PHYSICAL INFRASTRUCTURE AND AGRICULTURE PRODUCTION IN BALOCHISTAN: A DISTRICT LEVEL ANALYSIS

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CERTIFICATE

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Table of Contents

List of Tables

Abstract

This study aims to investigate the effects of physical infrastructure on agricultural output Balochistan. This impact is being examined at aggregated and disaggregated level. The aggregated level counter the impact of physical infrastructure on total agriculture production and total area under cultivation, while disaggregated analysis examines the impact of physical infrastructure on the production of major crops, fruits, and vegetables. The empirical analysis is based on a panel of six districts over the period of 2008-2017. We estimated the Random effect model. The overall results confirm that physical infrastructure has a positive and significant impact on the agriculture output of Balochistan, i.e., both the aggregated and disaggregated level. Thus to accelerate the agricultural productivity in province the government should invest in the physical infrastructure.

Keywords: Physical infrastructure, Roads, Agriculture Production, Agriculture Development

CHAPTER 1
INTRODUCTION

1.1 Background

It is an undeniable fact that a country or region requires an optimal level of infrastructure to attain economic development. This debate is more relevant to developing countries, where investment in physical infrastructure is considered as a core part of development policy (Brock, Van Dijk, Van Koesveld, & Wagenaar, 1996). In recent development discourse, infrastructural development is the most debatable agenda among economists and urban planners. Evidences divulge from endogenous growth model and empirical inquiry suggests that infrastructure development mends the long-term production and income level of an economy (Barro, 1990; Futagami, Morita, & Shibata, 1993). (Ankarcrona et al., 1995; Canning & Bennathan, 2000; Easterly & Rebelo, 1993; Lipton & Ravallion, 1995).

To inquire about the role of infrastructure in the sustainable development process, various concepts and approaches are developed. In the view of Srinivasu and Rao (2013) infrastructure comprises of capital goods which are not utilized directly but rather they provide services by using labor and other inputs. Broadly viewing, the infrastructure is categorized into three heads; (a) physical infrastructure which includes water supply, sanitation, irrigation, energy, telecommunications, and transportation sectors (Snieska & Simkunaite, 2009); (b) the social infrastructure which comprises of telecommunication, education and health; and (c) the institutional infrastructure which contains agriculture corporates and markets (Manjunath & Kannan, 2017).

There is a general agreement that establishing infrastructure (for instance roads) is not the true economic development but rather it performs a distinct role (proximate cause) in economic growth, in particular to households and firms. Besides the amount of infrastructure, its quality is also considered main causing factor for investment, urbanization, and business establishment locations (Ali & Pernia, 2003). The well-established infrastructure directly effects the businesses, sectoral productivity, and economic development. The differences in infrastructure investment among countries and regions are often seen in uneven economic development (V. Ahmed, Abbas, & Ahmed, 2013; Ali & Pernia, 2003).

In every economy, infrastructure is an important aspect for agriculture and industrial sector, as it facilitates both sectors in achieving economies of scale through the reduction in transaction costs and achieving faster market access especially for enterprises like food processing, transport sector, trade and restaurant service (Sahoo, Dash, & Nataraj, 2010; Shenggen & Zhang, 2004). Yet, the favorable effects of infrastructure not only channelize to the existing agriculture sector (Felloni, Wahl, Wandschneider, & Gilbert, 2001) but also cause to use more land resources (Jacoby, 2000) and positive growth in income and consumption of households (Escobal & Ponce, 2002).

In Pakistan, insufficient and deteriorated infrastructure have become a binding constraint to economic development (Addo, 2006). Pakistan has a fragile infrastructure setup in particular to roads connectivity (Imran & Niazi, 2011). Off course, the availability and access to better roads significantly stimulates the agriculture production. The dissemination of China Pakistan Economic Corridor (CPEC) provides an excellent opportunity to Pakistan to modernize their infrastructure setup with $62 billion FDI inflows (Khawar, 2017). In the line, around 36 percent of CPEC funding is allocated for infrastructure, transport and communication (Esteban, 2016). It is pretended that great network of connectivity will conceive new look-in for development in Pakistan in specific to the agriculture sector.

The pace of growth and development of Balochistan is closely associated with the agriculture and mining sectors. As the agriculture sector remain quite important for Balochistan while making a significant contribution to provincial GDP. Balochistan one-third portion almost 30 percent of the gross domestic product and 40 percent of the labor force is associated with the agriculture sector (World Bank, 2013). However, Balochistan's agriculture sector is working below its potential due to deteriorated infrastructure specific to road and rail linkages which are not well-maintained for many years which ultimately result in lower agriculture growth performance.

1.2 Problem Statement

Infrastructure development remains the major issue in economic development of Pakistan (Jan et al, 2012). If we look at the human development index of Pakistan, Balochistan ranks at very low level due to deteriorated infrastructure condition. Especially when we talk about the Balochistan whom agriculture sectors have major contribution in economic development. So it's imperative to counter this issue to improve the agriculture sector.

1.3 Research Questions

Study is based on following research questions

I. Does physical infrastructure affect the agriculture production and cultivated land of Balochistan?

II. Does physical infrastructure have any impact over Production of Major crops and vegetable production?

1.4 Research Objectives

The objective of this dissertation is to explore the role of infrastructure in agriculture production of Balochistan. This study based on the following specific objectives.

i. To analyze the impact of existing physical infrastructure on agriculture production and cultivated land of Balochistan.

ii. To make the disaggregated analysis on the basis of different nature of agriculture outputs, (a) Major crops (b) Fruits and vegetables.

1.5 Research Gap

As transport infrastructure is the crucial determinant of economic growth specifically to the agriculture sector. Balochistan can be viewed as the most underprivileged province of Pakistan in terms of infrastructure. Therefore, debates on underdevelopment of the province have become more sensitive. Unfortunately, researchers have ignored this area. Only a few studies have analyzed the role of physical infrastructure on agriculture production and to the best of our knowledge, hardly any study yet carried out to empirically analyze the role of physical infrastructure in agriculture production of Balochistan.

1.6 The Significance of the Study

In the context of Pakistan, the present study significantly contributes to the existing literature. This study specifically highlights the role of physical infrastructure in agricultural production of the Balochistan province, which has frequently remained the negligible dimension of research discourse in Pakistan. To do more precise scrutiny, this study do aggregated analysis by investigating the combined effect of agriculture output and cultivated land. Moreover, for making in-depth analysis this study also attempts to conduct disaggregated analysis by considering various nature of agriculture outputs, (a) Major crops (b) Fruits and vegetables, in response to existing physical infrastructure, such an inquiry enhances our understanding about the dynamics of various form of crops.

Into the line, another important contribution to the literature is measuring the district wise Road density that has never been measured in context of Balochistan, in specific to the selected districts of the province. This study also depicts that, how road infrastructure significantly effects the agriculture production, especially in case of least developed area where road infrastructure is in deteriorated situation, whereas study is useful for policy makers to view this dimension of agriculture development because more than fifty percent of total roads are unpaved in Balochistan. Study is beneficial those agents which are associated with the agriculture sector of the province.

