Impact of Rural Infrastructure on Poverty In Pakistan: Spatial Econometric Analysis

By

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Econometric models.

Econometrics – statistical methods

Mathematical Statistics.

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بسم الله الرحمن الرحيم

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A Dissertation
Submitted in the Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
IN
STATISTICS

Supervised by

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Certificate

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Abdullah

A DISSERTATION SUBMITTED IN THE PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF THE MASTER OF SCIENCE IN STATISTICS

We accept this dissertation as conforming to the required standard.

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2017

Dedication

To my Parents,
For the endless support and patience.

To my Teachers,
For the constant source of Knowledge and Inspiration.

To my friends,
The ones that are close and the ones that are far.

Forwarding Sheet by Research Supervisor

The thesis entitled **"Impact of Rural Infrastructure on Poverty in Pakistan: Spatial Econometric Analysis"** submitted by **ABDULLAH** (Registration # 64-FBAS/MSST/S15) in partial fulfillment of M.S degree in Statistics has been completed under my guidance and supervision. I am satisfied with the quality of his research work and allow him to submit this thesis for further process to graduate with Master of Science degree from Department of Mathematics and Statistics, as per IIU Islamabad rules and regulations.

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ABDULLAH TANOLI

DECLARATION

I hereby declare that this thesis, neither as a whole nor a part of it, has been copied out from any source. It is further declared that I have prepared this dissertation entirely on the basis of my personal efforts made under the supervision of my supervisor **Dr. Muhammad Akbar**. No portion of the work, presented in this dissertation, has been submitted in the support of any application for any degree or qualification of this or any other learning institute.

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List of Abbreviations

List	Descriptions
ADB	Asian Development Bank
WB	World Bank
GDP	Gross Domestic Product
PRC	People's Republic of China
GIS	Geographic Information System
DFID	Department for International Development
UNDP	United Nation Development Program
PSLM	Pakistan Standard Living Measurement
PCA	Principle Component Analysis
IFAD	International Fund Development
AIC	Akaike Information Criterion
LM	Lagrange Multiplier
2SLS	Two Stage Least Square
BP	Breusch-Pagan
JB	Jarque Bera
OLS	Ordinary Least Square
SAM	Spatial Autoregressive Model
SEM	Spatial Error Model
SAC	Spatial Genera Model
TFP	Total Factor Productivity
LISA	Local indicator spatial association

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ABSTRACT

The goal of this study is to empirically examine the impact of rural infrastructure on district-wise poverty in Pakistan while considering spatial dimension. Spatial dimension is not considered in previous studies to analyze the impact of infrastructure on poverty in Pakistan. The poverty is taken as dependent variable while Income, Finance, Physical1, Physical2, Health, Energy, communication, Education for boys, Education for girls are used as explanatory variables. Data of the variables representing various types of infrastructure are taken from Mouza statistics 2008. The model is estimated by OLS. However, local and global Moran's I tests show that there exists spatial clustering and spatial dependence among districts w.r.t. poverty. Hence, Spatial econometric models are estimated and Spatial lag model estimated by 2SLS is selected as the best model. The results show that income, physical 1, physical 2, health and communication infrastructure are not significant whereas Finance, Energy, and Education infrastructure significantly affect poverty in Pakistan. However, education infrastructure for boys positively affect poverty because most of male educated person are likely to migrate from rural areas to main cities. It is recommended that government must have to improve rural infrastructure to eradicate poverty in Pakistan.

Chapter 1

INTRODUCTION

1.1. Introduction

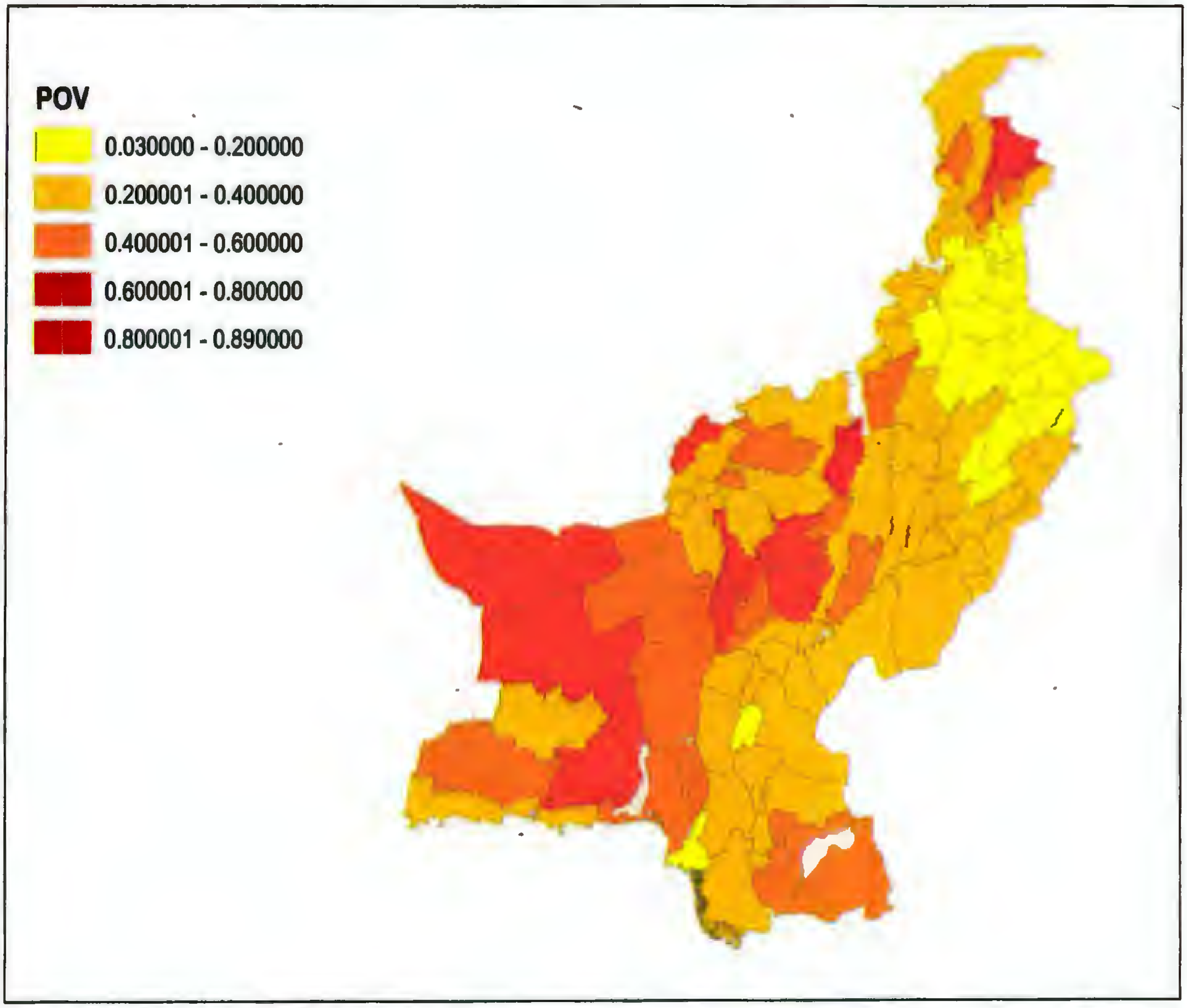
The problem of poverty reduction and economic Growth has been a major goal for policy makers in developing countries. Poverty is the major issue in Asian countries. Poverty in Asian countries is essentially of a rural phenomenon. It is because 70% to 80% population belongs to rural areas (World Bank, 2006). During the past 30 years, East Asia and Southeast Asia has made significant progress in reducing rural poverty, (IFAD, (2001)). Rural poverty is more common and more severe than urban poverty.

In Pakistan, rural poverty continues to increase and per capita development indicators are worse in rural areas as compare to urban areas. rural areas of Punjab and Baluchistan have severe poverty than other areas (IFAD, 2001). A number of previous studies show that there is a large difference in poverty between provinces. Extreme poverty occurs in the high hills, arid zones, desert areas and coastal areas of Pakistan as shown by Figure (1.1 & 1.2). According to Naveed & Ali (2012), approximately 58.7 million people out of 180 million people live under the line of poverty. This means that approximately 32% of the total population lives less than $ 1 a day, which is a very intense condition.

