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SOCIO-ECONOMIC IMPACT OF CPEC ON AGRICULTURAL PRODUCTIVITY OF PAKISTAN: A PRINCIPAL COMPONENT ANALYSIS

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Abstract

Corridors perform a substantial role to boost up agribusiness comprehensively for developing a linear agglomeration of people and pursuits pre-existing transport structure. This research explored the social and economic impact of China Pakistan Economic Corridor on agriculture productiveness. The analysis has been executed among the distinct districts of agricultural economic zones. The paper signifies accessibility and usage of infrastructure, to analyze nexus. Regardless of available facts & figures, the data restricted the variables that might be deemed the research support of higher investment in infrastructures, energy and dams whilst at the similar time stressing the need to take steps to maximize the utilization of existing resources. Indices for the development of Infrastructure have been designed by applying Principal Component Analysis. Random effects model is implemented to analyze how diverse categories of infrastructure affect agricultural productivity. CPEC projects have potential to cover the current energy crises in Pakistan and open up business horizons for the small scale farmers to raise productivity and exports.

Keywords: *Agribusiness, agriculture economic zones, agriculture productivity, CPEC project, Principal Component Analysis*
Jel Codes: *Q1, Q13, Q17, Q18, R11*

1. Introduction

Economic globalization impulse the world high-income economies to set core policies for construction of corridors to scale up cross-borders trade. Mostly developing nations get benefitted to use agro corridors to expand their agricultural sectors. Such corridors boost agribusiness comprehensively to build on a linear agglomeration of people and pursuits pre-existing transport structure. (Healey, 2004). Economic corridor and transportation system is a paramount approach for the growth of poorer areas of country by concentrating on investment in the important areas like roadways, trade, agriculture and energy development

(Ramachandran & Linde, 2011). CPEC is an ideal model of intergovernmental coordination and regional integration which in turn is the product of Sino-Pak all weather friendship that can seem to be in common maxim "higher than Himalaya, sweeter than honey and deeper than Ocean". The most trustworthy, reliable and all weather friends that referred to as iron brother (Sial, 2014 & Tharoor, 2015). China-Pak determine to develop such economic corridor that is aspiration and tactical choice for both Beijing and Islamabad for peaceful development (Mengsheng, 2015). China Pakistan Economic Corridor (CPEC) was formally inaugurated by Chinese President Xi Jinping in Islamabad in the course of his visit on Monday 20 April 2015 (Ali et al., 2017). Formation of CPEC will be accomplished in three levels until 2030 with the projected cost of $46 billion, a total of $11.8 billion in infrastructure projects, $33.8 billion in energy projects such as solar, coal, wind, hydro and wind energy which will add more 10400 Megawatt of energy in the power system of Pakistan (Mughal, 2016). Furthermore, Power Projects, Dams, establishment of economic zones and up gradation of Gawdar International Airport and Sea port are the part of this project for sustenance development. (Haider, 2015 & Mengsheng, 2015).The advancement of infrastructure linkages raise the business size amongst the regions of Central Asia, West Asia, South Asia and Western China.

Agricultural industry which is contributing nearly 18.9% in the GDP of Pakistan could get benefit directly as well indirectly from CPEC through development of backward and forward nexus (Economic Survey of Pakistan, 2017). CPEC will make business prospects and strengthen the existing agro trade among bordering countries directly or indirectly which boost the living standards of Pakistani consumers and producers. This Project will develop the reciproco trade to a number of billion in the forthcoming years (Hussain et al., 2015). CPEC would carry through a fundamental role in uplifting of agriculture industry of Pakistan. CPEC will pass through diverse ecological zones of Pakistan hence it will bring a constructive change in agriculture production which would raise the supply of agriculture merchandise in the regions (Ahmed & Mustafa, 2016).

