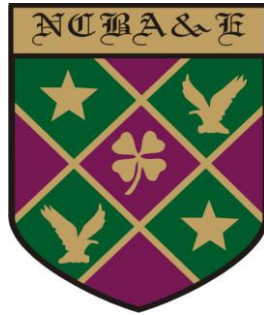


*National College of Business
Administration and Economics
Lahore*



**IMPACT OF ROAD INFRASTRUCTURE ON
ECONOMIC DEVELOPMENT: A TIME SERIES
ANALYSIS FROM PAKISTAN**

BY

SABA AKRAM

**MASTER OF PHILOSOPHY
IN
ECONOMICS**

DECEMBER, 2019

NATIONAL COLLEGE OF BUSINESS ADMINISTRATION AND ECONOMICS

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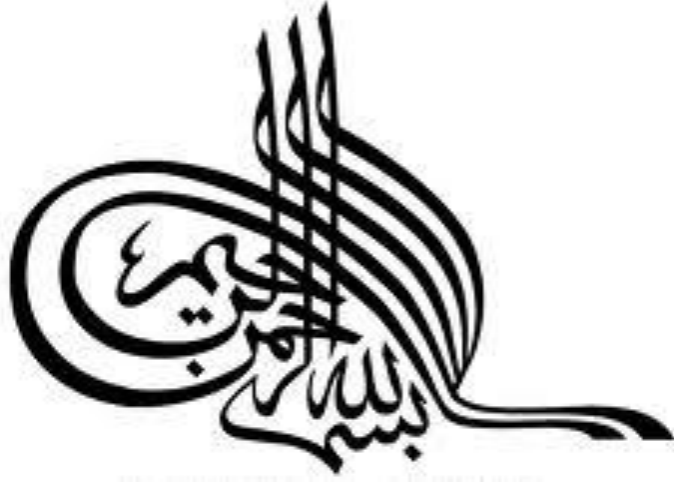
**BY
SABA AKRAM**

**A dissertation submitted to
Faculty of Social Sciences**

**In Partial Fulfillment of the
Requirements for the Degree of**

**MASTER OF PHILOSOPHY
IN
ECONOMICS**

December, 2019



*In the name of ALLAH,
The Most Beneficial,
The Most Merciful,*

**NATIONAL COLLEGE OF BUSINESS
ADMINISTRATION AND ECONOMICS
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Dissertation Committee:

Chairman

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Administration and Economics

DECLARATION

It is to declare that this research work has not been submitted for obtaining similar degree from any other university/college.

SABA AKRAM
December, 2019

DEDICATED TO

*My Mother and Father whose affection,
love, encouragement and prays of day and night
make me able to get such success, Along with my
hard working and respected supervisor
Dr. Muhammad Abdul Quddus.*

ACKNOWLEDGEMENT

All praises and thanks to ALLAH Who blessed me with enough ability and competency to complete this dissertation. I feel deepest and heartiest gratitude for different personalities who have been very cooperative and helpful during the writing of this thesis. I owe a debt of gratitude to my kind supervisor Prof. Dr. Muhammad Abdul Quddus (Head of Economics Department in NCBA&E) for his sympathetic attitude and knowledge suggestions during my entire research work.

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RESEARCH COMPLETION CERTIFICATE

Certified that the research work contained in this thesis entitled **“Impact of Road Infrastructure on Economic Development: A Time Series Analysis from Pakistan”** has been carried out and completed by **Saba Akram** under my supervision during her **M.Phil. Economics** Programme.

(Dr. Muhammad Abdul Quddus)
Supervisor

SUMMARY

This study has examined the relationship between road infrastructure and economic development in Pakistan. In this study, we used three types of econometric model in which independent variables are such as MPA, trade of goods and services, government education expenditure, urban population, and gross fixed capital formation (GFCF). The dependent variables are gross domestic product per workers, FDI and industrial sector growth. The MPA is the mobility proportional to accessibility. We applied Autoregressive Distributed Lag Model (ARDL) Approach for empirical analysis covering the data from 1973-2019. The results indicate that there is positive relationship between road infrastructure, trade of goods and services, gross fixed capital formation, education expenditure and economic development of Pakistan.

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CHAPTER 1

INTRODUCTION

Infrastructure, define as “The basic system or services (e.g. roads, power supplies and building) that a society or enterprise required for work efficiently” (Oxford Merriam-Webster and Cambridge dictionaries). Infrastructure can be classified as social or physical. Social infrastructure contain institutions such as government, education, health system (hospital) and communication system. Physical infrastructure includes all kinds of physical networks such as roads, airports, ports and railways (Maamari, 2017). Long term economic growth can achieve through efficient infrastructure assets and services. The efficient infrastructure sector affects any economy in different ways it reduces transaction costs, ease the movements of goods, ideas and services, increase competitions, and regional specialization (Fretz, 2014).

Road infrastructure in any society plays an important role in both primary inputs demand such labor movement and consumption pattern. With the help of safe and sound road transport system increased industrial units in rural areas, employment opportunities increased, farmers and producers linked each other in markets and in this way the poverty level decreased in any country (Economic Survey of Pakistan, 2017). The distance between origins and destination reduce by reducing congestion and also saved travel time by an improvement in transport infrastructure. When transport sector in good condition then it provides benefits to passengers in low freights and vehicle-operating costs. Better transportation system provides more incentives to companies in a way lower delivery costs, reliable and cheaper freight services and reduce their inventories (Gunasekera, 2008). Cross border and domestic transport infrastructure, reduce trade cost and increased trade and investment. When trade increase means that the economy grow, then available resources of government increase to invest in different social activities, social protection system, health and education (Choudhary and Sultana, 2018).

Road transport infrastructure is an essential sector for both advance and less developed economies. In less developed economies an efficient road infrastructure plays an essential function in every economic activity such as marketing of agricultural products, education, and proving access to health. The casual relationship between roads and development recognized by country leaders President Bush. He said that the interstate highway system sustained development in U.S. and enhanced uniting of the states as never before, socially, economically and politically (Queiro and Gautam, 1992).

Transport infrastructure re-emerged in Europe an important policy issue over the last two decades. Spain in 1980s to 1995s was developed a progressive program of road building and increased its motorway networks. Before construction of road in any area gather information how these road location effects on new manufacture activities. Some analysts consider the location decision is a very important factor in building roads because this way cost of transportation low and the economy grow. Due to new road infrastructure the attraction of location increases for new manufacturing establishment (Holl, 2004). Government fulfills its responsibility of managing the economy and encourages economic growth through development of transport infrastructure. Here example of China, at the end of 2008, when the international financial crisis arises, but the central government of China announced a four-trillion Yuan (\$2041 billion) money for economic growth activities, but half money spent in the construction of transportation infrastructure for instance airports, highways and railway, etc., In China income gap between regions is not widening because positive spillover effect of transport infrastructure (Xueliang, 2013).

Turkey enlarged its inter-provincial/local road stocks from 2003 and 2013. The expressways have significantly improved the ability and quality of roads. Some regions connectivity improved because these regions connected to international trade gateways. Due to improved connectivity to the international trade gateways reduce transportation cost and enhanced exports of this country which was 3% (Cosar, and Demir, 2016).

The expansion of the urbanization level as well as its geographical spread through investment in various transport infrastructures. In India, positive association exists among urban population and development of infrastructure. Transport infrastructure progress means improvement in accessibility when improvement occurs in the transport infrastructure of any area then those areas attract people. In this way urbanization enhanced, boosting economic activities and productivity increased (Maparu & Mazumder, 2017).

In Sub-Saharan Africa, Ethiopia is interesting because of its heavy reliance on road infrastructure for its public transport and freight. A manufacturing firm's town attractiveness enhanced due to better road accessibility and in this way 36% entrants occur of new firms (Shiferaw, et al. 2013). The improvement in various types of transport infrastructure system positively related to development and economic growth. In Romania transportation infrastructure, i.e., roads and railways enhanced development through liberalization of trade. Romania recently joined European Union (EU)

and the EU is frequently linked with trade liberalization. So, transportation system (roads and railways) of Romania increased trade liberalization. In 2010, 74% goods transferred by roads and 14% by railways in Romania (Pogorletchi, 2014).

The main *hurdle of low-income countries* for industrial development are high transport costs and *impoverished* infrastructure. Mostly manufactured goods markets are fragmented and small in less developed countries for the reason behind poor infrastructure. In this situation, firms start at small level these firms set their target small and production for local markets. All these arguments and observation reliable for Sub-Saharan Africa because under-developed infrastructure, small industrial sector and produce manufacturing good at local level (Shiferaw, et al, 2013).

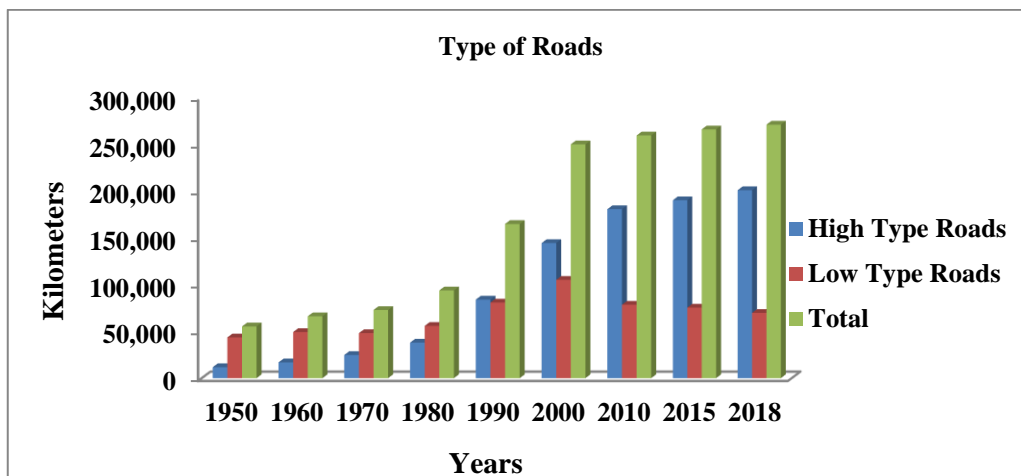
In 2018, Pakistan every province has different shares of road network, 41 % lies in Punjab, which is the largest share of total road infrastructure, 31% exist in Sindh, 11% in Khyber Pakhtunkhwa (KPK) and 1% in Gilgit-Baltistan (GB) (Times of Islamabad, 2018). In 2018, the total length of roads of Pakistan is 271 (000) kilometers, containing Azad Jammu Kashmir (AJK) and Gilgit-Baltistan as compared to 266 (000) kilometers over the last year (Economic Survey of Pakistan, 2018).

In 1950's the low type roads which were 44 (000) kilometers as compared to high type roads 12 (000) kilometers, which represent 26% of the high type roads in Pakistan. In 1960's more or less increments occur in both types of roads such as high type roads were 50 (000) kms and which shows that 34% of this type of roads. In 1970's the low type roads which were 25 (000) kms and high type roads were 49 (000) kms and it also shows that 50% of low type roads. In 1980's high type roads were 38 (000) kms and low type roads were 56 (000) which explained that 68% of low type roads. In 1990's the length of high type roads increased which was 85 (000) kilometers and low types roads length decreased 81 (000) kilometers and high type roads were 103% of low type roads. In 2000's the high type roads were 144,625 kilometers and low type roads were 105,320 which represent 137% of high type roads. In 2001 to 2007, due to importance of high type roads various low type roads transformed to high type roads (Pakistan Economic Survey, 2008). As time passes, the portion of high type roads increases as compared to low type roads. In 2010, the length of low type roads was 106 (000) kms and the length of high type roads were 145 (000) and it was 230% of high type roads. In 2015's the high type roads were 190 (000) kms and low type roads were 78 (000) which shows that 251% of high type roads. In 2018, the estimated length of high type roads 201(000) kilometers and low types roads are 70 (000).

Table 1.1
Estimated Length of Roads (kms)

Years	High Type Roads	Low Type Roads	Total Roads
1950	11,730	43,646	55,376
1960	16,860	49,376	66,236
1970	24,776	48,230	73,006
1980	38,035	55,925	93,960
1990	84,107	80,925	165,032
2000	144,652	105,320	249,972
2010	180,866	78,597	259,463
2015	190,355	75,550	265,905
2018	201,100	69,872	270,971

(Source: Pakistan Economic Survey, various issues)



(Source: Pakistan Economic Survey, various issues)

Figure 1.1: Estimated Length of Roads from 1950 to 2018

The above graph explains length of major roads (high type roads) and local roads (low type roads) in kilometers over 68 years. Over the passage of time there were increasing trends in high type roads in Pakistan. On the other hand, low type roads were increasing trend till 2000, after that low type road had converted into high type roads.

1.1 IMPORTANCE OF ROAD INFRASTRUCTURE IN PAKISTAN:

We analyze the importance of road network in Pakistan, so we run numerical data of road infrastructure on Eviews software and data which exist in the form of high type roads, low type roads and total road.

1.1.1 Time Series Analysis of Pakistan Data

The time series data (1973-2018) available on the road network and GDPPC of Pakistan. There found an optimistic association among gross domestic product per capita (constant 2010US\$) and road density (total roads, in km/million inhabitants). The correlation equation of two variables is:

$$GDPPC = 0.000387 + 0.002245 \times RD$$

where GDPPC is gross domestic product per capita and RD stand road density. The R square value is 0.839916, coefficient of the t-statistics is 15.02027 and the number of degrees of freedom is 44 (figure 1.1).

We found a positive relationship between GDPPC (GDPPC (\$/inhabitant)) and high type roads: HTR (km/Million Inhabitants). The correlation coefficient is:

$$GDPPC = 0.00046 + 0.003052 \times HTR$$

The R square value is 0.919055, t-statistics coefficient is 22.0957 and the degree of freedom is 44 (figure 1.2).

1.2 NOVELTY OF THE STUDY

Physical Infrastructure consists of roads, ports, airports, railroads and telecommunication, etc., is a necessity for world integration and economic development. As earlier researchers focus on various kinds of transportation infrastructure (roads, railway, airports and etc.,) in their own studies. As in the case of Pakistan some recent research conducted on transportation infrastructure in which they made the transportation infrastructure index and some divided transport infrastructure into roads and railway. However, the specification of this study is that it takes road infrastructure in ratio form of high type road to low type roads. The road infrastructure network allows for physical connected within countries and across international borders. High type roads are national highways, motorways and provincial highways. Low type roads are secondary roads, regional road networks and other road networks.

1.3 STATEMENT OF THE PROBLEM

The central objective of study is to identify that how road infrastructure has direct and indirect influence on development and GDP growth of nation. An efficient road infrastructure network is crucial for the development of low-income countries like South Asian countries. In developing countries, where 80 to 90 percent of transporting facilities provided by roads networks. At various developmental level road mobility and accessibility require to maintain economic growth. In less developed economies where large portion of population is living in agrarian areas, therefore they need good quality road infrastructure for linking with urban areas and marketing their commodities. The backward region is also connected to develop region through well organized road infrastructure, and the population of these regions has achieved many opportunities such as jobs, education and trade. So, there is a large demand for efficient road infrastructure for transferring goods and services. Road networks consider the center of connectivity of all modes of transport. A good road network has the capacity to encourage the development and growth of other sector of any economy.

1.4 RESEARCH QUESTIONS

- Does the road infrastructure improvement increase economic development of Pakistan?
- Does the road infrastructure increase Industrial growth of Pakistan?
- Does the road infrastructure increase FDI of Pakistan?

1.5 OBJECTIVES OF THE STUDY

- To explore the effect of road infrastructure on economic development.
- To analyze the impact of road infrastructure on industrial sector's growth.
- To examine the impact of road infrastructure on FDI.
- To provide policy implications.

1.6 HYPOTHESIS

Following hypothesis are being used for this study:

H₀: Road infrastructure does not affect on economic development of Pakistan.