It is established fact globally that infrastructure, particularly in rural areas, is essential to human development. A large part of the world's population still lives in rural areas, where they have to face the lack of economic, social, and basic infrastructures. Consequently, poverty levels in these areas are very high (World Bank, 2008). According to World Bank (2008), nearly 63 percent of the population lives in rural areas. In Pakistan, there is large difference in poverty levels as well as development of socio-economic

Figure. 1.1. Map of Pakistan showing District-wise poverty index

Figure 1.2. Map of Pakistan showing different levels of Poverty



characteristics and infrastructure in various rural areas. Punjab is well integrated with some of the prosperous urban cities and hence poverty levels are the lowest in these areas compared to other areas of the country. Ease of access to communications infrastructure such as roads and transport linking rural areas of economic center and electrification can be an inspiration for the development of new industries in the area that promotes welfare of the people, which helps in solving their financial problems. The fact that infrastructure, especially in rural areas, is essential to human development. (World Bank, 2006), most people still live in rural areas where they have to face the shortage of infrastructure, social and economic facilities. Poverty levels in different rural areas vary with the characteristics of socioeconomic and the development of infrastructure.

The development of any countries depends upon the development of infrastructure. Therefore, the researcher tries to prove a link between infrastructure and poverty reduction. There are three schools of thought in the context of poverty reduction and infrastructure development. Investment in schools and hospitals, according to the first school of thought, may help to achieve poverty reduction goals (Jahan and Mccleery 2005). The second school of thought is that investment in social infrastructure and communication infrastructure will help to reduce poverty. Third school of thought is that there is no role of infrastructure in reducing poverty. Criticism points out that the benefits from infrastructure investment are less than expected, and Secondly, there is a minor connection among the reduction of poverty and Infrastructure due to miss management, false policies, and corruption in the developing countries Ali Ifzal. and Pernia (2003)

As can be seen from the above discussion, infrastructure development plays an important role in the reduction of poverty. Surprisingly, there is no research in order to analyze the impact of rural infrastructure on poverty in Pakistan. The concrete evidence of other developing countries has been found that development of rural infrastructure leads to the increase in agricultural and non-agricultural income. It also leads to the reduction of input prices of agricultural commodities such as fertilizers, seeds and transportation costs which increases employment opportunities and develops new small industries. All these factors help in poverty reduction directly or indirectly (Kawon 2005) and Khandker Bakht and Koolwal, (2009).

Road, transportation, is considered to be a major part of the communications infrastructure and the social infrastructure is composed of educational schools, and healthcare units. Due to the improvement of road infrastructure and transport facilities, farmers can introduce improved farming practices which improve overall productivity and easy access to markets. Apart from this, rural road infrastructure will be linked to urban areas, quality of education and cleanliness or health facilities can also be enjoyed. Good infrastructure of the transportation is a pillar of sustained economic growth and an effective tool for rural poverty reductions (Fan, S., & Chan-Kang, C. (2004))

(Arif and Iqbal, (2009)) investigated the nexus of poverty and rural infrastructure in various agricultural areas of Pakistan. The study found that a positive and significant relation among the rural infrastructure and poverty reduction. Some other studies are obtained by using time series data, but these studies focus on the national level, ignoring regional differences at the provincial and Districts levels. This study fills in the research gap by examining impact of rural infrastructure on district wise poverty while considering spatial dimensions in the case of Pakistan. While considering the above discussion, the following objectives are specified in this study.

1.2. Objectives

1. To determine the role of physical, health and education infrastructure in eradication district wise-poverty in Pakistan.
2. To detect district wise spatial patterns of poverty in Pakistan.
3. Estimation of best spatial econometrics model using classical approach.

1.3. Outlines of The Study

In order to achieve the above objectives, this study is divided in five chapters. After introduction in first chapter, chapter-2 presents literature review along with some basic concepts about poverty, infrastructure and spatial econometrics. Material and methodology of analysis is presented in chapter-3. Chapter (4) contains results and discussion whereas conclusion is presented in chapter (5).

Chapter 2

Literature Review

2.1. Introduction

This chapter contains basic concepts about poverty, infrastructure and spatial econometrics. Moreover, review of previous studies regarding the topic under consideration is also presented in this chapter.

2.2. Basic Concepts of Poverty and Infrastructure

Poverty is due to the lack of basic human needs, such as nutrition, clean water, education, health care, shelter and clothes, because of the inability to afford them. It can also be called absolute poverty. Relative poverty compared with society or country, fewer resources or less income conditions. Poverty is a multidimensional phenomenon because it's have two main kinds which are absolute poverty, and relative poverty both are discussed above. The poverty line is set by (WORLD BANK), is that the poverty line is $ 1.25/day/person in Pakistan. on other hand, main kinds of infrastructure, i.e. communication infrastructure, energy infrastructure, financial infrastructure and social infrastructure are mentioned. Communication infrastructure include roads, transportation while energy infrastructure consists of electrification, sui gas, petrol pump, c.n.g facilities, etc. and social infrastructure consists of schools, health facilities. Commercial and online bank facilities is the indicator of financial infrastructure. Investment in both communication infrastructure and social infrastructure, directly and indirect impact on the economic development of the country. Therefore, it helps in reducing poverty. Generally, the government's investment on the road project, there is a major impact on farm and non-agricultural income.

2.3. Review of Literature

Review of literature consists of two parts. In the first part, review of those studies is presented which contains analysis of the impact of infrastructure upon poverty in other countries of the world. Secondly, a brief review of the studies related to poverty in Pakistan is presented.

Lipton and Ravallion (1995), Ahmed and Donovan (1992), studied in Indonesia and Malaysian countries (south Asian countries). Multiple regression technique they use and found that largely investment on the infrastructure of communication significantly decreased poverty incidents. Gannon and liu (1997), Refers to the microeconomic mechanism that generates investment in rural road infrastructure have a significant effect on economic growth and the incidence of poverty. Jacoby (1998), using a non-parametric method for the data of Nepalian, the utility of rural road networks across people at different levels of income has been estimated. He found that on average, access to the market is more favorable to poor families, but not enough to reduce the income gap in the population.

Kwan (2000), Through the Indonesian provincial data, studied the link between infrastructure and poverty in (1976-1996). The sample divided into good or bad province and he found that the impact of poverty on growth was nearly four times higher in governorates with a higher level of road availability than those with lower road availability. Escobal (2001), using a bit doubled censured technique for the establishment of the link between income diversification and rural road infrastructure. The author found that the discovery of access to roads, electrification and education is important for determining the diversity of rural incomes. It was also found that, appropriate access to roads and other public assets could increase the profitability of agricultural and non-agricultural incomes.

Shahidur et al. (2006), the "fixed effect" method for family data or household data in Bangladesh to identify linkages between road infrastructure and poverty reduction. Their results show that rural road infrastructure investment is good for the poor. they say the road infrastructure improves agricultural production, high wages, low input prices, transport costs and increases the value of production prices. Khandker and Koolwal (2009), pool data set is used for three household panel between the year (1991 to 2001), Analyze the impact of rural infrastructure and microcredit on the consumption pattern and income of the poor in Bangladesh. He found that the discovery of areas where metal roads and good electrification infrastructure have led to increased agricultural and non-agricultural incomes, leading to poverty reduction in these areas.

Directly or indirectly effect of the infrastructure development for the reduction of poverty, especially in non-urban areas. The reduction of poverty through economic development is the indirect channel of communication infrastructure. Current researches have shown that roads and electricity are to ensure the steady growth of the agricultural and industrial sectors, incrementation in the level of employment, and enhance in the level of the income of farmers and non-agriculture or non-farm alike. Improvement in all these section is a condition for reducing long term poverty. Kwon (2005a), In Indonesia, investigation of the impact of the infrastructure of rural road on poverty reduction. He found or investigated that road investment in infrastructure, leading to poverty reduction to improve the performance of regional economic development. Those provinces with improved infrastructure, a 1 per cent increase in gross domestic product will result in a 0.33 per cent reduction in the incidence of poverty while other side badly infrastructure in province, the incrementation of 1% in GDP will lead to the only 0.09 percent reduction in the incidence of poverty.