CHAPTER 2
THEORETICAL FRAMEWORK

2.1 Introduction

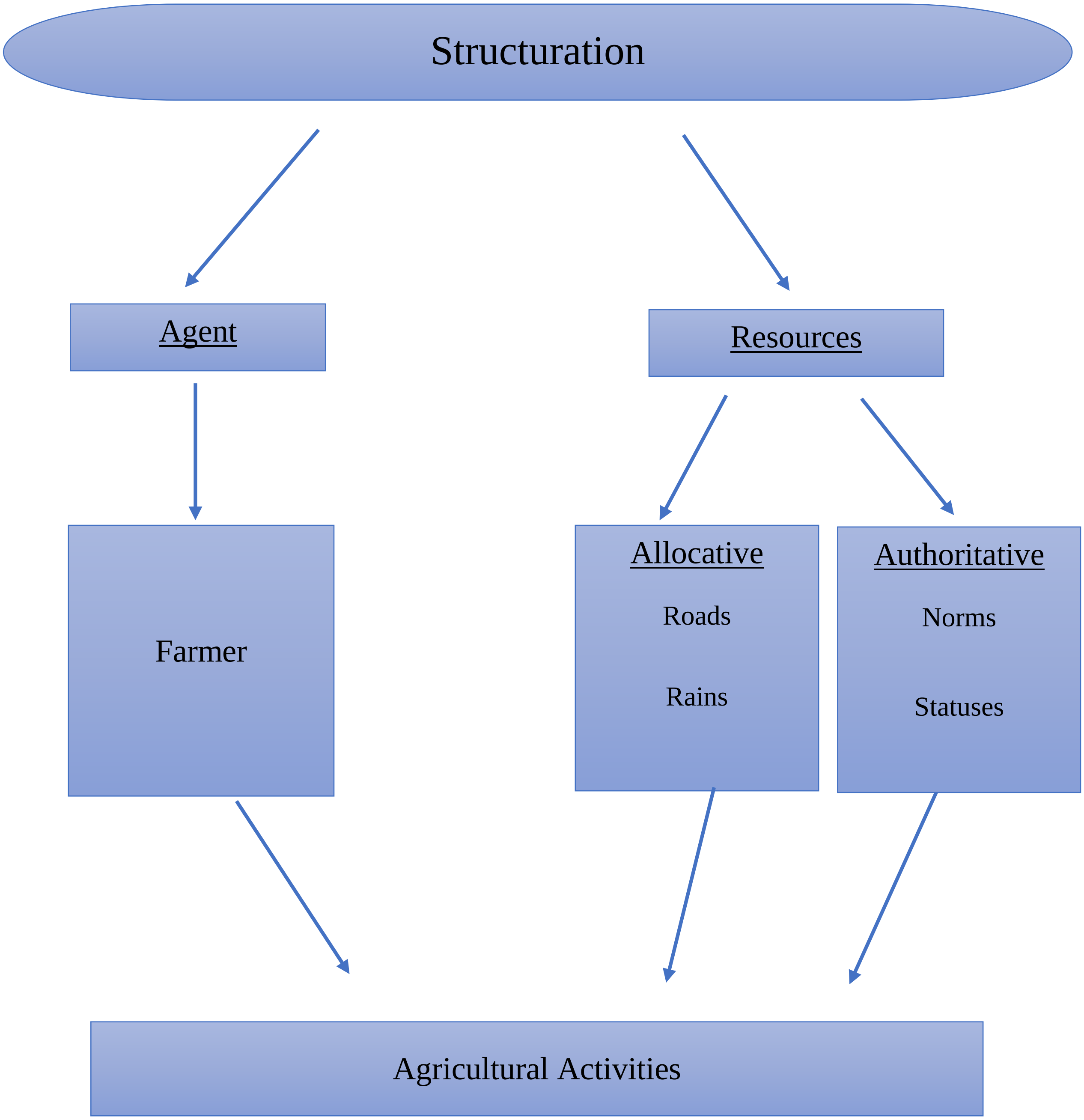
Theories are accepted prepositions and statements use in explanation or interpretation of observed regularities or patterns (Gregory et al., 2011, Bryman, 2012). This study employ the structuration theory which entwines structure/agency (farmer) to explain the relation between roads and agriculture. Employing the structuration that provides a framework for explaining the relation between roads and agriculture where farmers and the structures they are involved and entwined to explain the relation between subsistence agriculture and roads

2.2 Structuration Theory

In the application of this theory Postulated by Anthony Giddens (1984), the structuration theory neither emphasizes the primacy of the structure over the agent (farmer) nor the agent over the structure. The theory emphasizes the knowledgeability of individual agents in the reproduction of social practices (Dyck and Kearns, 2006: 87). In the words of Gregory et al., (2009: 725) the structuration theory is a bridge theory that explains the intersections between agency and the structures they are involved and ask social researchers to focus on social practice. This is because routinized social practices with it structural properties allow the binding of time and space.

Giddens identified two types of resources. They are authoritative and allocative resources. Authoritative resources are capabilities that generate command over the human agent while allocative resources are derived from aspects of the material world (Giddens, 1984). At the core of the structuration theory is the duality of structures. The duality of structure is a recursive process in which structure is both a medium and an outcome of reproduced social practices (Giddens, 1981; Dyck and Kearns, 2005: 87).

Framework of the Structuration theory



Source: Adapted from Giddens (1984).

The structuration theory provides a framework for understanding that subsistence farmers make use of both authoritative and allocative resources in their subsistence communities for subsistence agricultural activities but the subsistence communities constrains farmers agricultural activities by binding subsistence farmers to the resources provided. Farmer reveals a great deal about the relation between roads and agriculture. Farmers are knowledgeable and take all agricultural decisions but not out of the resources provided by their communities. Allocative resources come from the external world and farmers have little or no control over them yet it determines their production success. The rain and the roads comprises the two allocative resources in this case. Roads are modern and are primarily to facilitate agricultural activities. When the rainy season begins a subsistence farmer then needs roads to access modern farm inputs like fertilizers and after harvest a farmer needs road to access the market or traders (Mitiku, 2009). The rain as a structure is recursive in that it is most important resource for agriculture production because it determines production output. It is also an outcome of production because of farmers' continual dependence on it (Dyck and Kearns, 2006).

CHAPTER 3
LITERATURE REVIEW

3.1 Introduction

The development of agricultural sector restrained to cross country economic policies and development differences within a nation. Besides, the performance and growth of agriculture sector around the globe is conditional on the available infrastructure and territorial development policies, however, fewer studies examined this association. This chapter provides the national and international research work done on the relationship between infrastructure development and agriculture performance of the different countries and regions.

3.2 Road Infrastructure and Agriculture Output Growth

Shenggen and Zhang (2004) analyzed the link between infrastructure and regional economic development in rural China while using a simultaneous equation model. Findings of the study exhibited the positive and significant impact of road and irrigation infrastructure on agriculture output. In the same line R. Ahmed and Mustafa (2014) analyzed the impact of infrastructure on agricultural output. The results of the study predicted that infrastructure has positive spillover effects on intermediate input and private capital (insignificant). Additionally, the infrastructure has strong and positive links with agriculture output and convenient in poverty reduction.

Similar to the above studies, Looney (1994) Study also established positive and significant impact of public infrastructure, however, results advocated that rural development programs have not significant impact on the agriculture output. In another study which aims is to jointly seek the impact of government investment in infrastructure and financial investment over agriculture output. The results of the study revealed that financial institutions remain interested when the infrastructure system exist in better conditions. Additionally, the general results suggested a positive impact of government investment (investment in infrastructure) and financial institution on agriculture output except for irrigation (Binswanger, Khandker, & Rosenzweig, 1993), while other studies established the same relationship (Datt & Ravallion, 1998).

