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IMPACT OF TRANSPORT AND TECHNOLOGICAL INFRASTRUCTURE IN ATTRACTING FDI IN PAKISTAN[3]

This study analyzes the long run and short-run impact of transportation and technological infrastructure in attracting FDI in Pakistan, while transportation infrastructure is disaggregated into roads, rail, and air transport, and technological infrastructure is disaggregated into telecommunication, oil, and power consumption. The study uses annual time series data of Pakistan from 1973 to 2018 and applies the ARDL bounds testing approach for analysis. Results show that all the indicators of infrastructure, i.e. roads, railways, air transport, telecommunication infrastructure, power and oil consumption, have a positive and statistically significant impact on FDI in the long run. Oil and power consumption shows a greater impact on FDI because foreign investors associate the country's development with its energy consumption. Transport infrastructure needs more improvement and development to facilitate foreign investments in the country. Government, as well as the private sector, has to pay attention to improving infrastructure facilities not only to fetch more FDI but for the economic progress of the country. Investment in infrastructure is required to provide better and efficient transport and technological infrastructure to facilitate the production process.
Keywords: FDI; Infrastructure; Transportation; Technology; Pakistan
JEL: C32; F21; O18

1. Introduction

The process of openness of economies and globalization in the world has brought more investments to developing countries. FDI is a key factor in the development of an economy as it is a source of finances and stimulate economic growth (Khadaroo, Seetanah, 2009). FDI reduces the technological, financial and skill deficits in developing countries. The main benefits of FDI to the developing nations include an increase in employment, productivity

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and capital formation, improvements in technology, infrastructure, skills development, export participation and market access. Recognizing the importance of FDI, developing countries have started to improve their policies which are inhibiting investments and have been moving towards more liberal investments and trade regimes (Singh et al., 2008).

There are a number of factors that determine FDI inflows in an economy, among those factors, infrastructure is an important and crucial factor, which determines FDI by influencing the desirability of location decisions for foreign firms. Infrastructure is defined as economic arteries and veins. It includes roads networks, ports, railways, power lines and pipes, telecommunications, education, health and sanitation. Infrastructure is the basic structure required for the proper functioning of an economy. It is an important component of an economy required for its development and is also considered as one of the macroeconomic indicators of economic growth (Fitrandi et al., 2014). Infrastructure is not only required for a country to grow, but it also helps to attract more investments in the economy and is considered as the pre-condition for both economic growth and attracting FDI (Pradhan et al., 2013). The growing importance of infrastructure and its association with FDI and economic growth have grabbed the attention of researchers and policymakers from the last few decades.

Better infrastructure like a well-developed communication system, roads network, provision of electricity reduces the cost of doing business by reducing delivery time, lowering labour cost and better communication (Kinda, 2010). Adequate infrastructure facilitates not only foreign investment, but also domestic investments in the economy. An efficient infrastructure attracts foreign investors to run their business smoothly and facilitates the production process and results in an increase in employment as well, thus helping both consumers and producers and improves the quality of life (Rehman et al., 2011). Among different components of infrastructure; advancement in transportation, telecommunication and technological infrastructure is of great importance and required to maintain the economic progress and competitiveness of a country.

Transportation infrastructure is considered as one of the important components of an economy because economic opportunities are generally related to the mobility of people, goods, and information. According to Robbins and Perkins (2012), foreign investors associate the level of a country's economic development with the modernized transport system. Investors are likely to invest in the countries, having efficient transport system, which lowers the cost of production and easy access to markets (Saidi, 2016). Efficient transport infrastructure and high connectivity of roads and railway networks are associated with economic development and prosperity. However, technological infrastructure is also an important factor for the development of an economy. Technological infrastructure mainly includes power generation and telecommunications. A stable communication between the host country and investors is required for increasing business and trade, which increases investment opportunities and economic prosperity. During the last few years, the telecommunication sector was the major recipient of FDI in Pakistan (Zeb et al., 2014). Continuous advancement in technological infrastructure helps a country to upgrade its industries and production as well as to face the challenges of the global economy. Another component of technology infrastructure is power generation which is also a major issue in Pakistan as electricity shortfalls affect the production process and all other sectors and industries of the economy, which makes investors hesitant to invest (Talat, Zeeshan, 2013).