Kwon (2005b) also found that development in road infrastructure contribute significantly to the reduction of poverty and improvement in the economic development in people's republic of China (PRC). For direct relationship between communication infrastructure and the incidence of poverty. (Kwon, 2005a), the author found that the improvement of rural infrastructure in Indonesia improves the level of employment and wages of the poor. According to the (World Bank, 2006), In this report, the first source to connect farmers from rural to urban areas in order to facilitate access to markets, the development of road infrastructure. The report shows an increase of rural infrastructure also create employment opportunities for non-agricultural sector.

Wars (2005), This suggests that any type of investment is to provide access to a variety of road infrastructure and have a very positive impact on reduction of poverty. among the years (1997-1998) and (2002-2003), The Indonesian government is increasingly entering all the roads of the original inhabitants, as the number of poor people in rural areas has fallen by 13 per cent. South Asia, three countries of the field survey India, the People's Republic of China and Indonesia (2005 Asian Development Bank), It reveals the important practice of evidence linking the reduction of poverty and rural infrastructure. Improve rural transport systems to reduce the travel costs of the poor, increase income of the agricultural and promote non-farm events and increase employment, and employment rate in the areas of rural. In the context of non-income poverty, the infrastructure of the rural has a direct impact on the rural poor by reducing the cost of services for rural poor. Because of rural village road infrastructure, access to health care units, schools, industries, social and financial services is also improving. Access to infrastructure to mitigate the risks faced by rural families play an important role.

Review of some studies related to poverty in Pakistan is also presented here. Small study conducted at the national level, the infrastructure and poverty linked. from that are Arif and Iqbal (2009), found that the link among the rural infrastructure and the reduction of poverty among the different agriculture areas for Pakistan. Multiple regression analysis is used and the author found that There is an important and positive relationship between rural infrastructure and poverty. Ahmad and Malik (2012), used a multiple regression analysis technique for time series data in (1981 to 2010), To study the relationship between rural infrastructure and Pakistan's economic growth. He found that economic growth and infrastructure development in rural areas a significant positive correlation. Ahmad and Malik (2012), In the period 1970 to 2005 using multiple cobb-Douglas utility function. He studied the effects of energy, physical and social infrastructure on TFP (total factor productivity) in Punjab, province of Pakistan. It found that investments in communications, energy and social infrastructure have a significant positive impact on the overall factors of production (TFP).

Ali and Abdulai, A. (2010) using a multiple regression analysis technique for the cross-sectional data for the Punjab Province of Pakistan. to analyze direct impact of adoption or acceptance of (BT) Bacillus thuringiensis cotton on yields, poverty, income of household and pesticide demand, He found that the use of new technologies had a significant and positive effect on household income, poverty reduction, cotton production. Impact of technology on productivity and household incomes are consistent with the positive and the potential role of new technologies in agriculture in the direct reduction of rural poverty by increasing the income of agricultural households. Bhutto and Bazmi (2007, November). Examined that the nexus between the agriculture development, poverty reduction, population development. indicated that the farm will proceed to be 1 of the most necessary section of the economy of Pakistan for year to-come. It is proposed that a Pakistan has strengthened the farm productivity by providing supply of a chain, including easier credit for small farms, accessibility of good fertilizers and pesticides, tractors and combine services, harvest services, improved irrigation efficiency and, finally, educated farmers. He found that the high population rate Growth should be curtailed in order to increase agricultural in rural areas of Pakistan productivity significant impact on poverty.

From the above studies, we conclude that the rural infrastructure strongly connected to the incidence of the poverty, mean that relationship between the reduction of poverty and rural infrastructure. also, the direct and indirect relation too. A number of studies were conducted in developing and developed countries to address these issues. However, no one has yet studied these issues at the Pakistani district level by spatial analysis.

2.4. Basic concepts of Spatial Econometrics

The sub field of econometrics, Spatial Econometrics initiated as a recognizable field in Europe in the primarily 1970 for to manage with the sub-nation data in regional econometrics models. In general term, spatial regression can-be considered as the arrangement of infrastructure to deal with the methodology relate that takes after the unmistakable extreme thought of spatial impact, particularly are the heterogeneity and auto-correlation in spatial context. Anselin, and Florax (2012).

Spatial Econometrics is a sub branch of traditional econometrics that deal with spatial auto-correlation and spatial heterogeneity in regression model Anselin, L. (2001). The spatial auto-correlation can also call by the name of spatial dependency. Spatial econometrics is a sub branch of econometrics studying with spatial interface effects between the units of the geographical. Units could be, Districts, states, countries, regions, etc. Anselin, L. (2013). The spatial econometrics accounts for the associating of spatial effect in regression analysis.

The interpretation or dealing the spatial dependency and spatial heterogeneity is strongly referred the spatial econometrics. if such a spatial dependency happens among the geographical units, it is referred to as spatial auto-correlation. A 2nd one deriver behind increased interest in spatial econometrics is the need to handle spatial data. This has been stimulated by the explosive diffusion of geographic information system (GIS) and the associated availability of geocoded data i.e. data set that include the location of the observational units LeSage, J. P. (2008).

General econometrics vary from other branch of statistics in focusing on theoretical models whose parameter are estimated using Regression analysis. While the spatial econometrics is small changes that improve something or of this, where either the theoretical model includes interaction between different entities or the data observation are not truly independent. Thus, model incorporate spatial auto-correlation or spatial dependency or neighborhood effect can be estimated using spatial econometrics method such a model is common in regional science, real estate economy, and education economics, and urban, rural etc. the concrete example of spatial econometrics is the house price depend on the number of bedroom, bathroom, etc. House price also and strongly depend on location: price of houses in the same neighborhood are similar. The second example are related to precision agriculture: different rate of nitrogen is applied in a corn field. Corn yield will be different because of the different nitrogen application but they will be similar if the field plots are spatially closed.

When we are analyzing or modeling the standard regression has mostly ignored the two-main issue, which are dealing in the spatial context, these two-main issues are spatial heterogeneity and spatial dependence among the observation. Ignoring these two fact of the standard econometrics, these two kind of issue leads the big difference between the traditional econometrics and spatial econometrics.

Possibly because they violate the assumption of Gauss Markov used in the modeling of standard regression. With respect to the spatial-dependence among the observation, memories Gauss Markov assume that independent variable is fixed. Spatial dependence disrupts this assumption. This is important for alternative assessment methods, means that other estimation method.

On the other hand, another assumption of gauss Markov that a single relationship-linearly with constant variance, this assumption should also violate due to the cause of spatial heterogeneity. If the relationship differs as we move across the spatial data sample or, the variance modification, alternative procedure is requisite or needed to successful model of this variation and delineate or draw appropriate inferences. The alternative estimation methods can be used when transaction or dealing with spatial data sample. This subject is never discussed in standard regression. LeSage, J. P. (1999).

According to Tobler, W. R. (1970) The first laws of geography have been organized everything is connected, but the closest thing is more organized than the distant things. This first law is the base of the fundamental conception of spatial dependence or spatial autocorrelation. spatial dependence, or spatial autocorrelation, can be seen dependence between observation on the dependent variable in a regression model.

In the time series literature concentrations on the dependence between observations over time and uses the symbol (t-1) to denote variables lagged in time, the observation on a time series can be seen as points on a line. If the time series is casual, points further in time depend only on the previous ones. But observations in spatial data have a location in a two-dimensional plane. As a consequence, observation do not usually have a specific order, and the dependence between the observation may extend in all directions. the spatial econometrics literature is interested in the dependence among observations across space and uses the so-called spatial weights matrix (W) to describe the spatial arrangement of the geographical units in the sample. The spatial dependence reflects a condition where observed value at one location or region depend on the values of neighboring observations at nearby location.