3.3 Infrastructure, Product Prices, and Cost Structure

The problem of transaction cost and price dispersion is main concern specifically among agriculture producers. Physical infrastructure may counter these problems. Different studies have been conducted to view the role of infrastructure in term of these factors.

Mamatzakis (2003) conducted a study on Greek agriculture sector and tried out to spill out the impact of public infrastructure on Greek agriculture productivity. The Study found that infrastructure has an inverse relation with the cost of production, which declares that infrastructure has a positive impact on agriculture production. In the same direction, Jacoby (2000) investigated the benefits of rural roads by access to markets, and how it could be beneficial in term of cost of production. The finding of the estimations shows that rural roads have a positive impact on the income of farmers and households, the increase in traveling cost make an adverse impact on farmers' wages. Generally, results indicate that rural roads are beneficial for farmers and households which may lead to making a positive impact on agriculture productivity.

In addition, another study of Minten and Kyle (1999) attempts to investigate the role of infrastructure in term of distance and road quality by the casual difference in absolute and relative food price among producer and whole seller. The study finds that price variation exists and producer faces twice higher transportation cost on unpaved roads. The study generally illustrated that better roads are instrumental in reducing the regional price dispersion in market and agriculture producer.

Recently, Salazar and Jones (2017) tried to quantify the impact of extensive local transport infrastructure and new bridges construction on agriculture market outcomes by measuring the price deviation among agriculture markets. The results of the estimates indicate the positive significant effect of new bridges and domestic infrastructure over the price dispersion along markets and agricultural market outcome but these impacts are found only among closer markets, while the insignificant impact on long-distance markets. (de Janvry & Sadoulet, 1994; Goetz, 1992) found that transportation cost is the core reason for household price deviation which prevails for the same commodity among the selling and purchasing item. While depends on the product, transport costs make up one-quarter to one-third of the wholesale price of domestic products (Shapiro & Tollens, 1992; Thorbecke, 1992)

3.4 Social and Economic Impacts of Road Development

The role of physical infrastructure is broadly considered as vital to both households in term of migration, business formation locations, and sectorial transition. The social and economic impact which underpins the quality of life, reducing the ratio of road accidents, Aschauer (2000) with reference to Agénor and Moreno-Dodson (2006) good road connectivity is productive in accomplishing the admirable standard of health and education.

According to the study of Shamdasani (2016) who investigated that how the household decision in agriculture sector effect rural connectivity through improvement in transport infrastructure. Findings of the study demonstrated that improvement in transport infrastructure give rise to make assortment in crop portfolio of household's due to new agriculture technologies and increment in mobility of workers access to labor market, and study found negative impact over household villagers closer to towns transited to non-agriculture sector owing to rural connectivity ease their access to jobs in non-agriculture sector.

Addition to existing literature another study by Sheng, Jackson, and Lawson (2018) evaluated the beneficial value of farmland due to improved transport infrastructure in the agriculture sector of Australia. Results reveal that improved infrastructure have a significant impact on the household farmland value with constraints to farm size, type, and more particularly estimation show that infrastructure is highly affected by those households who are engaged in the large farms. In a similar way to the aforementioned studies, Berg, Blankespoor, and Selod (2018) discussed the relationship between road improvement and rural development by examining the relationship between market access and land cultivation area. The results of estimation display that market access index has the positive and significant effect with five-time increment in cropland area by households. In addition, estimations indicate that some places are been observed with decreasing marginal rate of the land crop which could be a reason for farming household migration towards non-agriculture activates.

3.5 Linking Rural Infrastructure and Agriculture Productivity

There are many factors which play their key role in agriculture productivity and rural infrastructure is important of them. According to Gang, Gang, and Yan (2003) infrastructure development has a hegemonic part in escalating the agriculture productivity. For the same purpose, Llanto (2012) investigated the impact of infrastructure on agriculture productivity of Philippine. The findings of the study suggest that paved road and electricity have a positive and significant effect, while irrigation and rainfall have a positive but insignificant impact on the agriculture productivity. Furthermore, in the disaggregated exploratory analysis, the study found that 2 among 12 regions' agricultural productivity has a negative association with rural infrastructure.

Similarly, Li and Liu (2009) aimed to elaborate the effect of rural infrastructure development on agriculture technical efficiency. The results of the study indicated that explanatory variables sets in the model are road, electricity, water supply, and vocational schools have a positive and significant impact on the dependent variable. While telecommunication has a negative impact on the dependent variable.

On the other side, Manjunath and Kannan (2017) figure out the effects of rural infrastructure on agriculture productivity. The study categories the infrastructure in three sections (i) economic infrastructure (ii) social infrastructure (iii) institutional infrastructure. The outcome of the study indicated that Infrastructure Availability Index and Infrastructure utilization Index both positively and significantly effected the agriculture land productivity. In the same line study by Kiprono and Matsumoto (2014) investigated how road improvement affects agriculture input use, farm productivity. The results of the estimation illuminate that betterment in road access has a positive impact on farm productivity and use of agriculture inputs by observing the increase in the share of land allotted for the yield of maize and more escalation in fertilizer use, however, these impacts have been captured for remote areas mostly.

3.6 Summary of Literature

Table 3.1 Summary of Literature Review

Title	Author (s)	Sample Period/Region	Methodology	Findings
Impact of CPEC on Agriculture Sector of Pakistan	Riaz Ahmed	2013-2014	Analytical frame Work	The Research findings demonstrated the strong relationship between infrastructure and agriculture output
Infrastructure and Regional economic development in rural China	Shenggen FAN and Xiaobo ZHANG	1996 Agriculture Census	Simultaneous Equation Model	The estimated Results found that Infrastructure (Road and Irrigation services) have a significant impact on the agriculture output.
The Impact of infrastructure on Pakistan Agriculture Sector	Robet. E. Looney	1972-1990	Fixed effect Model	Study Found Moderate stimulus effect of Government investment regard infrastructure on Agriculture output of Pakistan.
How Infrastructure and financial institutions affect agriculture output and investment in India	Binswanger et al	1960-1982	Fixed effect Model	General results show the positive impact of government investment (infrastructure) and financial institution on agriculture output except for irrigation.
Effect of Public Infrastructure and Productivity growth in the Agriculture sector of Greek	E.C Mamatzakis	1960-1995	3 stage SLS Method	The study found the clue that infrastructure have reverse relation with the cost of production, which declares that infrastructure has a positive impact on agriculture production (Crop and livestock).
Access to Markets And the benefits of Rural Roads	Hanan G. Jacoby	1995-6 NLSS Survey	Semi-parametric Approach and OLS Regression	As per the finding of the study widespread Rural roads have positive impacts on the income, and negative on the wages of farmers and households.
The effect of distance and road quality on food the collection, marketing margins, and traders Wages	Bart Minten And Steven Kyle	Ministry of Agriculture Belgium Survey October-November 1990	Ordinary Least Square method	Results state that Price variation exists, and producer Observe twice higher transportation cost due to dirt roads.
The Impact of infrastructural Shocks on agriculture markets	Cesar Salazar And Sam Jones	2005-2012	Average Treatment Effect And difference in difference Model	Overall results found Positive and Significant impact only among closer and disconnected markets unless insignificant relationship