H₁: Road infrastructure does affect on economic development of Pakistan.

H₀: Road infrastructure does not affect on industrial sector growth of Pakistan.

H₁: Road infrastructure does affect on industrial sector growth of Pakistan.

H₀: Road infrastructure does not affect on FDI in Pakistan.

H₁: Road infrastructure does affect on FDI in Pakistan.

1.7 ORGANIZATION OF THE STUDY

This thesis consists on the following structure, chapter first present the introduction, novelty, problem statement, research questions, objectives of the study, hypothesis and significance of the study on the research topic “impact of the road infrastructure on economic development of Pakistan: A time series analysis (1973-2018)”. Chapter 2 consists on the literature review related to this study. The methodology and source of the available data for this research work are presented in chapter 3. Chapter 4 provides the empirical results of this study. The conclusion and policy recommendation is existing in chapter number 5.

CHAPTER 2

LITERATURE REVIEW

This chapter gives an overview of extant literature on topic by summarizing the related study. The studies of those authors have been selected who discussed the variables being used for this work Gross Domestic Product Per Capita, Industrial Sector Growth, Foreign Direct Investment (FDI), Ratio of High Type Roads to Low Type Roads (MPA), Trade of goods and service, Urban Population, Education Expenditure and Gross Fixed Capital Formation per worker.

Ng et al. (2019) they investigated how economic growth enhanced through development of road infrastructure. They applied fixed effects methodology on cross sectional data of 60 countries from 1980-2010. Road infrastructure play vital role in mobility and accessibility of goods and services. Efficient road infrastructure removes physical barrier, and enhanced access to markets, employment opportunities and etc. They concluded that there exists a positive correlation among the expansion of road length per thousand population and GDP growth. A 1% increased in road infrastructure, improved economic growth by 35.36%. They also suggested that economic growth also enhanced through export of goods and service. The economic growth enhanced 0.75% due to 1% increased in export level.

Enilolobo and Sodeinde (2019), investigate the relationship between infrastructural development, industrial sector productivity and development of human capital in the case of Nigeria. They applied Johansen's co-integration methodology on time series data taken 1991-2014. Independent variables of this study were access to clean water, electricity production, sanitation facilities and human capital. The dependent variable was the production level of industrial sector. Infrastructure sector was divided into three components such as improved sanitation facilities (SANF), accessibility to clean water, which related to health care factor and electricity generation. The human capital relates to education level (primary level enrolment) in Nigeria. They concluded that their extant important connection among education level and industrial sector productivity. The 1% increase in education level 0.23% increase in production of industries. There were positive relationship between electricity production and industrial sector productivity but statistically insignificant. Access to clean water (11%) and sanitation facilities (31%) positively related to industry value added.

Choudhary and Sultana, (2018) studied the transportation infrastructure impact on economic growth of Pakistan. They adopted Generalized Method of Moments (GMM) on time series data from 1991-2015. They took dependent variable as an economic growth while whole transportation infrastructure and gross domestic capital formation treated as explanatory (independent) variables. Results predicted that development of road infrastructure enhanced the economic growth of economy. The model showed a long period relation among economic growth, total transport and gross domestic capital formation. They concluded that economic growth and road infrastructure network both positively linked with each other. The 1% improvement in road infrastructure caused a 0.47 % increase in economic growth of Pakistan. Economic growth increased 1.09% due to increased 1% in gross domestic capital formation.

Wan and Zhang, (2018), they examined how Chinese manufacturing firms productivity directly and indirectly affected by Infrastructure. They divided the infrastructure into two components such as roads, telecommunication and then observed the effect of these Infrastructure stocks directly on firms productivity. The indirect effect of infrastructure on firm productivity analyzed by agglomeration. They used time series data from 2002-2007 and adopted Two-Stage least squares (TSLS) methodology. They concluded that agglomeration coefficients positively related to infrastructure indicators such as telecommunication and roads. A 1% increased in road agglomeration firms productivity enhanced by 0.009%. The firm total factor productivity increased by 0.26% due to 1% improved road infrastructure.

Ng et al. (2018) they studied the connection between road infrastructure and urbanization. They use fixed effects on panel data from 1980-2010. According to the law of migration, there were two factors push and pull which explained emigration from rural areas to cities. Pull factors included employment opportunities, health facilities, living environment and education. The push factors included instability associated with economic, social, or political and inadequate employment opportunities. The MPA (ratio of high type roads to low type roads) interrelated with export permit to exam the influence of per capita export levels on urban expansion as enhanced road mobility. The improvements in road mobility allowed export-led urban growth. The coefficient for MPA (ratio of high type roads to low type roads) and its interaction with EXP (export) was positive and significant. They suggested that export growth had a positive effect on urbanization and that this effect grew in accordance with an increase in road mobility.

Ng, et. al., (2017) investigated that how road mobility and accessibility affect develop, developing and less developed countries economic growth. They used Fixed-effect regression. The time period of cross-sectional study

was 1980-2010. They used interaction term which is (1) Ratio of higher mobility to higher accessibility roads (mpa) and export (2) mpa ratio, export and education. Mpa ratio and export increased economic growth by 0.6% and 0.001% increased in economic growth by mpa ratio, export and education. The GDP of the high and medium income countries increased by 0.7% with the improvement in road mobility because in this way export rise. These types of roads help countries to transfer goods in international markets at low transportation time and rate. The export of the low income countries increased within a country by the higher road accessibility and Economic growth of these types of countries is 0.036%.

LI et al., (2017) examined the transport infrastructure *geographical* spillover impact on new Silk Road Economic Belt in China. They used an F-SLM (Spatial Lag Model with fixed effect) methodology on panel data from 2005-2014. The panel data consist of the 31 provinces of New Silk road. They suggested that transportation variables (highways and railways) and economic growth were interconnected with each other. They concluded that regional GDP growth directly and indirectly affected by transport sector, 85.71% directly and 14.29%, indirectly.

Maparu and Mazumder, (2017) analyzed causal association among transportation infrastructure network, economic development and urban population in India. They applied Granger Causality technique and used time series data of India from 1990-2011. They found short period unidirectional causality in economic development, total road density and other Public Work Department road density. Long run unidirectional causality found in economic development, surfaced road density, total road density, airways-freight, other Public Work Department road density and total transport expenditure. The vector error correction model suggests a bivariate correlation among transport network and economic development. The ganger causality exited among national highways to urbanization and GDP to national highways.

Mohmand et. al., (2016) studied the influence of transportation infrastructure on economic growth in Pakistan. They used panel data from 1982-2010 and adopted Granger Causality methodology. The causality extant from economic growth to transport network investment in long period, but there was no causality in the short run. Developed province like Punjab and Sindh found bidirectional causality, but underdeveloped like Khyber Pakhtunkhwa (KPK) found unidirectional causality. In Punjab and Khyber Pakhtunkhwa (KPK) transport network investment increased by 72% and 6% respectively. But Baluchistan, a least developed province no any type of casuality exist among economic growth and transportation investment. At National level, 91% increased in transportation investment.

Kaur, et al., (2016) examined how physical infrastructure development attracts FDI (foreign direct investment) in developing countries in the case of India. They take time series data from 1991-2010 and applied Vector Auto Regression (VAR) model. They found positive and considerable association between different type of transportation infrastructure such as paved roads, railway and foreign investment. FDI is mostly taken to manufacturing sectors, efficient railway and road networks system improved the ability of the manufacturing sector to transfer goods from one place to another rapidly at lower transport cost. They suggested that 1% increased in road infrastructure investment augmented FDI (foreign direct investment) by 0.11.

Holl, (2016), investigated the connection among highway and manufacturing firms productivity in Spain. The investment in transport infrastructure (highways) increased agglomeration which in turn augmented local density, economic activities and productivity of firms. They used on fixed-effects Two-Stage least squares (TSLS) panel data from 1997-2007. The firm-level productivity significantly affected by the distance to highways, some firms has distance to highways 10 kms and some located at 20-30 kms. He concluded that the firms outcome and productivity positively related to improvement in highway level. The 18% higher total factor productivity growth of suburban firms which situated near the new highways as compared to more than 20 km. The 11% higher productivity growth of companies that received highway within 10 km. The results of highways in rural areas were not significant with respect to suburban. In suburban area 1% increased in highways firms productivity increased by 19% and productivity of rural firms increased by 3.9%. Highway strongly affected suburban area firms and significantly urban firms.

Pogorletchi, (2014) investigated the correlation among transportation infrastructure and economic growth of Romania. They applied random and fixed effect methodology on panel data from 1995-2010. The two most important types of transportation infrastructure used which were roads and railway. The dependent variable was gross regional product as a proxy for gross domestic product. The road variable was divided into simple, modern and light covering roads and then used same groups of road at county and national level to check administrative status of Romania. The quality of local government matter because well-organized government enhanced capital stock with efficient usage of all resources and improved transportation infrastructure. They suggested that total asset of roads at national level was more important than county level roads. The gross regional product (GRP) increased 0.36% by 1% increase in length of national roads. The railway stock was positively related to Romania but less likely to roads infrastructure.

Shiferaw et al., (2015) examined the affiliation among road infrastructure quality and enterprise dynamics of Ethiopia. They used two-stage least squares approach and the time period of panel data was 1996 to 2008. The variables such as number of manufacturing firms (dependent variable), quality of road infrastructure and “X” control variables (independent variables). Before entrants every firm first seen locality infrastructure quality and then takes a decision about starting a business. The numbers of firms in a town significantly increased due to improved road accessibility and travel time (speed). Better road access attracted those firms entrants which were large in size and in this way market broadens. There was a positive linkage between road network infrastructure standard and average size of entrants. When travel time reduces by 1% to major commercial destination, then 4% in the size of new entrants in Ethiopia. The 1% increased road accessibility, enhanced 3% manufacturing firms.

Yu et al., (2015) evaluated that expansion of motorway network enhanced economic agglomeration in China. They adopted Generalized Method of Moments (GMM) methodology on the panel data from 2000-2010. They divided regions into: 1). Coastal eastern and (2). Western. They found encouraging and statistically significant association between road network improvement and spatial economic agglomeration. Now a day’s road infrastructure plays an important role in the development of China’s spatial. The spatial agglomeration increased by 0.208 due to 1% improvement in the road network in coastal eastern region. Motorway construction had a positive spillover effects because neighboring units participating rate increased in eastern industrial clusters. In the western regions, road infrastructure coefficient was negative, but education coefficient was statistically significant which 0.085. In lagging areas, economic agglomeration increased through investment in education.

Cosar and Demir, (2014) investigated how international trade affected by improvement in the domestic road infrastructure of Turkey. This paper used fixed effect approach. They used province level panel data from 2003-2012. Turkey made a large-scale public investment in the national road stock divided the two lane road networks into four lane expressway. In this way improving the quality of road network and seen how these roads increased export of the country. Before investing in road infrastructure, it was important to realize that invested in any region was benefited or not. When these regions connected to international trade gateways than export increased more than average. Transportation cost also reduced with better quality of roads. The 1% decrease in province gateway transport cost than 3% increased in export of turkey and

this was statistically significant at 1%. When the transport cost of sensitivity industries decreased, then exports of those industries increased by 5%.

Shiferaw et al. (2013) examined how road infrastructure attracts enterprise in Ethiopia. They applied Two-stage least squares approach on panel data and time period of the data was 1997-2010. A town with good road infrastructure attracts more firms and every entrepreneur first sees the initial firm size and then taken a decision about an entrance. These types of road reduce travel time to major economic destinations. A 1% increased in road accessibility than it increased the size of firms entrants by 36%.

Pradhan et al. (2013), analyzed in India how transport network enhanced foreign direct investment and GDP growth. They used Autoregressive distributed lag bound testing and Granger-causality approaches on time series data from 1970 to 2012. They used transportation infrastructure as predicted variable, FDI and gross direct investment as predictor variable. Transport infrastructure was divided into two types like as road and railway. They used Transportation infrastructure into two different ways: 1) separately used rail and road, 2) made a composite index of rail and road infrastructure (TCI). The results predicted that long run association exists between economic growth, total transport infrastructure (TCI) and foreign direct investment. If transport infrastructure, increase 1% than 4.42% augmented in foreign direct investment, 0.41% increased in TCI (total transport infrastructure), economic growth enhanced 8.84%. The bidirectional causality exists between foreign direct investment and economic growth. The unidirectional causality found from transport infrastructure to both foreign direct investment and economic growth.

Melo et al. (2013) explored the productivity of transportation network investment in Europe, US and other countries. They reviewed the Meta analysis and used 33 studies. The techniques which used GMM (Generalized Method of Moments), VAR, Random effect and fixed effect. Road infrastructure more preferred by US as compared to European countries. The higher production (output) elasticity of roads as compared to other types of transportation. They concluded that one percent increased investment in road transport than output elasticity enlarged by 6%. Transport investment in high income countries achieved small benefits as compared to small and medium. Transport's output elasticity was 3% in long term was better than medium and short run. Because in a long run economy get benefit from transportation for many years.

Blyde, (2013) investigated how the good quality road increased exports in Colombian. The time period of the panel data was taken from 2004-2006

and used Fixed Effect Model. Improve road quality means reduced transport cost and increased exports among the regions. Two effects achieved in this study to reduce transportation cost (1) saved the time of traveling from one region to another, (2) reduces all cost to use these types of roads, i.e. repairing, depreciation costs, and etc. Higher transport cost means that longer routes and longer routes associated with roads in poor conditions. Transport cost reduced by 0.51 after paving roads. On the average 2% increased in export due to reduction in transport costs.

Cheteni, (2013) analyzed that how the South Africa transport sector increased productivity after investment in transport infrastructure. The time period of this study was 1975-2011. They adopted Vector Error Correction Mode (VECM) and Bayesian Vector Autoregression (BVAR) model technique. They concluded BVAR was better than VECM because all variables were statistically significant in both periods, but GDP is significant at second year. According to BVAR, 1% increased in real domestic fixed transport investment than GDP enlarged by 0.02 percent in the first year and 0.005 percent in the next. According to VECM, in the short run GDP augmented 0.06% in first year and 0.02 in second year by 1% increased investment in transport networks. In long run positive relationship found between real domestic transports fixed investments (RGDI) and GDP.

Jan et al. (2012), explored association between hard infrastructure and development of Pakistan's economy. They applied Johansen Co-integration methodology on time series data which taken from 1973-2008. They used GDP as the regress and, employed labor force, infrastructure and gross private fixed capital formation as regressors. They used Principal component analysis to created Infrastructure index and Physical infrastructure index divided into three dimensions, i.e. energy, telecommunication and transportation infrastructure. They concluded that all independent variables were positively and statistically significantly linked with gross domestic product. The 1% increased in infrastructure index (LINFINDEX) enhanced 0.46% economic development. The employed labor force (LLAB) increased economic development by 0.47% and gross fixed private capital formation (LGFPCF) enhanced economic development by 0.098%.

Faridi et al. (2011), they studied how telecommunication, transportation infrastructure enhanced economic growth of Pakistan. They used time series data from 1972 to 2010. They applied autoregressive model and found that there is positive relationship of GDP with Gross fixed capital formation, employed labor force, total length of roads and negative relationship of gross domestic product with telecommunication. If transportation infrastructure increases 1% than gross domestic product increases 0.09%. Likewise, 1%

enlarge in gross fixed capital formation than 11% raise in GDP. The employed labor force also increases economic growth that's why 1% increase labor force enhanced GDP 6.5%. The 1% improvement in telecommunication infrastructure decreases GDP by 8.9%. The negative impact of telecommunication sector due to misuse of this communication facility in Pakistan.

