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Does infrastructure increase exports and reduce trade deficit? Evidence from selected South Asian countries using a new Global Infrastructure Index

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Abstract
This study investigates the short- and long-run impact of infrastructure on export and trade deficit in selected South Asian countries during 1990–2017 by using Pooled Mean Group (PMG) estimator and cointegration techniques like Pedroni and Kao test. The empirical results of PMG approach confirmed the existence of significant long-run impact of aggregate and sub-indices of infrastructure (i.e., transport, telecommunication, energy and financial sector) on export and trade deficit. The findings suggested that infrastructure positively promotes exports while negatively affecting trade deficit. The relationship between infrastructure and export is worthy bulletin for South Asian economies to encourage the quantity of exports and catch-up on established economies. The control variables of exchange rate, human capital, per capita GDP and institutional quality enhance exports and retard trade deficit significantly in the long run. Furthermore, the Pedroni and Kao test indicates strong evidence of cointegration in selected variables. Fully modified ordinary least square (FMOLS) and dynamic ordinary least square (DOLS) support robust and consistent results to the main model of this study. Furthermore, the study recommended that in long run aggregate and sub-indices of infrastructure promote exports and decrease trade deficit in selected South Asian economies.

Keywords: Infrastructure, Export, Trade deficit, Cointegration, South Asia

1 Introduction

Structuralists consider that availability of infrastructure plays important role in markets connectivity and trade promotion while the lack of infrastructure disrupts markets and retards trade. Infrastructure makes a huge difference in the process of development and the comparative edge of an economy, particularly in trade (Ahmad et al. 2015; Anderson and Wincoop 2003). Researchers estimated that poor infrastructure penalize international trade (Donaubauer et al. 2018; Yeaple and Golub 2002). Countries with better infrastructure (such as Singapore and Hong Kong) perform well in international trade and punch above their weight while countries with weak infrastructure (such as Bhutan and Pakistan) perform poor on external sector

(Portugal-Perez and Wilson 2012). This means infrastructure is crucial for trade promotion and global economic integration (Brooks and Menon 2008).

Despite the fact that infrastructure affects the cost of production and level of trade (Clark et al. 2004), many international trade theories overlooked the role of infrastructure. Traditional international trade theories assumed zero transportation and energy cost which hardly justify the ground realities at a time when infrastructure services play a dominant role in the regional as well as international trade (Djankov et al. 2010). Hoekman and Nicita (2008) argues that 10% decrease in transport costs increase trade by 6% while 10% increase in overall investment in infrastructure contribute 5% to exports in developing countries. On the other hand, lack of infrastructure increases the cost of production, reduces profitability and causes unnecessary delay in economic activities (Duval and Utoktham 2009; Martinez-Zarzose 2007).

South Asian poor performance on external sector is attributed to a number of variables including lack of skilled labor, meager foreign direct investment, shortage of capital, etc.; however, rarely any study focused on the role of infrastructure despite its significant contribution to trade and business (Andrés et al. 2014; Bhattacharyay 2014). It is difficult to understand the South Asian external sector performance without understanding the role of infrastructure in the region. For example, lack of energy, transport and communication and its related infrastructure adversely affect inter-regional and international trade in South Asia (Estache and Wren-Lewis 2011; Brun et al. 2005; Limao and Venables 2001; Clark et al. 2004). Keeping in view the importance of physical infrastructure in robust external sector, Asian Development Bank report (2017) advised South Asia to focus on investment in infrastructure in order to boost exports and tackle the perennial trade deficit. Therefore, in this paper we are trying to examine does infrastructure affect international trade, particularly exports and reduce trade deficit in selected South Asian countries?

Previous studies have some shortcoming to better understand the role of infrastructure in international trade by using the individual aggregate data of land line and mobile connectivity for telecommunication—and the total length of roads and the number of aircraft departures for transport infrastructure cost (for example, Ismail and Mahyideen 2015; Roller and Waverman 2001; Hoffmann 2003; Limao and Venables 2001). Some recent studies devised principal components analysis (PCA) (for example, Kumar 2006; and Francois and Manchin 2013). However, using PCA in a panel data tends to unduly restrict the set of countries and the data series that can be included in the analysis (Donaubauer et al. 2015). Therefore, in this study we use a new Global Infrastructure Index (used by Donaubauer et al. 2015) based on annual dataset of 30 indicators of the quantity and quality of infrastructure and sub-indices on transport, communication, financial and energy to better understand the role of physical infrastructure in promoting exports and curtailing trade deficit in selected South Asian countries. This study uses the Pooled Mean Group (PMG) technique to examine the long- and short-run impact of infrastructure on exports and trade deficit. The superiority of PMG procedure over other econometric technique is that it allows for both short-run and long-run results. In addition, it also suggests the speed of adjustment to the long run (Jouini 2015; Pesaran et al. 1997, 1999). We also employ the Padroni and Kao cointegration test to examine the cointegration between the variable of our interest. Fully modified ordinary least square

(FMOLS) and dynamic ordinary least square (DOLS) are also used for further robustness and to obtain long-run coefficients of cointegration.

Rest of the paper is organized as: Sect. 2 presents infrastructure services and trade in South Asia, Sect. 3 reports data source and description of the variables, Sect. 4 provide the detail about econometric methodology and Sect. 5 consists of results and discussion, Sect. 6 shows robustness check with alternative methodologies, while conclusion and policy implications is accommodated in Sect. 7.

2 Infrastructure services and trade in South Asia

Infrastructure remained a big hurdle for South Asia to reap potential and develop rapidly. For example, 40% firms in India, 45% in Pakistan, 60% in Bangladesh and 75% in Nepal reported that inadequate infrastructure is a major obstacle to their pursuit to grow rapidly (Jha and Arao 2018). Infrastructure deficit in South Asia is ever increasing and reached to a level where it hurts the domestic economy as well as the external sector of the region. The gap between supply and demand for infrastructure is continuously on the rise.[1]

In South Asia, road density varies considerably. Road density is highest in Bangladesh despite the fact that just 30% of its roads are paved and more than 60% of its rural population lack access to all-season roads (Asian development Bank 2011). The road density is lowest in the tough terrain Bhutan and Nepal. Meanwhile India has the world's second longest road network (i.e., 3.5 million km road network, and has 70,000-km-long national highway network), but road quality in India leaves much to be desired. More than half of its roads are not paved and great deal of highways have just two lanes. Road network is shattered in rural India areas, where only 60% of the population has access to all-weather roads (Asian Development Bank, reports study 2017; Andrés et al. 2014). Road condition in Pakistan is not different than any other part of South Asia. Total length of roads in Pakistan was 269,618 km in 2016, out of which 63% was paved. Around 60% of the road network is in poor condition due to poor maintenance and vehicle overloading, etc. The share of national high way and motor ways in total road network in Pakistan is just 4.2% but together the two handles more than 85% of Pakistan total traffic (Asif et al. 2019). Poor road quality not only contributes to the cost of production, but it also retards the much needed connectivity in the movement of people and goods. Resultantly, poor transport infrastructure keeps domestic as well as in international trade on hold (Jha and Arao 2018; Andrés et al. 2014).