Transportation infrastructure is considered as a backbone of strong and dynamic economies (Quazi, 2007). Governments of developed nations use significant portions of their budget in improving transportation infrastructure. But the cost of these projects is too high for developing and less developed nations because they do not have sufficient funds to complete the projects on their own. So, they require foreign investments for the improvement of their infrastructure for the proper functioning of the economy. Attracting more FDI in India fosters transport infrastructure and increases economic growth (Pradhan et al., 2013). Being a developing country, Pakistan also requires foreign investments to cope up with the resource gap and maintain economic growth. The literature had shown infrastructure as a determinant of FDI, but the association of FDI with transport and technological infrastructure in Pakistan is not focused much. This study explores the long run and short-run impact of transportation and technological infrastructure in attracting FDI in Pakistan. However, transportation infrastructure is disaggregated into roads, rail, and air transport, while technological infrastructure is disaggregated into telecommunication, oil and power consumption.

The rest of the study is structured in the following manner. Previous literature is discussed in section 2. Methodology and data are described in section 3. Results are analyzed in section 4. Section 5 contains a conclusion and policy recommendations.

2. Literature Review

Asiedu (2002) examined the determinants of FDI in seventy developing countries from 1988 to 1997. The results showed that infrastructure, trade openness and high return on investments positively increase FDI inflows. Moreover, infrastructural developments and high returns have positively affected FDI in non-SSA countries and are insignificant in SSA countries. Shah et al. (2004) studied the role of infrastructure as a determinant of foreign direct investment in Pakistan from 1960 to 2000. The results suggested that infrastructural provision has positive effects on inward FDI. However, infrastructure had a significant relationship with the investment opportunities, thus attracting FDI in the country. Sahoo (2006) identified the determinants of FDI by using data on market size, labour force, growth rate, infrastructure index and trade openness from 1975 to 2003 for South Asian countries. The results of the study depicted that transportation infrastructure attracts more FDI to developing countries.

Quazi (2007) studied investment climate and determinants of FDI in Latin America for 9 countries from 1995 to 2004. The study revealed that better infrastructure along with trade openness, high return and familiarity of investors with host country significantly increases FDI inflows and lack of economic freedom decreased FDI inflows. Khadaroo and Seetanah (2009) investigated the link between transport infrastructure and FDI in African countries from 1984 to 2002. Results showed that transport capital had a positive and significant effect on FDI, while the countries with improved transport and infrastructure had significantly attracted more investment. Kinda (2010) explored the effect of infrastructure and financial development on foreign investments from 1970 to 2003 for fifty-eight developing countries. Results indicated that an increase in physical infrastructure mainly communication infrastructure positively affected FDI inflows in SSA countries.

Babatunde (2011) explored the interaction between trade, infrastructure, foreign direct investment and economic using unbalanced panel data for forty-two SSA countries from 1980 to 2003. Results depicted that trade openness had a positive and significant relationship with infrastructural development and FDI, which helped to increase economic growth. Rehman et al. (2011) studied the role of infrastructure in attracting FDI in Pakistan from 1975 to 2008 by using the ARDL approach. The results showed that infrastructure positively attracted foreign direct investment both in the short and long run. Barzelaghi et al. (2012) investigated the role of transportation infrastructure, trade intensity and market size in FDI attraction in Iran from 1974 to 2007. Results of cointegration indicated that transport infrastructure positively and significantly affected FDI in the long run, but no significant impact was seen in the short run.

Sharma et al. (2012) analyzed the determinants of FDI in Malaysia from 1971 to 2004. The results depicted a positive impact of physical infrastructure on FDI in the short run only, while in the long run, FDI and the quality of physical infrastructure were negatively related. Ab et al. (2013) studied the determinants of FDI inflows in developing countries using panel data from1982 to 2008 for thirty-two developing countries. Results depicted that infrastructure had a positive impact on FDI attraction except for trade openness which did not show a strong influence on FDI. Lodhi et al. (2013) investigated the factors that affected FDI in Pakistan from 1976 to 2010. The result showed that the coefficient of electricity generation was highly significant and positively related to the inflow of FDI in Pakistan.

Pradhan et al. (2013) analyzed the long-run relationship between transport infrastructure, foreign direct investment and economic growth in India from 1970 to 2012. Results showed the presence of long-run relationships between transport infrastructure, FDI and GDP. However, there was bidirectional causality between FDI and economic growth, while transport infrastructure showed one-way causality to FDI and economic growth. Zafar (2013) examined the factors affecting foreign direct investment in Pakistan, India and Bangladesh from 1991 to 2010. The study found that infrastructure is statistically significant in bringing FDI in India but insignificant in Pakistan. Nourzad et al. (2014) analyzed the interaction between foreign direct investment and infrastructure in forty-six countries from 1980 to 2000. The findings indicated that all three types of infrastructure, i.e. telecommunication, power generation, and roads or highways helped to improve the marginal effect of FDI on real income.