Hong et al. (2011), they explored the impact of transportation system on regional economic growth of China. They applied a two-stage least-squares (2 LSL) fixed effect methodology on panel data of 31 Chinese provinces from 1998-2007. They used three kinds of transport infrastructure networks: land transportation (railway, roadway and highway), water transportation, and air transportation. Transportation infrastructure quality in the eastern region is more efficient as compared to other region such as western and central regions. They concluded that land transport infrastructure and economic development strongly connected each other. Economic development increased 1.456 due to a 1% increased in land transportation. The water transport network (0.93) was significantly and positively associated to economic growth. The insignificant influence of air transport on economic growth.

Burki and Khan, (2010) investigated the spatial disparity and manufacturing industries agglomeration in Pakistan. Firms not equally spread across all districts. Mostly located in those regions where access to high road density, large markets, skilled and educated work force. They adopted ordinary least square (OLS) method on time series data from 1995-2006. They concluded that manufacturing industries concentration (agglomeration) statistical significantly and positively related to road density. A 1% increased in road density enhanced manufacturing firms by 5.4%. They also suggested that technical education more important and statistically significant for industrial agglomeration as compared to formal education. Agglomeration increased 0.0014 by 1% enlarged in technical education.

Nworji and Oluwalaiye, (2012) studiedS impacts of government spending on road infrastructure by Nigerian economy. They adopted Ordinary Least Square (OLS) methodology and time series data type from 1980-2009. The dependent variable was GDP, defence expenditure, Inflation and transport and communication were independent variables. Government spending on the transportation infrastructure, especially road networks positively correlated to economic growth of Nigeria. They suggested that 1% increased spending on road infrastructure, GDP increased by 164.1065%.

Gunasekera et al. (2008) investigated how transformational changes occur due to investment in transportation infrastructure such as highways

(A6 and A9). They used cross-sectional data for two periods of time 1990-2000 and applied Heteroskedasticity-Consistent Estimator. These highways linked approximately half of the Sri Lanka. Highway region such as A6 and A9 consist of firms. Firms were divided into 4 manufacturing groups (1) manufacturing firms of textile and leather (TM); (2) manufacturing firms of food (FM); (3) Mining, quarrying, and mill firms (MQM); and (4) other manufacturing firms (OM). Some firms, such as MQM, FM, TM and OM situated close to the highway region. After improvement in the highway productivity level enhanced by 15% of those firms which situated near as compared to away. FM (manufacturing firms of food) firms were away from highway regions, but more productive and located near to agriculture producers. The MQM, OM, TM, firms were capital intensive and FM labor intensive. Due to the transformation from agriculture to industrial sector that's why these firms required more capital. The income of those households also increased by 80 percent, which located near the highway. Improvement in highway enlarged education level and in this way enhanced skilled person.

Khadaroo and Seetanah, (2008) examined the link among transport capital and economic performance in Mauritius from 1950-2000. They used time series data and applied vector error correction model (VECM). They divided public capital stock into non-transport and transport capital. In short-term, significant and positive involvement of transport to output. In long term, output elasticity 0.263, the economy took some time to fully operative of transportation capital, but output elasticity was 0.145 in the short run. Private capital also increased growth rate of Mauritius 0.7 percent after one year. Non-transport capital also positively contributed to the economic growth of Mauritius which increased output growth by 23%. There was a constructive correlation among transport capital and private capital stock: 1% increased in transport than 0.09 increased in private capital stock.

Graham, (2007), he studied the influence of transport investment on agglomeration and productivity in UK. He used time series data from 1995 to 2002 and applied GLS (Generalised Least squares). The transportation investment altered the economic activities and changed densities accessible to firms. The investment in transport sector increased agglomeration level and agglomeration measured by effective densities. The effective densities in other way calculated output elasticity of firms. The agglomeration effects were stronger for public and transport service as compared for manufacturing sectors. The manufacturing sectors required more capital and labor was essential for services sector. The public service firms include health, education, administration and social work, etc. The output elasticity of transport sector (0.325), public service (0.292), and computer services (0.034), etc.

Khadaroo and Seetanah, (2007) investigated how a transport infrastructure sector of Sub Saharan African countries attract foreign direct investment. They adopted Generalized method of moments (GMM) technique on panel data from 1984-2002. Accessibility of vital infrastructure, i.e., roads, ports, highways, electricity and communication network augmented productivity, and in this way attraction of FDI increased. In the case of SSA (Sub Saharan African), FDI inflows in multinational industries/ companies which located in those areas where easy access to road, electricity, and etc. They suggested that 1% increased in transport (road) infrastructure investment enlarged FDI by 0.08. FDI also positively and significantly related to export level of SAA. The FDI increased by 0.15 due to 1% increased in export level.

Holl, (2004) analysed the impact of transportation infrastructure on agglomeration economies and firms birth in Portugal. They used a fixed effect technique on pool data from 1986-1997. The new infrastructure investment attracts most sectors situated near to motorway locations, in this way increased firm-birth and agglomeration level. The most agglomerated areas of Portugal were Lisbon and Porto which closed to motorway within 10 km. They suggested that positive linkages found among transport infrastructure investment and firm birth. The maximum births of new firms occurred in clothing, footwear and textile sector. The market access (ACC) of manufacturing sector enhanced by 0.047 when 1% increased in firm profit. The market access (ACC) of footwear and textile sector was 0.093 and agglomeration of that sector was 0.39.

Holl, (2004), analyzed correlation between road infrastructure and manufacturing location in Spain. They applied fixed effect method on panel data from 1980-1994. Road infrastructure was divided into two parts which were intra-regional demand accessibility and inter-regional demand accessibility. In intra-regional demand accessibility where already exist too many industries that's why these industries not allow to enter of new manufacturing sectors in these areas and these industries force to new industries move away. The relationship between inter-regional demand accessibility and new manufacture sectors positive. Local profit opportunities of municipality enlarged with the increased accessibility of suppliers because production cost fell due to intermediate goods and input cost reduces. New motorway areas increased 14% birth of new manufacture within 10 km distance. All new manufacturing plants prefer those locations which close to motorways except chemical products sector. New manufacturing plant openings fall 12-94% because these municipalities outside the 10km corridors.

Boarnet, (1995), analyzed how highways affect Economic Productivity in America. Highway plays vital task in describing pattern of growth in US metropolitan regions. Highway of US benefited for political relations with other countries when see the benefit-cost analysis and also enhanced business activities. The locations of every highway planned before constructions and highway facilitate in production, and firms respond to these advantages to shift their firms near highway.

On the basis of reviewing literature, it is found that there is positive relationship of all selected variables on gross domestic product per worker, industrial sector growth and FDI. Developed and developing countries benefited from well-organized road infrastructure because with the help of these types of roads, goods and services easily transfer from one to another place. The next chapter showcases the data of the selected variables and methodology used for this research work.

CHAPTER 3

DATA AND METHODOLOGY

This chapter consists on detail of econometric model which used in this research work for empirical analysis. We used Gross Domestic Product Per Capita, Foreign Direct Investment (FDI), Industrial Sector Growth, MPA, trade, Urban population, Government expenditure on education, Gross fixed capital formation, and Gross fixed capital formation per worker as a proxy of physical capital stock per worker to examine the influence of all these variables on economic growth in case of Pakistan. The time series collected from different sources (Pakistan economics survey and World Development Indicator) from the year 1973-2018. Various econometric techniques were used such as: Unit Root Tests (ADF, PP), Auto Regressive Distributed Lag Model (ARDL), CUSUM and CUMSUMsq.

3.1 THEORETICAL FRAMEWORK

Literature supported that improved road infrastructure network has a positive influence on the industrial sector growth, foreign direct investment and economic growth of any economy (Choudhary and Sultana, 2018; Cheteni, 2013). We are living in the age of mobility it is not possible to refuse the importance of transportation. Due to transportation infrastructure not only physical goods move between locations it also facilities the movements of human beings and services (Beyzatlar, et al. 2014).

The Solow growth model indicates that two capital stocks such as physical and human capital stock have a positive and significant effect on economic growth. In the Solow growth model, human capital stock refers workers' level of education, skills and experience. The physical stock indicates basic infrastructure such as roads, machines, technology and building that are required for the production of goods and services of (Ng et al., 2017). There is a positive relationship between transportation infrastructure development and urbanization. Any region attraction increase due to improvement in transportation infrastructure economic sector boost reduces transportation cost and agglomeration increase and in this way enhanced urbanization level, (Maparu and Mazumder, 2017).

In any region existence of better road infrastructure network increase industrial sector growth because transportation cost low to access input

materials and markets. Furthermore, competition and production level of these areas enhanced due to efficient accessibility as compared to inferior accessibility regions (Vickerman, et al. 1999). The reduction of transportation cost enables firms easy access to specialized labor, achieve agglomeration benefits and lower the cost of production (Shiferaw, et al. 2012). The cost of distance lower permit firms to inaugurate contacts (communication) over larger distances and all these possible due to investment in transport network system (Albarran, et al. 2013). Similarly, investment on transport network shift economies from the agricultural sector to industrial sector and in this way improvement occurs at the development level of countries (Gunasekera, 2008). The firms's trade flows is negatively related to distance in any country. The good quality road infrastructure reduces transport cost and enhanced abilities of firms to access international markets (Albarran, et al. 2013).

Foreign direct investment in any country is determined with respect to availability of good quality infrastructure, economic openness, comparative labour cost and country size. Foreign investor basically invests in multinational companies and firms. Similarly, a necessary condition for foreign investors to operate a business successfully is an efficient infrastructure system such as highways, roads, telecommunications and etc. (Khadaroo, and Seetanah, 2007).

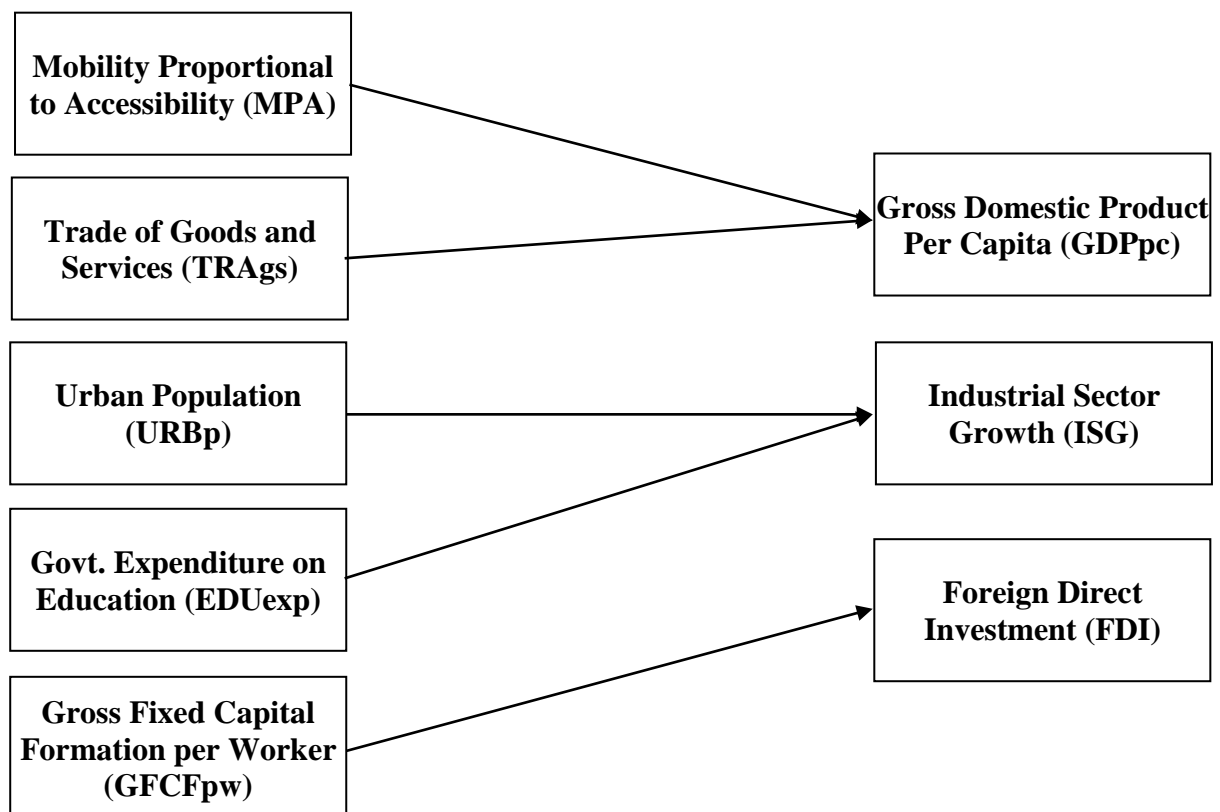


Figure 3.1: Theoretical Model of the Study

3.2 DATA

The data set of this study contain 45 years observation which starting from 1973-2018. In this study we used three variables along with Gross Domestic Product Per Capita (GDPPC) in real term, Foreign Direct Investment Inflow (FDI), Industrial Sector Growth (ISG) taken a dependent variables of these different model but we used same independent variables such as Ratio of high type roads to low types roads (MPA), Trade of goods and services (TRAgS), Urban population (URBp), Government expenditure on education (EDUexp), Gross fixed capital formation (GFCFpw), and GFCF as a proxy of physical capital stock (GFC) in all models.

3.3 ECONOMETRIC MODEL

The functional forms of three types of models for this study are expressed as:

Gross Domestic Product Per Capita:

$$\ln\text{GDPPC} = f(\text{MPA}, \text{TRAgS}, \text{URBp}, \text{EDUexp}, \text{GFCFpw})$$

where;

$\ln\text{GDPPC}$ = log of Gross Domestic Product Per Capita

MPA = Ratio of high type roads to low types roads

TRAgS = Trade of goods and services

URBp = Urban population

EDUexp = Government expenditure on education

GFCFpw = Gross fixed capital formation per worker as a proxy of physical capital stock per worker

Foreign Direct Investment:

$$\text{FDI} = f(\text{MPA}, \text{TRAgS}, \text{URBp}, \text{EDUexp}, \text{GFCFpw})$$

where;

FDI = Foreign Direct Investment Inflow

MPA = Ratio of high type roads to low types roads

TRAgS = Trade of goods and services

URBp = Urban population

EDUexp = Government expenditure on education

GFCFpw = Gross fixed capital formation per worker as a proxy of physical capital stock per worker

Industrial Sector Growth:

$$ISG = f(MPA, TRAgS, URBp, EDUexp, GFCFpw)$$

where;

ISG = Industrial Sector Growth

MPA = Ratio of high type roads to low types roads

TRAgS = Trade of goods and services

URBp = Urban population

EDUexp = Government expenditure on education

GFCFpw = Gross fixed capital formation per worker as a proxy of physical capital stock per worker.

The econometric format of above general models is:

$$GDPPC_t = \alpha_0 + \alpha_1 MPA_t + \alpha_2 TRA_t + \alpha_3 URBp_t + \alpha_4 EDUexp_t + \alpha_5 GFCFpw_t + \varepsilon_t \quad (3.1)$$

$$ISG_t = \alpha_0 + \alpha_1 MPA_t + \alpha_2 TRA_t + \alpha_3 URBp_t + \alpha_4 EDUexp_t + \alpha_5 GFCFpw_t + \varepsilon_t \quad (3.2)$$

$$FDI = \alpha_0 + \alpha_1 MPA_t + \alpha_2 TRAgS_t + \alpha_3 URBp_t + \alpha_4 EDUexp_t + \alpha_5 GFCFpw_t + \varepsilon_t \quad (3.3)$$

where α_0 is intercept and $\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5$ represent slopes of MPA, TRAgS, URBp, EDUexp, GFCFpw although, “ ε ” show error term of the models.