Besides transportation, the shortage of energy and its related infrastructure is a huge constraint for inter-regional and international trade in South Asia. Garsous (2012) argues that energy sector has more significant impact than any other sector of infrastructure on international trade. Investing in the energy sector is crucial for development and for securing a high trade balance.

Access to electricity is a good indicator to understand the quality of energy infrastructure. Recently, the access to electricity in the selected South Asian countries has

[1] Asian Development Bank study (2017) estimates that the South Asia region needs to invest between US$1.7 trillion and US$2.5 trillion (at current prices) to fill the widening gap in infrastructure (such as transport, telecommunication, and energy) and to address the issue of infrastructure deficit.

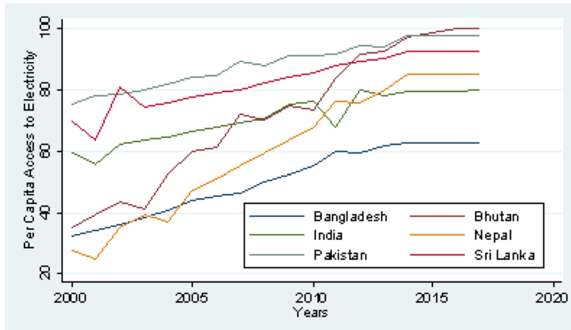

Fig. 1 Per capita access to electricity (source: World Development Indicators (WDI))

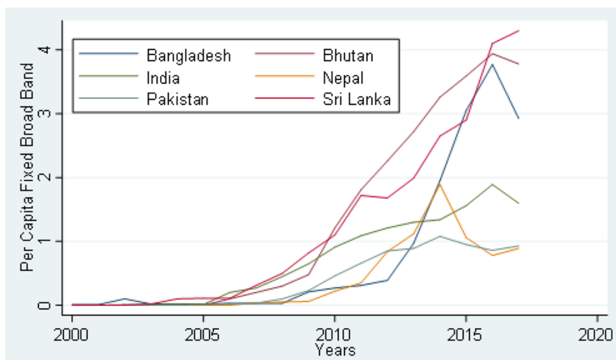

Fig. 2 Per capita fixed broadband (source: World Development Indicators (WDI))

improved, however, the access to the basic input of electricity is still a big issue in South Asia, particularly in Bangladesh and India where a quarter of their population has yet to get access to electricity. Access to electricity in Nepal and Sri Lanka is more than 90% while it is around 99% in Pakistan (see Fig. 1), but despite a broad access to electricity, rampant load shedding and short supply of electricity has deprived Pakistan to excel on economic front (Asian Development Bank, reports study 2017).

Beside transport and energy, effective telecommunications are another important factor that provides a low-cost channel for searching, gathering and exchanging information. Modern day trade and production owes a lot to telecommunication (Fink et al. 2005; Roller and Waverman 2001).

South Asian countries introduced broadband between by the start of new millennium and since then the broadband per capita availability experienced rapid growth (Fig. 2). The broadband availability in Sri Lanka increased from 0 in 2000 to 4 in 2017, in India it increased from none in 2000 to 3.77 in 2017. Currently per capita broadband availability is 1 in Nepal, 0.97 in Pakistan and 1.9 in Bangladesh (Fig. 2). Broadband availability in developed region is 25 while in China it is 22.90 in 2016. On the basis of need assessment, telecommunication sector needs $2.3 trillion investment from 2016 to 2030 (Asian Development Bank, reports study 2017). Compared with the regional competitors (such as East Asia, Southeast Asia and West Asia), the

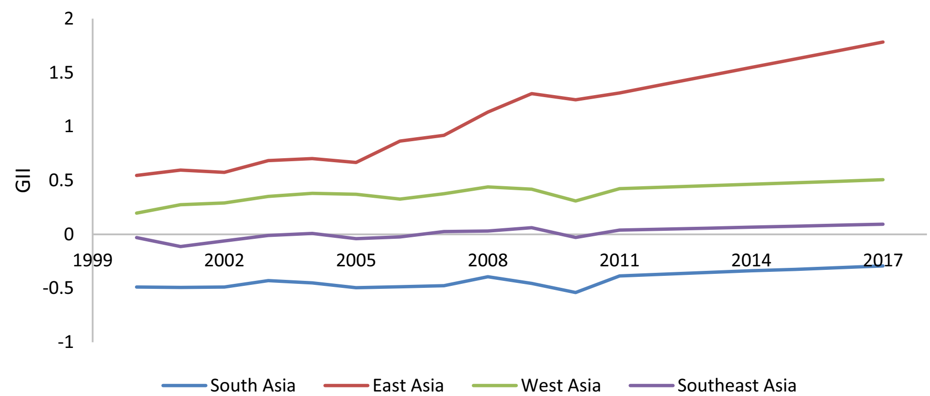

Fig. 3 Global Infrastructure Index in Asian Region (source: see Appendix 1)

quality of aggregate infrastructure system in South Asia is poor and needs improvement (see Fig. 3).

The gap in infrastructure in the sectors of transportation, energy and telecommunication is a big hurdle in the rapid development of many regions, but the issue is very obvious in South Asia (Brooks 2016). Countries in South Asian region are aware of the fact that lack of infrastructure not only rips them of productive economic activities locally, but also the countries are losing opportunities to connect globally and enjoy the benefits of internationalization (Andrés et al. 2014).

3 Data description and source

To assess the impact of infrastructure on exports and trade deficit over the period of 1990–2017, we rely on a new Global Infrastructure Index used by Donaubauer et al. (2015). The detail regarding this infrastructure index is given by Donaubauer et al. (2015). Most importantly the devised index contains further four sub-indices of infrastructure, i.e., transport, telecommunication, financial and energy to better understand the role of physical infrastructure in enhancing exports and decreasing trade deficit in selected[2] South Asian countries (i.e., Bangladesh, Bhutan, Nepal, India, Pakistan, Sri Lanka). This new Global Infrastructure Index contains 30 indicators in order to cover all the important dimensions of quality and quantity infrastructure. Unobserved Components Model (UCM) is used to determine the weight given to each component in the construction of the index (see Appendix 1). Similarly, we uses Quality of Institution Index[3] (ln_QI), which is a composite index constructed on data collected from International Country Risk Guide (ICRG). The developed index takes six variables of institutional quality like, law and order situation, corruption, government stability, investment profile, bureaucratic quality and democratic accountability are taken into consideration for the aim of to cover all the key extents of institution quality, by taking the average of all these six variables. The detail about this index is found in Rehman and Ding (2019).