Spatial heterogeneity is a property usually assign to a landscape or ta a population. It refers to the uneven distribution of several concentration of each species within an area. The deficiency of structural-stability of the many phenomenon over space, the spatially-units of the observation, themselves are distant from homogenous LeSage, J. P. (2008).

For example: of the Census-tract, different field size, urban locations are level uneven population or income. To the extent that the measurement of these aspects of diversity is reflected in errors, "misspecification, variables missing" they may result in heteroscedasticity. the simplest example of spatial heterogeneity are the data districts wise and two, three variables are education, population, infrastructures, industries, all these variables are unevenly distributed in the entire districts of Pakistan. The unevenly distribution of these variables are strongly referred to the spatial heterogeneity. The concrete examples of spatial heterogeneity are they arises with the division of existing or living area of homes. While the division of Mid price and low price homes have roughly the same distributions, a dissimilar or different form arises for high priced homes. The part of the Spatial econometrics which are spatial heterogeneity cite to the uneven distribution of a trait, attribute or qualitative, event, or relationship across a region Anselin, L. (2013).

The establishment for most extreme models is a show of whether one area is a spatial neighbor of another; or identically, which locales are neighbors of a given district. this is a square symmetric $R \times R$ network (matrix) with (i, j) component equivalent to 1 if areas i and j are neighbors of each other, and zero otherwise. by tradition, the corner to diagonal components of this "spatial neighbors" network are set to zero.

As LeSage, J. P. (1999) found that, there is an embarrassingly vast number of approaches ways to build such a matrix. These include: Linear contiguity: *iandj*are neighbors on the off chance that they share some portion of a typical or common eastern or western border.

Rook contiguity: two areas are neighbors if they connect to part of a common border on any side. Bishop continuity: two areas are spatial neighbors on the off chance that they connected at a "point". This is the spatial simple of two components of a chart meeting at a vertex. Queen contiguity: this is the compound of Rook and Bishop Contiguity. Two districts are neighbors in this sense in the event that they share any piece of a typical fringe, regardless of how short

Another word *Rook,* common boundaries, *bishop,* common vertices, or *queen* both boundaries and vertices. In a customary network or regularly grid, neighbors can be characterized in various ways. In likeness of the session of chess, the queen contiguity, bishop contiguity, and finally the rook contiguity is differentiated or mark as different. In irregularly grid, neighbors are generally defined by a commonplace or common border not vertex.

Location must be measured for dissecting or analyzing spatial impacts i.e. spatial heterogeneity and spatial dependence. Area information can be utilized from two sources. Distance and neighborhood the Contiguity mirrors the relative area of one spatial unit to different areas in space. Neighborhood ships of spatial units are generally settled from a map. Neighboring locations are relied upon to show a high level of spatial-dependence than locations situated distant separated, as to heterogeneity, connections might be comparative for neighboring locations. While the Distance are the area in space represented to by longitude and latitude is one source of data information. This information permits ascertaining distance between points in space. In regional science focuses in space may speak to focuses or urban areas of districts or regions. It is normal or expected that the quality of spatial dependence will decrease with separation distance. Perceptions that are near to show similar relationship; those that are most separation may display unlike relationship in these situations we have a spatial heterogeneity.

Spatial weight matrix can be conduct on the basis of spatial neighborhood or contiguity matrix actually spatial neighborhood matrix is a spatial weight grid. So, the spatial contiguity matrix W^* is a binary n × n grid which entrance w_{ij}^* are zero or one. An entrance w_{ij}^*=1 if districts or regions i and j are neighbors and 0 otherwise; the diagonal components or element of spatial weigh matrix W^* set equal to zero. $w_{ij}^* = 1$ if i and j are relative; 0 otherwise. The spatial weigh matrix is conducted on the basis of neighborhood criteria. Which are Rook, bishop, linear, queen contiguity.

Finally, then the spatial weigh matrix can be transformed to the most common method which are the row standardization technique, in this step we can sum the rows of the spatial weigh matrix are make to sum to unity. Let W^* with elements w_{ij}^*be a spatial neighbor's matrix. To row-standardize this; we partition every component or element consecutively by the aggregate of the components in the row. By typically or symbolically we can compose it below.

$$w_{ij} = \frac{w_{ij}^*}{\sum_{i=1}^{n} w_{ij}^*}$$

The spatial weight grid is also referred to as a *row-stochastic matrix*, since, if there are no islands, each component is between one and zero, and the sum of the row is to one, like probability. Note that, dissimilar the neighbor's matrix, the spatial weights matrix or the spatial contiguity matrix is no longer symmetric.

One of the important factors which are the combination of spatial weight matrix and variables as well as error term is called spatial lag variables. There are three types of spatial lag variables are spatial independent variables $WX = \sum_{j=1}^{n} w_{ij}\, x_j$, where i=1, 2, 3, 4... n. spatial dependent variables $WY = \sum_{j=1}^{n} w_{ij}\, y_j$, where i=1, 2, 3, 4... n. And spatial error variables $W\varepsilon = \sum_{j=1}^{n} w_{ij}\, \varepsilon_j$, where i=1, 2, 3, 4... n.

While the difference between in time series analysis lag and spatial econometrics: Because time is unidirectional, the application of lag operator L in time-series analysis e.g. Shifts observations of a variable Y one or more periods back in time that is First-order lag: $L.\, y_{t=}y_{t-1}$ Second-order lag: $L^2.\, y_{t=}y_{t-2}$ K^{th} order lag: $L^K.\, y_{t=}y_{t-k}$ is straightforward. While the Spatial lag operator W Relates a variable X at one unit in space to the observations of that variable in other spatial units. Which discussed above? In spatial arrangements, a number of shifts in different directions are possible. Since space is characterized by multidirectional, first-order lags for all n Regions. $L.x = Wx$ Second-order lags $L^2.x = W_2x ...... L^k.x = W_kx$ Contiguity class k comprises all k^{th} order neighbors lack straight forwardness.

The spatial weight matrix is very important for the Moran's I statistics, because the spatial weight matrix is captured the neighboring areas, Moran's I is a statistical tool for measuring the spatial autocorrelation, it's range from -1 to +1. If the value of the Moran's I statistic is positive, it's mean that spatial dependence has in our data, if the value of the Moran's I statistics neither positive nor negative, mean zero value, it's indication that there is No spatial clustering pattern. If the value is negative, there is no spatial impact in our data. Beside the Lagrange Multiplier test also telling us the degree of the spatial dependence.

2.5. Conclusion

We concluded that there is a strong relationship between rural-infrastructure and the reduction of the poverty. Developed and developing countries have undertaken a number of studies to address these issues. However, not found after studies to explore this issue in Pakistan at the district level by spatial analysis. In the case of Pakistan, there is no empirical research on this issue, the proposed research is justified. Furthermore, fundamental definiens the spatial econometrics, and its connection with tradition econometrics, and some introduction regarding poverty and spatial weight, Moran's I.

Chapter 3

Material and Methodology

3.1. Introduction

This chapter consists of five sections which explain material including data and methodology of analysis used by the study. After introduction, specification of the model is done in the second section. Third section discusses data and construction of variables whereas methodology of analysis is explained in fourth section. The last section concludes the chapter.

3.2. Model's specification

In 1936, Johan Maynard Keyne's made first endeavor to connect the infrastructure (indirectly) with the poverty reduction and gave a general hypothesis of employment, premium and money. He contends that the best device to bring back the economy from retreat or market inability to the full employment level is public infrastructure construction. In this way, Keynes general hypothesis could down to earth suggestion for the developing countries. Andreso et.al, (2006) states that building of infrastructure affects at both micro as well as macro level. The study found that investment in general infrastructure at the small-scale level has two principle impacts. Initially price impact and second one is quantity impact. In such case, investments in infrastructure causes welfare of the general population as both increment in quality and number (quantity) of definite products and services. On the other side, investment in infrastructure significantly affect at macro level by improving financial development (economic growth) of the nation.

