	→	LN_ENERGY	100	0.58041	0.56
LN_ENERGY	→	LN_IRRIGATION		0.31221	0.73
LN_MOBILE	→	LN_ENERGY	100	0.05958	0.94
LN_ENERGY	→	LN_MOBILE		6.03301	0.003***
LN_RAIL_LINES	→	LN_ENERGY	100	0.36453	0.69
LN_ENERGY	→	LN_RAIL_LINES		1.0226	0.36
LN_IRRIGATION	→	LN_HEALTH	100	0.49697	0.60
LN_HEALTH	→	LN_IRRIGATION		0.54368	0.58
LN_MOBILE	→	LN_HEALTH	100	1.33147	0.26
LN_HEALTH	→	LN_MOBILE		0.06891	0.93
LN_RAIL_LINES	→	LN_HEALTH	100	7.42073	0.001***
LN_HEALTH	→	LN_RAIL_LINES		0.17216	0.84
LN_MOBILE	→	LN_IRRIGATION	100	0.55698	0.57
LN_IRRIGATION	→	LN_MOBILE		0.55668	0.57
LN_RAIL_LINES	→	LN_IRRIGATION	100	0.19799	0.82
LN_IRRIGATION	→	LN_RAIL_LINES		0.93898	0.39
LN_RAIL_LINE	→	LN_MOBILE	100	0.22149	0.80
LN_MOBILE	→	LN_RAIL_LINES		2.39206	0.09*

*** *Significant at* $p < 0.01$ ** *Significant at* $p < 0.05$ * *Significant at* $p < 0.10$