Fitrandi et al. (2014) examined the relationship between infrastructure development and FDI inflows in thirty provinces of Indonesia from 2000 to 2009. The results showed that the coefficients of all proxies to infrastructure development were significantly positive and the provinces with the higher level of infrastructure were associated with more FDI inflows. Wekesa et al. (2016) studied the effects of transport, energy, communication and water and waste infrastructure on inward FDI in Kenya from 1970 to 2013. Results showed a positive impact of transport infrastructure on FDI inflows. Saidi (2016) analyzed the impact of road transport on the economic growth through its role in attracting foreign direct investment to Tunisia from 1975 to 2014. The results demonstrated that if the total size of the road network in Tunisia increases, then the volume of FDI inflows increases as well, while economic growth has a significant impact on FDI inflows in Tunisia.

Anarfo et al. (2017) examined the role of infrastructural development and natural resources in FDI attraction in Ghana from 1975 to 2014. Results showed that infrastructural development and natural resources play a positive and significant role in attracting FDI in Ghana. Och et al. (2017) studied the factors influencing FDI inflows from 1994 to 2014. Results revealed that infrastructure measured as length of paved roads did not show a significant impact on FDI in either short or long run. Ozcan (2018) examined the impact of transport infrastructure and services on foreign direct investment (FDI) to Turkish provinces from 2000 to 2010. Results suggested that an increase in air traffic and road density have a positive and significant impact on FDI in turkey.

Yousaf and Erum (2018) investigated the impacts of infrastructure on domestic investment from 1975 to 2013. Results showed that length of roads, telephone lines and GDP have a positive and significant impact on investments, while inflation and interest rate have a negative impact on investments. Jaiblai and Shenai (2019) explored the determinants of FDI in ten Sub-Saharan economies from 1997 to 2017. Findings of the study revealed that better infrastructure, smaller markets, higher openness and depreciation in the exchange rate attracted more FDI in the Sub Saharan economies.

The literature has shown infrastructure as a major determinant of FDI. Existing literature can be divided into two strands; one showed a significant impact of infrastructure in attracting FDI, while the other strand showed no significant impact of infrastructure on FDI. However, few studies are conducted in Pakistan to examine the impact of transport and technological infrastructure on FDI attraction. The present study fills the gap in the existing literature by analyzing the impact of different indicators of transport and technological infrastructure on FDI attraction in Pakistan.

3. Methodology and Data

The relationship between FDI and infrastructure is examined by a number of studies that showed FDI as a function of infrastructure and other variables, i.e. domestic market size, political risk, inflation rate, economic openness, human capital, exchange rate, taxes, and cost of labour (Aseidu, 2002; Sahoo, 2006; Jameel and Khadaroo, 2009; Rehman et al., 2011; Fitrandi et al., 2014; Wekesa et al., 2016; Anarfo et al., 2017 and Och et al., 2017). However, following Wekesa et al. (2016), this study includes major social, economic and political factors as determinants of FDI. Hence, the model becomes:

$$FDI= f (GDPPCG, CF, TO, INF, ER, INFRA)$$

where, FDI is foreign direct investment, GDPPCG is GDP per capita growth as a proxy for market size, CF is capital formation, TO is trade openness, INF is the inflation rate, ER is the exchange rate, and INFRA is infrastructure.

This study disaggregates infrastructure into transportation infrastructure and technological infrastructure. However, to get an even better picture of infrastructure on FDI, transportation infrastructure is further disaggregated into roads, railways, and air transport, while technological infrastructure is further disaggregated into telecommunication, oil

consumption, and power consumption. Hence, the study estimates the following nine econometric models:

$$FDI_t = \alpha_o + \alpha_1 GDPPCG_t + \alpha_2 CF + \alpha_3 TO_t + \alpha_4 INF_t + \alpha_5 ER_t + \alpha_6 ROADS_t + \varepsilon_t \quad (1)$$

$$FDI_t = \alpha_o + \alpha_1 GDPPCG_t + \alpha_2 CF + \alpha_3 TO_t + \alpha_4 INF_t + \alpha_5 ER_t + \alpha_6 RAIL_t + \varepsilon_t \quad (2)$$