3.3. Data and Construction of Variables

Data of the variables used in this study are taken from two data sources for 110 districts of Pakistan. Data of district-wise poverty index are taken from Arif and Nazim (2012). Using alkire and foster measure (2007), the study constructed head count ratio at the district level in Pakistan on the basis of PSLM 2008-09 by using data of four key households' dimensions i.e. education, health, living condition and ownership. Data source of Arif and Nazim (2012) is PSLM-2008-09 Data source of the variables regarding rural infrastructure is Mouza Statistics 2008 published by the agriculture census organization. Composition of the variables representing different types of infrastructure, i.e. construction of variables, is as follows.

Education infrastructure is represented by the Percentage of villages which have access to educational institutes like primary school, middle school, higher school, and college at a distance of one kilometer from the mouza. Percentage of villages which have access to health care units like hospital/dispensary, rural health center, basic health unit, chilled and mother care center at a distance of one kilometer represents health infrastructure. Financial infrastructure is determined by the percentage of villages which have access to commercial and online banking at a distance of one kilometer. Physical infrastructure is further divided into two part, physical-1 and physical-2. Physical-1infrastructure is represented by the percentage of villages which have access to facilities of Piped water supply, filtration, sewerage while the physical-2 infrastructures are determined by the percentage of villages which have access to facilities of toilet, bricked street, and bricked drains. Data of income infrastructure is derived as the percentage of villages which have industrial production units creating employment for the people. Energy infrastructure represents the percentage of mouzas where electricity, Natural gas, Liquefied Petroleum Gas (LPG), Diesel, and

Compressed Natural Gas (CNG) have been provided. Communication infrastructure is determined as the percentage of villages which have access to road within 1000-meterdistance from mouza and have transport facility.

Indices of different types of rural infrastructure are constructed by using Principal Component Analysis technique. The analysis of "PC" is a basically a variable decrease method and allocate weight as indicated by the change(variance) of the variable. This system diminishes the quantity of relationship by gathering or grouping together those variables which are exceptionally correlated with each other into one segment or element. The first component or primary segment clarifies the most extreme measure of variety in the data and last segment the base (minimum). The first PC examination represent a sizeable piece of the variety in the information(data). In every one of the cases the first principle component can clarify more than 70 percent of variety and thus just the first was taken and further examination depends on these indices.

3.4. Methodology of Analysis

The specified model in equation (3.3) can be written into matrix form as follows.

$$\mathbf{Y} = \mathbf{X}\boldsymbol{\beta} + \boldsymbol{\varepsilon} \qquad (3.4)$$

Here Y represent poverty level of each district, X is the matrix of independent variables such as the communication infrastructure of index, the infrastructure of financial index, the index of the social infrastructure, energy infrastructure, income infrastructure and physical infrastructure. where $\boldsymbol{\beta}$ is the vector of coefficients and ε is the random error term. The model is estimated by using Least square estimator, i.e.

$$\hat{\beta} = (X^t X)^{-1} X^t Y \qquad (3.5)$$

There are 110 districts of Pakistan which are spatially connected. Table (A) in Appendix presents spatial connections of districts. Probably the most important argument for application of spatial approach is that the independence assumption between the observation (location) is no longer valid. Attributes of observation i (location) may influence the attributes of observation j (location). When dealing with space, one must bear in mind first law of Tobler's of geography i.e. "Everything is related to everything else, but close thing is more related than the things that are apart (Tobler, W. R. (1970))". In this section, we'll focus on the specification of spatial dependence, on specification tests to detect the spatial dependence it's weaker expression spatial autocorrelation in regression model that incorporate spatial dependence. Least square estimates are biased and inconsistent due to spatial dependence (See Anslin and Bera (1998)). The valid estimates may be obtained by estimating spatial regression model. Before spatial modeling, we can check the spatial factor, on the basis of Local Moran I test, **LISA** clustered map and **Moran** scattered plot.

The Local Moran I statistic detects local pattern of spatial autocorrelation between two units and hence, it can be used as indicator of local spatial clusters. Local Moran I statistics is given below.

$$I_i = \frac{(x_i - \bar{x}) \sum_{j=1}^{n} w_{ij}(x_j - \bar{x})}{\sum_{j=1}^{n}(x_j - \bar{x})^2/n}$$

Here 'n' represents the number of spatial observation and x is the variable of interest. Moreover, w_{ij} is the spatial weight matrix with the diagonal on zeroes. Local Moran I test is applied to detect spatial dependence w.r.t. poverty between each pair of neighboring districts and the results are presented in Table 3.1. Positive value of the statistic indicates that the two neighboring districts have similar high or low values of poverty and hence are considered as

Table. 3.1. Results of Local Moran I test statistic

OBS	I_i	$E.I_i$	$Var.I_i$	$Z.I_i$	Pr(z > 0)
1	0.000714121	-0.009174312	0.1883666	0.022783765	4.91E-01
2	0.234652237	-0.009174312	0.1883666	0.561796492	2.87E-01
3	1.217716013	-0.009174312	0.4841728	1.763216129	3.89E-02
4	0.755923728	-0.009174312	0.1883666	1.762849031	3.90E-02
5	2.7669704	-0.009174312	0.319836	4.908834706	4.58E-07
6	0.198772124	-0.009174312	0.1554993	0.52733587	2.99E-01
7	1.46064623	-0.009174312	0.1554993	3.727349746	9.68E-05
8	1.701406566	-0.009174312	0.1320226	4.70781623	1.25E-06
9	0.103491441	-0.009174312	0.2376676	0.231103695	4.09E-01
10	0.223404522	-0.009174312	0.1144151	0.687588447	2.46E-01
11	1.193304347	-0.009174312	0.2376676	2.466563753	6.82E-03
12	1.232560292	-0.009174312	0.2376676	2.547086838	5.43E-03
13	0.680128231	-0.009174312	0.2376676	1.413920034	7.87E-02
14	0.392042065	-0.009174312	0.319836	0.709438837	2.39E-01
15	1.38450032	-0.009174312	0.2376676	2.858751218	2.13E-03
16	1.794794268	-0.009174312	0.2376676	3.700359652	1.08E-04
17	1.698327147	-0.009174312	0.1144151	5.048001386	2.23E-07
18	1.838885641	-0.009174312	0.2376676	3.790801324	7.51E-05
19	0.345936506	-0.009174312	0.1554993	0.900533214	1.84E-01
20	0.241969528	-0.009174312	0.1883666	0.578656136	2.81E-01
21	0.928625053	-0.009174312	0.1554993	2.37818572	8.70E-03
22	0.673966436	-0.009174312	0.1320226	1.88012221	3.00E-02
23	1.746688319	-0.009174312	0.1554993	4.452730072	4.24E-06
24	1.435503387	-0.009174312	0.2376676	2.963370386	1.52E-03
25	2.542540348	-0.009174312	0.1554993	6.47094847	4.87E-11
26	0.554620953	-0.009174312	0.319836	0.996914084	1.59E-01
27	0.289612859	-0.009174312	0.319836	0.528321462	2.99E-01
28	-0.294979508	-0.009174312	0.319836	-0.505366475	6.93E-01
29	0.392658277	-0.009174312	0.4841728	0.577490659	2.82E-01
30	0.515781181	-0.009174312	0.1554993	1.331246004	9.16E-02
31	0.195916393	-0.009174312	0.2376676	0.420688797	3.37E-01
32	0.012319147	-0.009174312	0.1883666	0.049522702	4.80E-01
33	0.340587415	-0.009174312	0.1883666	0.805879887	2.10E-01
34	0.347788822	-0.009174312	0.1883666	0.822472522	2.05E-01
35	0.135463204	-0.009174312	0.4841728	0.207864709	4.18E-01
36	0.185655078	-0.009174312	0.1883666	0.448902996	3.27E-01
37	-0.091840972	-0.009174312	0.1554993	-0.209636175	5.83E-01
38	0.018626586	-0.009174312	0.4841728	0.039953849	4.84E-01
39	0.10818891	-0.009174312	0.4841728	0.168667665	4.33E-01
40	0.015861908	-0.009174312	0.1883666	0.057685516	4.77E-01