After taking the natural logarithm of the models;

$$\ln GDPPC_t = \alpha_0 + \alpha_1 \ln MPA_t + \alpha_2 \ln TRAgS_t + \alpha_3 \ln URBp_t + \alpha_4 \ln EDUexp_t + \alpha_5 \ln GFCFpw_t + \varepsilon_t \quad (3.4)$$

$$\ln ISG_t = \alpha_0 + \alpha_1 \ln MPA_t + \alpha_2 \ln TRAgS_t + \alpha_3 \ln URBp_t + \alpha_4 \ln EDUexp_t + \alpha_5 \ln GFCFpw_t + \varepsilon_t \quad (3.5)$$

$$\ln FDI = \alpha_0 + \alpha_1 \ln MPA_t + \alpha_2 \ln TRAgS_t + \alpha_3 \ln URBp_t + \alpha_4 \ln EDUexp_t + \alpha_5 \ln GFCFpw_t + \varepsilon_t \quad (3.6)$$

where “*ln*” is natural logarithm and ε_t is error term in above equations.

3.4 ECONOMETRIC ESTIMATION STRATEGIES

Gross Domestic Product Per Capita (GDPPC), Foreign Direct Investment Inflow (FDI), Industrial Sector Growth (ISG) used as dependent variables of these three models but independent variables are MPA (Ratio of high type roads to low types roads), Trade of goods and services (TRAgS), Urban population (URBp), Government expenditure on education (EDUexp), Gross fixed capital formation (GFCF), and Gross fixed capital formation per worker as a proxy of physical capital stock per worker (GFCFpw) in all models. The long-run and short-run cointegration in models are found out by the Auto Regressive Distributed Lag (ARDL). ARDL model is used when there exists mix order of co-integration means that some variables became stationary at level [*I* (0)] and other variables became stationary at first difference [*I* (1)]. ARDL test has ability to capture structural break effect in series.

Unit root test such as Augmented Dickey Fuller (ADF) and Phillips Perron (PP) applied to confirm stationary level of the variables and after these tests we realized that ARDL technique applicable or not. Before applying the ARDL technique the optimal lag length criteria adopted to find the optimal lags in the model. ARDL bound testing for co-integration expressed the existence of a long-term correlation between dependent or independent variables. After ARDL bound testing, estimated long and short period analysis of any study. The stability of data checks with the help of CUSUM and CUSUMsq.

3.4.1 Unit Root Tests

The time series data always relate to problem of stationarity. In 1974, Newblod and Granger first time gave the idea of unit root because in time

series there may be existence of stochastic trend and outcome would lead to spurious regression. To find the stationary level of selected variables of this study, we used Augmented Dickey Fuller (ADF) and Phillips Perron (PP) because these tests give better results.

3.4.1.1 Augmented Dickey Fuller (ADF) Unit Root Test

The ADF unit root test was augmented by Dickey (1979) and fuller (1988). The ADF test used for long time data set to check the stationarity of selected variables. The model of ADF unit root test given below:

$$y_t = \sigma y_{t-1} + x_t' \vartheta + \mu_t$$

where, y is dependent variable, t is a time period, σ is parameter of lagged term of dependent variable, μ is error term and x is independent variable. To find the stationary level of variables there exists three properties such as constant, trend, constant and trend. The equations of the following properties are given below:

$$\Delta x_t = \gamma_0 + \vartheta x_{t-1} + \gamma_1 \Delta x_{t-1} + \gamma_2 \Delta x_{t-2} + \dots + \gamma_p \Delta x_{t-p}$$

$$\Delta x_t = \tau + \vartheta x_{t-1} + \gamma_1 \Delta x_{t-1} + \gamma_2 \Delta x_{t-2} + \dots + \gamma_p \Delta x_{t-p} + \gamma t$$

$$\Delta x_t = \gamma_0 + \tau + \vartheta x_{t-1} + \gamma_1 \Delta x_{t-1} + \gamma_2 \Delta x_{t-2} + \dots + \gamma_p \Delta x_{t-p} + \gamma t$$

where, Δ shows changes during the time period “t” of the study. “ γ_0 ” shows constant; “ τ ” is the time trend in the model. “ $\gamma_0 + \tau$ ” term shows the existence of both constant and trend in the model. The null hypothesis of ADF unit root test is as follows:

$$H_0: \vartheta > 0.10$$

An alternative hypothesis is:

$$H_1: \vartheta < 0.10$$

H_0 is null hypothesis and null hypothesis accept when our critical value is greater than 0.10 (prob.) value of table which means that series has a unit root problem. We may accept the H_1 when our critical value is less than 0.10 (prob.) value of table means that series does not have a unit root problem. Mostly used test for unit root is Augmented Dickey Fuller (ADF) but sometimes it misleads the results. So, Phillips and Perron (1988) modified

ADF test also developed non-parametric unit root test which is known as Phillips Perron unit root test.

3.4.1.2 Phillips and Perron (1988) Unit Root Test

Phillips and Perron non-parametric unit root test became popular due to its reliability and feasibility. The PP unit root test is different from ADF in manner of parameters. PP test has the ability to deal with problem of serial correlation and heteroskedasticity in errors. PP test equation as follows:

$$\Delta y_t = \beta' D_t + \pi y_{t-1} + v_t$$

v_t is the heteroskedasticity during the time “t” in the model. v_t deal with the problem heteroskedasticity and serial correlation in PP test. The PP equations with variance parameters can be written as:

$$\xi^2 = \lim_{T \rightarrow \infty} T^{-1} \sum_{t=1}^T E(U_t^2)$$

$$\phi^2 = \lim_{T \rightarrow \infty} \sum_{t=1}^T E(T^{-1} S_T^2)$$

where, S_T^2 and ξ^2 are sample variance of least square residual U_t^2 and the long run variance estimate is ϕ^2 . The PP test hypothesis same as in ADF test.

3.4.2 Testing for Co-integration

There are various econometric techniques such as Engle and Granger (1987), Phillips and Hensen (1990), Johansen (1991, 1992, 1995) and Johenen-Juselius (1990) are available for determined the existence of cointegration. This study uses Auto Regressive Distributed Lag (ARDL) bound testing to co-integration based on Pesaran and Shin (1999) and Pesaran et al. (2001). The ARDL technique reduces the number of parameters to be estimated. The ARDL approach to co-integration does not need any pre-testing for the order of the co-integration, at level $I(0)$ or first difference $I(1)$, of the variables used in model. ARDL is applicable on mix order of co-integration (stationary at $I(0)$ or $I(1)$). This technique gives best results in case of structural break in series.

3.4.2.1 Auto Regressive Distributed Lag (ARDL) Model

The ARDL bound testing to co-integration was used to confirm presence of the long period association among dependent and independent variables, which developed by Persaran et al. (2001). The equation of unrestricted error correction model (UECM) is as follows:

$$\begin{aligned}\Delta \ln \text{GDPP}_t = & \alpha_1 + \alpha_t \text{T} + \alpha_{\text{GDPP}} \ln \text{GDPP}_{t-i} + \alpha_{\text{MPA}} \text{MPA}_{t-i} \\ & + \alpha_{\text{TRA}} \text{TRA}_{t-i} + \alpha_{\text{edu}} \text{EDU}_{t-i} + \alpha_{\text{urban}} \text{Urban}_{t-i} \\ & + \alpha_{\text{GFCF}} \text{GFCF}_{t-i} + \sum_{i=0}^p a_i \Delta \ln \text{GDPP}_{t-i} \\ & + \sum_{i=0}^q a_i \Delta \text{MPA}_{t-i} + \sum_{i=0}^r a_i \Delta \text{TRA}_{t-i} \\ & + \sum_{i=0}^s a_i \Delta \text{Edu}_{t-i} + \sum_{i=0}^t a_i \Delta \text{Urban}_{t-i} \\ & + \sum_{i=0}^t a_i \Delta \text{GFCF}_{t-i} + \theta \text{ECT}_{t-i} + \varepsilon_t\end{aligned}$$

$$\begin{aligned}\Delta \text{ISG}_t = & \alpha_1 + \alpha_t \text{T} + \alpha_{\text{GDPP}} \text{ISG}_{t-i} + \alpha_{\text{MPA}} \text{MPA}_{t-i} + \alpha_{\text{TRA}} \text{TRA}_{t-i} \\ & + \alpha_{\text{edu}} \text{EDUexp}_{t-i} + \alpha_{\text{urban}} \text{Urban}_{t-i} + \alpha_{\text{GFCF}} \text{GFCFpw}_{t-i} \\ & + \sum_{i=0}^p a_i \Delta \text{ISGP}_{t-i} + \sum_{i=0}^q a_i \Delta \text{MPA}_{t-i} + \sum_{i=0}^r a_i \Delta \text{TRA}_{t-i} \\ & + \sum_{i=0}^s a_i \Delta \text{Eduexp}_{t-i} + \sum_{i=0}^t a_i \Delta \text{Urban}_{t-i} \\ & + \sum_{i=0}^t a_i \Delta \text{GFCFpw}_{t-i} + \theta \text{ECT}_{t-i} + \varepsilon_t\end{aligned}$$

$$\begin{aligned}\Delta \text{FDI}_t = & \alpha_1 + \alpha_t \text{T} + \alpha_{\text{FDI}} \text{FDI}_{t-i} + \alpha_{\text{MPA}} \text{MPA}_{t-i} + \alpha_{\text{TRA}} \text{TRA}_{t-i} \\ & + \alpha_{\text{edu}} \text{EDUexp}_{t-i} + \alpha_{\text{urban}} \text{Urban}_{t-i} + \alpha_{\text{GFCF}} \text{GFCFpw}_{t-i} \\ & + \sum_{i=0}^p a_i \Delta \text{FDI}_{t-i} + \sum_{i=0}^q a_i \Delta \text{MPA}_{t-i} + \sum_{i=0}^r a_i \Delta \text{TRA}_{t-i} \\ & + \sum_{i=0}^s a_i \Delta \text{Eduexp}_{t-i} + \sum_{i=0}^t a_i \Delta \text{Urban}_{t-i} \\ & + \sum_{i=0}^t a_i \Delta \text{GFCFpw}_{t-i} + \theta \text{ECT}_{t-i} + \varepsilon_t\end{aligned}$$

In above model, ARDL consist on constant and trend term. The term Δ with variables shows short run analysis of selected variables. Variables without Δ term show long run analysis. ECT_{t-i} confirmed the speed of adjustment from short term to long term in a year. Lag length criteria were used to determine maximum number of lags that would be useful for further procedure to apply ARDL test. The lower and upper critical bound values in ARDL bound test used to check the long term relationship between dependent and independent variables.

The long-term equation for $\ln \text{GDPPC}$ can be written as;

$$\begin{aligned}\ln \text{GDPPC}_t = & \alpha_1 + \alpha_t \text{T} + \alpha_{\text{GDPP}} \ln \text{GDPPC}_{t-i} + \alpha_{\text{MPA}} \text{MPA}_{t-i} + \alpha_{\text{TRA}} \text{TRA}_{t-i} \\ & + \alpha_{\text{edu}} \text{EDUexp}_{t-i} + \alpha_{\text{urban}} \text{Urban}_{t-i} + \alpha_{\text{GFCF}} \text{GFCFpw}_{t-i} + \varepsilon_t\end{aligned}$$

and short term equation can be written as;

$$\begin{aligned}\Delta \ln \text{GDPPC}_t = & \alpha_1 + \alpha_t \Gamma + \sum_{i=0}^p a_i \Delta \ln \text{GDPPC}_{t-i} + \sum_{i=0}^q a_i \Delta \text{MPA}_{t-i} \\ & + \sum_{i=0}^r a_i \Delta \text{TRA}_{t-i} + \sum_{i=0}^s a_i \Delta \text{Eduexp}_{t-i} \\ & + \sum_{i=0}^t a_i \Delta \text{Urbanp}_{t-i} + \sum_{i=0}^t a_i \Delta \text{GFCFpw}_{t-i} \\ & + \theta \text{ECT}_{t-1} + \varepsilon_t\end{aligned}$$

The equation of ISG for long period can be written as:

$$\begin{aligned}\text{ISG}_t = & \alpha_1 + \alpha_t \Gamma + \alpha_{\text{ISG}} \text{ISG}_{t-1} + \alpha_{\text{MPA}} \text{MPA}_{t-1} + \alpha_{\text{TRA}} \text{TRA}_{t-1} \\ & + \alpha_{\text{edu}} \text{EDUexp}_{t-1} + \alpha_{\text{urban}} \text{Urbanp}_{t-1} + \alpha_{\text{GFCF}} \text{GFCFpw}_{t-1} + \varepsilon_t\end{aligned}$$

and short period equation can be written as;

$$\begin{aligned}\Delta \text{ISG}_t = & \alpha_1 + \alpha_t \Gamma + \sum_{i=0}^p a_i \Delta \text{ISG}_{t-i} + \sum_{i=0}^q a_i \Delta \text{MPA}_{t-i} + \sum_{i=0}^r a_i \Delta \text{TRA}_{t-i} \\ & + \sum_{i=0}^s a_i \Delta \text{Eduexp}_{t-i} + \sum_{i=0}^t a_i \Delta \text{Urbanp}_{t-i} \\ & + \sum_{i=0}^t a_i \Delta \text{GFCFpw}_{t-i} + \theta \text{ECT}_{t-1} + \varepsilon_t\end{aligned}$$

The FDI equation for long term:

$$\begin{aligned}\text{FDI}_t = & \alpha_1 + \alpha_t \Gamma + \alpha_{\text{FDI}} \text{FDI}_{t-1} + \alpha_{\text{MPA}} \text{MPA}_{t-1} + \alpha_{\text{TRA}} \text{TRA}_{t-1} \\ & + \alpha_{\text{edu}} \text{EDUexp}_{t-1} + \alpha_{\text{urban}} \text{Urbanp}_{t-1} + \alpha_{\text{GFCF}} \text{GFCFpw}_{t-1} + \varepsilon_t\end{aligned}$$

and short term equation:

$$\begin{aligned}\Delta \text{FDI}_t = & \alpha_1 + \alpha_t \Gamma + \sum_{i=0}^p a_i \Delta \text{FDI}_{t-i} + \sum_{i=0}^q a_i \Delta \text{MPA}_{t-i} \\ & + \sum_{i=0}^r a_i \Delta \text{TRA}_{t-i} + \sum_{i=0}^s a_i \Delta \text{Eduexp}_{t-i} \\ & + \sum_{i=0}^t a_i \Delta \text{Urbanp}_{t-i} + \sum_{i=0}^t a_i \Delta \text{GFCFpw}_{t-i} \\ & + \theta \text{ECT}_{t-1} + \varepsilon_t\end{aligned}$$

CHAPTER 4

EMPIRICAL RESULTS AND DISCUSSION

We are going to see the “Impact of road infrastructure on economic development in Pakistan. This chapter starts by descriptive statistics and also checks the association among selected variables with the help of correlation analysis. On the basis of unit root test such as Augmented Dickey Fuller (ADF) and Philips Perron (PP) test, we used Auto Regressive Distributed Lag (ARDL) bound testing to compute short and long run analysis. The stability of data is checked by using the CUSUM and CUSUMSQ tests.

4.1 DESCRIPTIVE ANALYSIS AND CORRELATION ANALYSIS FOR lnGDPPC

Before applying different tests on studies, descriptive analysis used to explain the nature of the data and it also tells about the normality of the data. The descriptive statistics table shows the values of mean, median (measure of central tendency), maximum, minimum (measure of spread), standard deviation, Jarque-Bera, and etc.