[2] The data of Afghanistan and Maldives are unavailable, so we exclude these two countries from the analysis.

[3] $(V_i - V_{min})/(V_{max} - V_{min})$ formula is applied for the normalization. Now (V_i) original index and (V_{min}) is the minimum value attained by country in original index.

Table 1 Data description and source

Dependent variables	Notation	Data source
Exports (country total exports in million USD)	LN_EXY	World Development Indicators
Trade deficit (exports–imports in million USD)	LN_TRD	World Development Indicators
Independent variables		
New Global Infrastructure Index	LN_GINFR	Donaubauer et al. (2016) (Appendix 1)
(i) Transport infrastructure	LN_TINFR	
(ii) Communication infrastructure	LN_CINFR	
(iii) Energy infrastructure	LN_EINFR	
(iv) Financial infrastructure	LN_FINFR	
Human capital (Secondary School Enrolment) (a reflection of productivity)	LN_HC	World Development Indicators
Per capita GDP	LN_PGDP	World Development Indicators
Quality of institution	LN_QI	World Development Indicators
Exchange rate (official exchange rate)	LN_EXR	World Development Indicators

Furthermore, this is a panel data study and heterogeneity[4] would be a major concern since the panel is a combination of time-series and cross-sectional data. The size of the countries in the present study is not homogenous, thus, we convert the selected monetary variables into per capita form such as export, trade deficit, exchange rate and per capita GDP. In case of nominal form of the monetary variables, the variation of the variables might also be due to the change in price. Thus, the analysis fails to capture the actual impact of the variables on trade. So the undermentioned variables are divided by their respective country's population.

The selected variables naming, Global Infrastructure Index and trade deficit consist of negative values which we convert into positive by dividing -1 before taking natural log (LN). It is important to standardize the measurement of the variables, as it will improve fitness and homogeneity. The natural logarithm is a reliable method of the many methods. This study has taken the initiative to standardize the measurement in order to gain better and more meaningful interpretation as well. Table 1 presents the selected dependent and independent variables, notation, data description in braces and the sources. Moreover, all variables are converted into natural log.

3.1 Theoretical justification

Infrastructure plays a vital role in promoting trade and cure trade deficit. Transport infrastructure can help a country to connect its remote area domestically and to business areas world wide at low cost (Donaubauer et al. 2018). Good quality of energy infrastructure promotes capital-intensified industrialization and thus reduces production cost. Marketing is one of the most important tools of promoting product to capture market which can be made possible through telecommunication. Better financial infrastructure helps to solve financial and liquidity barriers in the way of trade (Rehman et al. 2019; Yeaple and Golub 2002).

[4] PMG estimator also deals with heterogeneity problem. The detail is found in econometric methodology (Sect. 4).

4 Econometric methodology

The frequently used methods for dynamic heterogeneous panels are the mean group (MG) estimator and fixed effect and random effect estimator. MG estimator, on one hand, estimates equation for each group separately and inspect the mean of the estimate which, according to Pesaran and Smith (1995), are consistent estimates of the average of parameter. However, MG estimator is not capable of considering similarities of certain parameter across groups. On the other hand, fixed and random effect estimator allows intercept to vary group wise while all other coefficients and variances in error are restricted to be the same.

This study considers Pooled Mean Group (PMG) estimator because of the advantage that it takes into account both pooling and averaging. The intercept, short-run coefficients and variances in error, in (PMG) estimator, varies across groups while the long-run coefficients are restricted to be the same. Their reason behind similar relationships between variables in the long run across groups is that common arbitrage conditions, technologies and other common factors influence all groups in the same pattern. Besides, it seems less compelling to assume short-run variation and variances to be the same across groups (Pesaran et al. 1997).

a. Model specification

The latest work on Panel data analysis involving time span (T) and number of cross section (N) is presented under two headings, i.e., (Pooled Mean Group (PMG) and mean group (MG) panel ARDL models. In PMG, cross sections are pooled and intercept terms are permitted to vary across cross sections (Pesaran et al. 1997, 1999) while in MG, model may be built individually for each cross section with possible difference in intercepts, slope coefficients, and error variances (Pesaran et al. 1999). PMG and MG permits short-run parameters, intercepts terms and error variance to vary across groups, however, the two approaches differ in the long run. Contrary to MG, PMG restrains the long-run coefficients to be homogenous. The homogeneity of long-run slope coefficient is useful when there are reasons to expect the long-run equilibrium relationship between the variables are similar across countries. MG model imposes no restrictions on coefficient, both in the long as well as in the short run; however, the necessary condition for the validity of MG approach is to have a sufficiently large time-series dimension of the data. Pesaran (2004) consider that MG approach is quite sensitive to outlier and small model permutation. Keeping in view the small number of countries (N) and sufficiently large time-series data (T), in this study we opt for PMG. Hausman test will confirm that PMG or MG approach is used in this case. The general form of the empirical specification of the PMG[5] model can be written as:

$$Y_{it} = \sum_{j=i}^{p} \gamma_{ij} Y_{i,t-1} + \sum \emptyset_{ij} Z_{i,t-j} + \mu_t + \varepsilon_{it}, \tag{1}$$

[5] For consistent results, large time cross section (T) and number of cross section N is crucial to resolve the problem of heterogeneity. Similarly, the resulting residual of error correction model be serially uncorrelated and the explanatory variables be treated as exogenous.

where number of cross sections $i=1, 2, \ldots. N$ and time $t=1, 2, 3 \ldots. T$. Z_{it} is a vector of $K \times 1$ regressors, γ_{ij} is a scalar, μ_i is a group-specific effect. The disturbance term is an $I(0)$ process if the variables are $I(1)$ and co-integrated then a major characteristic of co-integrated variables is their rejoinder to any deviance from long-run equilibrium. This characteristic infers error correction dynamics of the variables in the system are swayed by the deviance from equilibrium. So it is common to re-parameterize above equation into the error correction equation as:

$$\Delta Y_{it} = \theta_i, y_{i,t-j} - \beta_i Z_{i,t-j} \sum_{j=i}^{p-1} \gamma_{ij} \Delta y_{i,t-j} + \sum \emptyset_{ij} \Delta Z_{i,t-j} + \mu_t + \varepsilon_{it}. \quad (2)$$

The error correction parameter θ_i indicates the speed of adjustment. If $\theta_i=0$, then there is no evidence that variables have long-run association. It is expected that θ_i is negative and statistically significant under the prior supposition that variables indicate a convergence to long-run equilibrium in case of any disturbance.