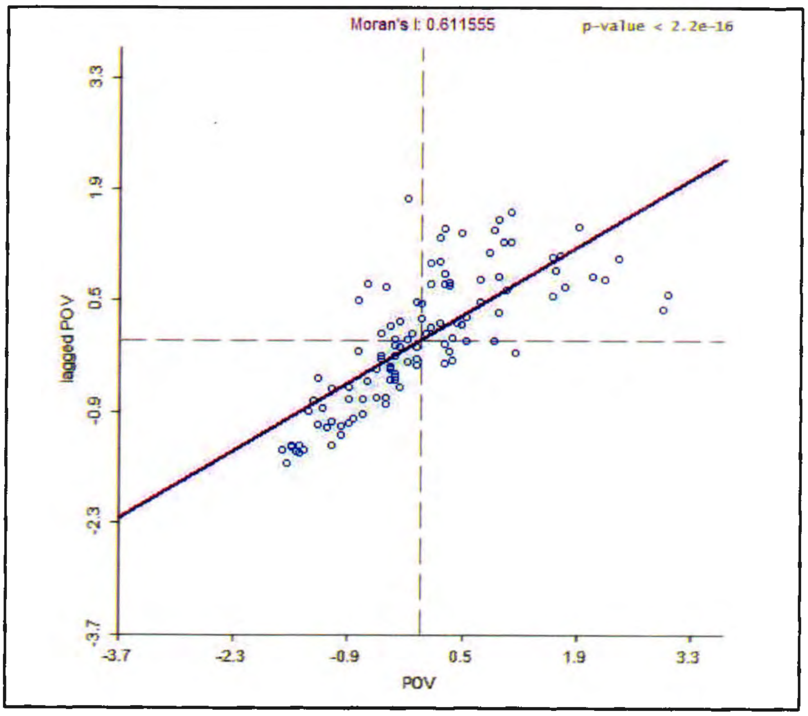
OBS	I_i	$E.I_i$	$Var.I_i$	$Z.I_i$	Pr(z > 0)
41	0.91976815	-0.009174312	0.319836	1.642574675	5.02E-02
42	0.599467645	-0.009174312	0.1144151	1.799369147	3.60E-02
43	-0.295873476	-0.009174312	0.1883666	-0.660578537	7.46E-01
44	1.233640963	-0.009174312	0.319836	2.197570872	1.40E-02
45	1.758180219	-0.009174312	0.2376676	3.62525571	1.44E-04
46	0.238007375	-0.009174312	0.1320226	0.680287014	2.48E-01
47	0.898085754	-0.009174312	0.1554993	2.300740449	1.07E-02
48	-0.006780677	-0.009174312	0.1554993	0.006070071	4.98E-01
49	-0.473386776	-0.009174312	0.4841728	-0.667139423	7.48E-01
50	-0.168444443	-0.009174312	0.319836	-0.281624638	6.11E-01
51	-0.026651225	-0.009174312	0.319836	-0.030903029	5.12E-01
52	0.005697163	-0.009174312	0.1883666	0.034265106	4.86E-01
53	2.151995086	-0.009174312	0.4841728	3.105908215	9.48E-04
54	1.981718142	-0.009174312	0.1554993	5.048747292	2.22E-07
55	1.332814361	-0.009174312	0.1320226	3.693386343	1.11E-04
56	2.36321796	-0.009174312	0.1554993	6.016200941	8.93E-10
57	2.108027876	-0.009174312	0.1883666	4.878208584	5.35E-07
58	1.962509792	-0.009174312	0.1554993	5.00003642	2.87E-07
59	1.26224688	-0.009174312	0.1320226	3.499172357	2.33E-04
60	2.567407275	-0.009174312	0.2376676	5.28516885	6.28E-08
61	2.154127916	-0.009174312	0.1883666	4.984426882	3.11E-07
62	2.09895024	-0.009174312	0.319836	3.727628074	9.66E-05
63	1.453196499	-0.009174312	0.319836	2.58579337	4.86E-03
64	1.031859014	-0.009174312	0.4841728	1.496113152	6.73E-02
65	0.668270742	-0.009174312	0.2376676	1.389597563	8.23E-02
66	0.53046451	-0.009174312	0.1554993	1.368481775	8.56E-02
67	1.071301202	-0.009174312	0.1554993	2.740001256	3.07E-03
68	0.816741126	-0.009174312	0.1883666	1.902977337	2.85E-02
69	1.223271121	-0.009174312	0.1554993	3.125385065	8.88E-04
70	0.998452488	-0.009174312	0.2376676	2.066877214	1.94E-02
71	0.313911859	-0.009174312	0.1007203	1.018028124	1.54E-01
72	1.176761805	-0.009174312	0.1883666	2.732494695	3.14E-03
73	1.129896557	-0.009174312	0.1554993	2.888594487	1.93E-03
74	0.657575549	-0.009174312	0.1144151	1.971157451	2.44E-02
75	0.159029187	-0.009174312	0.1883666	0.387554745	3.49E-01
76	0.017633288	-0.009174312	0.2376676	0.05498863	4.78E-01
77	0.044866195	-0.009174312	0.2376676	0.110849663	4.56E-01
78	0.133453616	-0.009174312	0.1554993	0.361693251	3.59E-01
79	0.645057011	-0.009174312	0.1554993	1.659079382	4.85E-02
80	0.161833873	-0.009174312	0.2376676	0.35077761	3.63E-01
81	0.149706381	-0.009174312	0.1320226	0.437267312	3.31E-01

OBS	I_i	$E.I_i$	$Var.I_i$	$Z.I_i$	Pr(z > 0)
82	0.109553161	-0.009174312	0.1007203	0.374104241	3.54E-01
83	0.000830005	-0.009174312	0.1883666	0.023050773	4.91E-01
84	-0.002050557	-0.009174312	0.1883666	0.016413719	4.93E-01
85	-0.042947513	-0.009174312	0.1144151	-0.099845984	5.40E-01
86	0.011728686	-0.009174312	0.1554993	0.053008366	4.79E-01
87	0.136980742	-0.009174312	0.2376676	0.299798051	3.82E-01
88	-0.074646809	-0.009174312	0.2376676	-0.134299338	5.53E-01
89	-0.051318113	-0.009174312	0.1320226	-0.115987075	5.46E-01
90	0.102178541	-0.009174312	0.1554993	0.28238211	3.89E-01
91	-0.043404843	-0.009174312	0.1883666	-0.078869969	5.31E-01
92	-0.066819073	-0.009174312	0.1883666	-0.132818286	5.53E-01
93	-0.010482549	-0.009174312	0.1320226	-0.003600497	5.01E-01
94	-0.010142253	-0.009174312	0.319836	-0.001711533	5.01E-01
95	0.018454138	-0.009174312	0.2376676	0.056672385	4.77E-01
96	0.01657791	-0.009174312	0.2376676	0.052823803	4.79E-01
97	0.16821443	-0.009174312	0.2376676	0.363865618	3.58E-01
98	0.356927159	-0.009174312	0.4841728	0.526139953	2.99E-01
99	-0.003515671	-0.009174312	0.1554993	0.01434987	4.94E-01
100	0.094572457	-0.009174312	0.2376676	0.212808783	4.16E-01
101	0.004347934	-0.009174312	0.2376676	0.027737275	4.89E-01
102	0.126399364	-0.009174312	0.1883666	0.31237294	3.77E-01
103	-0.080960686	-0.009174312	0.1554993	-0.18204462	5.72E-01
104	0.097796075	-0.009174312	0.319836	0.189147182	4.25E-01
105	0.049225667	-0.009174312	0.9771831	0.059077855	4.76E-01
106	0.049225667	-0.009174312	0.9771831	0.059077855	4.76E-01
107	0.062952487	-0.009174312	0.2376676	0.14794886	4.41E-01
108	0.080155847	-0.009174312	0.2376676	0.183236959	4.27E-01
109	0.000427956	-0.009174312	0.1320226	0.026427113	4.89E-01
110	-0.396967249	-0.009174312	0.319836	-0.685703241	7.54E-01

spatially correlated to each other. A negative value of the statistics indicates that the two neighboring districts are not spatially related to each other, i.e. they have dissimilar values of poverty. Statistical significance is set at the 95 percent confidence level. P-value less than 0.05 shows that the spatial dependence between the two districts is significant. Results of the above table show that local Moran's I is significant for 39 pairs of districts where as the I statistic is insignificant for 71 pairs of districts. It implies that 39 pairs of districts are spatially correlated and 71 districts are not spatially correlated. For further analysis about spatial impact, we can also check the spatial cluster pattern on the basis of LISA, and Moran's scatter plot which are given below.