The purpose of this research is to check out the social & economic impact on agriculture around the districts. The present research investigates the linkages between CPEC framework and agricultural efficiency throughout the varied ecological zones of Pakistan. Apart from infrastructures, other inputs and factors which are the drivers of farming productivity have also been evaluated in the paper. Keeping in view the significance of Sustainable improvement goals and Human improvement Index, this research had designed two welfare indices (UNDP, 2014) for districts of Pakistan, one for current sociable predicament and second one to examine the impact of CPEC project on wellness by applying the Standard Deviation Method which based upon the concept of Simplest Forecasting Model (Nau, 2014).

The paper has been arranged into six parts. After a short intro the paper aims at critiquing the existing literary works in connection with infrastructure and agricultural productivity in global and Pakistani contexts. The third part is about collection of data resources and methodology. The fourth part highlights the selection of developmental indicators in the research. The fifth section followed by the results and discussion and the last portion of the paper presents the conclusions of the analysis.

2. Review of Literature

In this portion some materials relevant to CPEC projects and its socio-economic effects for Pakistan is reviewed. Limited scientific work has been observed in the context of agricultural productiveness and public investment.

Hussain and Ali (2015) argued that CPEC raised sociable interaction among persons. It is important for Pakistan as well as China because it improved the economic activities in Pakistan. Master Plan of CPEC was determined by 2015 in four major parts of cooperation, i.e. Transportation, Energy, Infrastructure and Commercial synergy. Hussain and Ali (2015) explained that China Pakistan Economic Corridor not only a route rather it carry huge degree of interaction through highway, railway, energy and special economic zones etc. Tong (2015) predicted that jobs creation took place mainly from the localized areas rather from China or from any other certain state of the country. It is also reviewed that since several projects through CPEC, the employment generation also took place in a significant level.

2.1 Linking Energy and Agricultural Output

Rural electrification heightens the irrigated land, expands irrigation amenities and consequently the production of crops harvested through subterranean irrigation method is usually greater than those beneath canal or reservoir irrigation (Shah et al. (2006). Fan et al. (1999 and 2000) analyzed the association between irrigation and roadways facilities and production advancement and found solid association between these two parameters. In accordance with Fan et al. (2002) government spending development strengthening investments, such as farming study and growth, irrigation, distant education, infrastructure (including highways, energy and telecoms) all added to agricultural productiveness expansion and minimize territorial inequality and non-urban poverty in China. Fan et al. (2004) studied that most of the public investments (agricultural exploration and growth, irrigation, distant education, and infrastructure including highways and electricity) has positive effects on agricultural output development and rural poverty declination.

2.2 Impact of Infrastructure on Agriculture

Many scientific studies readily available which determined the advancement of infrastructure and provided innovation in agriculture. Investment in transportation structure and communication effected in promo of global trade as investment minimizes transport expenses Bouët et al. (2008). There are several limitations which usually change the agriculture production. Moïsé et al. (2013) applied a Gravity Model Approach to find this restriction in agriculture field. They further more deduce that transportation and trade relevant infrastructure are very important for exports of agricultural merchandise. Gilbert and Nilanjan (2012) examine that for South Asian economies, the effective transportation structure would improve GDP. The maximum level of increase would be 14.8% as a proportion of current GDP in Nepal, followed by 4.6% in Sri Lanka and 4.10% in Bangladesh. In overall terms, India would acquire the major part by $4.3 billion, followed by Pakistan at $ 2.6 billion. Utilizing farm level information Segun et al. (2008) empirically evaluated the place of infrastructure in agricultural output in Nigeria and found that rural infrastructure index had the optimum positive effect on farming efficiency. In a local level research, Li and Liu (2009) evaluated the effect of infrastructure growth in agricultural output technical productivity and founded that apart from telecoms, all the other infrastructure factors had a good effect on agricultural development.