With increase in time period of analysis, dynamic panels; non-stationarity is very important issue and in present study this issue has been taken into consideration by applying Levin, Lin and Chu (LLC) and Im, Pesaran and Shin (IPS) unit root tests (Prud'homme 2005). The condition is: when all the chosen variables in the model are stationary at $I(1)$, $I(0)$ or a mixture of $I(0)$ and $I(1)$. PMG being an ARDL-model is sensitive to the selection of lag length and hence, we utilize the Akaike Information Criteria (AIC) to obtain our optimal lag length. On the basis of above model, we consider the following hypothesis.

H_0 There is no impact of infrastructure on exports in South Asia.

H_1 There is significant impact of infrastructure on exports in South Asia.

H_{01} There is no impact of infrastructure on trade deficit in South Asia.

H_2 There is significant impact of infrastructure on trade deficit in South Asia.

b. Panel cointegration tests

In order to examine the presence of a long-run convergence among our variables of interest, we carry out a panel cointegration test. The objective of the panel cointegration test is to combine information on similar long run across the various panel members (Law et al. 2014). Pedroni (1999, 2004) suggested seven cointegration tests for panel data on the basis of the cointegrating residuals of ε_{it}, three of which considered to be group mean panel cointegration tests and are based on the between-dimension. They are devised by dividing the numerator by the denominator before adding over the N-dimension. The other four, referred to as panel cointegration tests, are based on the within-dimension and are formulated by adding both the numerator and the denominator over the N dimension. Moreover, Kao test is also being used for cointegration between dependent and independent variables (Kao and Chiang 1999), on the foundation of Eq. (1) with the test for the null hypothesis of no cointegration being considered.

Table 2 Unit root test results

	Level		First difference	
	Levin Lin Chu test	IM Pesaran test	Levin Lin Chu test	IM Pesaran test
Export	0.941	−0.118	−3.403***	−3.029***
Trade deficit	−1.185**	−0.802	−4.249***	−4.688***
Human capital	1.089***	0.456***	−4.638***	−4.478***
Exchange rate	0.070	0.534	−4.402***	−3.762***
Per capita GDP	0.454	0.761	−4.139***	−3.211***
Institutional quality	−5.636***	−4.804	−3.226***	−3.143***
Transport infrastructure	−2.668***	−2.377***	−7.752***	−8.063***
Telecommunication infrastructure	−1.801***	−2.286**	−4.253***	−6.180***
Energy infrastructure	−1.274***	−2.761***	−4.585***	−4.604***
Financial infrastructure	0.176***	−1.593*	−2.049***	−4.661***
Aggregate infrastructure	−2.142***	−2.328***	−6.001***	−7.297***

****, ** and * denote the significance at 1%, 5%, and 10%, respectively. All variables are in natural log form. The results are based on intercept and trend

H_0 There is no cointegration between infrastructure and exports in South Asia.

H_1 There is significant cointegration between infrastructure and exports in South Asia.

H_{01} There is no cointegration between infrastructure and trade deficit in South Asia.

H_2 There is significant cointegration between infrastructure and trade deficit in South Asia.

5 Empirical results and discussions

Prior to observe the potential long- and short-run impact of infrastructure on export and trade deficit, it is essential to create the order of integration among the selected variables because if the variable(s) are integrated of order $I(2)$ the results do not remain valid (Ouattara 2004). For this reason, Levine et al. (2002) and Im et al. (2003) unit root tests is employed to examine the order of integration among the chosen variables. The results in Table 2 point out that all variables are either integrated of order $I(1)$ or $I(0)$ and no one of the variables is integrated of order $I(2)$ or above, which clearly support the Pooled Mean Group (PMG) estimation procedure rather than other alternative cointegration technique (Lv and Xu 2018; Pesaran et al. 1997, 1999).

The descriptive statistics of the explanatory variables is shown in Appendix 2. Appendix 3 presents the Pearson correlation coefficients among all the selected variables of the present study. It can be seen from Appendix 2 that there is strong positive correlation between the export and all others explanatory variables. On other hand, there is strong negative correlation between trade deficit and all other independent variables. In the subsequent regression, in order to alleviate the interference of multicollinearity on the regression results, there is no multicollinearity problem in our selected variables.

The empirical results in Table 3 show the outcomes of the PMG heterogeneous panel procedure. The result exhibits notable variations subject to the method of estimation.

Table 3 Pooled Mean Group method results (export is dependent variable)

Variables	Transport infrastructure	Telecommunication infrastructure	Energy infrastructure	Financial infrastructure	Aggregate infrastructure
Long-run results					
Exchange rate	− 3.0573***	− 0.5454***	− 0.1234*	− 1.4267***	− 0.7673**
Std. error	0.6979	0.0269	0.0994	0.3677	0.3298
Human capital	0.1536	1.5653***	0.1917*	0.1418	0.1670
Std. error	0.3075***	0.1994	0.1175	0.5383	0.4494***
Per capita GDP	1.7352	0.8590***	0.5565***	1.4300***	1.0565
Std. error	0.2093	0.013	0.0386	0.2013	0.2349
Institutional quality	1.6017***	0.0531***	0.1887*	0.9098***	0.4234***
Std. error	0.5920	0.0219	0.1171	0.1538	0.0513
Transport infrastructure	1.3117***				
Std. error	0.4232				
Telecommunication infrastructure		0.4720***			
Std. error		0.0155			
Energy infrastructure			0.7733***		
Std. error			0.2598		
Financial infrastructure				0.2549***	
Std. error				0.0628	
Aggregate infrastructure					0.3267***
Std. error					0.0878
Short-run results					
Exchange rate	− 0.5190	− 0.0306	− 0.1256	− 0.4713	− 0.5334
Std. error	0.4602	0.1472	0.2514	0.2414	0.4803
Human capital	0.0592	0.9343	0.2223	0.1845	0.1577
Std. error	0.1673	0.8129	0.4239	0.1946	0.2007
Per capita GDP	2.1747*	0.3917	0.9911***	1.0156	0.9119***
Std. error	1.2822	0.3526	0.1564	0.1227	0.3089
Institutional quality	0.1410	0.1099	0.0890	0.0864	0.3214**
Std. error	0.4021	0.0770	0.2367	0.1373	0.1544
Transport infrastructure	0.0773				
Std. error	0.1899				
Telecommunication infrastructure		0.2901			
Std. error		0.1239			
Energy infrastructure			0.0853		
Std. error			0.3017		
Financial infrastructure				0.0494	
Std. error				0.0509	
Aggregate infrastructure					0.0874**
Std. error					0.0489

Table 3 (continued)