Table 4.1
Descriptive Statistics and Correlation Analysis

	lnGDPPC	MPA	TRAgS	EDUexp	URBp	GFCFpw
Mean	6.654509	1.447556	33.09556	2.291111	31.81556	16.09111
Median	6.703556	1.250000	33.40000	2.400000	32.10000	16.50000
Maximum	7.087239	2.880000	38.90000	3.100000	36.60000	19.30000
Minimum	6.158249	0.510000	25.40000	1.000000	26.00000	12.20000
Std. Dev.	0.277152	0.639890	3.333505	0.434753	3.082720	1.737530
Skewness	-0.303650	0.336373	-0.472183	-0.962798	-0.195737	-0.485442
Kurtosis	2.005823	2.089411	2.668598	4.077181	1.888606	2.310247
Jarque-Bera	2.544749	2.403297	1.878102	9.127953	2.603340	2.659455
Probability	0.280166	0.300698	0.390999	0.010421	0.272077	0.264549
Correlation						
lnGDPPC	1					
MPA	0.7686	1				
TRAgS	-0.2159	-0.4659	1			
EDUexp	0.2702	0.1321	0.1556	1		
URBp	0.9923	0.7775	-0.2851	0.2115	1	
GFCFpw	-0.3841	-0.5556	0.4598	0.1292	-0.4315	1

(Source: Author’s Calculation)

The spreadness of the data from their mean value (how much deviation exists in the data from their mean value) is measure by using the standard deviation. The standard deviation values of all selected variables are present in the above table. It shows the deviation of each variable from its mean value. Results of standard deviation explain that there is deviation in 0.277 log of gross domestic product per capita (lnGDPPC) from its mean value, 63.98% deviation in Ratio of high type roads to low type roads (MPA) from its mean value, 3.33 deviation in trade from its mean value, education is 0.434 deviated from its mean value, urban population is 3.082 deviates from mean value and 1.737 deviation exist in gross fixed capital formation (GFCF).

Skewness is a measure of asymmetry of the probability distribution of the real valued random variable about its mean. In descriptive statistics, skewness check the facts that data is skewed to right or left of the mean means that whether data is positively or negatively skewed. If value of skewness is equal to zero, it means that data is perfectly symmetric. The value of Ratio of high type roads to low type roads (MPA) and urban population is positively skewed (right of the mean). The value of gross domestic product per capita, export, education and gross fixed capital formation are negatively skewed it means that skewed toward left of the mean.

The Jarque-Bera test is applied to confirm the normal distribution of the data. If probability value of the Jarque-Bera is greater than 0.05, then we may say that the data is normally distributed.

The correlation matrix has been adopted to check the relationship (association) among variables. The range of correlation analysis lies between -1 to +1. The positive 1 means that variable positively correlated and negative 1 means that variable is negatively correlated. Results show the highest degree of association between lnGDPPC and urban population and the value is 0.9923. The value is 0.7686 is showing the correlation between log of gross domestic product per capita (lnGDPPC) and MPA (ratio of high type roads to low type roads). Negative correlation exists among the log of gross domestic product (lnGDPPC) and trade and value is -0.2159. The value 0.2702 is shown that there is a positive association between education and log of gross domestic product per capita. Gross fixed capital formation has negative correlation with log of gross domestic product per capita and the value is -0.3841.

4.2 UNIT ROOT ANALYSIS

Unit root tests are used to check the stationary of data. It is essential to confirm the stationary of time series analysis because if the stationary of the

variables is not checked then results may be spurious. If all variables become stationary at a level, then move on to simple regression analysis. If some variables stationary at level while other variables at first difference then apply Auto Regressive Distributed Lag (ARDL) technique. If some variables became stationary at first difference and some at second difference, then apply Auto-Regressive models to check the empirical results of the study. Co-integration methodology is applied when all variables become stationary at first difference and also used ECM (error correction model) for one endogenous variable.

Augmented Dickey Fuller (ADF) and Phillips Perron (PP) unit root tests have been used to ensure the stationary level of variables which we elected for research work, whether variables are stationary or not and the level of the stationary of those variables. The problem of hetroskedasticity and serial correlation in errors deals with Phillip Perron unit root test. The ADF unit root test is used to verify the stationary of data usually for long term analysis.

4.2.1 Augmented Dickey-Fuller Unit Root Test

Augmented Dickey-Fuller unit root test is one of the most used tests. Results of ADF are shown in Table 4.2. The outcomes reveal that some variables such as log of gross domestic product per capita, MPA (the ratio of high type roads to low type roads), trade, education, and urban population are stationary at 1st difference and some variables such as education and gross fixed capital formation are stationary at level.

Table 4.2
Augmented Dickey-Fuller Unit Root Test

Variables	ADF Test t-Statistics Value		Stationary
	Level	1 st Difference	
lnGDPPC	-1.9718 (0.5997)	-5.0376 (0.0010)***	<i>I(1)</i>
MPA	-2.3372 (0.4060)	-5.7572 (0.0001)***	<i>I(1)</i>
TRAgS	-2.5718 (0.2944)	-7.2306 (0.0000)***	<i>I(1)</i>
EDUexp	-3.8711 (0.0222)**	-5.7075 (0.0001)	<i>I(0)</i>
URBp	-2.9116 (0.1689)	-7.9067 (0.0000)***	<i>I(1)</i>
GFCFpw	-4.2664 (0.0080)***	-5.2891 (0.0005)	<i>I(0)</i>

(Source: Author's Calculation)

4.2.2 Phillips-Perron Unit Root Test

Phillips Perron unit root test was used to verify the findings of the Augmented Dickey-Fuller unit root technique. The Phillips Perron is a non-parametric unit root test which removes the problem of misspecification. In Table 4.3, the Phillips-Perron unit root test confirms that some variables such as a log of gross domestic product per capita, MPA (the ratio of high type roads to low type roads), trade, education are stationary at 1st and other variables like urban population and gross fixed capital formation are stationary at level.

Table 4.3
Phillips-Perron Unit Root Test

Variables	PP Test t-Statistics Value		Stationary
	Level	1 st Difference	
lnGDPPC	-1.7003 (0.7343)	-5.0085 (0.0011)***	<i>I(1)</i>
MPA	-1.9965 (0.5870)	-5.7898 (0.0001)***	<i>I(1)</i>
TRAgS	-2.5718 (0.2944)	-8.5687 (0.0000)***	<i>I(1)</i>
EDUexp	-2.4989 (0.3272)	-5.7227 (0.0001)***	<i>I(1)</i>
URBp	-4.0851 (0.0128)**	-8.0312 (0.0000)	<i>I(0)</i>
GFCFpw	-4.2384 (0.0086)***	-5.2138 (0.0006)	<i>I(0)</i>

(Source: Author's Calculation)

4.3 LAG-LENGTH CRITERIA

Lag selection criteria an important technique before applying ARDL, as without proper lag selection the cointegration may give misleading results. There are various ways to choose the lag-length criteria such as Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), Log Length (LogL), LR, Hannan-Quinn Information Criterion (HQ), and Final prediction error (FPE). Mostly follow AIC because the accuracy power of AIC is very high. According to AIC, the optimal lag-length of the model is 1 (-0.919273*). So, we conclude that 1 is the value of optimal lag length criteria for selected model.

Table 4.4
VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-212.1918	NA	0.001029	10.14846	10.39420	10.23908
1	61.76436	458.7173*	1.64e-08*	-0.919273*	0.800969*	-0.284901*
2	90.60535	40.24324	2.52e-08	-0.586295	2.608440	0.591824

“* indicates lag order selected by the criterion”

(Source: Author’s Calculation)

4.4 AUTO-REGRESSIVE DISTRIBUTED LAG (ARDL) MODEL

Results of unit root tests have recommended using the ARDL model for checking long term co-integration in the model because variables have mix order integration and 1 is maximum lag length criteria for selected model. Table 4.5 indicates the finding of ARDL bound testing. The null hypothesis is that there is no long term association in ARDL model, if F-Statistics value becomes lower than lower bound value. There is also no long period connection in selected model when F-Statistics value becomes greater than upper bound value.

Table 4.5
ARDL Bound Testing to Co-Integration

ARDL Bound Testing					Diagnostic tests		
Estimated Model	Optimal Lag Length	F-Stat	1 Percent		χ^2 Serial Correlation	χ^2 BPG Hetro	Ramsey Reset
			LB	UPB			
FlnGDPPC (lnGDPPC/MPA, TRAgS, EDUexp, URBp, GFCFpw)	(9, 4, 2, 4, 4, 3)	12.9419	3.06	4.15	3.739101 (0.2110)	1.274929 (0.4559)	2.022929 (0.2501)

(Source: Author’s Calculation)

On the other hand, if F-Statistics value falls among the upper and lower bound than outcome is inconclusive. The results in the above table show that F-Statistic value is higher than upper bounds; so it reject null hypothesis (H_0 : There is no long run association). The conclusion is that long term correlation exists in model.

Diagnostic tests used to confirm the stability of data. In the right side of the Table 4.5, predict the normality, non-serial correlation and specification of the model. The serial correlation test is showing that there is no serial correlation in model. Heteroskedasticity test shows that variance of model is constant over time and mean is zero.

When confirms the long run co-integration in the model, this research investigated the short and long term influence of MPA (ratio of high type roads to low type roads), trade, education, GFCF (gross fixed capital formation per worker) and urban population in Pakistan.

4.5 ERROR CORRECTION MODEL

The error correction term shows speed of adjustment of variables such as MPA (ratio of high type roads to low type roads), trade, education, urban population and gross fixed capital formation per worker (GFCFpw) from short to long term. The value of error correction term should be negative and statistically significant. The short term analysis outcomes are shown in below Table 4.6.

Table 4.6
Error Correction Model for the Short-Run Analysis

Dependent Variable = lnGDPPC				
Variables	Coefficient	Std. Error	t-statistics	Probability Value
MPA	0.021126	0.006914	3.055391	0.0378**
TRAgS	0.006459	0.000699	9.240812	0.0008***
EDUexp	0.022368	0.002589	8.638288	0.0010***
URBp	0.035482	0.009996	3.549766	0.0238**
GFCFpw	0.010262	0.001321	7.770063	0.0015***
ECT (-1)	-0.016629	0.001105	-15.04936	0.0001***
R²	0.995167			
Adj. R²	0.983085			
D.W.	2.027193			
F-Stat.	12.94190			
“*, **, *** significant at 10 percent, 5 percent and 1 percent level respectively.”				

(Source: Author’s Calculation)

The ratio of high type roads to low type roads (MPA) has a positive linked with GDPPC as predicted that a 1 unit increase in MPA will cause a 0.021% augment in gross domestic product per capita (Ng, et al. (2019); Choudhary and Sultana (2018); Nworji and Oluwalaiye, (2012)). The trade level also enhanced gross domestic product per worker as seen in Table 4.6, where 1% increase in trade level will enlarge gross domestic product 0.0064% (Ng, et al. (2019)). The government education expenditure and gross domestic product per capita has a positive relationship in short term and suggests that 1% raise in education expenditure will cause a 0.022% increase in gross domestic product per capita.

Urban population and log of gross domestic product per capita positively linked each other in the short run as a 0.035% increase in gross domestic product per capita (GDPPC) due to 1% increased in urban population. The GFCF (gross fixed capital formation) also has a affirmative association with gross domestic product per product in short run and suggests that 1% enlarge in gross capital formation will cause a 0.011% augment in gross domestic product (Choudhary and Sultana, (2018); Faridi, et al. (2011)) .

Error correction term (ECT) is negative and statistically significant at 1% level of significance. It shows the speed of adjustment of variables from short to long period is -0.016 in a year.

4.6 LONG RUN ESTIMATION

This study estimated long term influence of the ratio of high type roads to low type roads, trade, urban population, expenditure on education and gross fixed capital formation on LGDPPC in case of Pakistan. The long term estimated consequences are given in Table 4.7.

Table 4.7
Long - Run Analysis

Dependent Variable =lnGDPPC				
Variables	Coefficient	Std. Error	t-statistics	Probability Value
C	1.300229	1.086815	1.196367	0.2976
MPA	0.109945	0.025548	4.303430	0.0126**
TRAgS	0.106459	0.061668	3.873159	0.0179**
EDUexp	0.059045	0.088742	6.754226	0.0025***
URBp	0.070580	0.024386	3.455046	0.0219**
GFCFpw	0.110262	0.011467	9.562275	0.0005***
R²				
			0.995167	
Adj. R²				
			0.983085	
D.W.				
			2.027193	
F.Stat.				
			12.94190	
“*, **, *** significant at 10 percent, 5 percent and 1 percent level respectively.”				

(Source: Author’s Calculation)

The constant term shows that everything zero, but the log of gross domestic product per worker may increase by 1.30 due to other factors. All independent variables positively related to gross domestic product per worker in Table 4.7.

The coefficient of ratio of high type roads to low type roads (MPA) is positively related to gross domestic product per worker such as a 1 unit increase in MPA (ratio of high type roads to low type road) will bring change 0.109% in gross domestic product in long term. Trade of goods and services is positively linked with GDPPC (gross domestic product per capita). If trade increases 1% than gross domestic product per worker increased by 0.11%. Education expenditure has a positively connected with gross domestic product per worker. If there is a 1% raise in education expenditure, it will be causes a 0.059% increase in gross domestic product per capita. In long term, there is positive correlation exists among GFCF (gross fixed capital formation) and GDPPC, if 1% boost in GFCF than 0.11% enhanced in gross domestic product per worker. Urban population positively related with of gross domestic product per worker.

The value of R^2 reveals that 99.5% dependent variable describe by the independent variables. The adjusted R^2 shows specification of model after adding an additional (extra) variable in model. The value of adjusted R^2 is less than R^2 it means that model is perfectly fitted. The problem of auto-correlation or serial correlation predict with the help of Durban-Watson test. If the Durban-Watson, values lies between 1.5 to 2.5 then there is no problem of auto-correlation.

4.7 STABILITY TEST

Stability of data checked by stability test which are CUSUM and CUSUM Square. Results of CUSUM and CUSUM Square are shown in figure 4.1. and figure 4.2. In figure 4.1, the CUSUM line lies between lower and upper bounds at the 5% level of significance. So, concluded that data is stable and reliable. In figure 4.2, the CUSUM Square line lies between the lower and upper bounds at the 5% level of significance; it means that the data is significant and reliable for this study. It also shows that after taking the findings of a long period and short period estimation, data is still stable and significant at 5% level of significance.

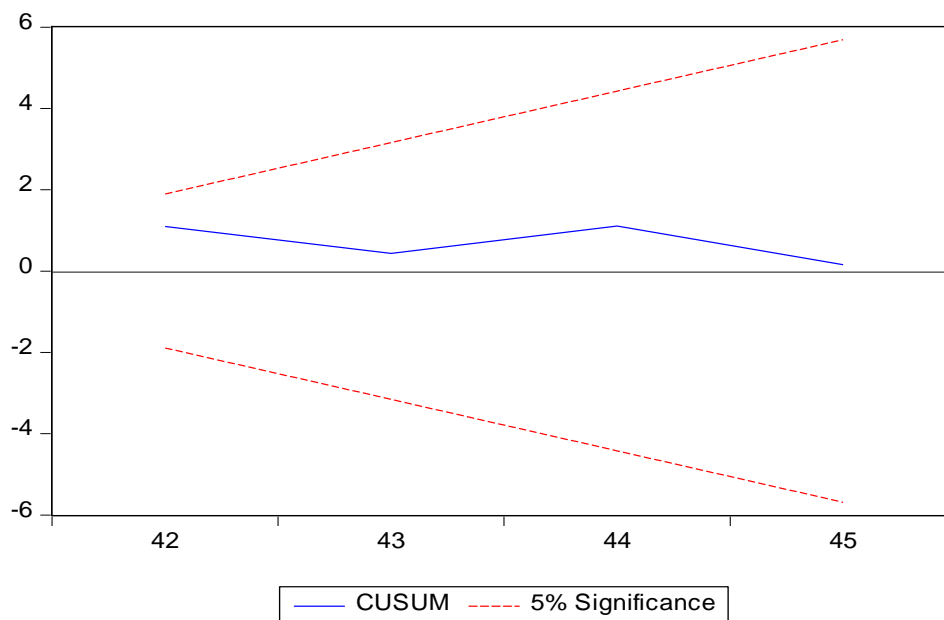


Figure 4.1: CUSUM

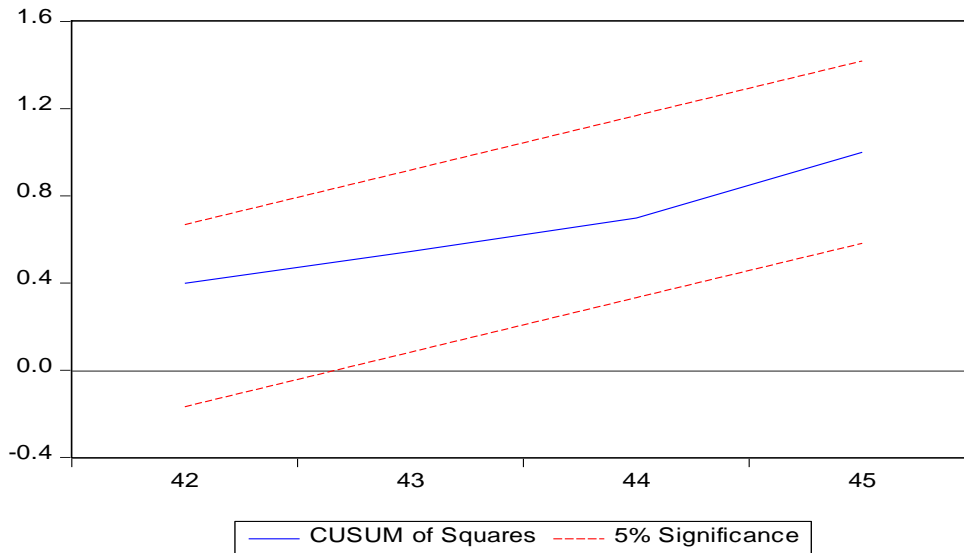


Figure 4.2: CUSUM Square

4.8 DESCRIPTIVE STATISTICS AND CORRELATION ANALYSIS FOR INDUSTRIAL SECTOR

The Table 4.8. presents the finding of correlation analysis and descriptive statistics of industrial sector with other independent variables such as the ratio of high type roads to low type roads (MPA), export, education expenditure, urban population and gross fixed capital formation.