				established among too distant markets above 500 Km.
How Rural Road infrastructure effects the Agriculture Production	Yogita Shamdasani	1999 and 2006	Difference in Difference Method	Results interpreted that improvement in roads connectivity diversify the household crop portfolio, one aspect of the study found negative impact those who are closer to towns moved to the non-agriculture sector because of improving rural connectivity
Evaluating the benefits from transport infrastructure in agriculture	Jackson et al. 2018	2009-11	Hedonic Regression Model	Results clearly insights that Infrastructure strongly effects the farmland value of Large and Crop farms.
Roads and Rural Development in Sub-Saharan Africa	N.Berg at el	1990-1970	Fixed Effect OLS Regression	Estimations clear out the inductive evidence that improved market access and time reduction leads to increment in land crop area. Some places are been observed with decreasing the marginal rate of land crop which could be a reason of farming household migration towards non-agriculture activates.
Impact of Infrastructure on Agriculture Productivity	Gilberto M. Lanto	1991-2006 Philippine	Random Effect GLS Method	The author detected that paved road and electricity has a positive and significant effect, while Irrigation and rainfall have a positive but insignificant impact, out of 12 regions, 2 were negatively associated with rural infrastructure
The Effects of Rural infrastructure development on agriculture technical efficiency	Zongzhang Li and Xiaomin Liu	2006 Agriculture census	Tobit Model	The finding of the study sights that Road, Electricity, Water Supply, and vocational Schools have a positive and significant impact on Agriculture technical efficacy except for telecommunication.
Impact of Rural Infrastructure on Agriculture Development	Manjunath and Kannan	1980- 2010	Random Effect Model and Pooled OLS	Estimation results revealed the Positive and significant impact of Infrastructure availability index and Infrastructure utilization Index on Agriculture Productivity Growth
Road And Farming, the effects of infrastructure improvement on agriculture input use, farm	Philemon Kiprono And	2004-2013	Difference in differences (D-I D)	The positive impact of Improved road infrastructure is been observed on-farm productivity and use of

productivity and Market participation	Tomoya Matsumoto			agriculture inputs, the majority of impacts are omitted from remote areas.

CHAPTER 4
DATA AND METHODOLOGY

The main purpose of the study is to analyze the role of physical infrastructure on agriculture production in Balochistan. The underlying study use the Secondary data of six districts over the time period of 10 years (2008-2017), which Include various form of physical infrastructure, districts wise road density, districts distance to targeted market, along with other control variables like water availability and Multidimensional poverty, to analyze the response of total agricultural output and cultivated area. Nevertheless, to make an in-depth inquiry, the study do the disaggregated level analysis for different crops into two main categories; (a) major crops, and (b) fruits and vegetables, to evaluate the dynamics of various agricultural output.

4.1 Sample Selection

The study uses data of six districts out of total thirty districts. The selection of districts is made over the highest average value of area under cultivation from 2008–2017, Panel data consist of a large number of data points so it provides sufficient number of degree of freedom and reduce the possibility of multicollinearity among the explanatory variables. same approach is utilized by Chand, Garg, and Pandey (2009) taking the averages while selecting the districts. Since, top six districts with highest average values are the major contributors to the agriculture sector of the province.[1]

This study use the following equations to estimate the effect of infrastructure on agriculture output, cultivated area and on the disaggregated level for various crops:

4.2 Model Specification

Based on the above objectives of the study, the econometric models are given below as:

[1] List of the selected districts is available in table C2 of appendix C.

Model I

This model illustrates infrastructure impact on total agriculture output;

$$LAGRY_{it} = \beta_0 + \beta_1 RD_{it} + \beta_2 LDTM_{it} + \beta_3 WA_{it} + \beta_4 DX_{it} + \mu_{it} \ldots\ldots\ldots\ldots\ldots \text{(3.1)}$$

Model II

This model explore the impact of physical infrastructure on area under cultivation;

$$LAUC_{it} = \beta_0 + \beta_1 RD_{it} + \beta_2 LDTM_{it} + \beta_3 WA_{it} + \beta_4 DX_{it} + \mu_{it} \ldots\ldots\ldots\ldots\ldots\ldots \text{(3.2)}$$

For the sake of disaggregate analysis, we estimate two models by using different nature of agriculture outputs; (a) Major crops, and (b) Fruits and vegetables.

Model III

This model demonstrates the impact of physical infrastructure on major crops;

$$LMCY_{it} = \beta_0 + \beta_1 RD_{it} + \beta_2 LDTM_{it} + \beta_3 WA_{it} + \beta_4 DX_{it} + \mu_{it} \ldots\ldots\ldots\ldots\ldots\ldots \text{(3.3)}$$

Model IV

The model below is used to analyze the impact of physical infrastructure on fruits and vegetables;

$$LFVY_{it} = \beta_0 + \beta_1 RD_{it} + \beta_2 LDTM_{it} + \beta_3 WA_{it} + \beta_4 DX_{it} + \mu_{it} \ldots\ldots\ldots\ldots\ldots\ldots \text{(3.4)}$$

4.3 Variables and abbreviations

LAGRY= Log Agriculture output, LAUC= Log Area under cultivation, LMCY = Log Major crops output, LFVY= Log Fruits and vegetable's output, RD = Road density, LDTM= Log Distance to targeted market, WA= Water availability, DX= Multidimensional Poverty. μ = Error term, whereas "i" illustrate district and "t" stands for time.

4.4 Definition and Measurement of Variables

Table 4.1 Definition of variables and measurement

Dependent Variables	***Definition***
Agriculture Output	Agriculture output is defined as total agriculture production per year, which includes the Crops, Pulses and seeds, vegetable and fruits. Variable is measured in tones
Total Area Under cultivation	Area under cultivation is defined as that particular land on which agriculture production takes place, for farming purpose. Variable is measured Hectares.
Major crops output	Major crops are defined as those crops which are cultivated on large scale and most demandable crops. Variable is measured in tones.
Fruits and vegetables Output	Total production of fruits and vegetables produced in that specific district. Variable is measured in tones.

Independent variables	***Definition and Measurement***
Road Density	Road density is defined as the availability of road per square kilometer of land area, to calculate each year road density of selected districts we divided the annual road length by total area of the district. To get each district road density same method was adopted for all selected districts. $$RD = \frac{Road\ length(km)}{Total\ Area\ (skm)}$$
Distance to Targeted market (Whole sale Market)	Distance to targeted market is defined as the distance between local export markets to its targeted whole sale market, we calculated this variable by measuring road distance of each local export market of the district to its targeted whole sale market. The same formula is applied over all selected districts. Variable is measured in kilometers.
Water availability	Water availability is defined as a water supply for agriculture purpose from multiple sources which may include rivers, canals, reservoirs and tube wells. As study deal, this variable as a dummy, those districts whose source of water is canal system assigned 1, and those whose sources of water is groundwater like tube wells was assigned value 0.
Multidimensional poverty	Multidimensional poverty is made up of several factors that constitute poor people's experience of deprivation, such as poor health, lack of education, inadequate living standard, lack of income, the variable is calculated annually for each district.

4.5 Data Sources

This study uses panel data of agriculture and infrastructure sector of Balochistan from 2008 to 2017. The data of agriculture sector variables and infrastructure variables have been collected from multiple sources as mentioned below in table (3.2).