$$FDI_t = \alpha_o + \alpha_1 GDPPCG_t + \alpha_2 CF + \alpha_3 TO_t + \alpha_4 INF_t + \alpha_5 ER_t + \alpha_6 AIR_t + \varepsilon_t \quad (3)$$

$$FDI_t = \alpha_o + \alpha_1 GDPPCG_t + \alpha_2 CF + \alpha_3 TO_t + \alpha_4 INF_t + \alpha_5 ER_t + \alpha_6 TRANSI_t + \varepsilon_t \quad (4)$$

$$FDI_t = \alpha_o + \alpha_1 GDPPCG_t + \alpha_2 CF + \alpha_3 TO_t + \alpha_4 INF_t + \alpha_5 ER_t + \alpha_6 TELE_t + \varepsilon_t \quad (5)$$

$$FDI_t = \alpha_o + \alpha_1 GDPPCG_t + \alpha_2 CF + \alpha_3 TO_t + \alpha_4 INF_t + \alpha_5 ER_t + \alpha_6 POWER_t + \varepsilon_t \quad (6)$$

$$FDI_t = \alpha_o + \alpha_1 GDPPCG_t + \alpha_2 CF + \alpha_3 TO_t + \alpha_4 INF_t + \alpha_5 ER_t + \alpha_6 OIL_t + \varepsilon_t \quad (7)$$

$$FDI_t = \alpha_o + \alpha_1 GDPPCG_t + \alpha_2 CF + \alpha_3 TO_t + \alpha_4 INF_t + \alpha_5 ER_t + \alpha_6 TECHI_t + \varepsilon_t \quad (8)$$

$$FDI_t = \alpha_o + \alpha_1 GDPPCG_t + \alpha_2 CF + \alpha_3 TO_t + \alpha_4 INF_t + \alpha_5 ER_t + \alpha_6 TRANSI_t + \alpha_7 TECHI_t + \varepsilon_t \quad (9)$$

Where, FDI is foreign direct investment, GDPPCG is GDP per capita growth, CF is capital formation, TO is trade openness, INF is the inflation rate, ER is the exchange rate, ROADS is road transport measured as total length of roads in kilometres, RAIL is railways measured as goods transported million ton-km, AIR is air transport measured as freight carried million ton-km, TRANSI is composite transportation infrastructure index which includes roads, rail, and air transport, TELE is telecommunication infrastructure measured as a number of fixed telephone lines per 1000 people, POWER is power consumption measured as electricity power consumption (KWH per capita), OIL is oil consumption measured as kg of oil equivalent per capita, TECHI is composite technological infrastructure index which includes telecommunication, oil consumption and electricity consumption.

The first step in analyzing the time series data is to check the stationarity of the variables because if there is a unit root problem in data, the results are misleading. The most widely used tests for checking unit root are Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) tests. Dickey and Fuller (1981) gave Augmented Dickey-Fuller (ADF) test to check stationarity, while Phillips and Perron (1988) gave PP test for unit root. After stationarity tests, the cointegration between variables is checked. Engle and Granger (1987) and Johansen and Juselius (1990) methods for cointegration required the variables to have the same order of integration. However, Pesaran et al. (2001) introduced a technique of cointegration called Autoregressive Distributive Lag Model (ARDL), which is applicable on a mixture of variables, i.e. I(0) and I(1). ARDL bounds testing approach to cointegration has the assumptions that the dependent variable should be integrated of order I(I) and none of the variables should be integrated of order I(2). Error Correction Model (ECM) can be derived from ARDL by a simple linear transformation. The error correction term (ECT) shows short-run dynamics by maintaining the long-run information. The specification of ARDL model is as follows:

$$\Delta Y_t = \delta_o + \sum_{i=1}^{k} \Delta\alpha_i \, Y_{t-1} + \sum_{i=1}^{k} \Delta\beta_i \, X_{t-i} + \varphi_1 Y_{t-1} + \varphi_2 X_{t-1} + \varepsilon_{it}$$

where, Y is the dependent variable and X represents the explanatory variable. The terms with Δ on the right-hand side shows the first difference of the variables. α, and β represents the short-run dynamics while, φ_1 and φ_2 are the long-run coefficients showing a marginal change in the dependent variable, due to change in explanatory variables.