Variables	Transport infrastructure	Telecommunication infrastructure	Energy infrastructure	Financial infrastructure	Aggregate infrastructure
Constant	− 0.2699	1.7603	0.9300	− 0.6134	− 0.9540
Std. error	0.6757	1.6136	0.5594	0.7883	0.1231
$ECT_{(-1)}$	− 0.2954*	− 0.3867**	− 0.2478**	− 0.1220**	− 0.2429***
Std. error	0.1496	0.2183	0.1421	0.0671	0.0683
Hausman test (*P*-values)	0.4886	0.9995	0.2896	0.0063	0.4585
Pearson CD test (*P*-values)	0.2679	0.4855	0.2749	0.3271	0.6453

****, ** and * denote the significance at 1%, 5%, and 10%, respectively. Control variables are the same in each regression. In order to decide between PMG and MG estimator, this study employed Hausman test. Hausman test results confirmed the PMG in all columns. The Pearson CD test presents that there is no problem of cross-sectional dependency

The PMG estimation result shows that a plausible long-run impact of aggregate and sub-indices of infrastructure (transport, telecommunication, energy and financial sector) on export is positive and significant at 1% level in selected South Asian economies. The significant role of aggregate and all other sub-indices of infrastructure in exports confirm the findings of Donaubauer et al. (2018) and Brooks and Menon (2008). Thus we reject the null hypothesis of no impact of independent variables on dependent variable, rather we accept alternative hypothesis. The empirical results are consistent with the opinion that, infrastructure matters to trade mainly because they decrease the cost of trade and ensure the ease of doing business in host economies. Lower trade costs rise the potential for increased export markets (Brooks and Menon 2008; Limao and Venables 2001). This study uses the South Asian economies which are less developed countries. So, Garsous (2012) argues that larger the number of developing countries in the sample, the more likely a positive impact of infrastructure on trade is likely to be observed. This would allow to the conclusion that the less developed the country, the more likely infrastructure to matter. Andrés et al. (2014) and Asif and Rehman (2019) found that infrastructure development has been a main determinant in reducing Asia's trade costs and thereby export expansion. Among the infrastructure the effects of others control variables, i.e., exchange rate (ln_EXR), human capital (ln_HC), per capita GDP (ln_PGDP), institutional quality index (ln_IQ) on exports is significant in all columns. It indicated that the undermentioned control variables increase the export significantly, except exchange rate which is consistently negative and significant in the present results. It presents that, when exchange rate of host economy increases, automatically the price seems to be high. So export will decrease. The results are in the line of Sahoo and Dash (2012) and Ayogu (1999). Similarly, institutional quality has significant positive impact on export. It signifies that better quality of institutions significantly encourage export in domestic economy. This empirical results negate the claim of Khan et al. (2019) that institutional quality does not contribute to export in South Asian economies. Furthermore, it can be seen in lower half of Table 3, that in short run most of independent variables are insignificant except aggregate infrastructure (ln_GINFRA) is significant in both short as well as in the long run. The values of $ECT_{(-1)}$ in Table 3 show slow adjustment to equilibrium position by exports. Likewise, in the present study, most of the developing counties experience persistent low economic growth; it is very likely that such a long-run relationship exists. However, there is little evidence to suggest their speed of adjustment to the long-run steady state should be the same (Tan 2009).

On the other hand, the outcomes of PMG technique in Table 4 confirm the long-run effect of aggregate and all other sub-indices of infrastructure on trade deficit in selected South Asian economies. Thus we reject the null hypothesis of no impact of independent variables on dependent variable, so in this case also we accept alternative hypothesis. The results are supported by the study of Ahmad et al. (2015) and Brooks and Menon (2008). Our empirical results are consistent with the idea that, better infrastructure decrease the trade costs and alter the comparative advantages of a country, making greater fragmentation of production supply chains possible and spurring the country's international trade (Brooks and Menon 2008). Taking the example of Rehman et al. (2019) and Escribano et al. (2009), a reduction in transport and communication costs by 10% each would increase trade by about 6% and also 1% increase in aggregate infrastructure investment increases exports by about 0.6% and imports by about 0.3% in developing countries. This presents that availability of infrastructure increase exports more then imports. That is why the coefficient of aggregate infrastructure (Ln_GINFRA) and sub-indices including transport (Ln_TINFRA), telecommunication (Ln_CINFRA) and energy (Ln_EINFRA) sector is negative and significant at 1%. Our selected South Asian countries have huge trade deficit (imports > exports) from last two decades. The empirical results of this study signifies that better quality and availability of aggregate and chosen sub-indices of infrastructure encourage more export which will obviously decrease trade deficit in selected economies of south Asia (Donaubauer et al. 2018).

In addition to that, the effect of other control variables such as exchange rate, human capital per capita GDP, institutional quality index is significant and negative in most of the columns except human capital which has correct sign according to economics theory but insignificant. It is due to the fact that selected South Asian economies have insufficient human capital (i.e., decrease rate of enrollment in secondary school) and imports continuously rises up (Bhattacharyay 2014) which may cause insignificancy. One can examine the empirical results of Table 3, that the influence of human capital on export is positive and significant. It is due to the reason that export enhances relative to the speed of human capital in South Asian economies, while in short run the influence of aggregate and all other sub-indices of infrastructure on trade deficit is insignificant. The values of $ECT_{(-1)}$ in Table 6 show slow adjustment to equilibrium position by trade deficit due to above-mentioned reason.

Table 5 presents the Pedroni and Kao cointegration test results. The empirical results of Table 5 demonstrate the existence of a cointegration between dependent (i.e., export) and independent variables (such as ln_EXR, ln_HC, ln_IQ, ln_PGDP and ln_GINFRA) fully established in both (within-dimension and between-dimension) in all specifications because the v-statistic and the rho-statistics probability values are lower than the conventional level of significance, and also the ADF-statistic and PP-statistic indicate that their probability values are significant at 1% level of significance. The probability values of rho-statistic, v-statistic and ADF-statistic are also significant in case of trend and intercept (between-dimension and within-dimension).The PP-statistic (between-dimension and within-dimension) is significant at 1%, also ADF-statistic is significant at 1%.