Table 4.2 Variable with Data Source

Variables	***Source of Data Collection***
Agriculture Output	Balochistan Agriculture Research Institute, Quetta Balochistan.
Area Under cultivation	Balochistan Agriculture Research Institute, Quetta Balochistan.
Major crops output	Balochistan Agriculture Research Institute, Quetta Balochistan.
Output of Fruits and vegetables	Balochistan Agriculture Research Institute, Quetta Balochistan.
Road density	Variable is calculated by the researcher itself, For the sake of calculation of this variable, data were collected from Department of Communication, works, physical planning and housing and Planning and development department, Government of Balochistan.
Distance to Target market	Distance to target market is calculated using google map. The location of targeted markets are specified by the opinion of local exporters.
Multidimensional poverty index	OPHI and UNDP Pakistan with the collaboration OF Pakistan Institute of Development Economics, PIDE.

4.6 Estimation Technique

There are two conventional methods in the panel data analysis. The Fixed Effect model (FEM),[2] and the Random Effect model (REM). In FE technique, the unobserved heterogeneity among the cross-sectional units is observed in intercept, by placing dummy for each cross-sectional unit, where intercept of each cross-sectional unit is different and is time-invariant. Nevertheless, in the RE model, the cross-sectional heterogeneity is allowed to the ignorance zone i.e., to the error term. The selection between the FEM and REM are made on the basis of the Hausman test.

[2] One of the covariate is time-invariant in this study, in particular situation Fixed Effect model omit the effects of time invariant variable. So we might move towards a replacement model.

4.7 Descriptive statistics

In the table, 3.3 descriptive statistics of all the variables are shown. The largest average value among the series is captured by agriculture output (414007) followed by the mean value of major crops output (317281). The lowest mean value is associated with the road density (0.175). The average value of the remaining variables, area under cultivation, output of fruits and vegetables, distance to target market, water availability and Multi-dimensional poverty index are, respectively, 122071, 97173, 0.65 and 44. Following the third column standard deviation of series is mention. The highest standard deviation among series is observed of Major crops output (243267) followed by Agriculture output (224732).

Table 4.3 Descriptive Summary of all Variables

Variable	*Observations*	*Mean*	*Std. Dev.*	*Min*	*Max*
Agriculture Output	60	414007.8	224732.8	64935	869193
Area Under cultivation	60	122071.1	85080.92	27232	536666
Major crops output	60	317281.9	243267.5	49745	845021
Output of Fruits and vegetables	60	97173.37	143451.3	1186	529921
Road density	60	0.1755667	0.1900828	0.011	0.731
Distance to Target market	60	177.5	141.4187	37	390
Water availability	60	0.65	0.480990	0	1
Multidimensional poverty index	60	44.35	7.697292	28	61

Source: Author's own calculations.[3] Agriculture output, Major crops output, Output of Fruits and vegetables, are being measured in tones. While Area under cultivation is measured in hectares, similarly road density and distance to targeted markets are measured in kilometers.

[3] Note: All the variable are in non-log form. Data ranges from 2008-2017, and total number of observation are 60 (6x10).

The average value of the remaining variables, area under cultivation, output of fruits and vegetables, distance to target market, water availability and Multi-dimensional poverty index are, respectively, 122071, 97173, 0.65 and 44. Following the third column standard deviation of series is mention. The highest standard deviation among series is observed of Major crops output (243267) followed by Agriculture output (224732). The lowest standard deviation is of Road density (0.190) tracked by Multidimensional poverty index (7.69), following the same pattern standard deviation of Area under cultivation (85080), Output of Fruits and vegetable (143457), Distance to target market (141.4) and water availability (0.4809).

4.8 Conclusion

After setting up the econometric model and elaborating the methodology in detail, we can specify that whether the Random Effect Model or Hausman Taylor Model is to be used for estimations.

CHAPTER 5
RESULTS AND DISCUSSIONS

After choosing the appropriate specification of the model and elaborating the methodology in detail in the previous chapter, we now estimate the impact of physical infrastructure on the agriculture production of Balochistan by utilizing the Random Effect technique. As the first section, 4.1 of this chapter deal with aggregated analysis and while section 4.2 cover the disaggregated analysis. Before proceeding towards the analysis, it is important to check correlation among the variables.

Table 5.1 Correlation Matrix

Variables	Agriculture output	Area under cultivation	Major crops output	Fruits and vegetable 0utput	Road density	Distance to targeted market	Water availability	Multidimensional Poverty
Agriculture output	1							
Area under cultivation	0.561	1						
Major crops output	0.714	0.552	1					
Fruits and vegetable 0utput	0.185	-0.053	-0.418	1				
Road density	0.460	0.472	0.642	-0.362	1			
Distance to targeted market	-0.216	-0.392	-0.537	0.569	-0.640	1		
Water availability	0.773	0.608	0.788	-0.290	0.681	-0.670	1	
Multidimensional Poverty	-0.023	0.100	-0.080	0.098	-0.005	-0.255	0.0602	1

Source: Author's own calculations[4]

In table 4.1 the correlation matrix depicts that the highest positive correlation (0.788) occurs between water availability (WA) and major crops production (MCY). Similarly, a positive correlation exists between road density and agriculture output with magnitude of 0.46, while analyzing the correlation matrix, weak correlation is spotted amid Multi-dimensional poverty index (MPI) and Road density (RD) with the value of -0.0058. Hence we can conclude from the

[4] Note: All the variables are in non-log form

above table that there is no issue of multicollinearity among the variables as values are less than 0.80 (Gujarati & Porter, 2003).

5.1 Aggregated Analysis

As we are dealing with panel data, so the first step is to select the model which is the most appropriate for our data. To do this, we have to estimate the fixed effect (FE) and random effect model. However, one of our explanatory variables is time-invariant, in such a case we could not estimate the FE model, so we have to move towards Hausman-Taylor (HT) model to capture the effect of a time-invariant variable like in Xue (2008). Therefore, we estimate both the HT and RE models and employ the Hausman test to select between the two. Following table represents the finding of the Hausman test.[5]

Table 5.2 Hausman Test for the Selection between Fixed Effect and Random Effect

Ho: Difference in coefficient is not systematic	
Chi2 value	5.11
Probability chi2 value	0.2762

Source: Author's own calculations

The null hypothesis of the test suggests that the difference in coefficient is not systematic, which implies that the random effect model is more appropriate as compared to Hausman Taylor model. Since a probability value is greater than 0.1 (0.2762) which illustrates that Random effect model is more reliable in this case.

[5] Results of OLS and HT model are reported in appendix A and B.

