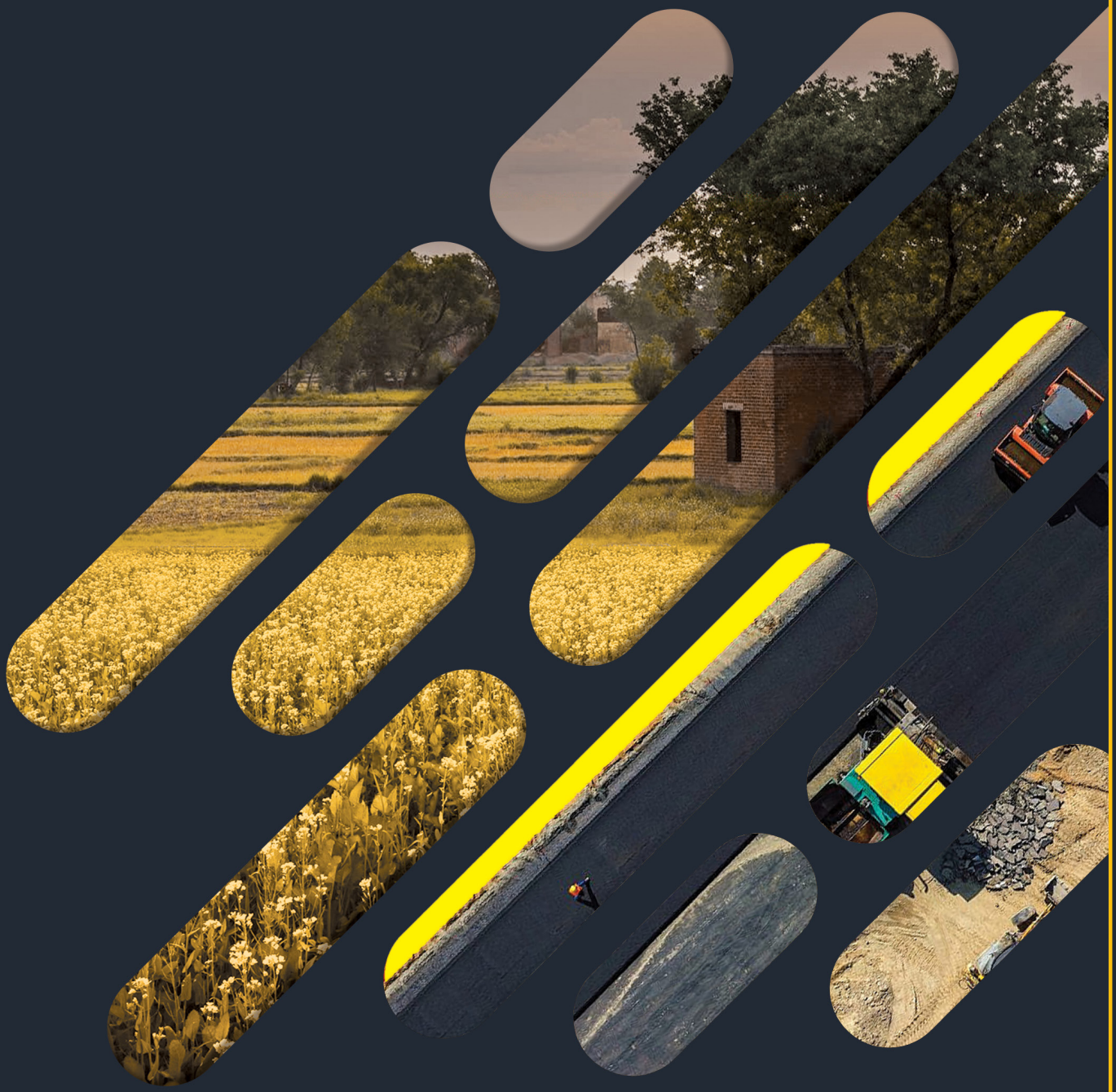
HOW RURAL ROADS AFFECT THE FARMERS?

AN EMPIRICAL ANALYSIS OF FARM-GATE PRICES IN PUNJAB, PAKISTAN



Punjab Economic Research Institute

About Punjab Economic Research Institute

The Punjab Economic Research Institute (PERI) is a statutory body attached with Planning and Development Board, Government of the Punjab, with a mandate to carry out socio-economic research on issues of provincial and national importance and to support planning and development work of Punjab Government. It is the oldest economic research institution in the country. The Institute was reorganized by the Punjab Government in 1977 in order to reactivate the Board of Economic Inquiry which had an unbroken record of economic research going back to 1919. The Institute became a statutory body in November 1980.

Vision

A dynamic and vibrant research institute that provides analytical inputs for the formulation of forward-looking provincial development strategies, and also undertakes high quality, evidence-based research to broadly improve public policy making in the province.

Mission

To be Punjab's leading provider of socio-economic insight on evidence-based research by adopting proactive and new ideas orientation to assist in policy formulation.

Our Strategic Focus

Research: Present neutral, independent and objective analyses and solutions to major policy issues; and undertake research studies.

Think Tank: Contribute to debate on public policy issues and undertake a strong advocacy role on issues of vital significance; and through intense study and interaction, provide strategic analysis and policy prescriptions of the concepts and doctrines in selected areas of public policy.

Knowledge Management and Learning: Collate, generate, store, exchange and share knowledge through publications, knowledge products, best practices etc.; Facilitate knowledge transfer between research institutes and relevant stakeholders; Produce publications, and analytical notes on public policy.

Punjab Economic Research Institute (PERI)
Planning and Development Board
Government of the Punjab
48-Civic Centre, Johar Town, Lahore.
Website: www.peri.punjab.gov.pk
facebook.com/peripndgop
twitter.com/peri_punjab
Tel: +92-42-99233441

Designed by: Mr. Haroon Masroor
Mr. Atif Jamal

How Rural Roads Affect the Farmers? An Empirical Analysis of Farm- Gate Prices in Punjab, Pakistan

Authors

Ahmed Chaudhry
Associate Research Fellow

Umair Mazher
Assistant Research Fellow

Mannan Hassan Khan
Assistant Research Fellow

Dr. Muhammad Avais Tahir
Chief of Research

Publication No. 447

General Editor:
Dr. Shahid Adil
Director,
Punjab Economic Research Institute (PERI)
Planning and Development Board
Government of the Punjab

Punjab Economic Research Institute (PERI)

Review Committee

Dr. Muhammad Irfan Baig (External Member)
Dean, Social Sciences,
Muhammad Nawaz Sharif University of Agriculture, Multan

Dr. Shahzada M. Naeem Nawaz
Research Fellow
Punjab Economic Research Institute, Lahore

Dr. Novaira Junaid
Associate Research Fellow
Punjab Economic Research Institute, Lahore

Dr. Muhammad Irfan Malik
Associate Research Fellow
Punjab Economic Research Institute, Lahore

Published in 2020 by the Punjab Economic Research Institute (PERI),
Planning and Development Board,
Government of the Punjab,
48-Civic Centre, Johar Town, Lahore.

The study was completed in August, 2019.

Preface

An integrated rural road network reflects the state of connectivity of the rural areas to the urban centers. In financial terms, the connectivity has a direct bearing on the transaction cost and indeed, assurance of efficient distribution of commodities. The rural roads in Pakistan cater for the mobility requirements of 132 million people of the country. World-wide, according to the Food and Agriculture Organization's (FAOs) report, 1.2 billion people around the globe, live in poverty and more than 75 percent of them are the dwellers of the rural area. These numbers make the rural populace logical subjects of growth strategy in the quest of converting agriculture from a barely sustainable to a commercial venture.

Punjab occupies the center stage in agriculture as it constitutes about 69 percent of the total area and 57 percent of the total cultivated area in Pakistan. This study attempts to analyze the impact of 5,302 km newly developed rural roads on farm-gate prices using the Ordinary Least Square (OLS) estimation technique. The results reflected a significant impact of rural roads on farm-gate prices that leads to the betterment of the rural community.

This report is the upshot of the effort of authors (Ahmed Chaudhry, Umair Mazher, Mannan Hassan Khan and Dr. Muhammad Avais Tahir). It carries the essence of the effort in a rigorous analysis of the impact of rural roads on the farm-gate prices and has well-argued and researched algorithm for the purposes of decision making and policy analysis. I'm highly indebted to the members of review committee for their untiring efforts in carefully construing the manuscript and remarking constructively. With due deference, I would also take this opportunity to record my gratitude for all luminaries for their valuable and insightful comments, especially Professor Dr. Muhammad Irfan Baig, Dean, Social Sciences, Muhammad Nawaz Sharif University of Agriculture, Multan which proved to be instrumental in improving the quality of the manuscript.

Using the findings of this study, the existing infrastructure in the rural landscape can be factored in developing agriculture as a commercial venture from a barely sustainable activity thus contributing towards the achievement of the Sustainable Development Goals (SDGs).