Moran scatter plot for the dependent variable is also used to detect local spatial pattern in a variable. The Moran's statistic together with a scatter plot, namely Anselin's Moran scatter plot which is designed to visualize the type and strength of the spatial autocorrelation on the basis of the slope of the regression line corresponds to the value of the Moran's I. Standardized value of the variable is displayed on the x-axis whereas standardized spatially lag of the same variable is taken on the y-axis of the scatter plot.

Figure 3.1. Moran scatter plot for the Dependent Variable (POVERTY)



The above scatter plot represents four quadrants each indicating four types of spatial association:

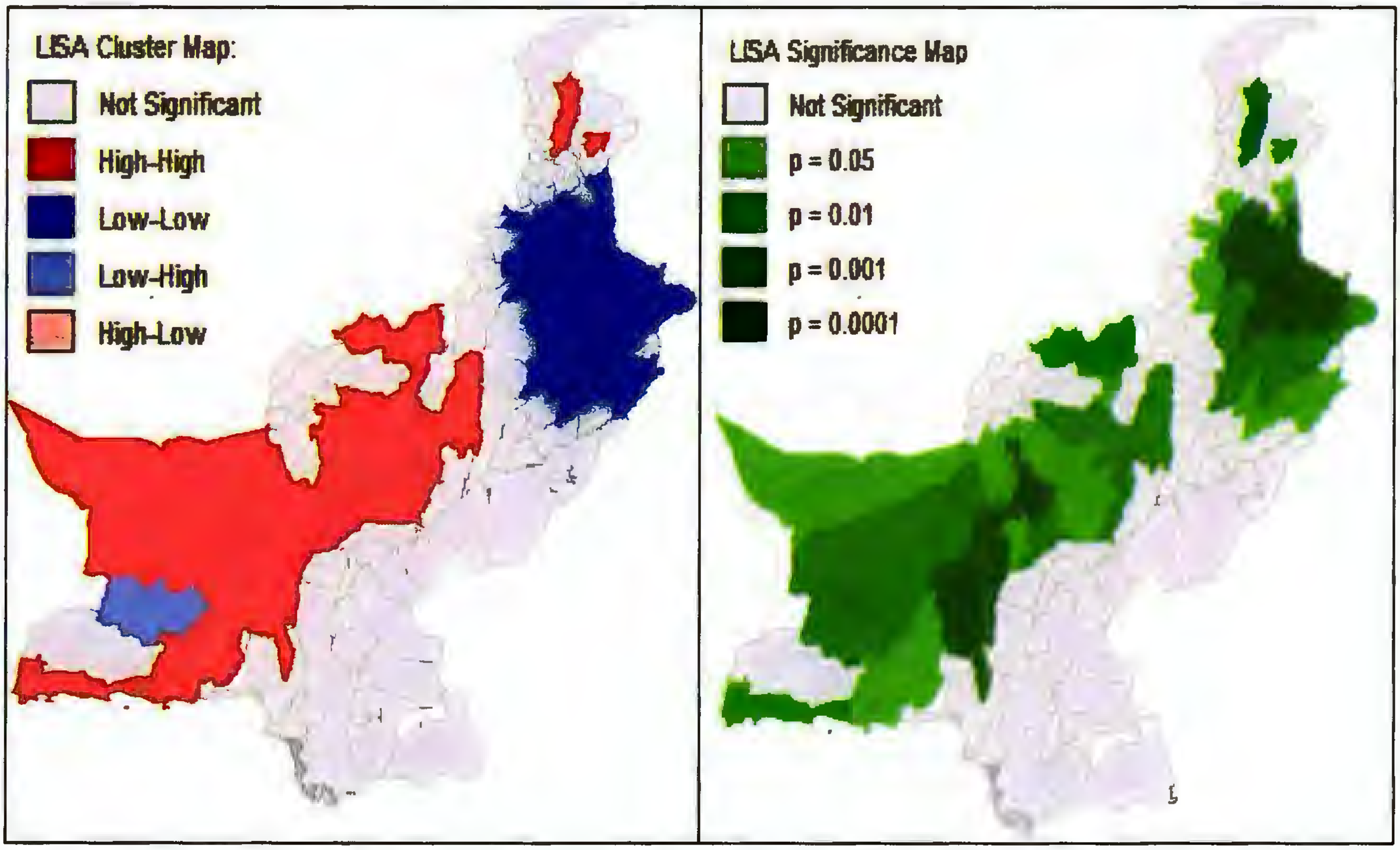
- Quadrant I: Districts with high value of poverty surrounded by the district with high value of poverty;
- Quadrant II: Districts with low value of poverty surrounded by the district with high values of poverty;
- Quadrant III: Districts with low value of poverty surrounded by the district with low values of poverty;
- Quadrant IV: Districts with high value of poverty surrounded by the district with low values of poverty.

Points lying in quadrants I and III represent those districts which have spatial dependence. Since most of the points lie in these two quadrants, it requires spatial econometric modeling of the phenomenon. Global Moran I test statistic= 0.611 with its P value as 0.000. this shows that overall spatial autocorrelation in district-wise poverty of Pakistan exists.

According to Anselin, L. (2013), observations fall into these four types of spatial association can be plotted in Local indicator of spatial autocorrelation (LISA) cluster map which is also used as an indicator of local spatial association. LISA clustered map of district-wise poverty in Pakistan is presented in Figure 3.2.

Results of the map represent spatial patterns with five categories represented by different colors Anselin, L. (2013). The significance map shows the locations with significant local Moran statistics in different shades of green. P value less than or equal to 0.05 shows the significance of spatial patterns. On the basis of LISA cluster map, the following five types of cluster patterns show in district-wise poverty in Pakistan. (i) "High-High" indicates higher values of poverty surrounded by neighboring districts with higher values of poverty and it implies that there is positive spatial autocorrelation. (ii) "Low-High" indicates low values of poverty index adjacent to neighboring districts with higher poverty values and it implies that there is negative spatial autocorrelation. (iii) "Low-Low" indicates lower values of poverty surrounded by neighboring districts with lower poverty values and it implies that there is positive spatial autocorrelation. (iv) "High-Low" indicates higher values adjacent to neighboring units with lower values and it implies that there is negative spatial autocorrelation. (v) "Not Significant" indicates that there is no statistically significant spatial autocorrelation. The High-High

Figure 3.2. Lisa Cluster Map and Significance Map



and Low-Low locations (positive local spatial autocorrelation) are typically referred to as spatial clusters, while the High-Low and Low-High locations (negative local spatial autocorrelation) are termed spatial outliers.

the apparent clustering of poverty rates indicates that the data are not randomly distributed, but instead follow a systematic pattern. The spatial clustering of variables, and the possibility of omitted variables that relate to the connectivity of neighboring localities, raise model specification issues.

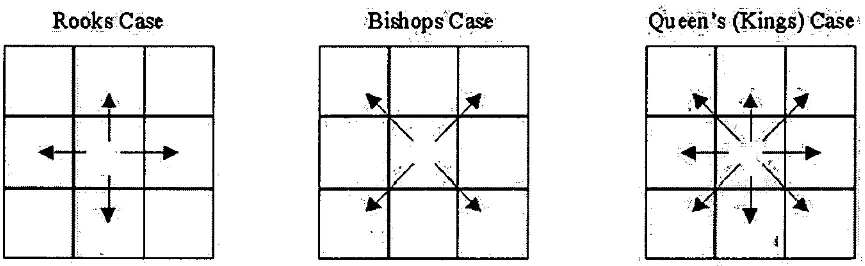
The LISA cluster map with its significance map and Moran scatter plot recommend spatial regression analysis of the phenomenon. Because they show that a positive spatial dependence (spatial autocorrelation) are exist. It implies that we have to move to estimate spatial regression model to get valid estimates in this study. Three main types of spatial econometrics models, spatial lag model or spatial autoregressive model, spatial error model, and the spatial general model is the combination of spatial lag and spatial error model. For the selection of the model can be use the langrage multiplier test and it also be used for detecting the spatial dependence. Before estimation of a spatial regression model, Global Moran I test is applied on the residual of the general linear model (OLS).