5.1.1 Model 1

To establish the links between physical infrastructure and agricultural output, we employ the Random Effect (RE) technique. The results of RE are reported in table 4.2. We have estimated 4 different specifications of the RE for robustness check.[6]

Table 5.3: Effects of Physical Infrastructure on Agriculture Output: Depended Variable Agriculture Output

VARIABLES	(1) RE	(2) RE	(3) RE	(4) RE
Road Density	0.346*** (0.129)	0.316*** (0.0595)	0.304*** (0.073)	0.320*** (0.071)
Water Availability	-	0.212** (0.095)	0.214** (0.090)	0.113* (0.060)
Distance To Target Market	-	-	-0.132* (0.069)	-0.046** (0.021)
Poverty Index	-	-	-	-0.017** (0.0088)
Constant	5.462*** (0.112)	5.338*** (0.098)	5.617*** (0.295)	6.322*** (0.591)
Observations	60	60	60	60
Number of district	06	06	06	06

Robust standard errors in parentheses, ***, ** and * represent 1%, 5% and 10% significance level respectively.
Source: Author's own calculation

Initially, when we regressed log total agricultural output on the road density (proxy for physical infrastructure) we observed that the road density has a positive and significant impact on total output. The coefficient associated with road density predicts that a 1 unit increase in the road density stimulates the total output by almost 34% at 1% level of significance. The possible reason which leads to this positive effect is that increase in the density of roads assure the availability of

[6] We have also estimated other models like Pooled (OLS), Hausman-Taylor (HT) but our core discussion is only based on Random Effect model (RE), justification for selecting this model is discussed in chapter 4.

basic raw material, reduce transportation cost, and minimize the role of middle man in the total agricultural transaction. All these in combine transform the agricultural production from substance level to commercialized one. This finding is also in line with (Salazar and (R. Ahmed & Mustafa, 2014; Salazar & Jones, 2017; Yeboah, 2016). This finding is also supported by the theory and also by the prior empirical studies, nevertheless, such a relationship could potentially be influenced by the inclusion of other important covariates in the underline model. Thus, in order to check the robustness of aforementioned association, in regression 2 of RE, we incorporate the availability of water, which is also considered as one of the most influential factors for agricultural output. Interestingly, with inclusion of water availability, which itself positively and significantly affect the agricultural output in our regression with magnitude of 21%, we also observe that road density has still had a positive and significant impact on log agricultural output, nonetheless, such effect is now nominally lower (31%) in magnitude than the first regression. Likewise the road density, water availability also positively and significantly cause the output level because each kind of agricultural productions require an optimal level of water availability, and without providing that optimal level of water, the desired level of agricultural production cannot be obtained. The result is consistent with the study of (Kang, Khan, & Ma, 2009; Llanto, 2012) who also came up with the same outcomes. In column 3 we added another important variable, Distance to targeted market which leftover negative and significant effect on output level with the coefficient value of 13%, the possible reason behind the inverse relationship among the distance to targeted market and agriculture output is that as the markets exist at higher distance it results in higher transportation cost for the farmers, which de-incentivize the agents to grow on commercial level. The finding is in line with the (Jacoby, 2000). Still, the association, in direction and magnitude, might be conditional to covariates which could potentially cause total agricultural production. Hence, in the final model RE 4, we added, multidimensional poverty index which negativity and significantly effect the agriculture production level, this inverse association is justified by the argument that as the poverty level in a district increases it adversely effects the decision of economic agents which in turn transfer into lower agriculture output . The findings are in line with (Christiaensen, Demery, & Kuhl, 2011). Hence, with the addition of all covariates, we observed the magnitude of road density shrink to almost 32%, water availability approximately to 12%, distance to targeted market to 5% and multi-dimensional poverty to almost 2 %.The overall findings support the view that infrastructure is the main causing factor of agriculture development.

5.1.2 Model 2

As discussed in the literature that agriculture output is not the sole dimension in the agriculture sector, but the area under cultivation has also the core role. Considering this dimension, we analyze the impact of physical infrastructure on area under cultivation. The findings of estimations are reported in Table 4.4. Similar to the aforementioned findings, here in all regression specifications (except first regression RE1) result of physical infrastructure (roads) is insignificant, as we know a single covariate like road density would not be the only variable that effects the area under cultivation. Thus to assess the true magnitude of the road density, the study added other covariates, like water availability. Tough, the water availability has a positive but insignificant effect, yet with its inclusion, road density now has a positive and significant impact on cultivated land. From specification 2 to 4, the coefficients associated with road density exhibit that with each additional unit of physical infrastructure the area under cultivation significantly increases. The possible cause of this relationship could be as the length of paved road increases it curtails the transaction cost through the fast access to raw material, this leads the farmer to increase the farming area. As the study is in line with the (Berg et al., 2018; Kiprono & Matsumoto, 2014; Shamdasani, 2016). Likewise the total agriculture output specification approach.

Table 5.4: Effects of Physical Infrastructure on Area Under Cultivation: Dependent Variable Area Under Cultivation. [7]

VARIABLES	(1) RE	(2) RE	(3) RE	(4) RE
Road Density	0.196	0.205*	0.214**	0.276**
	(0.127)	(0.117)	(0.0872)	(0.131)
Water Availability	-	0.0249	0.0597	0.304***
		(0.067)	(0.0734)	(0.103)
Distance To Target Market	-	-	-0.338***	-0.349***
			(0.129)	(0.045)
Poverty Index	-	-	-	-0.008
				(0.007)
Constant	4.952***	4.934***	5.619***	5.114***
	(0.108)	(0.118)	(0.261)	(0.439)
Observations	60	60	60	60
Number of districts	6	6	6	6

Robust standard errors in parentheses, ***, ** and * represent 1%, 5% and 10% significance level respectively. Definitions of the variables could be found in chapter 3.

Here with the incorporation of same covariates, we found that initially (first specification) road density positively and insignificantly affect the area under cultivation by 19%. in order to check the robustness of underline association in RE 2 we added new covariate as it one of most indispensable factor in context to our model, with the inclusion of water availability, the coefficient of physical infrastructure almost remain at 20%. Nevertheless, with the addition of covariates like water availability, to strengthen our model we add another variable in RE3, distance to targeted

[7] Results of the Model 2 are been estimated by using RE technique.

market as this variable has its own worth in context to physical infrastructure, distance to targeted market itself has negative and significant effect on cultivated land, with inclusion of this new covariate the road density effect become 21%. In final regression RE4, we included multi-dimensional poverty which got inverse and insignificant relation to area under cultivation. The negative relationship is justified with the argument that as poverty level increases of the district that effect the decision of farmers to increase the land for cultivation purpose but the contribution of this particular relationship is not sufficient to manipulate the area under cultivation. Meanwhile with the inclusion of all incorporation in final specification RE4, the effect of road density accelerated to 27%, and the effect of water availability also risen to 30%, finding in line with the study of (Elliott et al., 2014), same with the distance to targeted market with the magnitude of 34%, and multidimensional poverty to less than 1% though the result of this particular variable is insignificant. The inclusive findings declared that physical infrastructure is the main influential factor of agriculture development in specific to Area under cultivation.

5.2 Disaggregated Analysis

After analyzing the aggregated impact of infrastructure on agriculture production and area under cultivation, we move towards disaggregated analysis, in purpose to make more precise scrutiny, intention to making disaggregated analysis is to enhance our understanding in context to different nature of output, besides to make in-depth understanding in view to dynamics of different crops.

5.2.1 Model 3

Primarily when we regressed the log major crops output on road density, we observed that road density has a positive and significant impact on major crops production. The coefficient of road density portends that a unit increase in road density stimulates the output of the major crop by 16% at 10% significance level. The possible relationship is due to giving a feasible and convenient access central market from the resource, as this helps them to make the agriculture transaction in a cost-effective way, as the findings are justified with the study of (Sheng et al., 2018) and (Dorosh, Wang, You, & Schmidt, 2010). Interestingly with the addition of all plausible covariates in different specification, the impact regarding road density, albeit changes in size, however, remain same in direction throughout the specifications of RE as reported in table 4.5.