Dr. Shahid Adil
Director

Acknowledgement

As per the aims of the Punjab Economic Research Institute (PERI), the study was focused on the research issues of provincial and national importance. Considering the policy aims of the agriculture sector, the study aligns with the laid down objectives and can benefit the policy makers to achieve the desired goals simultaneously.

First and foremost, praise be to Almighty ALLAH on whom we rely for the sustenance of our life. It is because of His kindness that we were able to decode this socio-economic issue.

We thank Planning and Development Board for their cooperation and guidance. Moreover, thanks are conveyed to Director PERI for his kind guidance and leadership during the completion of this report.

For their tireless efforts, we extend our gratitude to the research team for collecting all the data from various parts of Punjab, which helped us to conduct this study. Last but not the least, special gratitude is being conveyed to Dr. Shahzada M. Naeem Nawaz, Research Fellow for his guidance in tackling certain aspects of the research report.

Table of Contents

Table No.	List of Tables	Pg.

Symbols, Notations and Abbreviations

Notation	Description
CRS	Crop Reporting Service
ECP	Election Commission of Pakistan
FAO	Food and Agriculture Organization of the United Nations
FY	Financial Year
GDP	Gross Domestic Product
MIPC	Multiparty Index of Political Competition
MPI	Multidimensional Poverty Index
OLS	Ordinary Least Squares
PERI	Punjab Economic Research Institute
PKR	Pakistani Rupees
PRRP	Punjab Rural Roads Program

EXECUTIVE SUMMARY

In an agrarian country like Pakistan, it is hard to overemphasize the significance of agriculture sector which absorbs around 38% of the labor force while contributing 18.5% to the Gross Domestic Product (GDP) of the country. A well connected rural road network is an important determinant of rural economic well-being. Roads enable the connectivity of rural areas to urban centers and markets by reducing the transaction costs and ensure the efficient distribution of commodities. Specifically, rural roads are a crucial part of this sector as they serve to ameliorate the mobility of 132 million people. Having many lives attached to the agriculture sector, rural development schemes bring an uplift in incomes and social status of the farmers.

Literature shows government expenditure on rural roads along with increasing agricultural productivity, decreasing rural poverty and uplifting farm and non-farm economic activity, also leads to an increase in farm-gate prices. Farm-gate prices are a good indicator of farmers' well-being as they contribute valiantly towards improving their financial conditions, thus enabling them to function efficiently for a sector which is considered the heart of the Pakistan's economy. On the policy side location of the construction of rural roads, i.e., between rural farms, villages, markets and urban centers, is also vital. If purpose behind the development of a rural road network is to benefit the farmers, as is the case in this report, new rural roads should be built or rehabilitated at places where their utility can be maximized: (a) areas where agriculture produce is high, (b) where roads do not exist previously, and (c) where rehabilitation of existing roads quality would reap significant improvement in market access and transportation. However, in developing countries, such public projects are prone to political maneuvering which compromises their proposed impact. Hence, the purpose of this report is two-fold. In the first part, we analyzed the impact of the newly built and rehabilitated rural roads on the farm-gate prices of wheat and cotton at district level in the province of Punjab, Pakistan. Since these roads are built under an exclusive road development program initiated by the provincial government, we also explored the relationship between cost allocated for rural roads and agricultural output for each district in Punjab in the second part of this study.

In this report, we studied the impact of the rural roads on the farm-gate prices of wheat and cotton at district-level in Punjab, Pakistan. For the first part, we performed regression analysis on 18 out of 36 districts of Punjab because the survey data for farm-gate prices was available only for these districts in the Farm Accounts Report 2016-17. For the second part, we explored the relation between district level agricultural output, multidimensional poverty and cost allocations for rural road program to find the efficiency of the governmental policymaking process in Punjab.

Punjab, the most populous province, constitutes about 69% of the total croped area and 57% of the total cultivated area in Pakistan. Employing OLS regression to perform the estimations and using the data of first three phases (5302 km) of newly built rural roads network in Punjab (2015-16) and farm-gate prices, our results indicated a positive and significant impact of rural roads on farm-gate prices. We estimated that wheat farmers in Punjab would receive an annual monetary benefit of PKR 3640 million from the roads built in the first three phases and PKR 5559 million from the roads built during all the five phases of the rural road program. Moreover, on policy side, the cost allocations to build these rural roads in each district of Punjab were found to have a positive relationship with agricultural output and multidimensional poverty in that district, indicating efficient distribution of resources.

INTRODUCTION

1. Introduction

A well connected rural road network is an important determinant of rural economic well-being. Roads enable the connectivity of rural areas to urban centers and markets by reducing the transaction costs and ensure the efficient distribution of commodities.

Most of the agriculture, in developing countries, takes place in rural areas making farmers, arguably, the most important rural market agents. It is observed that farmers typically belong to lower and lower-middle strata of the society and most farming households survive on subsistence farming. According to Food and Agriculture Organization of the United Nations (FAO), about 1.2 billion people around the globe live in poverty and more than 75% of them, belonging to rural population, are mainly dependent on agriculture production[1]. Therefore, in this report, our primary focus are the farmers.

Although it has been established in numerous studies that in developing countries, government expenditure on infrastructure, such as rural roads, leads to increased agricultural productivity, decreased rural poverty and an overall uplift in farm and non-farm economic activity (Binswinger et al., 1989; Fan et al., 2000; Joshi et al., 2004; Barrios, 2008; Lanto, 2012), however, in certain cases there are exceptions too because they concluded a weak impact of rural infrastructure on the agricultural productivity (Asher & Novosad, 2018).

Following this line, other researchers have shown that rural roads tend to reduce transportation and transaction costs, thus, increasing farm-gate prices (Ellis & Hine, 1998; Hine & Ellis, 2001; Arethun & Bhatta 2012; Ebata et al., 2015). However, others point towards the negative relationship between improvement in roads and farm-gate prices (Casabura et al., 2013). Thus, there is a mixed evidence in this regard.

Pakistan is a developing country in which about 42% of the total labor force is associated with farming and agriculture, while this sector contributes approximately 20% to the GDP[2]. We believe, it is imperative to analyze this impact of rural roads on the farm-gate prices for Pakistan because, firstly, farm-gate prices represent the prices which farmers directly receive for their produce; hence, they are a good indicator of a farmer's income and socio-economic status. Secondly, as reviewed in Section 3.2, most of the research on rural roads and farm-gate prices have been performed for African countries, and some for India. The socio-economic and geographic conditions of Pakistan vary considerably as that of the African Continent and to the best of our knowledge, impact of rural roads on the farm-gate prices is still unexplored for Pakistan. Finally, the newly developed rural road network in Punjab, the largest province of Pakistan, provides the requisite setting to carry out this study.

On policy side, the location of construction of rural roads, i.e., between rural farms, villages, markets and urban centers, is also vital. If the purpose behind development of a rural road network is to benefit the farmers, as is the case in this report, new rural roads should be built or rehabilitated at places where their utility can be maximized: (a) areas where agriculture produce is high, (b) where roads do not exist previously, and (c) where rehabilitation of existing roads quality would reap significant improvement in market access and transportation. However, in developing countries, such public projects are prone to political maneuvering (Nordhaus, 1975; Alesina & Stella, 2011) which compromises their envisaged impact.

Therefore, our purpose in this objective research is two folds. In the first part, we analyze the impact of the newly built and rehabilitated rural roads on the farm-gate prices of wheat and cotton at district level in the province of Punjab, Pakistan. Since these roads are built under an exclusive road development program initiated by the provincial government, we also observe relationship between funds allocated for rural roads and agricultural output for each district in Punjab[3] in the second part of this report.

---

[1]Source: http://www.un.org/en/ecosoc/integration/pdf/foodandagricultureorganization.pdf (accessed on May 24, 2018).
[2] Source: Pakistan Economic Survey 2016-17.
[3] See Section 2.1.1. for a brief summary of the program.

We believe that the province of Punjab in Pakistan is well suited to observe the causal impact of rural road on farm-gate prices. There are several reasons for this. First, the Government of Punjab in 2015 launched a rural road development program under which 8104 km of roads have been built and rehabilitated in five phases (2015-2018) in 36 districts of Punjab. Second, Punjab being the most populous province, constitutes about 69% of total cropped area and 57% of total cultivated area of Pakistan[4]. Its share in agriculture is estimated at over 62% in comparison to other three provinces. It also contributes about 70% of the total production of wheat, rice, sugarcane, cotton and maize, the five major crops of Pakistan.

For the first part, we perform regression analysis on 18 out of 36 districts of Punjab because the survey data for farm-gate prices was available only for these districts in the Farm Accounts Survey 2016-17. This sample of 18 districts is representative of the whole Punjab, so our results are generalizable. For the first three phases of rural roads – comprising of 5302 km – built during 2015-16, our results indicate that there is a positive and significant relationship between rural roads and farm-gate prices of wheat at district level in Punjab. The total rupee value of annual benefit to wheat farmers, received from the development of first three phases of rural roads program is estimated to be PKR 3.640 billion; and, if linearly imputed, all the five phases give a benefit of PKR 5.559 billion.