2.3 Use of Model in Infrastructure Development

Llanto (2012) used a random results GLS Regression Model and discovered that accessibility to electricity and cemented highways had a constructive significant effect on agricultural labor efficiency while irrigation had a positive but trivial relationship with farming workforce productiveness. The usage of fixed outcomes version with intro of agro environment and time connections, Binswanger et al. (1999) observed that other than irrigation, all infrastructure parameters affected whole crop productivity positively. Fan et al. (1999) applied a Simultaneous Equations Model and revealed that government investing on yields maximizing investments and farm infrastructure, directly effect in lowering rural poverty, and indirectly farming efficiency growth.

The aforesaid and other studies support the enhancement of infrastructure for promo of agribusiness. The improvement of road structure is persuaded because it minimizes the value of transportation and multiply productivity.

3. Data and Methodology

3.1 Data Sources

Data on Agricultural and CPEC infrastructural development indicators were obtained and compiled from different secondary resources. Data on agriculture, irrigation and health consists of both development and non-development expenses while data on CPEC Highways, Motorways comprises of only development expenditures and data on all parameters other than small town's electrification were obtained from many reports of Annual Development Programs and Budget reports, Punjab Government, Pakistan. The data on town electrification are taken from Punjab Development Statistics. To make actual data has been deflated by taking 2002-03 as base year. Data associated to CPEC tasks have been taken from CPEC Secretariat, Ministry of Planning, Development & Reform, Pakistan and Institute of Strategic Research, Islamabad (ISSI).

3.2 Methodology

To develop indices of CPEC infrastructure, the research followed the method of Principal Component Analysis (PCA) to mix the developmental indicators into composite indices. PCA is a broadly applied approach where it helps in explaining the variance of the observed parameters based on a set of measurements. Many studies have used PCA to build developmental indices (De & Ghosh, 2005; Dorosh et al., 2010). Principal Component Analysis (PCA) creates variables in descendant sequence of significance to describe the optimum amount of variance in the data, and the last component lowest (Haq & Zia, 2013). To calculate the impact of CPEC projects in development of quality of living, throughout ecological zones of Pakistan. Like Human Development Index are designed to measure average achievements in three fundamental dimensions of human development, education, health and standard of wellbeing (Alkire, et al. 2015).

The correlated original parameters are developed new group of uncorrelated variables using the correlation matrix. The PCA technique takes N variables x_1, x_2, x_N and finds linear combinations of these to produce principal components Y_1, Y_2... Y_N that are uncorrelated. This can be shown in the given below form:

$$
\begin{aligned}
Y_1 &= a_{11}x_1 + a_{12}\,x_2 + \ldots + a_{1N}\,x_N \\
Y_2 &= a_{21}x_1 + a_{22}\,x_2 + \ldots + a_{2N}\,x_N \\
&\ldots\ldots\ldots\ldots\ldots \\
Y_N &= a_{N1}x_1 + a_{N2}\,x_2 + \ldots + a_{NN}\,x_N
\end{aligned}
\tag{1}
$$

The Y_1 or the first main component is developed as $Y_1 = a_{11}\,x_1 + a_{12}\,x_2 + \ldots\, a_{1N}\,x_N$.

To establish the association between infrastructure and agricultural productivity, we used a large panel set using random effects in which agricultural efficiency such as, infrastructure indices, human capital and natural resource factor. The data set is a balanced panel of 50 Districts of Pakistan (i.e. Punjab, Sindh, KPK, Baluchistan and Gilgit Baltistan) alongside the CPEC for the sixteen-year period.

4. Assortment of Developmental Indicators

Social and Economic infrastructures are classified by geographical area. Overall infrastructure index has been developed by the usage of availability and utilization indicators of irrigation, electricity, transportation, health, and education (see Figure 1).