Table 5.5 Effects of Physical Infrastructure on Major Crops Output: Dependent Variable Major Crops. [8]

VARIABLES	(1) RE	(2) RE	(3) RE	(4) RE
Road Density	0.164*	0.145*	0.137*	0.146**
	(0.085)	(0.081)	(0.079)	(0.071)
Water Availability	-	0.053**	0.057**	0.069*
		(0.024)	(0.026)	(0.037)
Distance To Target Market	-	-	-0.613*	-0.551**
			(0.326)	(0.238)
Poverty Index	-	-	-	-0.012
				(0.0145)
Constant	5.322***	5.294***	6.576***	7.056***
	(0.145)	(0.129)	(0.624)	(0.732)
Observations	60	60	60	60
Number of districts	6	6	6	6

Robust standard errors in parentheses, ***, ** and * represent 1%, 5% and 10% significance level respectively. Definitions of the variables could be found in chapter 3.

From model 1 to 4, nevertheless, this relationship, in direction and magnitude might be provisional to covariates which could potentially cause major crops production, while we added new variable water availability in RE2, which positively and significantly effect to major crops output with the coefficient value of 0.053 at 5% significance level, finding of mention relation is in line with the study of (Hussain, 2012). yet the effect of road density on log major crops remain positive and

[8] Results of the Model 1 are been estimated by using OLS technique.

significant, while in RE3 with the addition of new covariate distance to targeted market which have most influential impact on our model, as the distance to targeted market has negative and significant impact on major crops production. The possible cause of this negative relationship, as major crops being exported to their targeted market in other provinces, the distance between markets are too long and more time consuming because higher cost of transportation. While The results are in line with the study of (Shenggen & Zhang, 2004). Moreover, we added last covariate multi-dimensional poverty which also negativity and insignificantly effects the major crops output. Provocatively with the addition of all covariates in our final of regression road density remains positive and significant but the magnitude contract to 14%, while the size of the coefficient of water availability and distance to target market fallen to 7% and 55%, the effect of multi-dimensional poverty remains less then2% only. The inclusive findings depict that physical infrastructure is one of the important pillars in major crops production.

5.2.2 Model 4

In context to Balochistan agriculture sector, the dimension of fruits and vegetable production has its own significance. Study undertakes this angle of agriculture sector, by analyzing the impact of road density on fruits and vegetable output. The findings of estimations are reported in Table 4.5. Similar to above said findings, when we regressed log fruits and vegetable output on road density, we observed road density is positively and significantly impacts the fruit and vegetable output, as the results of said relationship is align with the study of (Sambo et al., 2016), meanwhile coefficient associated with road density illustrates us that a unit change in the road density probably stimulate the fruit and vegetable production by 54% at 1% significance level. The potential outcome of this positive relationship could be of increment in the road density over the time, nevertheless, such relationship could be inclined by the inclusion of other important covariates in the mentioned model. Thus, in order to check the robustness and sensitivity of aforementioned association, in regression 2 of RE, we included the availability to our model which particularly has positively and significantly effects the dependent variable, but minimized the magnitude of road density to 51%.

Table 5.6 Effects of Physical Infrastructure on Production of Fruits and Vegetable: Dependent Variable Fruits and Vegetable Output.9

VARIABLES	(1) RE	(2) RE	(3) RE	(4) RE
Road Density	0.543***	0.518***	0.520***	0.522***
	(0.198)	(0.177)	(0.176)	(0.166)
Water Availability		0.078**	0.078**	0.054*
		(0.032)	(0.033)	(0.028)
Distance To Target Market			-0.084*	-0.081**
			(0.043)	(0.039)
Poverty Index				-0.005
				(0.005)
Constant	4.451***	4.409***	2.562***	2.782**
	(0.283)	(0.276)	(0.948)	(1.094)
Observations	60	60	60	60
Number of district	6	6	6	6

Robust standard errors in parentheses, ***, ** and * represent 1%, 5% and 10% significance level respectively. Definitions of the variables could be found in chapter 3.

Nevertheless, with the incorporation distance to targeted market in RE3 which left over its negative and significant impact at 10%, level of significance, the possible nous behind this negative relation is due to the development of quality increment of highways and trade routes this link the local production to domestic exports markets. Hence, in the final regression RE 4, we added, multidimensional poverty which negativity and insignificantly effects the agriculture production level. Nevertheless, with inclusion of all covariates in final regression (4) magnitude of road

[9] Results of the Model 1 are been estimated by using OLS technique

density fall down to 52% 43%, at 1% significance, water availability to 5% with 10% level of significance, moreover magnitude of distance to targeted market shrink to 8% and multi-dimensional poverty to less than 1%. As per the final results indicates that road density is also the causing factor in agriculture development in specific to fruits and vegetable production.

CHAPTER 6
SUMMARY AND CONCLUSION

The core purpose of this study was to analyze the impact of physical infrastructure on agriculture production of Balochistan. We have used the data of six districts over the period of 2008 to 2017, and employed the Random Effect (RE) Model. The estimation results of aggregated analysis illustrated that physical infrastructure has positive and significant effect on total agriculture output. Similarly, when we examined infrastructure impact on total cultivated area, the findings also revealed that it positively and significantly cause the area under cultivation. Onwards, for detail investigation, the study carried out the disaggregated analysis by splitting the total agricultural output into major crops, and fruits and vegetables, to know the dynamics of each dimension. Similar to the aggregated analysis, in the disaggregated analysis the estimates also predicted a positive and significant impact of physical infrastructure on total major crops production and fruits and vegetables productions. There are numerous reasons which support the aforementioned findings. First, the density of roads assure the availability of raw materials and remove barriers in the form of asymmetric information. Second, demines the role of middle man in agricultural transaction. Lastly, provide an optimal opportunity to timely export the agricultural output to the most suitable and profitable markets. Despite the favorable impacts of infrastructure, we also have variation in the magnitudes and significance level of the infrastructure across the different models. The possible reasons behind this varying effects are existence of the deteriorated infrastructure level, which never results in optimal outcome (Ulimwengu, 2009). The possible cause behind this deteriorated infrastructure is that, in selected sample, total length of roads (13512) kilometer, out of which (6369) km are unpaved roads[10].

[10] Figures are based on the data obtained from Department of Communication, works, physical planning and housing department (2017), Government of Balochistan.

6.1 Policy Recommendations

As the agriculture sector is playing a key role in the domestic economy of Balochistan. The government should devise proper and prudent policies in order to boost the agriculture sector. The possible way to ensure these policies is to develop the road infrastructure on priority bases for the selected sample, as these districts are the larger contributors in the agriculture sector of Balochistan. Meanwhile half of the road infrastructure of the selected sample is unpaved. Moreover China Pakistan economic corridor can play an important role and provide immense opportunity for developing the road infrastructure, Simultaneously the policies of CPEC should need to adopt in such a way that help farmer by giving a feasible access to big markets by improving the quality and length of roads. As distance among the markets are too long, farmers faces higher cost of production.