The following null hypothesis is tested for cointegration:

H_o: $\varphi_1 = \varphi_2 = 0$ (There is no co-integration)

H_1: $\varphi_1 \neq \varphi_2 \neq 0$ (There is cointegration)

F-statistics computed by ARDL bounds test is compared with the upper bounds and lower bounds. If the value of F-statistics falls outside the upper bounds than null hypothesis is rejected and there is cointegration between the variables. The value should not fall below lower bounds because, in that case, the null hypothesis is not rejected. But, if the value of F-statistics falls between the lower and upper bounds, then the results of the test will be inconclusive. Moreover, the causality among the variables is checked by the Granger causality test. Ganger (1988) presented a method for checking causality between variables.

Following Wekesa et al. (2016), this study constructs the composite transport and technological infrastructure index through principal component analysis (PCA) as:

$$\pi_i = W_1 X_{j1} + W_2 X_{j2} + \cdots + W_n X_{jn}$$

Where, π_i is the composite index for i^{th} category that is transportation index and technological index and W_i is the weight of the j^{th} indicator. PCA is used to identify a hidden pattern and the correlated variables in the dataset. It is used to reduce the original variables into a smaller number of variables explaining most of the variance in the original variables. Instead of including all the infrastructure variables in a single equation, indexes of transport and technological infrastructure are formulated to avoid the misleading results, due to the presence of correlation between the infrastructure variables.

The study uses annual time series data of Pakistan from 1973 to 2018. The data for foreign direct investment (FDI) inflow as a percentage of GDP, GDP per capita growth (GDPPCG), capital formation (CF) measured as total gross fixed capital formation as a percentage of GDP, inflation (INF) measured as GDP deflator annual percentage, the exchange rate (ER) measured as official exchange rate (LCU per $), and trade openness (TO) measured as total trade as a percentage of GDP are collected from Pakistan Economic Survey (various issues) published by Government of Pakistan. ROADS is road transport measured as a total length of roads in kilometres, RAIL is railways measured as goods transported million ton-km, AIR is air transport measured as freight carried million ton, TELE is telecommunication infrastructure measured as a number of fixed telephone lines per 1000 people, OIL is oil consumption measured as kg of oil equivalent per capita, POWER is power consumption measured as electricity power consumption (KWH per capita) are collected from Pakistan Economic Survey (various issues) as well. TRANSI is a composite transportation infrastructure index (which include roads, rail, and air transport) and TECHI is a composite technological infrastructure index (which include telecommunication, oil consumption and electricity consumption) are constructed through principal component analysis (PCA).

4. Results

The results of the ADF and PP tests are reported in table 1 and suggest that dependent variable FDI is integrated of order I(1), while the explanatory variables GDPPCG, capital formation, inflation, and rail are integrated of order I(0), while trade openness, roads, air, telecommunication infrastructure, oil consumption, power consumption, transport index and technology index are integrated of order I(1). Unit root tests revealed mix order of integration of variables. The results of both the tests show that none of the variables is integrated of order I(2).

Table 1

Results of ADF and PP Unit Root Tests

Variables	Augmented Dickey-Fuller (ADF)		Phillips-Perron (PP)		Order of Integration	
	At Level	At 1st difference	At Level	At 1st difference	ADF	PP
FDI	-3.3446*	-4.4693***	-2.0351*	-4.4320***	I(I)	I(I)
GDPPCG	-4.9905***	----	-4.9873***	----	I(0)	I(0)
CF	-3.7181**	----	-3.7044**	----	I(0)	I(0)
TO	-2.6008	-7.6082*	-2.6397	-7.8468***	I(I)	I(I)
INF	-4.6457***	----	-4.6491***	----	I(0)	I(0)
ER	-1.8249	-4.2108*	-1.8884	-4.1224***	I(I)	I(I)
ROADS	0.6040	-4.0977**	0.5029	-3.9390***	I(I)	I(I)
RAIL	-3.8541**	----	-2.2898	-4.4169***	I(0)	I(I)
AIR	-1.6701	-5.6000***	-1.5302	-5.5704***	I(I)	I(I)
TELE	-2.6834	-3.7315***	-1.7885	-5.4007***	I(I)	I(I)
POWER	0.9842	-5.4228***	1.3951	-5.4172***	I(I)	I(I)
OIL	-3.1087	-4.3114***	-2.1796	-4.3114***	I(I)	I(I)
TRANSI	0.6301	-4.0875**	0.4803	-3.9288***	I(I)	I(I)
TECHI	-2.2925	-3.6557***	-1.6366	-5.3169***	I(I)	I(I)

*Note: ***, **, * shows significance at 1%, 5% and 10% respectively.*

To check the presence of cointegration, ARDL bound test is applied. The results of ARDL bound tests for all the models are reported in table 2 and show that the value of F-statistic in all the models fall above the upper bounds value at 1% level of significance. Hence, the null hypothesis of no cointegration between the variables is rejected, which implies that a long-run relationship exists between the variables.