Table 4 Pooled Mean Group estimator results (trade deficit is dependent variable)

Variables	Transport infrastructure	Telecommunication infrastructure	Energy infrastructure	Financial infrastructure	Aggregate infrastructure
Long-run results					
Exchange rate	− 0.8650***	− 0.6846**	− 0.8017***	− 4.1071***	− 3.4787***
Std. error	0.2376	0.3581	0.2989	0.4929	0.7478
Human capital	− 0.0136	− 0.1006	− 0.0305	− 1.3230*	0.7265*
Std. error	0.2848	0.3298	0.3390	0.8826	0.4233
Per capita GDP	1.3501***	1.3395***	1.3543***	3.0160***	2.7465***
Std. error	0.1807	0.1735	0.1348	0.3011	0.6561
Institutional quality	− 0.2859	− 0.6712**	− 0.5844***	0.7035	1.5687***
Std. error	0.2488	0.3039	0.2682	0.7742	0.3632
Transport infrastructure	− 0.1078**				
Std. error	0.0554				
Telecommunication infrastructure		− 0.0464			
Std. error		0.1958			
Energy infrastructure			− 0.0247		
Std. error			0.1032		
Financial infrastructure				0.3237***	
Std. error				0.0802	
Aggregate infrastructure					− 0.4292***
Std. error					0.1751
Short-run results					
Exchange rate	2.5839***	2.2407**	2.5519***	2.5864	4.3304
Std. error	0.1816	0.7701	1.0489	1.6439	2.9042
Human capital	0.0903	0.3284***	0.0070	− 0.9086	0.9416
Std. error	1.4475	0.1039	1.3530	1.5923	0.8382
Per capita GDP	3.3435***	3.3054***	3.5189***	3.0206**	1.3757
Std. error	1.1054	0.7950	1.0498	1.4649	0.4562
Institutional quality	− 1.6697	− 1.1406	− 1.4167	− 0.6815	− 1.6054
Std. error	1.4140	1.1943	1.2166	0.9362	0.6058
Transport infrastructure	0.2748				
Std. error	0.3606				
Telecommunication infrastructure		− 0.5274**			
Std. error		0.2918			
Energy infrastructure			− 0.2832		
Std. error			0.3510		
Financial infrastructure				0.0257	
Std. error				0.0802	
Aggregate infrastructure					0.0113
Std. error					0.1587

Table 4 (continued)

Variables	Transport infrastructure	Telecommunication infrastructure	Energy infrastructure	Financial infrastructure	Aggregate infrastructure
Constant	− 0.7986***	− 0.5983***	− 0.6599***	0.9704*	− 1.3201
Std. error	0.1693	0.2918	0.1424	0.6286	1.7275
$ECT_{(-1)}$	− 0.436***	− 0.3745***	− 0.4001***	− 0.3108*	− 0.6665**
Std. error	0.181	0.1707	0.1622	0.2096	0.2864
Hausman test (*P*-values)	0.8237	0.987	0.8060	0.2345	0.986
Pearson CD test (*P*-values)	0.8372	0.5491	0.4414	0.6660	0.5327

****, ** and * denote the significance at 1%, 5%, and 10%, respectively. Control variables are the same in each regression. In order to decide between PMG and MG estimator, this study employed Hausman test. Hausman test results confirmed the PMG in all columns. The Pearson CD test presents that there is no problem of cross-sectional dependency

Table 5 Pedroni and Kao cointegration test (export is dependent variable)

Export	Within-dimension (Panel)		Between-dimension (Group)	
v-Statistic	− 1.4074*	2.6440	Group-rho	2.4950***
rho-Statistic	− 1.534*	− 1.9146**	Group-PP	− 1.6704*
PP-statistic	− 3.4253***	0.6203	Group ADF	− 1.9146**
ADF-statistic	− 1.178*	− 1.8524**	Kao test	− 2.22***

****, ** and * denote the significance at 1%, 5%, and 10%, respectively

Table 6 Pedroni and Kao cointegration test (trade deficit is dependent variable)

	Within-dimension (Panel)		Between-dimension (Group)	
v-Statistic	1.852***	− 1.7708**	Group-rho	0.159
rho-Statistic	− 0.812	0.868	Group-PP	− 2.214***
PP-statistic	− 2.323***	0.0472	Group ADF	− 2.204***
ADF-statistic	− 1.526***	0.548	Kao test	− 2.79***

****, ** and * denote the significance at 1%, 5%, and 10%, respectively

We observed from the results of Table 5 that the cointegration is strong when an export use is a dependent variable in the analysis because most of the variables show significancy (between-dimension, within-dimension and deterministic trend and intercept) (Pedroni 2004). Furthermore, Kao test in Table 5 clearly indicates that there is long-run relationship between the dependent and independent variables in South Asian countries, because of the reason that all variables are significant. Here, we clearly reject the null hypothesis (of no cointegration) and accept alternative hypothesis (presence of cointegration) (Ayogu 1999; Kao and Chiang 1999).

It can be seen from Table 6, this study also uses trade deficit as a dependent variable and apply Pedroni and Kao cointegration test. The results confirmed the presence of a cointegration fully conventional in both (within-dimension and between-dimension) in all specifications of *v*-statistics and rho-statistics because the *v*-statistic and the rho-statistics probability values are decreased than the conventional level of significance. The ADF-statistic and PP-statistic indicate that their probability values are significant at 1%

level of significance. In the case of deterministic trend and intercept (between-dimension and within-dimension) the rho-statistics and v-statistics probability value shows significance at 1% level. The PP-statistic and ADF-statistics (between-dimension and within-dimension) is significant at 1%. We concluded from the results of Table 6 that the cointegration is also strong when trade deficit used is a dependent variable in the regression analysis because most of the variables show insignificancy (between-dimension and within-dimension) (Pedroni 2004). Table 6 also shows Kao cointegration test. The results show the dependent and independent variables are co-integrated, because whole variables are significant in all specifications (Kao and Chiang 1999).

6 Robustness with alternative methodologies

As it is apparent from the fact that the selected sample countries contain heterogeneous properties, like different market size, per capita GDP and exchange rate and they are not exactly the same, therefore, there is probability that standard error may not be normally distributed. In this regard, serial correlation, heteroskedasticity and also the problem of endogeneity may occur (Utku-İsmihan 2019; Kirubi et al. 2009). For robustness check, and also for undermentioned problem this study uses fully modified least squares (FMOLS) and dynamic ordinary least square (DOLS) estimator (Habib et al. 2016). Pedroni (2004) proposes FMOLS and DOLS to attain the long-run cointegrating coefficients. In the existence of "unit root variables", the impact of super consistency may not control the endogeneity problem effect of the regressors if ordinary least squares (OLS) is used.

FMOLS estimator was formerly proposed in work by Phillips and Hansen (1990) to postulate optimal estimates of cointegrating regressions. This approach adjusts least squares to account for "serial correlation" effects and for the "endogeneity" in the regressors that result from the presence of a cointegrating association (Kirikkaleli 2016). Furthermore, the asymptotic behavior of FMOLS in models with full rank $I(1)$ regressors, models with $I(1)$ and $I(0)$ regressors, models with unit roots, and models with only stationary regressors (Yorucu and Bahramian 2015).