Adequate policy measures should be taken to ensure establishment of quality infrastructure in agro based areas, which would encourage better utilization of infrastructure facilities and enhance agricultural Production in a sustainable manner. The concerted efforts should be made to identify the priority infrastructures for different areas especially where the core sources of income is agriculture. Then, there is a need for assessing the amount of investment required from the public sector for providing these priority infrastructures. Given the importance of infrastructure for agricultural development, a suitable policy should be put in place for continuously assessing the strategies for improving and establishing new road infrastructure and for motivating the farmers to use such infrastructures for enhancing their income. Agriculture experts should be included as important stakeholders whose consultation at the stage of need-analysis for the infrastructural projects and at phases of execution of the projects. Moreover, to counter this government should provide incentives to the farmer that could help them to overcome the cost of production, and given them space to access the central markets in a convenient way. All mentioned points should be high in the agenda of policymakers.

6.2 The Way Forward

There are numerous aspects and boulevard on which future research can be conducted, to elaborate this issue. Some possible dimensions are:

a. The study can be extended to all districts of Balochistan, for a better understanding of the issue.
b. The empirical analysis can be future extend by making district-wise analysis, which will help us to understand the impact of said relationship on each district.

6.3 Limitations of the study

The study is limited to only six districts because we are lacking with the availability of data of all the districts.

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Appendix A

Results of Ordinary least square Method

Table A1: Effects of Physical Infrastructure on Agriculture Output: Depended Variable Agriculture Output

COVARIATES	(1) OLS	(2) OLS	(3) OLS	(4) OLS
Road Density	0.487*** (0.115)	0.209** (0.089)	0.070*** (0.012)	0.058*** (0.011)
Water Availability	-	0.444*** (0.042)	0.455*** (0.043)	0.365*** (0.040)
Targeted Market Distance	-	-	-0.127* (0.065)	-0.018** (0.007)
Poverty Index	-	-	-	- 0.0199*** (0.00539)
Constant	5.457*** (0.0400)	5.232*** (0.0402)	5.526*** (0.150)	6.286*** (0.214)
Observations	60	60	60	60
R-squared	0.115	0.713	0.726	0.777

Robust standard errors in parentheses, ***, ** and * represent 1%, 5% and 10% significance level respectively

Table A2: Effects of Physical Infrastructure on Agriculture Output: Depended Variable Area under cultivation.

COVARIATES	(1) OLS	(2) OLS	(3) OLS	(4) OLS
Road Density	0.772*** (0.107)	0.594*** (0.100)	0.177** (0.090)	0.152** (0.061)
Water Availability	-	0.284*** (0.0613)	0.306*** (0.0602)	0.348*** (0.0583)
Targeted Market Distance	-	-	-0.262*** (0.0751)	-0.315** (0.088)
Poverty Index	-	-	-	-0.018*** (0.005)
Constant	4.862*** (0.0416)	4.717*** (0.0552)	5.326*** (0.184)	4.969*** (0.252)
Observations	60	60	60	60
R-squared	0.271	0.502	0.555	0.566

Robust standard errors in parentheses, ***, ** and * represent 1%, 5% and 10% significance level respectively

Table A3: Effects of Physical Infrastructure on major crops output: Depended variable Major crops.

VARIABLES	(1) OLS	(2) OLS	(3) OLS	(4) OLS
Road Density	1.080*** (0.144)	0.935*** (0.169)	0.645*** (0.169)	0.426*** (0.111)
Water Availability		0.231*** (0.0781)	0.137** (0.064)	0.121* (0.0653)
Multidimensional Poverty			-0.0479*** (0.00963)	-0.0356*** (0.0106)
Distance to Targeted Market				-0.424*** (0.146)
Constant	5.170*** (0.0557)	5.053*** (0.0477)	7.484*** (0.459)	7.848*** (0.382)
Observations	60	60	60	60
R-squared	0.308	0.397	0.610	0.668

Robust standard errors in parentheses, ***, ** and * represent 1%, 5% and 10% significance level respectively

Table A4: Effects of Physical Infrastructure on fruits and vegetable output: Depended variable is fruits and vegetable output.

VARIABLES	(1) RE	(2) RE	(3) RE	(4) RE
Road Density	0.543*** (0.198)	0.518*** (0.177)	0.520*** (0.176)	0.522*** (0.166)
Water Availability		0.078** (0.032)	0.078** (0.033)	0.054* (0.028)
Distance To Target Market			-0.882* (0.432)	-0.081* (0.042)
Poverty Index				-0.005 (0.005)
Constant	4.451*** (0.283)	4.409*** (0.276)	2.562*** (0.948)	2.782** (1.094)
Observations	60	60	60	60
Number of district	6	6	6	6

Robust standard errors in parentheses, ***, ** and * represent 1%, 5% and 10% significance level respectively

Appendix B

Table B1: Result of Hausman-Taylor Model

	Model 1	Model 2	Model 3	Model 4
VARIABLES	HT	HT	HT	HT
Road Density	0.313**	0.188**	0.139*	0.527***
	(0.127)	(0.092)	(0.071)	(0.125)
Water availability	0.071**	-0.039**	0.019*	0.060***
	(0.035)	(0.019)	(0.023)	(0.024)
Distance to Targeted Market	-0.0539*	-0.306	-0.547**	0.912*
	(0.028)	(0.239)	(0.255)	(0.547)
Multidimensional Poverty	-0.0171***	-0.007	-0.012**	-0.005
	(0.00473)	(0.007)	(0.005)	(0.004)
Constant	6.345***	5.979***	7.067***	2.780**
	(0.443)	(0.581)	(0.588)	(1.176)
Observations	60	60	60	60
Number of district	6	6	6	6

Robust standard errors in parentheses, ***, ** and * represent 1%, 5% and 10% significance level respectively

Model 1 = Effects of Physical Infrastructure on Agriculture Output.

Model 2 = Effects of Physical Infrastructure on Area Under cultivation.

Model 3 = Effects of Physical Infrastructure on Major Crops Output.

Model 4 = Effects of Physical Infrastructure on fruits and vegetable output.

Appendix C

Table C1: List of Crops included in the sample

RABI CROPS		KHARIF CROPS	
1.	Wheat	14	Rice
2.	Barley	15	Sorghum (Jowar)
3.	Rape Seed/ Mustard	16	Millet (Bajra)
4.	Cumin	17	Maize
5.	Gram	18	Sesamum
6.	Mutter Pulse	19	Castor Seed
7.	Masoor	20	Moong
8.	Vegetables	21	Mash
9.	Fodder	22	Moth
10.	Canola	23	Fruits
11.	Sunflower	24	Onion
12.	Safflower	25	Potato
13.	Wheat	26	Vegetables
		27	Melons
		28	Chilies
		29	Fodder
		30	Coriander
		31	Garlic
		32	Guar Seed
		33	Tobacco
		34	Sugarcane
		35	Cotton
		36	Rice
		37	Sorghum (Jowar)
		38	Millet (Bajra)

Source: Balochistan Agriculture Research Institute, Quetta Balochistan

Table C2: List of districts included in the sample

1.	JAFFARABAD
2.	NASIRABAD
3.	JHAL MAGSI
4.	KILLA SAIFULLAH
5.	KHUZDAR
6.	LASBELA

Table C3: list of Targeted Markets of the Selected Districts

1.	Jaffarabad	Jecobabad(Sindh)
2.	Nasirabad	Jecobabad(Sindh)
3.	Jhal Magsi	ShahdatKot (Sindh)
4.	Killa Saifullah	Dera Ghazi Khan
5.	Khuzdar	Karachi(Sindh)
6.	Lasbela	Karachi(Sindh)