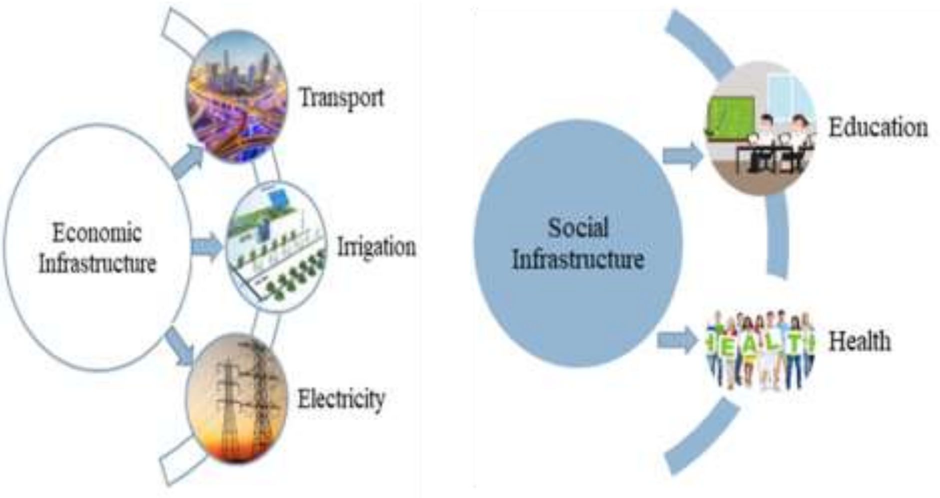

Figure 1. Indicators of Social & Economic Infrastructure

We briefly explained the parameters that are used in the paper to examine the impact of agriculture and CPEC infrastructural development indices. To indicate irrigation infrastructure we have used data and the proportion of net irrigated area to net seeded area to indicate accessibility of irrigation infrastructure and its utilization by the ratio of gross irrigated area to total gross cropped area. Number of small towns electrified per acres of geographical area and irrigation pump sets per acre of net sown area are used to indicate electricity structure (see Table 1).

The paper takes into account only road transport to catch the transportation structure since road is the main way of connectivity in remote areas. We use total road length (km) per thousand hectare of geographical area to indicate the spread of road network.

To develop the social infrastructure index, we used the available indicators such as number of Government schools per thousand hectare of geographical area and the number of hospital per lakh hectare of geographical area for education and health infrastructure respectively. Following is the table of descriptive data with the range of 550 observations and standard deviation that nexus between agricultural output and infrastructure.

Table 1. Summary of Variables

Sr. No.	Variable	Explanation	Mean	Stand. Deviation
i.	Agricultural Output	Rs. per acre of net seeded area	9.23	0.70
ii.	Availability of Infrastructure	Measure from principal component analysis (PCA) on available infrastructure	1.50	0.51
iii.	Utilization of Infrastructure	Using PCA for Infrastructure utilization	1.35	0.50
iv.	Total Infrastructure	Using PCA for infrastructure	1.65	0.40
v.	Water Pump (shallow well)	Consumption of water gallons of Net sown area. 100 gallons/min.	10.75	0.70
vi.	Machinery	Utilization of tractors per Acre of Net seeded area	3.52	0.85
vii.	Utilization of electricity	Percentage of kilowatts (kWh) used on net seeded area	33.50	13.12
viii.	Rainfall (mms) Variability	Average rainfall of district to normal rainfall	40.17	310.15

The current paper applies the Random Effects Model for estimation of association between infrastructure and agricultural development. The Random Effects Estimation has a general covariance matric to incorporate the distribution of residuals. Random Effects Model consists of individual error components which are not interrelated with each other contrary to the Fixed Effects Model, in Random Effects Model the individual intercept is uncorrelated with the repressors. The Wald-Chi square test shows the overall significance of the model. We calculate the relationship between infrastructure and agricultural efficiency using Random Effects GLS Regression Model.

$$Y_{dt} = \beta_i X_{it} + u_{it} \tag{2}$$

Y_{dt} is the dependent variable where d = district and t = time
X_{it} represents independent variables
β_i is the coefficient of independent variables
u_{it} is the error term
u_{it} is the composite error term including $u_{it} = c_{it} + \varepsilon_{it}$ where, c_{it} is the cross section error component and ε_{it} is the combined time series error.