The farm-gate prices of other major crops, namely cotton, rice, maize and sugarcane also depict a positive correlation with the newly built rural roads in Punjab at the district level.

For the second part, our analysis shows a positive relationship between district level agricultural output, multidimensional poverty and cost allocations for rural road program indicating efficient governmental policymaking process in Punjab, at least in case of this rural road program.

This report is arranged as follows; to contextualize our work, we provide a summary of rural roads and the situation of agriculture in Punjab in section 2. The literature review has been discussed in third section of this report. Data sources, variables and econometric specifications are described under methodology in section 4. Results are presented in section 5, and finally conclusions are in section 6 along with key policy recommendations.

[4] Source: Punjab Development Statistics 2016.

RURAL ROAD NETWORK AND AGRICULTURE IN PUNJAB:

SUMMARY AND CONTEXT

2. Rural Road Network and Agriculture in Punjab: Summary and Contextual Analysis

Punjab is the most populous province of Pakistan consisting of about 54% of its total population. Its share in Pakistan's GDP is estimated to be around 57%. With the aim to provide a context to the research, this chapter briefly analysis the state of rural road network and agriculture in Punjab.

2.1. Rural Road Network in Punjab

As of 2015, the total length of roads in Punjab is recorded to be about 108 thousand km (41%) out of a total of 263.9 thousand km for Pakistan. It is estimated that about 39 thousand km (36%) of the roads in Punjab are farm-to-market roads (Punjab Development Statistics, 2018).

2.1.1. Punjab Rural Roads Program (PRRP)

The Government of Punjab, in 2015, launched a road infrastructural development program in the rural areas of Punjab. Along with uplifting the overall rural economic well-being, the primary purpose of this program is the provision of market access to the farming communities living in rural areas.

The rural roads program is completed, under five phases, in a time span of about four years, i.e., 2015-2018. Under this program, a total of 886 roads, consisting of 8104 km of road-length, have been rehabilitated and constructed with an expenditure of PKR 61.8 billion over 36 districts of the Punjab. Table 2.2 shows the summary of the five construction phases of the rural road program.

Table 2.1 Punjab Rural Road Program Summary

Phase	Timeline	No. of Roads	Road Length (km)	Expenditure (Million PKR)
1	2015-16	251	2082.16	**12867.77**
2	2015-16	154	1570.13	**13206.3**
3	2016-17	166	1650.06	**13676.93**
4	2016-18	154	1435.39	**12157.75**
5	2017-18	161	1365.8	**9904.59**
Grand Total		**886**	**8104***	**61813***

Source: Communications and Works Department, Govt. of the Punjab (taken from the Urban Unit, Lahore) http://irispunjab.gov.pk/IrisKprrp.aspx (accessed on May 24, 2018)

*Figures are rounded off to the nearest digit.

2.2. Agriculture in Punjab

According to estimates by Pasha (2015), in FY 2012-13 Punjab has the largest share in agriculture in the national economy, i.e., 62.3%; whereas that of Sindh, Khyber Pakhtunkhwa and Balochistan is 23.1%, 10.5% and 4.1%, respectively.

Different variety of crops cultivated in Punjab are placed in two different categories depending on their months of cultivation: Kharif crop season runs from April to September while that of Rabi crops ranges from October to March. These two types of crops are cultivated by 5249800 farms[5], which constitutes about 69% (16,678 thousand hectares) and 57% (12,667 thousand hectares) of the total crop area and total cultivated area in Punjab, respectively. Of the total, wheat covers the largest cropped area, followed by cotton, rice, gram and sugarcane, respectively. Table 2.3 shows the major crops by cropped area in Punjab.

[5] Source: Census of Agriculture 2010 (Taken from Punjab Development Statistics 2016).

Table 2.2 Cropped Area by Crop in Punjab (2014-15)				
No.	**Crop**	**Crop Type**	**Cropped Area (Thousand Hectares)**	**% of Total**
1	Wheat	Rabi	6980	42.1
2	Cotton	Kharif	2322	14.0
3	Rice	Kharif	1878	11.3
4	Fodder	Kharif/Rabi	1763	10.6
5	Gram	Rabi	864	5.2
6	Sugarcane	Kharif	711	4.3
7	Maize	Kharif	673	4.1
8	Pearl Millet (Bajra)	Kharif	411	2.5
9	Rape and Mustard	Rabi	146	0.9
10	New Quinoa (Jowar)	Kharif	160	1.0
11	Potato	Kharif/Rabi	134	0.8
12	Others	Kharif/Rabi	543	3.3
	Grand Total		16585*	100

Source: Bureau of Statistics, Punjab, Lahore (table copied from Punjab Development Statistics, 2016).

* Includes Islamabad but excludes Orchards

RELEVANT LITERATURE

3. Relevant Literature

This chapter reviews the theoretical and empirical work on the correlation between rural roads development, agriculture productivity and farm-gate prices.

3.1. Road Infrastructural Development and Agricultural Productivity

Various studies show that infrastructural development is an important component of a country's economic growth (World Bank, 2005; Seethpalli et al., 2008; Straub & Terada- Hagiwara, 2010). Likewise, the development of rural roads also has a positive impact of the rural economic well-being. It is argued that a highly connected rural road network facilitates the access of farmers to markets by connecting agricultural areas to urban centers, which in turn are connected to international trading markets. Better connectivity between rural, urban and international markets reduces the input, transaction and transportation costs, and thereby incentivizes the farmers to increase their agricultural output and productivity. As a result, a reduction in food prices, a higher income for farm and non-farm labor, and an overall decrease in poverty is observed in connected rural areas (Jacoby, 2000; Joshi et al, 2004; Barrios, 2008; Llanto, 2012). Furthermore, Fan et al. (2000) prove that in addition to education and an irrigation system, rural roads significantly contribute both to the reduction in poverty, and growth in agricultural productivity in India. They estimate that PKR 100 billion (at 1993 constant prices) investment in roads would reduce the incidence of poverty by 0.65%. Moreover, they also estimate that about 124 and 41 poor people would be lifted out of poverty for an addition INR 1 million investments in rural roads and education, respectively.

It is observed that the remoteness of an area – as measured by physical distance and travel time determined through transport system quality – affects its food security status. Minten and Barrett (2008) report that for Madagascar, "Moving from the least to the most remote quintile is associated with an increase in the number of food insecurity by 10% and in the length of the lean period by 0.7 months". They also emphasize on the importance of transport infrastructure, literacy rates and access to extension services in rural areas in bringing about poverty reduction and productivity growth.

Similarly, it has been estimated that transaction costs increase with distance to a permanent market; and depending on the distance and transportation type, fixed transaction cost range from 19% to 58% of the market price. In addition, it is postulated that the welfare of semi-subsistence Kenyan households can be improved by investment in public infrastructure since the magnitude of transaction costs they face is equivalent to ad valorem tax of 28% (Renkow et al., 2001). Thus, on average, the farmers having access to bigger markets produce high crop output (Fungo et al., 2017).

For the sub-continent, Murgai et al. (2001) compared the Indian and Pakistani Punjab to study the impact of rural infrastructure on agricultural productivity. They analysed that crop yield was higher in Indian Punjab, its agricultural productivity was higher only by a small margin. They further explain that in Pakistani Punjab, about one-third of the reduced productivity growth is explained by inadequate and ill-utilized education and infrastructural investment. Their findings suggest, policies are needed for the promotion of public investment in roads, education and research to enhance agricultural productivity in Pakistani Punjab.

For Pakistan, Ahmed and Javed (2017) demonstrate that rural road infrastructure has a positive and significant effect on rural poverty. However, unpaved roads have a greater impact as compared to paved roads.

Similarly, other studies show that development of road infrastructure lead to a diversification in the crop sector (Joshi et al. 2004). It also provides access to better credit facilities, reduce the cost of borrowing and incentivize the farmers to take risks (Binswinger et al., 1989; Llanto. 2012).

A few studies also present evidence against the impact of rural roads on agriculture. For example, Asher and Novosad (2018) assess the impact of India's national rural road construction program in rural India. They argue that the causal impact of rural roads is "difficult to assess, mainly due

to the endogenity of road placement". They do not find any significant effect of rural roads on farm activities instead their results confirm a boost an increase only in non-farm work such as employment provision.

Having discussed the mixed literature on infrastructural development and agriculture activity, we now establish the link between road development and farm-gate prices in the next section.

3.2. Road Infrastructural Development and Farm-Gate Prices

The impact of rural road infrastructure on farm-gate prices, to the best of our knowledge, is a relatively underexplored subject. However, a number of studies, as cited below, indicate mixed findings.

Rural road construction offers and impact on the prices of agricultural output via two channels: demand side and supply side. On demand side, it reduces the transaction costs for the traders to reach farmers; and on supply side, it has same effect, i.e., facilitating farmer to reach the markets (Casaburi et al., 2013).

Arethun and Bhatta (2012) show that due to poor transportation services, farmers sell their produce at a lower price while paying higher for the commodities they buy. Therefore, improving the transportation facilities would reduce the transaction, transportation and input costs for the farmers, consequently reducing both the 'price band' between buying and selling prices and raising the farm-gate prices of agricultural products.