The fully modified (FM) estimator was originally devised to evaluate cointegrating links directly by modifying traditional OLS. One reason, this technique has verified beneficial in practice is that one can use the FMOLS corrections to determine how imperative these effects are in an empirical practice. This has assisted to make the approach less of a "black box" for practitioners. In cases where there are main differences with OLS the source or sources of those differences can generally be easily located and this in turn helps to stipulate the researcher with additional information about important features of the data. Contemporary simulation experience and empirical research indicates that the FM estimator performs well in relation to other procedure of estimating cointegrating relationship (Cappuccio and Lubian 1992; Hansen and Phillips 1990, Hargreaves 1994; Phillips and Loretan 1991; Rau 1992).

DOLS and FMOLS are superior to the OLS for many reasons; (1) OLS estimates are super-consistent, but the t-statistic gotten without stationary or $I(0)$ terms are only approximately normal (Hausman 1978). Even though, OLS is super-consistent, in the presence of "a large finite sample bias' convergence of OLS can be low in finite samples (2) OLS estimates may suffer from serial correlation, hetero skedasticity since the omitted dynamics are captured by the residual so that inference using the normal tables will not be valid—even asymptotically (Yorucu and Kirikkaleli 2017). Therefore, "*t*" statistics for the estimates OLS estimates are useless (3) DOLS and FMOLS take care of endogeneity issue by adding the leads and lags (DOLS). In addition, white Heteroskedastic standard errors are used. FMOLS does the same using a nonparametric approach, see Arize et al. (2000), and Arellano and Bond (1991).

To overcome these problems, we applied FMOLS, and DLOS methods (Breusch and Pagan 1980). These models are capable of dealing with above diagnostic issues attributable to Padroni and Kao cointegration test and also to PMG estimator. The results are reported in Tables 7 and 8 which are consistent with main models; however, there is reasonable improvement in explanation power of some of the indicators due to error correction.

7 Conclusion and policy implications

The measurement of infrastructure bears serious data limitations. Previous studies, for example, Straub (2011), Roller and Waverman (2001), Hoffmann (2003) and Limao and Venables (2001) use several proxies for infrastructure such as, the aggregate data of road density, railways and airport facility for transport infrastructure, broadband and mobile connection for telecommunication infrastructure and electricity consumption and access to electricity, etc., are for energy infrastructure, which may be difficult to deliver a wide-ranging and true picture of infrastructure channel. However, some studies like Francois and Manchin (2013), Sahoo and Dash (2012) and Kumar (2006) relax the problematic assumption by employing PCA, but using PCA in a panel data tends to unduly restrict the set of countries and the data series that can be included in the analysis Donaubauer et al. (2015). To overcome the above-mentioned limitation of previous studies, this study uses an inclusive index of infrastructure devised by Donaubauer et al. (2015), covering the data during 1990–2017 by applying Unobserved Component Analysis (UCM).

The aim of this research is to explore the long- and short-run impact of infrastructure on exports and trade deficit for selected South Asian economies by applying PMG estimator and cointegration techniques (i.e., Padroni and Kao test). The empirical results of PMG approach confirmed the significant positive long-run impact of aggregate and all others sub-indices (i.e., transports, telecommunication, energy and financial) of infrastructure on exports. Most of control variables of this study also play significant role in export like, exchange rate (ln_EXR), human capital (ln_HC), per capita GDP (ln_PGDP) and institutional quality index (ln_IQ) while, in short run only aggregate infrastructure is significant. This is good news for policy-makers in south Asia who want to catch-up on developed economies and diminish the gap between domestic country and advanced countries, in exports. The cointegration technique like, Padroni and Kao examines strong cointegration between aggregate infrastructure and export. This study also used fully modified ordinary least square (FMOLS) and dynamic ordinary least square (DOLS) cointegration approach for robustness and to detect diagnostic problems of serial correlation, heteroskedasticity and most importantly endogeneity. Here, FMOLS and DOLS show consistent and robust results with our main models.

Similarly, we also examine the effect of aggregate and undermentioned sub-indices of infrastructure on trade deficit and apply the same undermentioned techniques. The empirical results of this study suggested that infrastructure including all sub-indices

Table 7 Fully modified OLS results (export is dependent variable)

Variables	Transport infrastructure	Telecommunication infrastructure	Energy infrastructure	Financial infrastructure	Aggregate infrastructure
Long-run results					
Exchange rate	− 0.546***	− 0.469***	− 0.545***	− 0.595***	− 0.126*
Std. error	0.067	0.070	0.069	0.052	0.071
Human capital	0.441***	0.336***	0.343***	0.505***	0.329***
Std. error	0.060	0.063	0.065	0.046	0.056
Per capita GDP	1.181***	1.254***	1.152***	1.210***	0.975***
Std. error	0.040	0.043	0.041	0.306	0.040
Institutional quality	0.614***	0.507***	0.675***	0.592***	0.467***
Std. error	0.090	0.098	0.096	0.071	0.088
Transport infrastructure	0.025				
Std. error	0.026				
Telecommunication infrastructure		0.240***			
Std. error		0.048			
Energy infrastructure			0.091***		
Std. error			0.020		
Financial infrastructure				0.089***	
Std. error				0.009	
Aggregate infrastructure					0.305***
Std. error					0.024
ADJ. R^2	0.84	0.84	0.84	0.85	0.86
Dynamic ordinary least square					
Exchange rate	− 0.443**	− 0.531***	− 0.560***	− 0.480***	− 0.473***
Std. error	0.264	0.242	0.224	0.209	0.210
Human capital	0.735***	0.609***	0.727***	0.606***	0.460***
Std. error	0.288	0.204	0.192	0.185	0.143
Per capita GDP	1.143***	1.196***	1.204***	1.197***	0.748***
Std. error	0.150	0.159	0.129	0.109	0.130
Institutional quality	0.038	0.396	0.165	0.008	0.009
Std. error	0.456	0.340	0.355	0.265	0.242
Transport infrastructure	0.183				
Std. error	0.209				
Telecommunication infrastructure		0.016			
Std. error		0.175			
Energy infrastructure			0.073**		
Std. error			0.014		
Financial infrastructure				0.123***	
Std. error				0.036	
Aggregate infrastructure					0.357***
Std. error					0.067
ADJ. R^2	0.84	0.85	0.84	0.85	0.86

****, ** and * denote the significance at 1%, 5%, and 10%, respectively

Table 8 Fully modified OLS results (trade deficit is dependent variable)