**Table 4.8
Descriptive Statistics and Correlation Analysis**

	ISG	MPA	TRAgS	EDUexp	URBp	GFCFpw
Mean	21.1333	1.44755	33.0955	2.29111	31.8155	16.0911
Median	21.3000	1.25000	33.4000	2.40000	32.1000	16.5000
Maximum	25.5000	2.88000	38.9000	3.10000	36.6000	19.3000
Minimum	17.9000	0.51000	25.4000	1.00000	26.0000	12.2000
Std. Dev.	1.52613	0.63989	3.33350	0.43475	3.08272	1.73753
Skewness	0.36668	0.33637	-0.47218	-0.96279	-0.19573	-0.48544
Kurtosis	4.103135	2.089411	2.668598	4.077181	1.888606	2.310247
Jarque-Bera	3.290105	2.403297	1.878102	9.127953	2.603340	2.659455
Probability	0.193002	0.300698	0.390999	0.010421	0.272077	0.264549
Correlation						
ISG	1					
MPA	-0.3575	1				
TRAgS	0.4236	-0.4659	1			
EDUexp	-0.3444	0.1321	0.1556	1		
URBp	-0.2295	0.7775	-0.2851	0.2115	1	
GFCFpw	0.3019	-0.5556	0.4598	0.1292	-0.4315	1

(Source: Author's Calculation)

The characteristics of the data are represented with descriptive statistics. It shows the normality and central tendency of the data. The central tendency shows with the help of mean, median and mode. The data normality is measure by Jarque-bera. When Jarque-bera value exceeds 0.05 its mean that normality of data exists. The mean value of the ratio of high type roads to low type roads (MPA) is 1.4475, maximum value is 2.8800 and minimum value of MPA is 0.5100. Skewness and kurtosis explained the skewness of the data, whether data positive and negative skewed. Table 4.8. shows that industrial sector growth, trade, urban population and GFCF (gross fixed capital formation per worker), ratio of high type roads to low type roads and education are positively skewed.

The variables association among each other is checked by correlation matrix. The range of correlation matrix from 1 to -1. Negative 1 means negative correlation, no correlation when value is zero and positive correlation occurs when value is plus 1.

4.9 UNIT ROOT ANALYSIS

The value of forecasting is assumed through stationary data. It is difficult for forecasting if data is not stationary. The stationary of data is checked through many like as graphical method, unit root tests and correlogram. The most commonly used unit root tests are Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) unit root test. Because these tests have some advantages over other tests.

4.9.1 Augmented Dickey-Fuller Unit Root Test

Table 4.9, presents the results of Augmented Dickey-Fuller Unit Root Test. The results show that variables such as industrial sector growth, MPA (the ratio of high type roads to low type roads), trade, and urban population are stationary at first difference except the expenditure on education and gross fixed capital formation which is stationary at level.

Table 4.9
Augmented Dickey-Fuller Unit Root Test

Variables	ADF Test t-statistics value		Stationary
	Level	1 st Difference	
ISG	-3.0267 (0.1368)	-8.2562 (0.0000)***	<i>I(1)</i>
MPA	-2.3372 (0.4060)	-5.7572 (0.0001)***	<i>I(1)</i>
TRAgS	-2.5718 (0.2944)	-7.2306 (0.0000)***	<i>I(1)</i>
EDUexp	-3.8711 (0.0222)**	-5.7075 (0.0001)	<i>I(0)</i>
URBp	-2.9116 (0.1689)	-7.9067 (0.0000)***	<i>I(1)</i>
GFCFpw	-4.2664 (0.0080)***	-5.2891 (0.0005)	<i>I(0)</i>

(Source: Author's Calculation)

4.9.2 Phillips-Perron Unit Root Test

The Phillips Perron unit root test which removing the problem of misspecification. In Table 4.10, the unit root test Phillips Perron confirms that industrial sector growth, ratio of high type roads to low type roads (MPA), trade and education expenditure are stationary at 1st difference. Some selected variables such as urban population, and GFCF are stationary at level.

Table 4.10
Phillips-Perron Unit Root Test

Variables	PP Test t-Statistics Value		Stationary
	Level	1 st Difference	
ISG	-2.9283 (0.1639)	-10.0457 (0.0000)***	<i>I(1)</i>
MPA	-1.9965 (0.5870)	-5.7898 (0.0001)***	<i>I(1)</i>
TRAgS	-2.5718 (0.2944)	-8.5687 (0.0000)***	<i>I(1)</i>
EDUexp	-2.4989 (0.3272)	-5.7227 (0.0001)***	<i>I(1)</i>
URBp	-4.0851 (0.0128)**	-8.0312 (0.0000)	<i>I(0)</i>
GFCFpw	-4.2384 (0.0086)***	-5.2138 (0.0006)	<i>I(0)</i>

(Source: Author's Calculation)

4.10 LAG LENGTH CRITERIA

Table 4.11, shows the lag length criteria. There are many lag length criteria like SC, HQ, AIC, LogL, LR and FPE. Every criterion has a different range and method. Most of time AIC lag length criteria are followed in the analysis. According to AIC, finest lag length of model is 1 (7.146676*).

Table 4.11
VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-360.1136	NA	1.501963	17.43398	17.68222	17.52497
1	-108.0802	420.0557*	5.21e-05*	7.146676*	8.884345*	7.783600*
2	-80.13167	38.59557	8.51e-05	7.530080	10.75718	8.712940
3	-39.99169	43.96284	9.42e-05	7.332938	12.04947	9.061733

“ * indicates lag order selected by the criterion”

(Source: Author’s Calculation)

4.11 AUTO-REGRESSIVE DISTRIBUTED LAG (ARDL) MODEL

The ARDL model has two critical bounds values which are upper and lower bound at each level of difference. If F-statistics calculated value is exceeded upper and lower bounds, then we may say that model has long term cointegration. Furthermore, the decision will be ambiguous if calculated value lies among lower and upper critical bound. Results of ARDL model present in the Table 4.12.

Table 4.12
ARDL Bound Testing to Co-Integration

ARDL Bound Testing					Diagnostic Tests		
Estimated Model	Optimal Lag Length	F-Stat	1 Percent		χ^2 Serial Correlation	χ^2 BPG Hetro	Ramsey Reset
			LB	UPB			
FISG (ISG/MPA, TRAgS, EDUexp, URBp, GFCFpw)	(5, 4, 5, 5, 5, 5)	10.1167	3.06	4.15	0.6306 (0.5907)	2.8697 (0.1204)	0.3722 (0.5748)

(Source: Author’s Calculation)

Industrial sector growth is the function of the ratio of high type roads to low type roads (MPA), education expenditure, urban population, trade, and GFCF. By using the optimal lag length, the calculated value of F-statistics, which is 10.1167 exceeding the upper and lower bound. This shows that these variables have an effect on industrial sector growth in the long term. The model specification is investigated with the help of Diagnostic tests. Diagnostic tests explain that the problem of hetero-skedasticity and serial correlation does not exist in model.

4.12 ERROR CORRECTION MODEL FOR SHORT- RUN ANALYSIS

The speed of adjustment of variables towards the equilibrium is called the error correction term. The value of ECT should be statistically significant and negative. The results of error correction term are shown in Table 4.13.

Table 4.13
Error Correction Model for Short- Run Analysis

Dependent Variable = ISG				
Variables	Coefficient	Std. Error	t-statistics	Probability Value
MPA	0.730958	0.394133	7.461836	0.0007***
TRAgS	0.341081	0.046257	9.535351	0.0002***
EDUexp	0.108554	0.258835	7.759987	0.0006***
URBp	0.763416	1.261155	2.984103	0.0307**
GFCFpw	0.424901	0.143813	2.954533	0.0317**
ECT (-1)	-2.329324	0.186616	-12.48188	0.0001***
R2	0.983440s			
Adj. R2	0.941287			
D.W.	2.426340			
F.Stat.	10.11671			
“*, **, *** significant at 10 percent, 5 percent and 1 percent level respectively.”				

(Source: Author’s Calculation)

All variables are positively linked to industrial sector growth in short term. The 1% increase of MPA (ratio of high type roads to low type roads) will increased industrial sector growth by 0.73%. The industrial sector growth increased by trade of goods and services. The 1% increased in trade improved

industrial sector growth by 0.34% in short term. The industrial sector growth increased 0.108% due to 1% increased in education expenditure. Urban population is positively connected with industrial sector growth. The 1% increased in urban population will increase 0.76% industrial sector growth. There is a positive affiliation between GFCF and industrial sector growth. In the short run, industrial sector growth increases 0.42% by 1% increase of gross fixed capital formation. The error correction value is negative, which is -2.32 and statistically significant.

4.13 LONG - RUN ANALYSIS

The constant term value shows that when all variable results zero, then industrial sector growth increased by 1.05 due to other factors. The long term estimated are presented in Table 4.14.

Table 4.14
Long - Run Analysis

Dependent Variable = ISG				
Variables	Coefficient	Std. Error	t-statistics	Probability Value
C	1.051204	10.74842	0.097801	0.9259
MPA	0.940958	0.870374	3.378958	0.0197**
TRAgS	0.441081	0.099972	4.412027	0.0069***
EDUexp	0.719283	0.647637	2.654702	0.0452**
URBp	-19.41108	4.740010	-4.095156	0.0094***
GFCFpw	0.968230	0.282969	3.421679	0.0188**
R²	0.983440			
Adj. R²	0.941287			
D.W.	2.426340			
F.Stat.	10.11671			
“*, **, *** significant at 10 percent, 5 percent and 1 percent level respectively.”				

(Source: Author’s Calculation)

The ratio of high type roads to low type roads is positively related to industrial sector growth. As ratio of high type roads to low type roads increase by 1%, then industrial sector growth increase by 0.94%. Trade is positively associated with ISG (industrial sector growth) and coefficient value of trade is

0.44. The one percent increase in trade of goods and services increases industrial sector growth by 0.44%. Education is also positively related with industrial sector growth. If 1% increase in education, industrial sector growth increased by 0.71%. Urban population is negatively related to industrial sector growth but statistically significant in long period analysis. GFCF is positively related to the industrial sector.

R^2 explained that 98.34% dependent variable is explained by the independent variables. Adjusted R^2 explained specification of model after adding an additional variable in the model. Auto-correlation problem in model are investigated with the help of Durban-Watson test. If the Durban-Watson values lies between 1.5 and 2.5 then the problem of auto-correlation is not exist in model. F-statistics show the significance of the model.

4.14 STABILITY TEST

Stability test which are CUSUM and CUSUM Square are applied to investigate model stability. Figure 4.3. and 4.4. are explained the stability (reliability) test. The model is reliable if the center line lies between lower and upper bounds lines at the 5% level of significance. Figure 4.3, shows the CUSUM and here the data is stable because center line lies between upper and lower bound lines. Figure 4.4, presents the CUSUM Square, where center line also lies between upper and lower bound lines at the 5% level of significance.

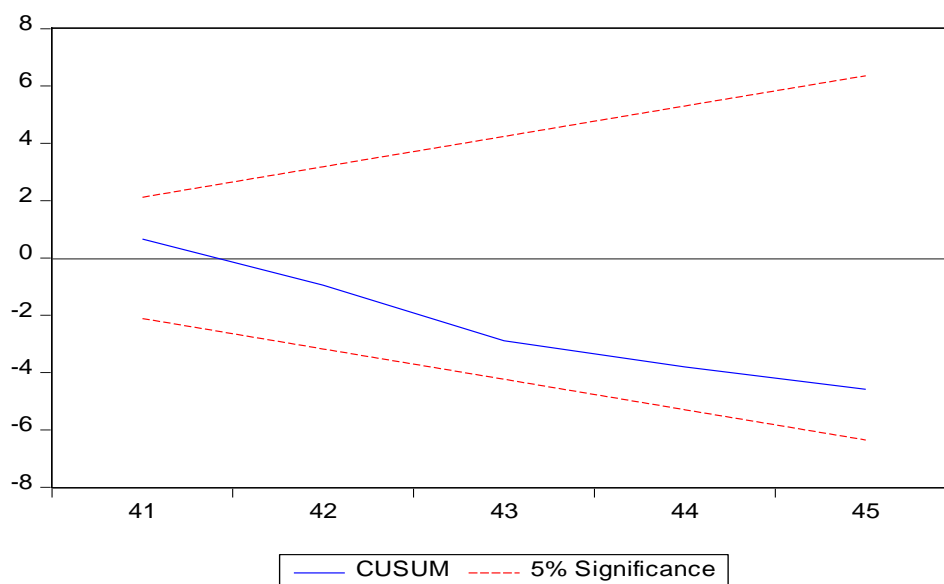


Figure 4.3: CUSUM

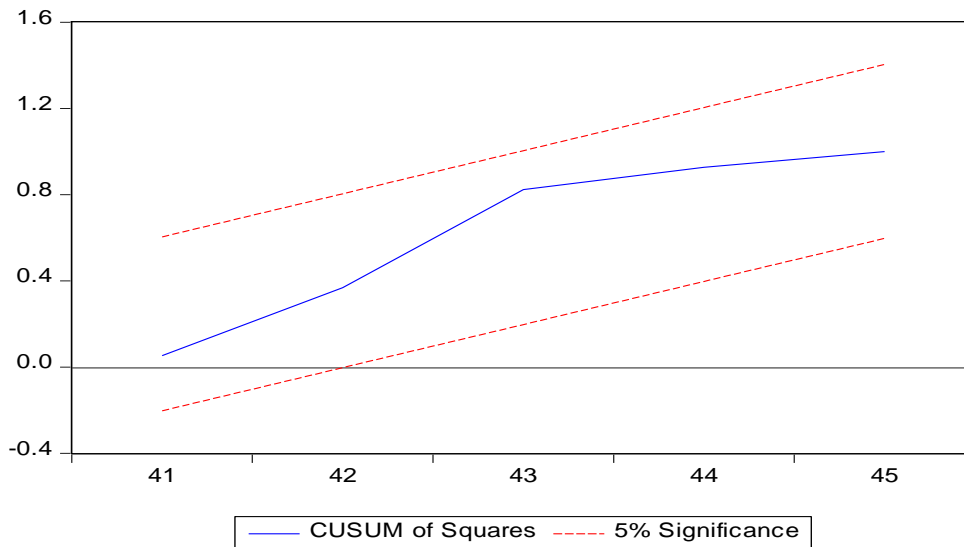


Figure 4.4: CUSUM Square

4.15 DESCRIPTIVE STATISTICS AND CORRELATION ANALYSIS FOR FDI

The results of correlation analysis and descriptive statistics are explained in Table 4.15, where FDI take as a response variable and the ratio of high type roads to low type roads (MPA), trade, education expenditure, urban population and gross fixed capital formation are independent variables.