It is empirically postulated for Africa – if competitive transport and food marketing prevails the farm-gate prices would increase by 6% and if 20% decrease in transportation cost is passed completely to the farmers provided the initial transportation cost is equivalent to 30% of the farm-gate price (Hine & Ellis, 2001). Similarly, (for Ghana) it is estimated that farm-gate prices increase by about 0.1% and 11% as an outcome of upgrading 5 km of 'earth roads to gravel standard' and by providing motorized transportation 5 km nearer to a village, respectively (Ellis & Hine, 1998).

Furthermore, Ebata et al. (2017) presenting their hedonic price model, identify that a decrease in travel time and distance by one unit raises the farm-gate prices of staple beans in Nicaragua by 2 to 2.5 cents/qq. They assess, an average farm's annual revenues would increase between $27.69 to &125.96 given a 25% drop in travelling time. They further suggest that their 'distance effects' estimates apply to other produces and crops.

In their study on Nicaragua, Michelson et al. (2012) inform that as a result of moving away towards more remote agricultural areas, gap between the farm-gate price received from 'traditional wholesalers' and that which are officially documented whole salers in the capital city of Managua, increases. They argue, this may be because of the monopsony power of farm-gate wholesalers in rural output market which may arise due to poor transportation infrastructure. In their words, "high opportunity costs of farmer time, or coordination failures among farmers leave resource-poor small farmers to accept the low price offered by traders at the farmgate". In the same line, Graubner et al. (2011) also report, remoteness of the farmland imparts monopsony power to the traders – who are usually the middlemen. They, in turn, offer lower farm-gate prices to the farmers.

On the other hand, Casabura et al. (2013) empirically demonstrate that although an improvement in the quality of rural roads has a negative association with transportation costs, it, however, also causes the price of rice and cassava move downwards in Sierra Leone. This is because the 'demand effect' dominates: more traders approach the farmers as compared to farmers reaching the traders and markets.

To summarize the above discussion, most of the studies show that rural roads have a positive impact on farm-gate prices, however a few studies also point towards a negative relationship between the two. Therefore, the relationship between rural road development and farm-gate prices has been inconclusive. As such there is need to provide fresh evidence in view of the recent rural road program.

METHODOLOGY

4. Methodology

This chapter describes the data sources and variables used in this study. Furthermore, we also provide the econometric specification to assess the impact of rural roads on farm-gate prices and to see if the budget for the construction of rural roads has been disbursed in Punjab's districts based on their agricultural produce.

4.1. Data and Variables

For the purpose of evaluating the impact of Punjab Rural Road Program (PRRP) on farm-gate prices in Punjab, we use data from Farm Accounts Survey conducted by Punjab Economic Research Institute (PERI), Lahore[6]. The data on rural roads was taken from the Urban Unit, Lahore[7]. To estimate the monetary benefit of the said program, we took data of crop production from the Directorate of Agriculture, Crop Reporting Service, Punjab (CRS)[8]. Summary statistics of the data is given below in Table 4.1.

Data for rural roads is available for all 36 districts of Punjab while Farm Accounts Survey covers only 18 districts so the data for these 18 districts on rural roads was merged with Farm Accounts' data for analysis.

4.1.1. Farm Accounts Survey Data

This is a primary survey data on farm accounts and family budgets of rural families in Punjab for 2016-17. The survey is conducted by the Punjab Economic Research Institute (PERI). Farm Accounts Survey covers 766 farm households and provides information on different key indicators including income and expenditures of farm and non-farm households, input usage, output levels and the cost of production of major crops in Punjab. The data covers 18 out of 36 districts so that they are representative for the whole Punjab. Three variables; farm-gate prices, market rate of crop and crop yield in our regression model are constructed from this dataset.

4.1.2. Punjab Rural Roads Data

The data on cost, budget allocation, construction and road-length of rural roads – built under PRPP – was taken from the open source of the Urban Unit. The data for only first three phases was in our regression as Farm Accounts Survey was conducted in 2016-17 and till 2016 only three phases of rural roads program were completed.

On the other hand, the data for already existing farm-to-market roads, as of 30th June 2015 was available in the Punjab Development Statistics 2016.

4.1.3. Crop Production Data

Once the impact of rural roads on farm-gate prices is established, we then use data on crop production from CRS in order to estimate the monetary benefit of rural roads to wheat-growers in Punjab. The data was taken from open source of CRS and units were converted from thousand tonnes to kilograms.

4.1.4. Multidimensional Poverty Index (MPI) and Multiparty Index of Political Competition (MIPC)

Both Multidimensional Poverty Index (MPI) and Multiparty Index of Political Competition (MIPC) have been added as additional controls in regression equation. These controls act as determinants of budget allocation for the construction of rural roads at the district level in Punjab.

[6] Source: https://peri.punjab.gov.pk/system/files/Farm%20Account.pdf#overlay-context=reports
[7] Data can be accessed from http://irispunjab.gov.pk/IrisKprrp.aspx
[8] The production estimate reports of Kharif and Rabi crops are available at http://www.crs.agripunjab.gov.pk/reports

MPI ranges from 0 to 1 with higher values representing more multidimensional poverty. The open source MPI data at district level in Pakistan is made available by the UNDP Pakistan. The data for the year 2014-15 is used since that was the time of initiation of the rural road development program, so the budget allocation decision is also made during that year.

The MIPC is constructed using the election data for 2013. This data is taken from Gallup Pakistan, made available by the Election Commission of Pakistan (ECP). We control for political competition because as the theory suggests, higher level of political competition leads to pro- growth economic policies since incumbents face a threat of removal from the office and a prospect of getting re-elected (Skilling & Zeckhauser, 2002; Besley et al. 2010; Alfano and Baraldi, 2016); it proxies for the political economy. Chaudhry and Mazhar (2018) empirically demonstrate that this theory stands true for Pakistan as well. Therefore, political competition is a determinant of budget allocation decision for the construction of rural roads.

Table 4.1 Summary Statistics

Variable	Observations	Mean	Std. Dev	Min	Max
Farm-gate Price	723	1165.14	33.31	1050	1300
Yield (40 kg)	723	36.58	10.37	22	42
Market Price	553	1178.44	175.47	4100	5000
Rural Roads	723	168.53	65.18	81.7	344.48
Already Existing Roads	723	1310.61	463.21	478.87	2081.53
Agricultural Output Prices	36	$3.12x10^{10}$	$1.54x10^{10}$	$3.57x10^{9}$	$7.58x10^{10}$
Multidimensional Poverty Index (MPI)	36	0.164	0.0926	0.0170	0.357
Multiparty Index of Political Competition(MIPC)	**36**	**0.562**	**0.0972**	**0.397**	0.765

4.2. Econometric Specification

In the first part of our analysis, we estimate our model using Ordinary Least Squares (OLS) regression. This is because our dependent variable is a continuous variable and we want to see if rural roads offer any causal impact on farm-gate prices. Post-estimation, we test and adjust for heteroscedasticity and report the final results. The regression equation is as follows:
Where, μ is the error term.

$$FarmgatePrices = \beta_0 + \beta_1 RuralRoads + \beta_2 MarketRate + \beta_3 CropYield + \beta_4 FarmtoMarketRoads + \mu \quad (1)$$

The rural road program is aimed to provide better transportation facilities to the farmers and also helping them to take their produce to markets efficiently. If that is the case, then more spending on rural roads should be observed in districts where there is more agricultural activity. Thus, to test this hypothesis in the second part of our analysis, we run a model presented in equation 2, by which we explore the main criteria for budget allocations under this program.

$$AllocatedCost_s = \delta_0 + \delta_1 AgriculturalOutput_s + \delta_2 MIPC_{13s} + \delta_3 MPI_{14s} + \mu \quad (2)$$

where Allocated Cost is the total budget/cost allocated (in million rupees) on rural roads construction in each district under the rural road development program, Agricultural Output is total agricultural contribution (n million rupees) of major crops in each district, MIPC13s gives the value of political competition in each district for the general elections of 2013, MPI14s

represents the value of Multidimensional Poverty Index for each district for the year 2014-15, s indicates the district while μ is the error term.

It is to be noted, with reference to equation 1, that the first three phases of the rural roads program were completed in 2015-16 while the data on farm-gate prices was taken from Farm Account Surveys conducted in 2016-17. With reference to equation 2, it is important to note that the data for total agricultural outputs was for the year 2014-15, which was before the total budget/costs allocation decisions for the construction of rural roads were made in each district. Hence, the problem of reverse causality is addressed in both of these models.

The results of first equation will address whether the rural roads have any significant impact on farm-gate prices or not and the results of second equation will tell us about the major determinant on which the budget allocation decision have been made. These results are discussed in next chapter.