5. Results and Discussion

Current study uses agricultural land productivity as the dependent variable measured by agricultural net domestic income rupee (Rs.) per acre of net seeded area. The explanatory variables in the model include overall availability and infrastructure utilization, water pump (shallow well), tractors and excavator, electricity, and rainfall variability. District dummy has been introduced to distinguish the districts so as to capture the regional variations in land output.

Table 2. Agricultural Output with CPEC Infrastructure

Variable	Ordinary Least Square (Pooled)	Random Results (I)	Ordinary Least Square (Pooled)	Random Results (II)
Availability of Infrastructure	0.20 (4.30)*	0.18 (6.15) *	-	-
Utilization of Infrastructure	-	-	0.22* (5.20)	0.27* (9.25)
Water Pump (shallow well)	0.21* (4.32)	0.15* (4.06)	0.23* (4.43)	0.15* (4.23)
Machinery (tractor, excavator, grinders etc.)	0.10** (2.87)	0.10*** (3.12)	0.12*** (3.25)	0.07** (0.003)
Rainfall (mms) Variability	-0.0003 (-0.59)	-0.0003 (-0.7)	-0.0003 (-0.61)	-0.0003 (-0.60)
Dummy	0.13* (5.05)	0.13* (7.71)	0.14* (6.93)	0.14* (9.31)
Constant	2.50* (10.78)	2.80* (17.80)	2.53* (11.52)	2.87* (17.20)
R^2 Overall	0.37	0.37	0.37	0.37
Breusch-Pagan (LM test)	1290.11 (0.000)	-	1412.93 (0.000)	-
F Value	F (5673) = 65.6 Prob>F=0.00	Wald Chi 2(6)=580.4 Prob>chi 2=0.0	F(5673)=58.1 Prob>F=0.00	Wald Chi 2(6)= 625.2 Prob>Chi2=0.00

Note: Number of observations were 550. t-value significant at *1%, significant at **5% and significant ***10%

The regression results of random effects Model (I) suggest a significant and positive nexus of agricultural land output with available infrastructure. 1-unit increase in the provisions of is associated with an increase of around 0.20 units in land productivity. Tractor use representing machinery is positive and significant at 10 %. The coefficient of the district dummy variable is positive and significant at 1% level suggesting that productivity of land is relatively higher in Central Punjab Districts. The model is fit as realized by the Wald chi square value of 580.4. The Breusch-Pagan statistic determines that panel regressions are appropriate than the pooled linear regressions. The model seems to be good explanatory framework, explaining around 37 % of the variance in the dependent variable. Infrastructure utilization index has shown that one explanatory variables have high and significant relationship with land productivity. Variations in rainfall as captured by the rainfall variability have negative though insignificant relationship with land productivity. The growth in adoption of mechanization in agriculture as indicated by usage of tractors and excavators also shows a positive association with land productivity. The overall R^2 of 37 % shows that the explanatory model is good. We regress overall infrastructure index which includes both availability and utilization infrastructure indicators, and other variables such as tractors and excavators, rainfall variation and district dummy on land productivity (see Table 2).

The regression output in random effects Model II shown that infrastructure utilization index has one of the descriptive variables that have high and significant nexus with land productivity. Coefficient value of utilization index is higher than that of availability index in determining improvements in land productivity that indicates that other than available infrastructures, the existing substructures require to be fully used to enhance the agriculture efficiency.

The Random Effects Model (III) shows that overall infrastructure has positive and highly significant impact on land productivity. A significant coefficient value of 0.39 for overall index of rural infrastructure implies that 1% improvement in provisioning and utilization of infrastructure facilities could induce increases in land productivity (see Table 3). The coefficient of district dummy is positive and significant suggesting that districts lying in the province of Sindh have relatively lower land productivity. Therefore, the results show that improvement in provisions and usage of CPEC infrastructures bring about increases in overall productivity in agriculture.