Variables	Transport infrastructure	Telecommunication infrastructure	Energy infrastructure	Financial infrastructure	Aggregate infrastructure
Long-run results					
Exchange RATE	− 0.840***	− 0.684***	− 0.843***	− 0.979***	− 0.418**
Std. error	0.176	0.190	0.168	0.188	0.191
Human capital	− 1.187***	− 1.253***	− 1.106***	− 0.999***	− 1.215***
Std. error	0.165	0.176	0.166	0.172	0.158
Per capita GDP	2.061***	2.264***	2.089***	2.181***	1.918***
Std. error	0.105	0.118	0.100	0.109	0.107
Institutional quality	1.140***	0.577**	0.963***	1.022***	0.832***
Std. error	0.273	0.290	0.249	0.272	0.252
Transport infrastructure	− 0.163***				
Std. error	0.068				
Telecommunication infrastructure		− 0.484***			
Std. error		0.133			
Energy infrastructure			− 0.009		
Std. error			0.059		
Financial infrastructure				− 0.161***	
Std. error				0.033	
Aggregate infrastructure					− 0.330***
Std. error					0.067
ADJ. R^2	0.83	0.81	0.81	0.83	0.82
Dynamic ordinary least square					
Exchange rate	− 1.225**	− 1.075**	− 0.015	− 0.595	− 1.469
Std. error	0.668	0.663	0.575	0.538	0.600
Human capital	− 0.951**	− 1.497***	− 0.869**	− 0.841**	− 1.337
Std. error	0.615	0.424	0.458	0.415	0.386
Per capita GDP	1.461***	1.872***	1.972***	1.647***	1.232
Std. error	0.303	0.314	0.248	0.230	0.304
Institutional quality	− 0.445	− 0.139	− 0.001	− 0.204	− 0.374
Std. error	0.927	0.663	0.724	0.621	0.599
Transport infrastructure	− 0.415**				
Std. error	0.113				
Telecommunication infrastructure		− 0.363**			
Std. error		0.144			
Energy infrastructure			− 0.149		
Std. error			0.128		
Financial infrastructure				0.181***	
Std. error				0.074	
Aggregate infrastructure					− 0.461***
Std. error					0.469
ADJ. R^2	0.86	0.84	0.86	0.87	0.89

****, ** and * denote the significance at 1%, 5%, and 10%, respectively decreases trade deficit (i.e., the impact of infrastructure on trade deficit is negative and significant in long but insignificant in short run). Beside, infrastructure the undermentioned control variables have significant impact on trade deficit in long run but insignificant in short run. Furthermore, the Padroni, and Kao cointegration test suggested that there is strong cointegration between the dependent and independent variables in all of the columns. FMOLS and DLOS of cointegration gives robust and consistent results.

The findings recommended that quality and availability of infrastructure (aggregate and sub-indices) matters to enhance trade and decrease trade deficit in selected South Asian countries. Hence, efficient infrastructure (i.e., transport, energy, telecommunication and financial sector) arrangements should be the priority for policy-makers to ensure further increase in exports and decline trade deficit which is most important problem of South Asia. The present study highlighted that availability of infrastructure accelerates regional and intra-regional trade however, we also find that the infrastructure decrease trade deficit in South Asian economies.

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Authors' contributions
FUR is the principal author of this article. AAN revised the manuscript and made changes accordingly, i.e., provided theoretical justification and origin & justification of econometric model. YD has provided supervision services. All authors read and approved the final manuscript.

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Appendices

Appendix 1

See Table 9.

Table 9 Variables and data sources of Global Infrastructure Index

S. no.	Variables	Normalization of the variables	Data source
01	Transport infrastructure (A) Land transport (i) Length of total road network (ii) Paved road (iii) Proportion of motorways (iv) Registered passenger cars	Population density	International Road Federation (IRF) World Road Statistic and World Development Indicators (WDI)
	(v) No. of registered commercial-vehicles	Population density of Pakistan	Facts and figures of (VDA) German Association (GAAI) of the Automotive Industry
	(vi) Length of total railway route	Population density of Pakistan	WDI
	(vii) Goods-transported	Area	
	(viii) Railway passengers	Population size	
	(B) C transport Overall carrying capacity of economy ships (i) Relative to its geographic area (ii) % of aggregate world-carrying capacity		(UNCTAD) United Nations Conference of Trade and Development Data Base
	(C) Air transport (i) Carrier departure registered in Pakistan	Relative to population	WDI
	(ii) Volume of air-freight	Relative to country size	
2	Telecommunication infrastructure (i) No. of fixed-telephone lines (ii) Mobile-cellular-telephone subscribers (iii) No. of ISDN subscribers For quality measures (a) Faults per 100 fixed-telephones lines in 1 year (expressed in per capita terms)		WDI
3	Energy infrastructure (i) Consumption of electric power (ii) Production of electric power Note: both undermentioned indicators are measure in per capita terms For quality measures: (a) Electric-power transmission and distribution losses (% of output)		WDI
4	Financial infrastructure (i) Stock market turn-over ratio [efficiency] (ii) No. of "Bank Account" per capita (iii) Values of overall "traded share" outside the major "10 traded companies" as a shares of the aggregate value of overall traded share (iv) No. of public recorded "companies per capita" (v) "Private credit" by deposit money, banks "Relative-GDP" (vi) Values of aggregate shares traded on the "Stock Market" exchange (relative to gross domestic product) (vii) Money (M2) and quasi-money percentage of GDP Note: all these selected indicators or employed in log form excluding no. of bank account and no. of public listed companies		World Bank Global Financial Development Data Base

Appendix 2

See Table 10.

Table 10 Descriptive statistic

Variables	Mean	SD	Min.	Max.
Export	4.890	0.961	2.866	6.973
Human capital	3.982	0.458	3.014	4.655
Per capita GDP	6.660	0.683	5.651	8.312
Institutional quality	1.417	0.235	0.358	1.700
Exchange rate	4.069	0.451	2.862	5.062
Trade deficit	3.531	1.296	−0.794	6.049
Transport infrastructure	−0.097	0.742	−4.998	0.888
Communication infrastructure	−0.345	0.457	−1.703	0.393
Energy infrastructure	−0.460	0.733	−4.895	0.674
Aggregate infrastructure	0.496	0.600	−2.969	0.216
Observations	106	106	106	106

Appendix 3

See Table 11.

Table 11 Pearson correlation coefficients of the selected variables

Variables	EXY	TRD	PDPG	HC	EXR	TINF	CINF	EINF	FINF	GINF
LnEXY	1.00									
lnTRD	−0.68	1.00								
LnPGDP	0.11	−0.18	0.28	1.00						
LnHC	0.10	−0.13	0.16	0.60	1.00					
lnEXR	0.99	−0.69	0.11	0.08	0.08					
LnTINF	0.50	−0.69	0.16	−0.03	0.06	1.00				
lnCINF	0.08	−0.01	0.13	0.65	0.27	−0.19	1.00			
lnEINF	0.34	0.00	0.17	0.15	0.07	−0.37	0.22	1.00		
lnFINF	0.63	−0.59	0.35	0.31	−0.03	0.69	0.17	0.11	1.00	
lnGINF	0.52	−0.65	0.33	0.26	0.06	0.86	0.13	−0.08	0.93	1.0

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