FINDINGS AND RESULTS

We present the results for equation 1 in Table 5.1. Findings show that one additional kilometer of newly built rural road in a district of Punjab brings an increase of 0.0373 rupee in farm-gate price of every 40 kg of wheat produce in the district. The coefficient of 0.289 on market rate shows that for every one-rupee increase in market rate, only 28.9% is transferred to farmers. Yield, taken as proxy for quality of crop, has a positive impact on farm-gate prices. Already existing network of roads seems to be ineffective in providing benefits to farmers.

Table 5.1 OLS Estimates of the Impact of Rural Roads on Farmgate Prices of Wheat

Variable (Units)	Coefficient
Dependent Variable: Farm-gate Prices of Wheat (in rupees)	
Constant	805.2*** (26.84)
Rural Roads (km)	0.0373** (0.0167)
Market Rate (Rs.)	0.289*** (0.0226)
Crop Yield (per 40kg)	0.225* (0.121)
Existing Farm-to-Market Roads (km)	0.00321 (0.00271)
Observations	551
R-squared	**0.248**
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1	

We ran same regression model for cotton crop and found similar results; rural roads have positive impact on farm-gate prices of cotton crop. Yield, market rate and already existing farm- to-market roads also depict a positive impact. Due to data limitations, we were unable to repeat OLS estimates for other major crops, however, the coefficient of correlation between farm-gate prices and rural roads was recorded at 0.52, 0.77, and 0.92 for rice, maize and sugarcane, respectively. The cotton regression table A1, correlation table A2 its graphs are reported in Appendix A.

The results for wheat are used in calculations of monetary benefit to farmers as those results are more robust and the degree of freedom is much higher in the first regression.

To explore if the agricultural output is a major determinant of cost allocation for the development of rural roads, as hypothesized in section 4.2, the OLS estimates for equation 2 are given in Table 5.2. The results in Table 5.2 need to be interpreted with caution since the estimates are based on 35 observations, which represent the 35 districts of Punjab, which may not fulfill the criteria of a large sample.

Table 5.2 OLS Estimates for the Determinants of Cost Allocations under the Rural Roads Program

Variable (Units)	Coefficient
	Dependent Variable: Cost Allocation (in million rupees)
Constant	**1,115** **(909.3)**
Agricultural Output	**0.0297**** **(0.00957)**
MIPC13	**1,783** **(1,631)**
MPI14	**-4,016**** **(1,788)**
Observations	**35**
R-squared	**0.270**
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1	

As hypothesized, cost allocations under the rural road development program are explained by the agricultural contribution of each district in Punjab; it is significant at 1% level of significance. Similarly, we observe a higher spending in districts which are more multi-dimensionally poor as depicted by the MPI14 variable. However, variable for political competition (MIPC13) is insignificant indicating that political competition did not play a role in cost allocation decision made by the authorities and policymakers.

To summarize our results, we find a positive and significant impact of rural roads on the farm-gate prices at district level in Punjab. Furthermore, the public expenditure on Punjab Road Program (PRRP) was based on the agricultural activity and socio-economic conditions in each district and not on political factors, at least in our model.

5.1. Monetary Benefit to Punjab's Farmers at District Level

We now calculate the rupee value of the benefit per year wheat farmers of each district in Punjab would have been gained from the development of rural roads. The estimations of the monetary benefits to the farmers are performed for all 36 districts as data for crop production and rural roads is available for all the districts. The monetary benefit is calculated by using the following formula:

$$Monetary\ Benefit\ (in\ rupees) = \beta_1 * Roads(km) * Wheat\ Production\ (40kg) \quad (3)$$

where β_1 is the coefficient on rural roads in wheat regression (eq. 1), Roads are the newly built rural roads under PRRP in each district, and Wheat Production total production of wheat in each the district measured in tonnes (40kg).

5.1.1. For Phases I-III

In table 5.3, we present estimated annual monetary benefits of the first three phases of rural roads program at district level to the wheat farmers in Punjab.

Table 5.3 Monetary Benefit to Wheat Farmers (Annual) w.r.t. Agro-Climatic Zones: Phase I-III

Rice-Wheat Zone			
District Wheat Output (40 kg)	**Rural Roads (km)**		**Benefit to Farmers (Rs. million)**
Sialkot	13,406,500	158.68	**72.44**
Gujranwala	16,729,750	205.61	**117.13**
Gujrat	7,049,000	171.6	**41.19**
Lahore	4,528,000	49.33	**7.61**
Shiekhpura	16,852,000	117.22	**67.26**
Nankana Sahib	10,560,500	93.4	**33.59**
Kasur	13,161,000	186.39	**83.53**
Narowal	8,914,000	135.92	**41.26**
Mandi Bahauddin	11,866,500	110.52	**44.66**
Hafizabad	13,857,750	81.7	**38.55**
(A) Total	**116,925,000**	**1,310**	**547**

Mixed Punjab Zone					
Sargodha	14,311,000		268.56		**130.87**
Jhang	22,935,000		150.01		**117.15**
Chiniot	8,023,750		77.42		**21.15**
Khushab	4,812,750		89.43		**14.66**
Faisalabad	23,678,250		344.48		**277.75**
Okara	17,690,000		188.67		**113.65**
T.T. Singh	14,563,500		149.05		**73.91**
(B) Total	**106,014,250**		**1,268**	**749**	
Cotton-Wheat Zone					
Bahawalnagar	30,460,750		215.25		**223.26**
Bahawalpur	24,,612,250		201.17		**168.60**
Sahiwal	12,612,750		178.81		**76.80**
R.Y. Khan	23,843,250		186.5		**151.42**
Multan	15,388,500		137.5		**72.05**
Vehari	21,320,750		213.8		**155.22**
Khanewal	18,838,500		150.7		**96.67**
Lodhran	19,917,000		147.45		**100.00**
Pakpattan	12,772,000		122.3		**53.19**
(C) Total	**155,153,500**		**1,553**	**1,097**	
Low Intensity Zone					
D.G. Khan	14,772,250		122.81		**61.78**
Rajanpur	14,875,750		70.15		**35.53**
Muzaffargarh	22,941,250		178.71		**139.60**
Layyah	17,569,250		102.25		**61.17**
Mianwali	11,404,250		92.5		**35.92**
Bakkar	12,984,750		96.27		**42.57**
(D) Total	**94,547,500**	**663**		**377**	
Barani Punjab Zone					
Attock	205,030,000		118.81		**829.48**
Jhelum	2,405,250		83.03		**6.80**
Rawalpindi	2,989,500		170.14		**17.32**
Chakwal	3,582,250		136.21		**16.61**
Total	214,007,000	508		870	
Grand Total (A+B+C+D+E)	**711,259,500**		**5302.35**		**3640.34**

Source: Authors' calculations

5.1.2. For Phases I-V

To calculate the monetary benefit of all the five phases of the rural roads program to the wheat farmers of Punjab at district level, we linearly interpolate our results for the first three phases to the remaining two phases. Thus, we give the estimates for all the five phases in Table 5.4.

Table 5.4 Monetary Benefit to Wheat Farmers (Annual) w.r.t. Agro-Climatic Zones: Phase I-V			
District	**Wheat Output (40 kg)**	**Rural Roads (km)**	**Benefit to Farmers (Rs. million)**
Rice-Wheat Zone			
Sialkot	13,406,500	238.97	**109.09**
Gujranwala	16,729,750	317.9	**181.10**
Gujrat	7,049,000	266.5	**63.97**
Lahore	4,528,000	77.38	**11.93**
Shiekhpura	16,852,000	190.57	**109.36**
Nankana Sahib	10,560,500	145.2	**52.21**
Kasur	13,161,000	273.87	**122.73**
Narowal	8,914,000	188.56	**57.23**
Mandi Bahauddin	11,866,500	183.26	**74.05**
Hafizabad	13,857,750	122.3	**57.71**
(A) Total	**116,925,000**	**2,005**	**839**
Mixed Punjab Zone			
Sargodha	14,311,000	424.01	**206.62**
Jhang	22,935,000	237.81	**185.72**
Chiniot	8,023,750	116.66	**31.87**
Khushab	4,812,750	140.93	**23.10**
Faisalabad	23,678,250	518.82	**418.31**
Okara	17,690,000	291.57	**175.63**
T.T. Singh	14,563,500	225.99	**112.07**
(B) Total	**106,014,250**	**1,956**	**1,153**
Cotton-Wheat Zone			
Bahawalnagar	30,460,750	330.8	**343.12**
Bahawalpur	24,612,250	290.73	**243.65**
Sahiwal	12,612,750	267.85	**115.04**
R.Y. Khan	23,843,250	289.65	**235.16**
Multan	**15,388,500**	**209.3**	**109.67**