Table 3. Agricultural Output with overall CPEC Infrastructure

Variable	Ordinary Least Square (Pooled)	Random Results (III)
Overall Infrastructure	0.32 (5.30)*	0.39 (8.52) *
Water Pump (shallow well)	0.21* (4.22)	0.15* (4.16)
Machinery (tractor, excavator, grinders etc.)	0.10 (2.77)	0.10** (3.02)
Rainfall (mms) Variability	-0.0003 (-0.55)	-0.0003 (-0.23)
Dummy	0.13* (5.23)	0.13* (6.93)
Constant	2.50* (10.92)	2.80* (17.97)
R^2 Overall	0.37	0.38
Breusch-Pagan (LM test)	-	1380.11 (0.000)
F Value	F (5673) = 67.6 Prob>F=0.00	Wald Chi 2(6)=582.5 Prob>chi 2=0.0

Note: Number of observations were 550. t-value significant at *1%, significant at **5% and significant ***10%

In Pakistan, the capital and major cities are the biggest clusters of economic activities and the main producer of local flows. In this context, the CPEC projects have a significant impact on the agriculture sector not only on social wellbeing but also on productivity because major cities of Pakistan interlinked with route. Moreover, CPEC will encourage cultural heritage and identity to the different culture of Pakistan. This Mega project will provide a quick accessibility to fundamental facility of daily life such as agriculture, banking, transportation, health and education especially in rural and remote areas which would definitely leads toward development and prosperity.

On the inauguration ceremony of CPEC, Minister of Planning and Development said that this multi-billion project resolve numerous economic and social issues. Development of infrastructure bring a positive change in agriculture productivity that would raise the supply of agriculture goods. The CPEC setup create approximately more or less than 700,000 direct employments from 2015 to 2030 in both agriculture and industrial sector, which ultimately add 2.5 to 3 percentage points to the GDP of Pakistan. CPEC investment perform a major role directly as well as indirectly on the growth of Agriculture sector of Pakistan. It will directly effect to boost up the GDP growth while the indirectly impact is higher as compare to direct impact because of massive investment in energy sector to get over the severe shortfall of electricity. Development of CPEC not only has the potential to give a boost to current decaying agriculture sector of Pakistan but also encourage the businesses of small scale farmers.

Moreover, Ministry of National Food Security and Research, Pakistan has formulated a design of business clusters for more than 40 items around the corridor as it will cross via distinct agricultural economic zones, so agriculturalists can enhance rural business and harvest agricultural crops at international standard (Bosan, 2017). Pakistan have a potential to increase the exports being a transit country between South, East and Central Asia, via China Pakistan Economic Corridor – CPEC. This will bring opportunities for small scale farmers to develop their businesses globally.

6. Conclusion

CPEC perform a substantial role to boost up agribusiness comprehensively for developing a linear agglomeration of people and pursuits pre-existing transport structure. The present paper assesses the association between infrastructure development and agricultural productivity across the districts interconnected to CPEC route. The random effect estimations showed the importance of rural infrastructure in boosting agricultural productivity. This multi-billion project has many socio economic impact on the small scale farmers as it will overcome the current energy crises in Pakistan and provide numerous jobs opportunities. It is essential to introduce new infrastructures and effective usage of existing ones in rural areas. Improvements in institutional mechanisms will extend the agricultural productivity long way. CPEC affects agricultural productivity directly through improvements in infrastructures. Thus, the study lift up proof in support of higher investment in development of infrastructures in distinct areas while at the same time focusing to taking steps on existing resources to maximize the utilization.

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Limitations of the Study

Our study limitation is that conducted abroad during the PhD research work that’s why our major focus on secondary data. In the current study, most of the Districts are included from Punjab Province relative to other provinces, because of lack of accessibility to facts & figures.

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