Table 4.15
Descriptive Statistics and Correlation Analysis for FDI

	FDI	MPA	TRAgS	EDUexp	URBp	GFCFpw
Mean	0.824444	1.447556	33.09556	2.291111	31.81556	16.09111
Median	0.600000	1.250000	33.40000	2.400000	32.10000	16.50000
Maximum	3.600000	2.880000	38.90000	3.100000	36.60000	19.30000
Minimum	0.100000	0.510000	25.40000	1.000000	26.00000	12.20000
Std. Dev.	0.795486	0.639890	3.333505	0.434753	3.082720	1.737530
Skewness	2.090673	0.336373	-0.472183	-0.962798	-0.195737	-0.485442
Kurtosis	7.159666	2.089411	2.668598	4.077181	1.888606	2.310247
Jarque-Bera	65.22465	2.403297	1.878102	9.127953	2.603340	2.659455
Probability	0.000000	0.300698	0.390999	0.010421	0.272077	0.264549
Correlation						
FDI	1					
MPA	0.3778	1				
TRAgS	0.1704	-0.4659	1			
EDUexp	0.1833	0.1321	0.1556	1		
URBp	0.5118	0.7775	-0.2851	0.2115	1	
GFCFpw	0.1590	-0.5556	0.4598	0.1292	-0.4315	1

(Source: Author's Calculation)

The statistics value of Jarque-Bera test declare that Foreign direct investment, the ratio of high type roads to low type road (MPA), export, education expenditure, urban population, and gross fixed capital formation are normally distributed. Some variables (foreign direct investment, ratio of high type roads to low type roads, export and urban population) are positively skewed and other negatively skewed like government expenditure on education and GFCF (gross fixed capital formation).

The correlation analysis shows that the association between the variables. It also shows that how one variable influence by other variables. All variables like the ratio of high type roads to low type roads (MPA), export of goods and services, education expenditure, urban population and GFCFpw (gross fixed capital formation) are positively correlated with FDI.

4.16 AUGMENTED DICKEY-FULLER UNIT ROOT TEST

The result of ADF unit root test shows that education and GFCF is stationary at level. The expenditure FDI (foreign direct investment), trade, and urban population are stationary at 1st level.

Table 4.16
Augmented Dickey-Fuller Unit Root Test

Variables	ADF Test t-Statistics Value		Stationary
	Level	1 st Difference	
FDI	-3.0224 (0.1382)	-4.6762 (0.0027)***	I (1)
MPA	-2.3372 (0.4060)	-5.7572 (0.0001)***	I (1)
TRAgS	-2.5718 (0.2944)	-7.2306 (0.0000)***	I (1)
EDUexp	-3.8711 (0.0222)**	-5.7075 (0.0001)	I (0)
URBp	-2.9116 (0.1689)	-7.9067 (0.0000)***	I (1)
GFCFpw	-4.2664 (0.0080)***	-5.2891 (0.0005)	I (0)

(Source: Author's Calculation)

4.17 PHILLIPS-PERRON UNIT ROOT TEST

In PP unit root test, the outcomes are shown in Table 4.17, that explain Foreign direct investment, MPA (ratio of high type roads to low type roads), trade of goods and services, and education expenditure are stationary at 1st difference. Urban population and gross fixed capital formation per worker (GFCFpw) are stationary at level.

Table 4.17
Phillips-Perron Unit Root Test

Variables	PP Test t-Statistics Value		Stationary
	Level	1 st Difference	
FDI	-2.3068 (0.4216)	-4.6903 (0.0026)***	<i>I(1)</i>
MPA	-1.9965 (0.5870)	-5.7898 (0.0001)***	<i>I(1)</i>
TRAgS	-2.5718 (0.2944)	-8.5687 (0.0000)***	<i>I(1)</i>
EDUexp	-2.4989 (0.3272)	-5.7227 (0.0001)***	<i>I(1)</i>
URBp	-4.0851 (0.0128)**	-8.0312 (0.0000)	<i>I(0)</i>
GFCFpw	-4.2384 (0.0086)***	-5.2138 (0.0006)	<i>I(0)</i>

(Source: Author's Calculation)

4.18 VAR LAG ORDER SELECTION CRITERIA

Lag length criteria are important technique before applying ARDL, as without proper lag selection results may be inaccurate. Table 4.18, shows the lag length criteria. There are many lag length criteria such as SC, HQ, AIC, LogL, LR and FPE. Most of time AIC lag length criteria are followed in the analysis. According to AIC, the optimal lag length of model is 1 (5.742119*).

Table 4.18
VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-347.8632	NA	0.566399	16.45876	16.70450	16.54938
1	-81.45555	446.0780*	1.28e-05*	5.742119*	7.462361*	6.376491*
2	-45.94963	49.54314	1.44e-05	5.765099	8.959834	6.943219

“ * indicates lag order selected by the criterion”

(Source: Author's Calculation)

4.19 ARDL BOUND TESTING

The model of ARDL has two critical bound which are lower and upper bounds at each level of difference. The model has long run cointegration, if the calculated value of F-statistics is greater than upper and lower bounds. The results of ARDL model present in the Table 4.19.

Table 4.19
ARDL Bound Testing to Co-Integration

ARDL Bound Testing					Diagnostic Tests		
Estimated Model	Optimal Lag Length	F-Stat	1 Percent		χ^2 Serial Correlation	χ^2 BPG Hetro	Ramsey Reset
			LB	UPB			
FFDI (FDI/MPA, TRAgS, EDUexp, URBp, GFCFpw)	(4, 4, 4, 5, 5, 5)	4.69572	3.06	4.15	2.8804 (0.1472)	0.5657 (0.8714)	7.6913 (0.0323)

(Source: Author's Calculation)

FDI is function of MPA, education expenditure, urban population, trade of goods and services, and GFCF (gross fixed capital formation). By using optimal lag length, F-statistics value is 4.69572 is greater than upper and lower bound. This shows that all variables have an impact on foreign direct investment in the long term. Diagnostic tests are used to explore specification of the model. Diagnostic technique explains that in model there is no problem of hetero-skedasticity and serial correlation.

4.20 ERROR CORRECTION MODEL FOR SHORT- RUN ANALYSIS

The speed of adjustment of variables towards the equilibrium is called the error correction term. The value of ECT should be negative and statistically significant. The results of error correction term are exposed in Table 4.20.

Table 4.20
Error Correction Model for Short- Run Analysis

Dependent Variable = FDI				
Variables	Coefficient	Std. Error	t-statistics	Probability Value
MPA	0.404956	0.261661	2.197334	0.0460**
TRAgS	0.117086	0.026009	6.424191	0.0004***
EDUexp	0.689853	0.237252	2.907681	0.0227**
URBp	0.186830	0.853249	3.383340	0.0117**
GFCFpw	0.271212	0.067054	4.044695	0.0049***
ECT (-1)	-0.838363	0.122622	-6.836993	0.0002***
R²				
	0.930725			
Adj. R²				
	0.792175			
D.W.				
	2.496151			
F.Stat.				
	4.695728			
“*, **, *** significant at 10 percent, 5 percent and 1 percent level respectively.”				

(Source: Author’s Calculation)

In short term all variables positively related to log of foreign direct investment. The 1% enlarge in MPA will cause the enhanced FDI by 0.40. Foreign direct investment and trade of goods and services is positively linked with each other. In the short run, 1% increased in trade than foreign direct investment increased by 0.12. The FDI (foreign direct investment) increased 0.68 due to the 1% increased in education expenditure. Urban population has a positive association with FDI. The 1% increased in the urban population will cause a 0.18 increase in foreign direct investment. There is a positive connection between the gross fixed capital formation and FDI. In short term, FDI increased 0.27 by 1% increased in GFCF. The ECT (error correction term) value is negative, which is -0.83 and statistically significant.

4.21 LONG - RUN ANALYSIS

When values of all variables are zero, then constant term 18.73521 shows that foreign direct investment increased due to other factors. The results of long term estimation are presented in Table 4.21.

Table 4.21
Long - Run Analysis

Dependent Variable = FDI				
Variables	Coefficient	Std. Error	t-statistics	Probability Value
C	18.73521	8.240622	2.273519	0.0572*
MPA	0.574956	0.653791	0.879418	0.0408**
TRAgS	0.167086	0.059860	2.791294	0.0269**
EDUexp	1.073288	0.395571	2.713265	0.0301**
URBp	0.186830	1.786193	1.616192	0.0150**
GFCFpw	0.299396	0.235127	1.273337	0.0243**
R²	0.930725			
Adj. R²	0.792175			
D.W.	2.496151			
F.Stat.	4.695728			
“*, **, *** significant at 10 percent, 5 percent and 1 percent level respectively.”				

(Source: Author’s Calculation)

The ratio of high type roads to low type roads and foreign direct investment are positively associated with each other. As ratio of high type roads to low type roads augmented by 1%, then foreign direct investment (FDI) augment by 0.57. Trade is positively linked to foreign direct investment. The FDI increased 0.16 due to 1% increase in trade of goods and services. Education expenditure has a positive correlation with foreign direct investment. If 1% increases in education expenditure will cause a 1.07 increase in FDI. Urban population also positively interrelated to FDI. The 1% increase in urban population will cause a 0.18 increase in FDI. The GFCF (gross fixed capital formation) is positively linked with FDI. If 1% boost in gross fixed capital formation will cause increased FDI by 0.29.

R² explained that 93.07% dependent variable is explained by independent variables. Adjusted R² shows the specification of the model after adding an additional variable in the model. In the model auto-correlation problem is investigated with the help of Durban-Watson test. The value of Durban-Watson, lies between 1.5 and 2.5 then there is no problem of auto-correlation. The significance of model is shown by F-statistics value.

4.22 STABILITY TEST

The reliability of the model is checked through stability tests which are CUSUM and CUSUM Square. Results are shown in figures 4.5. and 4.6. The value of CUSUM and CUSUM square lies within lower and upper bound than the model is stable.

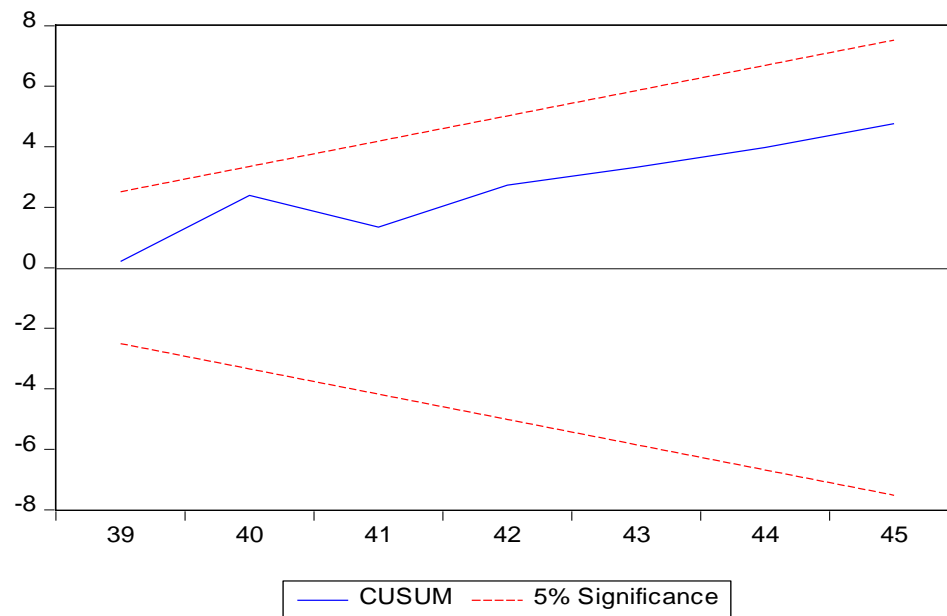


Figure 4.5: CUSUM

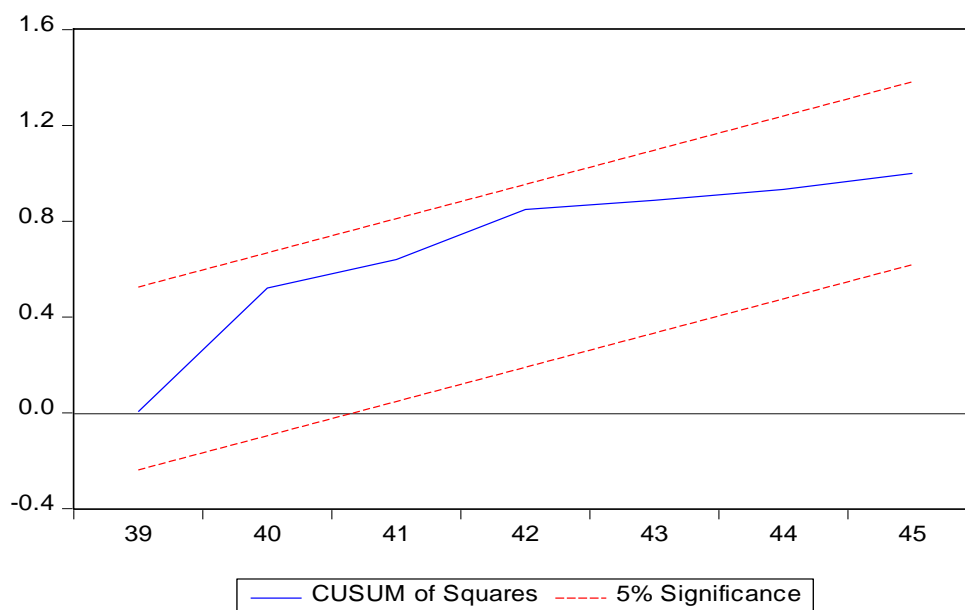


Figure 4.6: CUSUM Square

CHAPTER 5

SUMMARY, CONCLUSION AND POLICY IMPLICATIONS

5.1 SUMMARY

This research work estimates efficiency of road infrastructure on economic development of Pakistan. We used LGDPPC (log of gross domestic product per capita), industrial sector growth and foreign direct investment as a determinant of economic development and the ratio of high type roads to low type roads (MPA). The Auto Regressive Distributed Lag (ARDL) methodology used on this time series analysis, which taken from 1973-2018. The stability of data was checked through CUSUM and CUSUM of square approach.

Our results support the hypothesis that road infrastructure affects the economic development of Pakistan. The 1% raise in MPA caused a 0.02 increase in economic development of Pakistan for short time period. Although in long term 1% increase MPA therefore 0.109 economic development of Pakistan. It is, therefore, concluded that positive relationship exists between road network and economic development of Pakistan. As we saw that in short run the coefficient value of MPA is smaller than long term value, this values indicates that in short term improvement in process of economic development due to ratio of high type roads to low type roads has been slow as compared to long run. Because road infrastructure project long term projects. In both time periods such as long and short run, trade and economic development positively linked each other. In short run, the 0.04 increase in economic development of Pakistan due to 1% enhance trade. For long time period development of Pakistan's economy augmented 0.106 due to 1% increased in trade. Therefore, consequence of this study supports trade of goods and services also have an optimistic impact on economic development (Ivanova, et al. 2013; Oladipo, 2018, Boopen, 2006). The results reveal that expenditure on education by government also improved economic development of Pakistan. In short term, 0.02 increases in economic development due to 1% augment in education expenses. While in long run economic development enhanced 0.059 due to 1% raise in education spending of government.