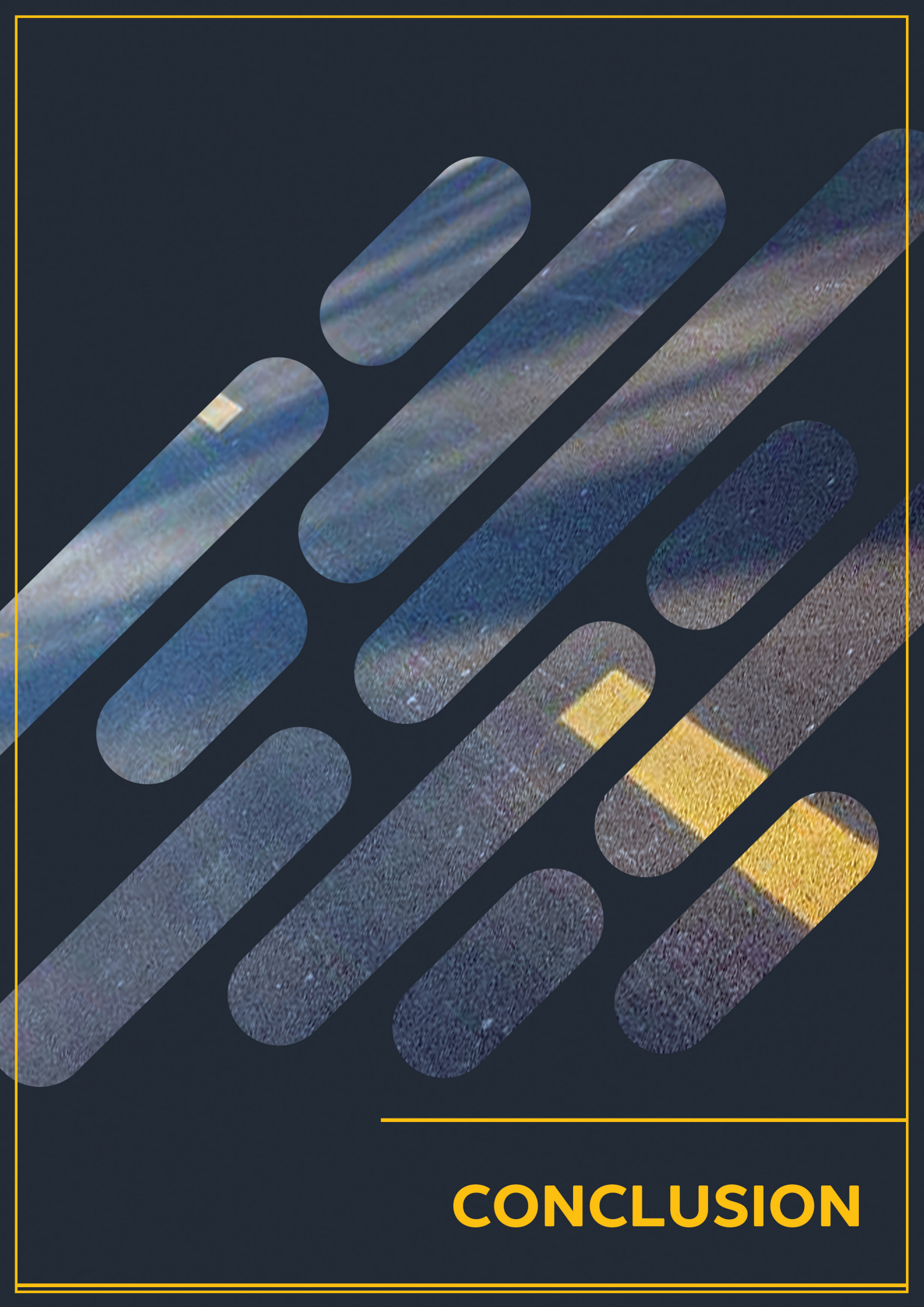
For phases I-III, consisting of 5302 km of rural roads, the total estimated monetary benefit in terms of annual rupee value to Punjab's wheat farmers is PKR 3640 million. Similarly, for phases I-V, the total monetary benefit per year to wheat farmers is estimated to be PKR 5559 million for a total road network of 8104 km constructed in Punjab.

Vehari	**21,320,750**	**314.46**		**228.30**
Khanewal	18,838,500	242.62		**155.63**
Lodhran	19,917,000	212.09		**143.84**
Pakpattan	12,772,000	190.35		**82.78**
(C) Total	**179,765,750**	**2,348**	**1,657**	

Low Intensity Zone				
D.G. Khan	14,772,250	172.81		**86.93**
Rajanpur	14,875,750	109.1		**55.26**
Muzaffargarh	22,941,250	265.48		**207.39**
Layyah	17,569,250	160.7		**96.14**
Mianwali	11,404,250	144.37		**56.06**
Bakkar	12,984,750	147.94		**65.41**
(D) Total	**94,547,500**	**1,000**	**567**	

Barani Punjab Zone					
Attock	205,030,000		183.06		**1278.04**
Jhelum	2,405,250		133.13		**10.90**
Rawalpindi	2,989,500		274.39		**27.93**
Chakwal	3,582,250		204.41		**24.93**
(E) Total	214,007,000	795		1,342	
Grand Total (A+B+C+D+E)	711,259,500		8103.54		**5558.91**

Source: Author's calculations



CONCLUSION

6. Conclusion and Policy Recommendations

In a developing country like Pakistan, where about 42% of the total labor force belongs to agriculture and farming sector, farmers' well-being is imperative. To improve the socio-economic conditions of the farmers and to facilitate them to raise their incomes, one of the options for the government is the development of rural infrastructure. Evidence shows that public expenditure for the development of rural infrastructure, such as rural roads, leads to increase in farm income and agricultural output. Similarly, building a rural road network also has a direct impact on increasing farm-gate prices by reducing the transaction and transportation costs of farmers and by providing them with an access to the urban centers and agricultural markets. Farm-gate price is the price farmers receive for their farm produce and it excludes any marketing cost, travel cost and agent's fee cost etc.

First, we have analyzed the impact of rural roads on farm-gate prices at district level in Punjab, Pakistan. We believe, the province of Punjab provides us the requisite setting to carry out our analysis because it has the largest share of agriculture in the national economy and produces the highest agricultural output. In addition, the Government of Punjab recently launched a rural road development program in 2015 in which 8104 km of rural roads have been constructed in five phases till 2018. Due to availability of farm-gate prices data only for the year 2016-17, we employ the data for the first three phases of rural roads (5302 km), constructed during 2015-16, in our baseline regression, so that we may observe the impact of rural roads on the farm-gate prices in the subsequent year.

Secondly, on the policy side, we investigated into the determinants of cost allocation for the development of rural roads in each district of Punjab. Since the purpose behind this program was to connect farms to the markets, we observed the impact of agricultural activity – measured as the price of total agricultural output for normalization – cost allocation at district level in Punjab. As additional determinants for this analysis, we also use multidimensional poverty and political competition. The Multidimensional Poverty Index gives the socio-economic status of the district while the Index of Political Competition determines if the elected representatives, facing a threat of removal from the office and a prospect of re-election are making pro-welfare policy decisions.

Our OLS results show that an additional one kilometer of rural road built under Punjab Rural Road Program increases the farm-gate prices of wheat by PKR 0.0373. When aggregated, we estimate the total rupee value of the increase in farm-gate prices, for the first three phases of the rural roads (5302 km) program to be PKR 3640 million for the wheat farmers in Punjab. With linear interpolation of our results, we further estimated this monetary benefit to be PKR 5559 million for all the five phases of the rural (8104 km) roads program.

The OLS estimates for cotton crop were positive but insignificant. Due to limited availability of farm-gate prices data for other major crops in Farm Accounts Survey 2017, we were unable to perform regression analysis. However, a positive strong correlation was observed between rural roads and farm-gate prices of rice, maize and sugarcane, with correlation coefficients recorded at 0.52, 0.77, and 0.92, respectively.

For the second part of our analysis, the results depicted a positive and significant relationship between cost allocation for the rural roads, agricultural activity and multidimensional poverty at district level in Punjab. While political competition was found to be insignificant indicating that, at least in our model, political factors did not play their role in determining the cost allocation for the rural roads program.

Focusing on the rural dynamics of Punjab, we estimated the impact of rural roads on the farm-gate prices for the crops of cotton and wheat. As a result of this study, we propose the following policy recommendations:

- Since we used Punjab as a requisite setting for conducting this analysis, the horizons of projects targeted towards development of rural infrastructure can be broadened to include other provinces as well. In this way, the study can benefit not only the

provincial, but also the federal government to improve the existing rural dynamics.

- With 80% of world's poor residing in rural areas, we recommend better infrastructure services for the rural community as our results indicate a strong and positive impact of it on the farm-gate prices in Punjab. The existing situation of rural infrastructure and transportation isn't enough to facilitate an ever growing population of Punjab.

- Not only that, a decrease in existing transaction costs is needed as it would aid the rural community in getting channelized with markets in a better way. Hence, appropriate returns to growers and efficient price to customers can be managed while improving the agriculture dynamics of the country.

- As highlighted in results, the outcome of such rural development programs can be maximized by initiating them in areas which higher agricultural activity.

- In addition to this, the improvement in rural infrastructure can uplift the lives of rural communities by increasing their incomes. Resultantly, we can mitigate poverty in such regions. With Pakistan being a signatory to the Sustainable Development Goals (SDGs), this can aid the country in achieving the goal 1 of the SDGs which calls for an end to poverty in all its manifestations by 2030.