The results of the long-run and short-run dynamics for all the models are shown in table 3, panel A and panel B, respectively. Results of the long run show that GDP per capita growth (GDPPCG) and inflation (INF) have a positive and significant impact on FDI in the long run in all the models. GDPPCG is positively related to FDI because investors are likely to invest in strong and healthy economies in order to earn more profits (Aseidu, 2002). Inflation has a significant positive impact on FDI because when there is an increase in FDI inflows, it exerts an upward pressure on the local currency, which affects the export industries negatively and lead towards an increase in inflation. The exchange rate (ER) shows a negative and significant impact on FDI, while a number of studies found similar results (Anarfo et al., 2017; Rehman et al., 2011; Zafar, 2013). Weak currencies pull in FDI because the rate of return by investing in weak currencies is greater than investing in strong currencies. Capital formation (CF) and trade openness (TO) have a statistically insignificant impact on FDI in

the long run, however, trade openness in models V and IX is negative and significant, which implies that trade openness is beneficial for FDI only if the trade is export-based.

Table 2

Bound Test for Total and Sectoral Oil, Coal, Gas and Electricity Consumption

Dependent Variable: FDI	F-Statistics	1 percent critical values Bound Test		Co-integration Exist
Model		I(0)	I(1)	
Model-I: $F_{(GDPPCG,TO,INF,ER,ROADS)}$ (1, 0, 2, 3, 2, 0, 0)*	5.3917	3.15	4.43	Yes
Model-II: $F_{(GDPPCG,TO,INF,ER,RAIL)}$ (1, 1, 1, 1, 0, 2, 1)*	5.3541	3.6	4.9	Yes
Model-III: $F_{(GDPPCG,TO,INF,ER,AIR)}$ (3, 1, 1, 3, 0, 3, 1)*	4.7113	2.66	4.05	Yes
Model-IV: impact of transport index on FDI $F_{(GDPPCG,TO,INF,ER,TRANSI)}$ (1, 0, 2, 0, 0, 2, 0)*	4.5465	2.66	4.05	Yes
Model-V: impact of telecommunication infrastructure on FDI $F_{(GDPPCG,TO,INF,ER,TELE)}$ (1, 1, 0, 0, 1, 3, 0)*	4.3903	2.66	4.05	Yes
Model-VI: impact of power consumption on FDI $F_{(GDPPCG,TO,INF,ER,POWER)}$ (1, 0, 1, 3, 2, 0, 0)*	4.9661	3.15	4.43	Yes
Model-VII: impact of oil consumption on FDI $F_{(GDPPCG,TO,INF,ER,OIL)}$ (1, 2, 2, 3, 0, 2, 1)*	6.0051	2.66	4.05	Yes
Model-VIII: impact of technology index on FDI $F_{(GDPPCG,TO,INF,ER,TECHI)}$ (1, 1, 1, 3, 0, 3, 1)*	5.4947	3.6	4.9	Yes
Model-IX: impact of transport and technology index on FDI $F_{(GDPPCG,TO,INF,ER,TRANSI,TECHI)}$ (1, 2, 1, 2, 1, 1, 2, 1)*	5.0250	2.96	4.26	Yes

**The model is not suffering from serial correlation, heteroscedasticity and specification error.*

The results of model-I show that roads (ROADS) have a positive and statistically significant effect on FDI in the long run, while Fitrandi et al. (2014), Jameel and Khadaroo (2009), Pradhan et al. (2013), Saidi (2016), and Wekesa et al. (2016) also found similar results. Roads have a positive impact on FDI because a good roads network decrease the cost of production by reducing delivery time and increasing the ease to transport goods from one place to another, thus attract more investors. Results of model-II and model-III show that railways and air transport have a positive and statistically significant impact on FDI. A better and efficient transportation by railways decrease the cost of transportation and attracts investors to invest in a country (Wekesa et al., 2016). Composite transportation infrastructure index (TRANSI) is incorporated in model-IV, which shows that the transportation index has a positive and statistically significant impact on FDI. Sahoo (2006) and Wekesa et al. (2016) also found similar results.