Our empirical results reveal that MPA has an optimistic influence on Pakistan industrial sector growth in both terms (short and long). It means that if investment in MPA increase it increase ISG (industrial sector growth). The

1% increase in MPA than 0.73 increases in ISG in short term and 0.94 increases in long term. The growth of industrial sector and trade is positively correlated each other which shows that trade improved country development. The 1% raise in trade increased industrial sector growth 0.34 in short term and 0.44 in the long run. These outcomes support our second hypothesis that road infrastructure affects Pakistan industrial sector growth. Road infrastructure network and trade of goods and services both are essential for ISG (industrial sector growth) (Shiferaw, et al, 2012; Albarran, et al, 2013). The industrial sector growth improved 0.42 by GFCF in short term and 0.96 in long term due to 1% augmented in GFCF (gross fixed capital formation).

Our third and last hypothesis that are related to the influence of Pakistan's road infrastructure network development on FDI (Ivanova, et al. 2013). The empirical results show that MPA is positively correlated with foreign direct investment in short term and it also positively related to FDI in long run. In short run 1% boost in MPA enlarged 0.40 FDI. In long run 1% increase in MPA enhanced 0.57 FDI. Education expenditure is positively related to FDI in both time periods. The 1% raise in education expenditure rise 0.68 foreign direct investment in short term, although in long term 1.07 enhanced foreign direct investment. Therefore, we concluded that FDI is notably related with MPA and education expenditure in both time periods.

In first case where we use GDPPC as a dependent variable, outcomes demonstrate that MPA (ratio of high type roads to low type roads), education expenditure and trade have major affects on the development of Pakistan in both periods such as long and short run. In second case, improvement in MPA, GFCF and trade boost the growth of manufacturing sector (ISG). FDI attractions also enlarge with development of roads networks and spending on human capital in last case.

5.2 CONCLUSIONS

In this study, we examined whether improvement in road mobility means that the increment in high type roads enhanced the development of Pakistan economy. Within the passage of time the development of road accessibility (low type roads) also occurs which facilities local business and trade activities. The road infrastructure network in this paper is presented by the length of two kinds of roads (high type and low type roads) in Kilometers. The MPA (high type roads to low type roads) is used to analyze the relationship between road infrastructure and economic development of Pakistan. Economic development is a broad concept and it consists on material as well as non-material aspects of human welfare. However, in this paper, we

have used the gross domestic product per capita (GDPPC) as a proxy for economic development.

This study also focuses on the association between improved road infrastructure and industrial sector growth in Pakistan. Any country has comparative disadvantage when transportation network services in poor quality and face high cost of transferring goods from one place to another. Results show that industrial sector is positively related with MPA (high type roads to low type roads) in short and long run. Within and outside of the country cost of doing business low and market accessibility boost due to better road networks. There is also a positive relationship between industrial sector growth and trade of goods and services.

The empirical results explained that foreign direct investment is positively and significantly related with road infrastructure. The attraction of the foreign investor increased because of the development of transportation infrastructure in Pakistan. Nowadays, developing economies including Pakistan are becoming the preferred destination of foreign direct investment (FDI) inflow due to efficiency of physical infrastructure.

The results of time series analysis to verify the existence of a long-run association between GDPPC and road network infrastructure in Pakistan. The coefficient of road infrastructure is positive and significant. A 1 unit augments in road infrastructure services increase the gross domestic product per capita by 0.11%. This confirms the importance of road network for the economic development of Pakistan.

5.3 POLICY IMPLICATIONS

This study has the following policy recommendations:

- Firstly, this study recommended that industrial sector growth, enhanced in the way of the efficient road infrastructure system because better road infrastructure reduces distance between firms, create more input and output linkages. Trade of goods and services is positively linked with ISG (Industrial sector growth).
- Secondly, FDI and road network infrastructure both positively associated with each other. The attraction of FDI increase in any economy due to effective road infrastructure. Government education expenditure optimistically correlated with FDI. In other words spending on education expenditure relates to human

capital. The development of human capital should be invested more and more on education to ensure that in this way improved economic growth. Many policies have been made by the government to improve the education level in Pakistan but they have fallen short of their targets. Similarly, there is a highly recommended that more spending on education by government from GDP.

- Thirdly, the outcomes of this research work (study) show that spending on road infrastructure network has considerable impact on development of economy and enhanced welfare of people in Pakistan. An efficient road network also boosts trade and human capital in society. That's why we recommend that government should more spend on the road infrastructure system to achieve better economic performance of Pakistan.

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APPENDIX-1

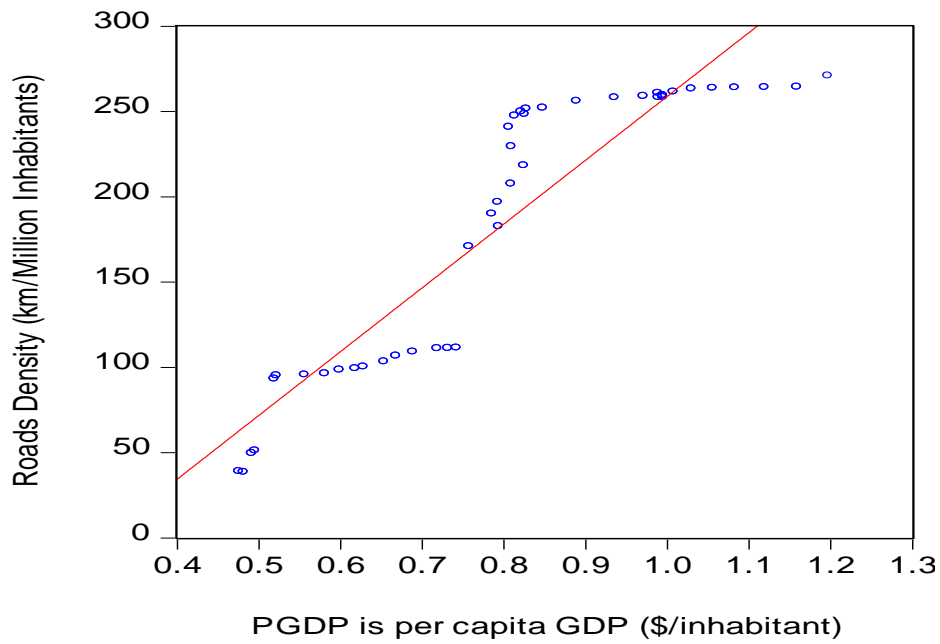


Figure 1.1: Relationship between GDP Per Capita and Road Density (\$1000)

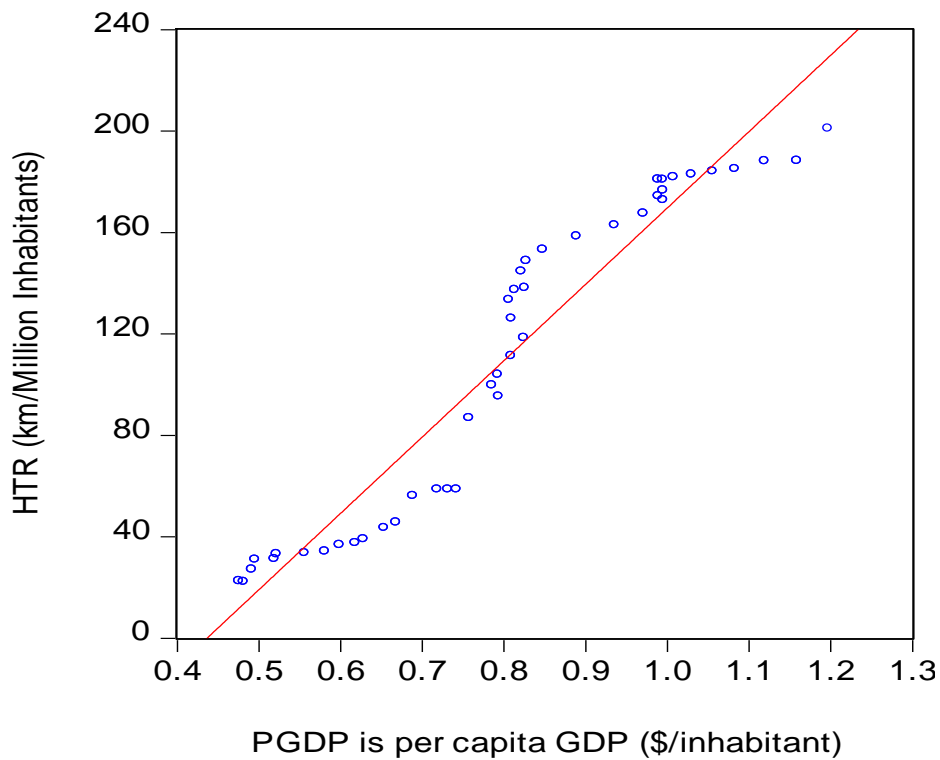


Figure 1.2: Association among GDPPC and HTR (\$1000)

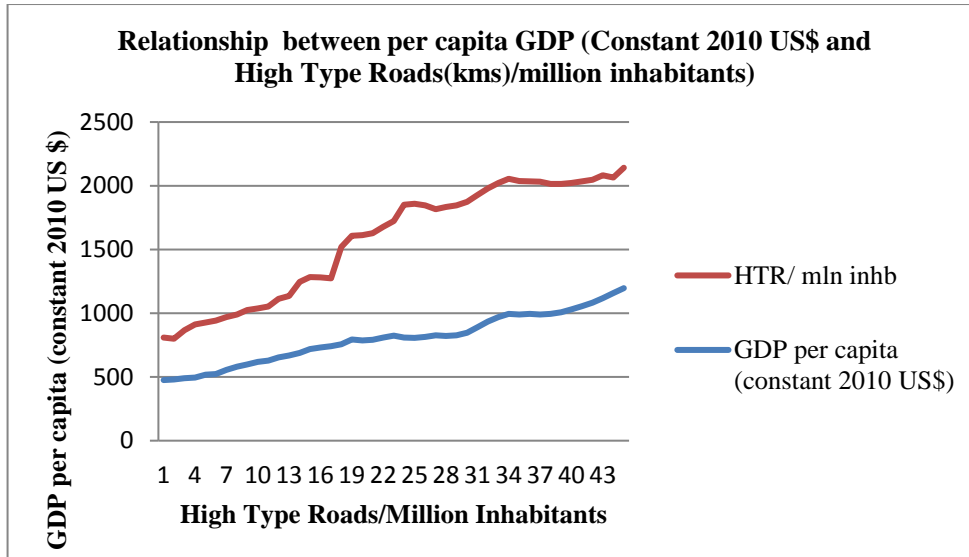


Figure 1.3: Relationship between per capita GDP (Constant 2010 US\$ and High Type Roads(kms)/million inhabitants)

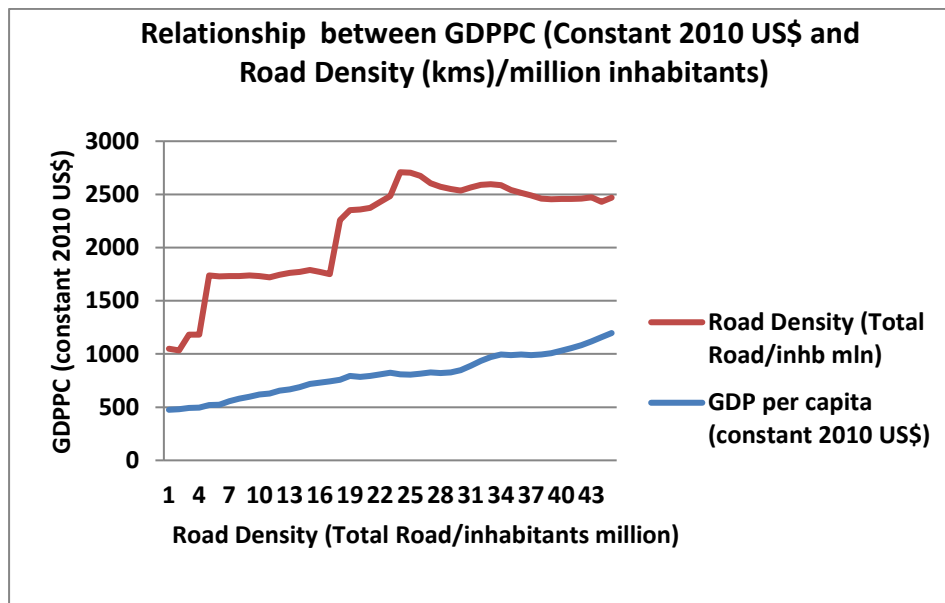


Figure: 1.4: Relationship between GDPPC (Constant 2010 US\$ and Road Density (kms)/million inhabitants)

APPENDIX-2

TIME SERIES DATA FOR PAKISTAN 1973-2018

Year	Population in mln	GDP / Capita (constant 2010 US\$)	High Type Roads (km)	Low Type Roads (km)	Total Roads Length (kms)
1973	67.9	475.4	22,629	16,354	38,983
1974	69.9	481.3	22,294	16,338	38,632
1975	72.2	491.3	27,111	22,662	49,773
1976	74.3	495.3	31,004	20,119	51,123
1977	76.6	518.8	31,249	62,166	93,415
1978	78.9	521.5	33,176	62,046	95,222
1979	81.4	556.4	33,611	62,049	95,660
1980	83.8	580.9	34,269	62,197	96,466
1981	86.4	598.5	36,824	61,758	95,582
1982	89.2	617.9	37,501	61,831	99,332
1983	91.8	627.9	39,081	61,291	100,372
1984	94.7	653.7	43,464	59,964	103,428
1985	97.6	667.8	45,636	61,164	106,850
1986	100.7	688.7	56,140	53,008	109,148
1987	103.8	718.5	58,677	52,560	111,237
1988	107.1	731.6	58,710	52,621	111,331
1989	110.4	742.1	58,740	52,692	111,432
1990	113.8	757.5	86,839	83,984	170,823
1991	117.3	793.5	95,374	87,335	182,709
1992	120.8	785.5	99,803	90,238	190,041
1993	124.5	792.7	104,001	92,816	196,817
1994	128.1	809.1	111,307	96,338	207,645
1995	131.6	824.5	118,428	99,917	218,345
1996	120.9	809.3	126,117	103,478	229,595
1997	126.9	806.6	133,462	107,423	240,885
1998	133.1	813.4	137,352	110,140	247,484
1999	139.6	825.8	138,200	105,320	247,340
2000	142.8	821.3	144,652	102,784	249,972

Year	Population in mln	GDP / Capita (constant 2010 US\$)	High Type Roads (km)	Low Type Roads (km)	Total Roads Length (kms)
2001	146.0	827.5	148,877	98,948	251,661
2002	149.3	847.5	153,255	98,674	251,880
2003	152.7	889.2	158,543	97,527	256,070
2004	156.0	935.6	162,841	95,373	258,214
2005	159.7	970.9	167,530	95,373	262,903
2006	162.9	994.9	172,827	91,491	264,318
2007	166.4	989.2	174,320	86,362	260,682
2008	169.9	994.7	176,589	84,030	260,614
2009	173.5	988.7	180,910	81,761	258,350
2010	177.1	994.2	180,812	79,850	260,760
2011	180.7	1007.4	180,866	78,597	259,463
2012	184.4	1029.8	181,940	79,655	261,595
2013	188.0	1055.6	182,900	80,515	263,415
2014	191.7	1082.7	184,120	79,635	263,755
2015	192.1	1033.5	185,063	78,879	264,212
2016	195.4	1119.1	188,192	76,020	264,212
2017	207.8	1158.5	188,331	76,070	264,401
2018	330.0	1196.6	210,100	69,872	270,972