- As highlighted in the study, we also recommend the use of Multidimensional Poverty Index (MPI) to be used in the criteria of budgetary allocation for different districts of Punjab as well as Pakistan. This dynamic index encapsulation at various levels of deprivation will enable us in targeting the districts which needs immediate assistance.

References

Ahmed, S. S., & Javed, A. (2017). The Effect of Public Sector Development Expenditures and Investment on Economic Growth: Evidence from Pakistan. *Journal of Economics and Political Economy,* 4(2), 203-214.

Alesina, A., & Stella, A. (2010). The politics of monetary policy. In Handbook of monetary economics (Vol. 3, pp. 1001-1054). Elsevier.

Alfano, M. R., & Baraldi, A. L. (2016). Democracy, Political Competition and Economic Growth. *Journal of International Development,* 28(8), 1199-1219.

Arethun, T., & Bhatta, B. P. (2012). Contribution of rural roads to access to-and participation in markets: Theory and results from northern Ethiopia. *Journal of Transportation Technologies*, 2(2), 165-175.

Asher, S., & Novosad, P. (2018). Rural Roads and Local Economic Development. Policy Research Working Paper; No. 8466. World Bank, Washington, DC. *World Bank*. https://openknowledge.worldbank.org/handle/10986/29895 License: CC BY 3.0 IGO.

Barrios, E. B. (2008). Infrastructure and rural development: Household perceptions on rural development. *Progress in planning,* 70(1), 1-44.

Besley, T., Persson, T., & Sturm, D. M. (2010). Political competition, policy and growth: theory and evidence from the US. *The Review of Economic Studies*, 77(4), 1329-1352.

Binswanger, H. (1989). The policy response of agriculture. *The World Bank Economic Review,* 3(suppl_1), 231-258.

Casaburi, L., Glennerster, R., & Suri, T. (2013). Rural Roads and Intermediated Trade: Regression Discontinuity Evidence from Sierra Leone. Available at SSRN: https://ssrn.com/abstract=2161643 or http://dx.doi.org/10.2139/ssrn.2161643.

Chaudhry, A., & Mazhar, U. (2018). Political competition and economic performance: empirical evidence from Pakistan. Economics Discussion Papers, No 2018-27. *Kiel Institute for the World Economy*. http://www. economics-ejournal. org/economics/discussionpapers/2018-27 Page, 2(1).

Council, S. (2014). Contribution to the 2014 United Nations Economic and Social Council (ECOSOC) Integration Segment.

Ebata, A., Velasco Pacheco, P. A., & von Cramon-Taubadel, S. (2017). The influence of proximity to market on bean producer prices in Nicaragua. *Agricultural Economics*, 48(4), 459-467.

Ellis, S., & Hine, J. L. (1998). The provision of rural transport services. Sub-Saharan Africa Transport Policy Program Working Paper, 37.

Hine, J. L., & Ellis, S. D. (2001). Agricultural marketing and access to transport services. Wokingham, United Kingdom: Transport Research Laboratory.

Fan, Shenggen, Peter Hazell, and S. K. Thorat. (2000) "Impact of public expenditure on poverty in rural India." *Economic and Political Weekly*: 3581-3588.

Fungo, E., Krygsman, S., & Nel, H. (2017, July). The role of road infrastructure in agricultural production. Southern African Transport Conference.

Gallup, Pakistan. Gallup Pakistan Electoral Database "1970-2013".

Government of the Punjab. (2015). Kharif Crop Estimates Data Book 2014-15. Crop Reporting Service. Directorate of Agriculture. http://crs.agripunjab.gov.pk/system/files/Kharif%20Crop%20Estimate%20Book%20Data%202014-15.pdf.

Government of the Punjab. (2015). Rabi Crop Estimates Data Book 2014-15. Crop Reporting Service. Directorate of Agriculture. http://crs.agripunjab.gov.pk/syste.m/files/

FINAL%20RABI%20CROPS%20%20ESTIM ATES%202014-15.pdf.

Government of the Punjab. (2016). Punjab Development Statistics 2016. Bureau of Statistics. Planning and Development Department, Punjab. https://bos.punjab.gov.pk/system/files/Dev-2016.pdf.

Graubner, M., Balmann, A., & Sexton, R. J. (2011). Spatial price discrimination in agricultural product procurement markets: a computational economics approach. *American Journal of Agricultural Economics,* 93(4), 949-967.

Hine, J. L., & Ellis, S. D. (2001). Agricultural marketing and access to transport services. Wokingham, United Kingdom: Transport Research Laboratory.

Jacoby, H. G. (2000). Access to markets and the benefits of rural roads. *The Economic Journal,* 110(465), 713-737.

Joshi, P. K., Gulati, A., Birthal, P. S., & Tewari, L. (2004). Agriculture diversification in South Asia: patterns, determinants and policy implications. *Economic and political weekly,* 2457-2467.

Llanto, G. M. (2012). The impact of infrastructure on agricultural productivity (No. 2012-12). PIDS Discussion Paper Series.

Michelson, H., Reardon, T., & Perez, F. (2012). Small farmers and big retail: trade-offs of supplying supermarkets in Nicaragua. *World Development,* 40(2), 342-354.

Minten, B., & Barrett, C. B. (2008). Agricultural technology, productivity, and poverty in Madagascar. *World Development,* 36(5), 797-822.

Murgai, R., Ali, M., & Byerlee, D. (2001). Productivity growth and sustainability in post–Green Revolution agriculture: the case of the Indian and Pakistan Punjabs. *The World Bank Research Observer,* 16(2), 199-218.

Nordhaus, W. D. (1975). The political business cycle. *The review of economic studies,* 42(2), 169-190.

Pakistan. (2017). Pakistan Economic Survey 2016-17. Islamabad: Economic Advisor's Wing, Ministry of Finance.

Renkow, M., Hallstrom, D. G., & Karanja, D. (2001). Rural Infrastructure, Transactions Costs and Marketed Surplus in Kenya. American Agricultural Economics Association.

Seethepalli, K., Bramati, M. C., & Veredas, D. (2008). How relevant is infrastructure to growth in East Asia?. *The World Bank.*

Skilling, D., & Zeckhauser, R. J. (2002). Political competition and debt trajectories in Japan and the OECD. *Japan and the World Economy,* 14(2), 121-135.

Straub, S., & Terada-Hagiwara, A. (2010). Infrastructure and Growth in Developing Asia (No. 231). ADB Economics Working Paper Series. *Asian Development Bank.*

Tahir, A., Azeem, S. M., & Danish, M. H. (2018). Farm Accounts Family Budgets of Rural Families and Cost of Prdouction of Major Crops in Punjab 2016-17. Punjab Economic Research Institute, Planning and Development Department, Government of the Punjab. https://peri.punjab.gov.pk/system/files/Farm%20Account.pdf#overlay-context=reports.

UNDP (2016). Multidimensional Poverty in Pakistan. http://www.pk.undp.org/content/dam/pakistan/docs/MPI/Multidimensional%20Poverty% 20in%20Pakistan.pdf.

World Bank. (2005). Philippines: Meeting Infrastructure Challenges. Washington, DC: *The World Bank.*

Appendix A: Other Tables
Results for Cotton Crop

Table A1 OLS Estimates of the Impact of Rural Roads on Farm-Gate Prices of Cotton	
Variable (Units)	**Coefficient**
Dependent Variable: Farm-gate Prices of Cotton (in rupees.)	
Constant	**399.1** (154.2)**
Rural Roads (km)	**0.0245 (0.117)**
Market Rate (Rs.)	**0.814 *** (0.0445)**
Crop Yield (per 40kg)	**3.082 *** (0.913)**
Existing Farm-to-Market Roads (km)	**0.0360** (0.0140)**
Observations	**126**
R-squared	**0.896**
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1	

Table for Coefficient of Correlations Between Rural Roads and Farm-Gate Prices of Major Crops

Table A2 Correlation Coefficients Between Rural Roads and Farm-Gate Prices of Rice, Maize and Sugarcane

District	PRRP Rural Roads (km)	Rice (Rs./40kg)	Maize (Rs./40kg)	Sugarcane (Rs/40kg)
Faisalabad	344.48	1453.57	1100	**214.17**
Okara	188.67	1005.41	960.93	**130**
Vehari	213.8	1272.5	843.46	**165**
Khanewal	150.7	1350	825	**-**
Bahawalnagar	215.25	1400	-	**152.5**
D.G.Khan	122.81	1250	-	**110**
Muzaffargarh	178.71	907.5	-	**161.25**
R.Y. Khan	**186.5**	**1250**	**-**	**120**
Sargodha	**268.56**	**-**	**825**	**180**
Rawalpindi	170.14	-	970	**-**
Gujranwala	205.61	1111.41	-	**-**
Hafizabad	81.7	974.14	-	**-**
Nankana	93.4	1103.70	-	**-**
Narowal	135.92	1146	-	**-**
Sheikhupura	117.22	1226.25	-	**-**
Correlation Coefficient		0.52	0.77	**0.92**