Table 3

Long Run and Short Run Dynamic of Transportation and Technological Infrastructure on FDI

Dependent Variable FDI									
Var	Model-I	Model-II	Model-III	Model-IV	Model-V	Model-VI	Model-VII	Model-VIII	Model-IX
Panel A: Long Run									
GDPPCG	0.1009*** (0.1816)	0.4319*** (0.1526)	0.4871** (0.1847)	1.1163*** (0.2953)	0.0219*** (0.1218)	0.5638*** (0.1104)	0.5812*** (0.1955)	0.3190** (0.1280)	0.7773*** (0.2124)
CF	-0.0691 (0.1986)	-0.0831 (0.1456)	-0.1182 (0.1222)	-0.2651 (0.1208)	0.3854 (0.1570)	-0.1820 (0.1007)	-0.3006 (0.3037)	0.0071 (0.2098)	-0.0044 (0.1295)
TO	0.0487 (0.0559)	0.0039 (0.0595)	-0.0686 (0.0646)	-0.0651 (0.0475)	-0.1278** (0.0668)	-0.0317 (0.0504)	0.1545 (0.0799)	-0.0598 (0.0551)	-0.1495* (0.0764)
INF	0.1009*** (0.0350)	0.2402*** (0.0576)	0.0929** (0.04124)	0.1291** (0.0489)	0.1678*** (0.0769)	0.0782*** (0.0274)	0.1117** (0.0473)	0.0462 (0.0637)	0.1767*** (0.0500)
ER	-0.0293** (0.0141)	-0.0973*** (0.0330)	0.0103*** (0.0030)	-0.0611*** (0.0173)	-0.0445** (0.0154)	-0.0527*** (0.0092)	-0.0402* (0.0220)	-0.0865** (0.0342)	-0.0340** (0.0148)
ROADS	0.0001*** (0.0000)	----	----	----	----	----	----	----	----
RAIL	----	0.0005** (0.0002)	----	----	----	----	----	----	----
AIR	----	----	0.0082*** (0.0029)	----	----	----	----	----	----
TRANSI	----	----	----	0.0001*** (0.0000)	----	----	----	----	0.0001* (0.0000)
TELE	----	----	----	----	0.0012* (0.0003)	----	----	----	----
POWER	----	----	----	----	----	0.0168*** (0.0022)	----	----	----
OIL	----	----	----	----	----	----	0.0250*** (0.0075)	----	----
TECHI	----	----	----	----	----	----	----	0.0008** (0.0003)	0.0009** (0.0004)
Panel B: Short Run ECM									
ECT(-1)	-0.4111*** (0.0421)	-0.3879*** (0.0395)	-0.4414*** (0.0535)	-0.3184*** (0.0382)	-0.2506*** (0.0287)	-0.5075*** (0.0568)	-0.3503*** (0.0412)	-0.4361*** (0.0431)	-0.4026*** (0.0437)

*Note: Standard errors are in parenthesis. ***, **, * shows significance at 1%, 5% and 10% respectively.*

The result of model-V shows that telecommunication infrastructure (TELE) has a positive and statistically significant impact on FDI. An efficient communication between hosts and investors is required for the smooth running of the business. Anarfo et al. (2017), Aseidu (2002), Fitrandi et al. (2014), Rehman et al. (2011), and Wekesa et al. (2016) also found similar results. The long-run results of model-VI and model-VII show that power consumption (POWER) and oil consumption (OIL) have a positive and statistically significant impact on FDI. Investors associate the level of development of a country with its energy consumption (Sahoo, 2006). Lodhi et al. (2013), Nourzad et al. (2014) and Wekesa et al. (2016) also found similar results. Composite technological infrastructure index is incorporated in model-VIII and shows that there is a positive and statistically significant impact of the technological index on FDI. Advancement in technology is required for efficient production (Sahoo, 2006). Results of model-IX show that both composite transport and technological indexes have a positive and statistically significant impact on FDI. However, the impact of the technological index is greater on FDI as compared to the transportation index. An efficient infrastructure facilitates the production process and attracts

foreign investors to invest in a country. These findings are similar to Fitrandi et al. (2014), Nourzad et al. (2014) and Wekesa et al. (2016).