Source: Authors' calculations

Figure A1
Rice: Rural Roads (km) and Farm-Gate Prices (Rs./40kg)

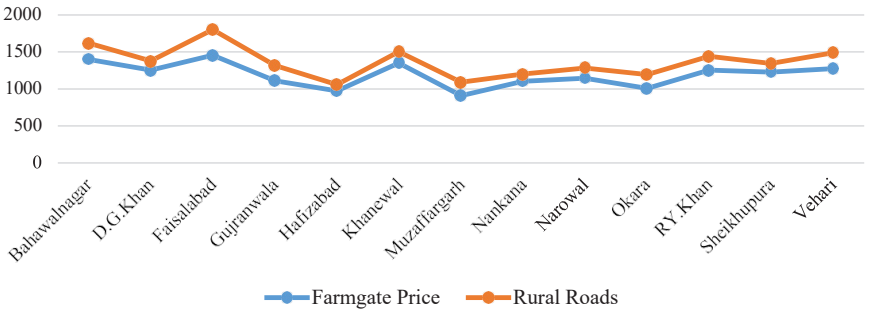


Figure A2
Maize: Rural Roads (km) and Farm-Gate Prices (Rs./40kg)

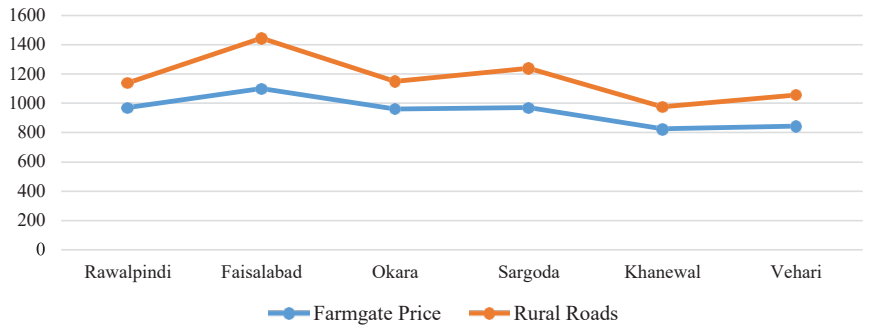
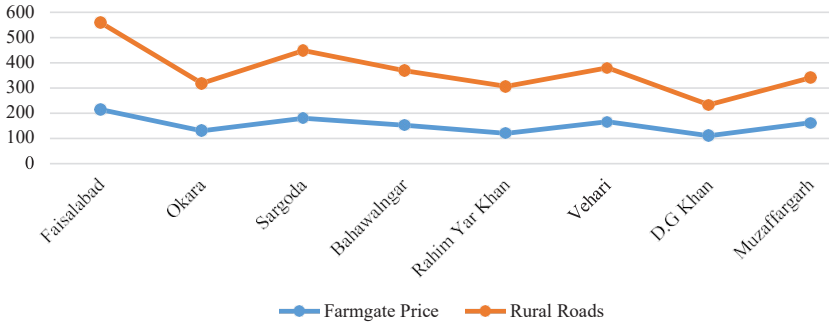


Figure A3
Sugarcane: Rural Roads (km) and Farm-Gate Prices (Rs./40kg)



Cost Allocation and Agricultural Output of Major Crops in Districts of Punjab

Table A3 Cost Allocation and Agricultural Contribution in Districts of Punjab w.r.t. Agro-Climatic Zones

District	Cost Allocated on Rural Roads (Million Rs.)	Total Agricultural Contribution (Rs.)
	Rice-Wheat Zone	
Sialkot	3100.8	21133.11
Gujranwala	3573.61	37646.80
Gujrat	2933.26	27089.92
Lahore	1120.79	19811.88
Sheikhupura	2431.74	39943.79
Nankana Sahib	1840.9	25345.74
Kasur	2824.15	35257.96
Narowal	2130.26	26799.31
Mandi Bahauddin	1891.1	27126.39
Hafizabad	1255.14	28616.32
(A) Total	23101.75	288771.22
	Mixed Punjab Zone	
Sargodha	3951.67	39130.70
Jhang	2248.58	3570.02
Chiniot	1044.56	26538.99
Khushab	1259.57	17491.62
Faisalabad	5427.6	62886.32
Okara	2940.25	34829.59
Toba Tek Singh	2249.75	38320.20
(B) Total	19121.98	222767.44
	Cotton-Wheat Zone	
Bahawalnagar	3016.4	53508.98
Bahawalpur	2835.09	39927.33
Sahiwal	2431.49	33828.59
R.Y.Khan	3099.68	75752.49
Multan	2086.29	22985.78
Vehari	2972.88	44822.96
Khanewal	2334.89	31852.74
Lodhran	2095.2	27959.89
Pakpattan	1790.97	34858.81
(C) Total	22662.89	365497.57
	Low Intensity Zone	
D.G.Khan	2009.46	21636.13
Rajanpur	1223.33	27801.13
Muzaffargarh	2658.37	44600.79
Layyah	1504.1	30086.81
Mianwali	1534.66	16740.68
Bhakkar	1297.37	36429.36
(D) Total	10227.29	177294.9

Barani Punjab Zone		
Attock	1999.53	**7486.45**
Jhelum	1468.13	**51960.71**
Rawalpindi	3846.92	**5341.33**
Chakwal	2187.15	**5338.66**
(E) Total	9501.73	**70127.15**
Grand Total (A+B+C+D+E)	**84615.64**	**1124458.25**

Source: The Urban Unit (Cost on Rural Roads) & Crop Rotation Surveys (Total Agriculture Contribution)

Appendix B: Variable Description

Farm-gate Prices

Value of cultivated product in agriculture minus the selling cost. Selling cost includes the transport cost, marketing costs, agents' fee costs etc. In simpler words, farm-gate price is the price which the producer gets for farm produce. Farm Accounts survey asks question on farm-gate price and we use it for our analysis.

Market Rate

The price of farm produce at marketplace is the market rate of crop. Market price is sum of farm- gate price, transportation cost from farm to market and other factors that might affect the market prices such as the presence of monopolistic competition. This variable is also taken from the Farm Accounts dataset. The variable is included in the model to control for any inflation or overall increase or decrease in district prices. Inclusion of this variable also sheds light on the relative share of increase in market price between farmers and non-farmer agents.

Yield (per 40 kg)

In agriculture, crop yield (also known as "agricultural output") refers to measure of the yield of a crop per unit area of land cultivation. In our analysis, we have taken yield of wheat per acre of land. The unit of measurement for yield of crop is: per 40 kg. The data is taken from Farm Accounts dataset. This variable is included to control for the agricultural productivity and quality of the product in order to isolate the impact of rural roads on farm-gate prices.

Rural Roads

This is our primary variable of interest. It contains information on rural roads built under Khadim-e-Punjab Rural Road Program. The unit of measurement is kilometer. The information is taken from The Urban Unit's online data source for Khadim-e-Punjab Rural Road Program The coefficient on this variable is the impact of one additional kilometer of rural road on average farm-gate price in PKR.

Already Existing Roads

This variable contains information on farm-to-market roads in kilometers which were already available in each districts of Punjab before the PRRP. It is included in order to isolate the impact of newly constructed roads under PRRP.

Agricultural Output

Data on agriculture produce is taken from CRS data source on major crops at district level. The unit of measurement for different crops is made as kilogram to make it uniform throughout. The major crops included in our calculations are: Basmati Rice, Maize, Gram, Sugarcane, Wheat, Cotton and Rice.

Multidimensional Poverty Index (MPI)

The Multidimensional Poverty Index, also known as adjusted headcount ratio, is an international measure of acute poverty. The MPI is calculated on the basis of various indicators related to education, health and standard of living. The education indicators are 'year of schooling', 'child school attendance', and 'quality of schooling'. Indicators related to health are 'Access to health facilities/clinics/Basic Health Units (BHU)', 'Immunization', 'Ante-natal care', and 'Assisted delivery'. Finally, indicators used for standard of living are 'Water', 'Sanitation', 'Overcrowding', 'Electricity', 'Cooking Fuel', 'Assets', and 'Land and Livestock'. MPI ranges from 0 to 1 with higher values representing more poverty.

Multiparty Index of Political Competition (MIPC)

MIPC is a measure of political competition. The construction of MIPC is given by:

$$\text{MIPC} = 1 - \sum_{i=0}^{n_i} (\text{Seats}_{is}/\text{Total Seats}_s) * (\text{Party}_{is})$$

MIPC ranges from 0 to 1 with higher values more political competition. Seats represents the Seats won by a political party i in district s, TotalSeats is the total number of seats on which the elections are contested in district s, Party gives the vote share of political party i in district s, and n is the total number of parties contesting in the district.

Punjab Economic Research Institute (PERI)
48-Civic Centre, Johar Town Lahore, Pakistan.

Tel: +92-42-99233441
Email: director@peri.punjab.gov.pk
Web: www.peri.punjab.gov.pk
f: https://www.facebook.com/peripndgop/