Table 4

Results of Causality Test

Model	F-statistics	Causality
GDPPCG → FDI	1.7538	No
FDI → GDPPCG	2.9256**	Yes
Inflation → FDI	0.3161	No
FDI → Inflation	1.7257	No
ER → FDI	0.6978	No
FDI → ER	8.2830***	Yes
CF → FDI	0.1897	No
FDI → CF	4.9298**	Yes
TO → FDI	0.1073	No
FDI → TO	0.3958	No
Transport index → FDI	2.5194*	Yes
FDI → Transport index	0.9998	No
Technology index → FDI	7.5425***	Yes
FDI → Technology index	6.6128***	Yes
Railways → FDI	1.3189	No
FDI → Railways	6.2175***	Yes
Roads → FDI	3.2031**	Yes
FDI → Roads	0.9145	No
Air transport → FDI	2.4350*	Yes
FDI → Air transport	1.3419	No
Telecommunication infrastructure → FDI	6.5839***	Yes
FDI → Telecommunication infrastructure	6.8112***	Yes
Power consumption → FDI	2.1858*	Yes
FDI → Power consumption	5.8103***	Yes
Oil consumption → FDI	2.5329*	Yes
FDI → Oil consumption	3.4030**	Yes

*Note: ***, **, * shows significance at 1%, 5% and 10% respectively.*

The results of short-run dynamics by converting ARDL into ECM are reported in table 3, panel B and show that the value of ECT for all the models is negative and significant. The value reveals the speed of adjustment and negative sign shows convergence in the short run. In sum, results show that technological infrastructure shows a stronger impact on FDI as compared to transport infrastructure. Among transport infrastructure indicators, air transport affects FDI with a greater magnitude as compared to roads and railways. Among technological infrastructure indicators, oil consumption has a greater impact on FDI than telecommunication and power consumption, while the magnitude of the technological infrastructure index is greater than the transportation index. These results clearly demonstrate that oil and power consumption have a greater impact on FDI in the long run as compared to all other infrastructure indicators used in the analysis.

Results of the Granger causality test are reported in table 4. Results show the presence of unidirectional causality from FDI to per capita GDP growth, exchange rate, capital formation, and railway infrastructure. Unidirectional causality also exists from roads, air transport, and composite transport index to FDI. It implies that an increase in railways increases FDI

inflows, while for increasing roads and air transport FDI is required. However, bidirectional causality exists among telecommunication infrastructure, power consumption, oil consumption, composite technological index and FDI. It shows that not only improvements in technology infrastructure require foreign investments but also more investments are attracted in these sectors.

5. Conclusion

An efficient infrastructure facilitates domestic investment as well as attract foreign investors. Advancement in transportation and technological infrastructure is of great importance and are required to maintain the economic growth and competitiveness of a country. This study explores the long run and short-run impact of transportation and technological infrastructure in attracting FDI in Pakistan, while transportation infrastructure is disaggregated into roads, rail, and air transport, and technological infrastructure is disaggregated into telecommunication, oil and power consumption. The study uses annual time series data of Pakistan from 1973 to 2018 and applies the ARDL bounds testing approach for analysis.

The results of the study show that transport and technological infrastructure have a positive and significant impact on FDI in Pakistan. All the indicators of infrastructure, i.e. roads, railways, air transport, telecommunication infrastructure, power and oil consumption, have a positive and statistically significant impact on FDI in the long run. Among these indicators, oil consumption and power consumption show a greater impact on FDI because foreign investors associate the country's development with its energy consumption. The increase in market size and inflation encourages FDI inflows, while the trade openness and capital formation play an insignificant role in attracting FDI in the case of Pakistan. Granger causality test implies that the increase in railways increases FDI inflows, while FDI is required for increasing roads and air transport and bidirectional causality exists among telecommunication infrastructure, power consumption, oil consumption, technological index and FDI. An efficient and advanced transportation and technological infrastructure are required for economic prosperity. Among the number of infrastructure indicators used in the study; power and oil consumption are the factors that attract more FDI in Pakistan. More FDI is attracted in the energy sector rather than improvement of roads, railways and air transport. It implies that transport infrastructure needs more improvement and development to facilitate foreign investments in the country. In order to increase economic prosperity, infrastructure facilities should be improved. On the other hand, FDI is also required to improve infrastructure facilities in Pakistan.

Government, as well as the private sector, has to pay attention to improving infrastructure facilities not only to fetch more FDI but for the economic progress of the country. Investment in infrastructure is required to provide better and efficient transport and technological infrastructure to facilitate the production process.

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