In spatial context, the Moran's I is a measure of spatial dependence or spatial autocorrelation developed by Patrick Alfred Pierce Moran (1950). Spatial autocorrelation is characterized by a correlation in an indication among nearby location in geographical space. The test statistics of the Moran's I as follows.

$$I = \frac{N}{W}\frac{\Sigma_i \Sigma_j w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\Sigma_i (x_i - \bar{x})^2}$$

Where N represent the number of spatial observation (unit) indexed by i and j, where x is the variable of interest, the representative the mean of x is $\bar{x}$, *where* w_{ij} is the spatial weight matrix with the diagonal on zeroes. The null hypothesis of the Moran's I test statistics of no spatial auto correlation. For the Moran's I test statistics the spatial weight matrix is very necessary.

Here we can shortly describe the Spatial weight which are denoted by W where $W=[w_{ij}]$ the w_{ij} mean spatial link matrix, if we have $w_{ij} \geq 0$ it means that i and j are spatially connected, in this situation $i \neq j$. If $w_{ij}=0$ it means that the observations (location) are not spatially connected because $i=j$. Furthermore, the weight matrix is squared symmetric matrix. It's construction on the basis of contiguity criteria which are rook (share the edges), bishop (share the corners), and queen contiguity (share the both). The detail information regarding contiguity criteria is given in the chart.



the complete format of the spatially weight matrix as follows.

$$W = \begin{bmatrix} 0 & w_{12} & \cdots & w_{1n} \\ w_{21} & 0 & \cdots & w_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ w_{n1} & w_{n2} & \cdots & 0 \end{bmatrix}$$

then finally we can transform the spatial weight matrix W to row standardized matrix, as follows.

$$W = \frac{w_{ij}}{\Sigma_j w_{ij}}$$

The spatial weight matrix W can measure the similarity, for example connectivity. And dissimilarity (distance). On the basis of data in 2009, District-wise spatial weight matrix of

Pakistan economy is presented in Appendix. Different types of spatial regression models are explained below.

Firstly, spatial Autoregressive model can be considered. Spatial lag dependence in a regression setting can be modeled similar to an autoregressive process in time series. Formally,

$$y = \rho Wy + X\beta + \varepsilon \tag{3.6}$$

The presence of the term Wy induces a nonzero correlation with error term, similarly to the presence of dependent variable, but different from the time series context. Contrarious to time series, $[Wy]_i$ is always correlated with ε_i irrespective of the structure of the errors. This implies that OLS estimates in the non-spatial model will be biased and inconsistent Anselin and Bera (1998). Secondly, Spatial error model is considered as another way to model spatial autocorrelation in regression model whose specification is as follows.

$$y = X\beta + \varepsilon \tag{3.7}$$

With $$\varepsilon = \lambda W\varepsilon + \mu$$

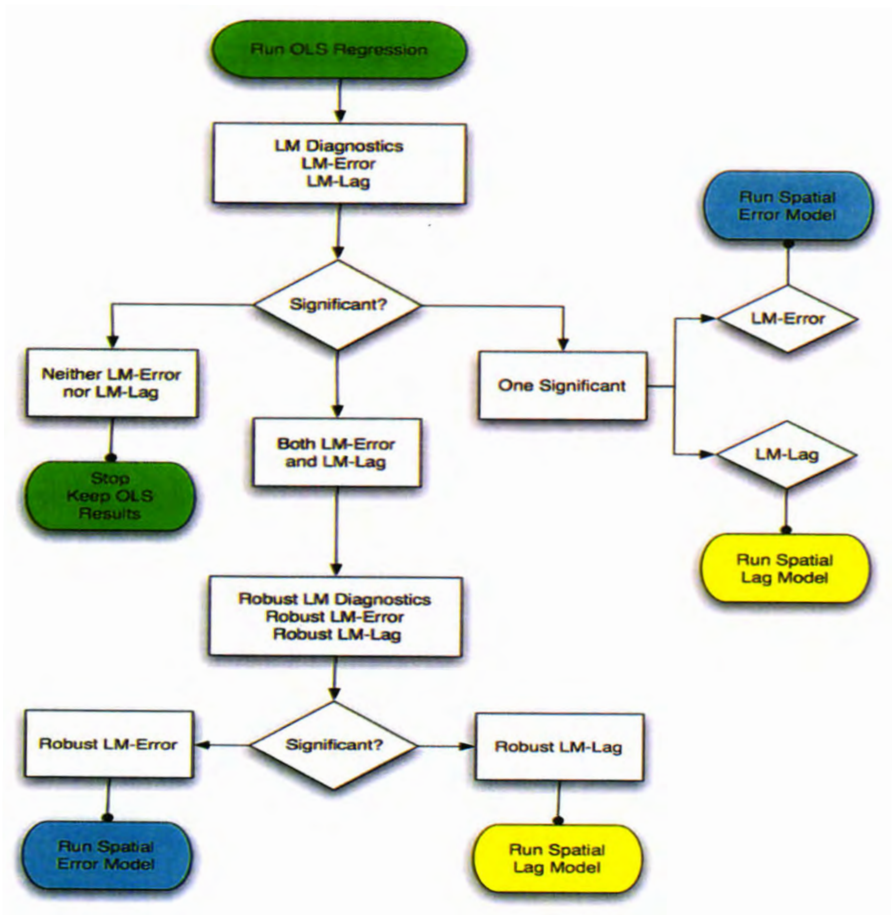
Thirdly, the general spatial model (SAC) aerie or (nests) of the both the spatial autoregressive model (SAR) and the model of the spatial error (SEM). If in the langrage multiplier result can only rho or lambda positive and significant then the spatial lag or spatial error model should be selected as the appropriate spatial model. If both spatial parameter rho and lambda are significant then we should be select the more significant parameter. If both are insignificant then we can move spatial general model (SAC). Which are given below.

$$y = \rho Wy + X\beta + \varepsilon \tag{3.8}$$

Where $$\varepsilon = \lambda W\varepsilon + \mu$$

LeSage (1999) presents multiple techniques for selecting appropriate specifications of spatial models. Since the spatial general model (SAC) is the combination of the spatial autoregressive model (SAR). we estimate first spatial general model. If both the spatial parameter (ρ, λ) are significant and positive then the spatial autoregressive model should be select. If only lambda or rho is significant and positive, then the SEM (the SAR) should be chosen as the appropriate spatial model. According to (Anselin, L (2004)) model is selected on the basis of LM test applied to spatial lag model and spatial error model. The decision process is explained in Figure 3.3.

Figure 3.3. The Spatial Regression Decision Process



3.5. Conclusion

We conclude that the most important thing which are occurring the spatial impact, in this circumstance we cannot analyze the OLS Regression because it gives biased and insignificant results, the second, selection of the spatial regression model by Lagrange Multiplier test or (The Spatial Regression Decision Process). Furthermore, accordance to the LISA map and Moran's scatter plot and its result suggest that there is a strongly spatial clustering, the interpretation of Moran's, I test, as well as regarding the spatial weight matrix. we are also some discussed regarding, data, definition of variables, model specification, and theoretical background regarding the infrastructure and poverty.

Chapter 4

Results and Discussion

4.1. Introduction

This chapter presents estimation results along with discussion. Second section contains estimation results of General Linear Regression model and Moran I test. Second section presents results of spatial econometric models. The best model is selected and its estimates are interpreted. The last section contains summary of the results.

4.2. Estimation Results of OLS

As a first step, the specified model in equation 3.3 is estimated as General Linear Regression model by employing Generalized Least Square method. Estimation results are presented in Table 4.1. Some diagnostic tests are applied to establish validity of the estimate d model. Results of these diagnostic tests are given in Table 4.2. The condition number of multicollinearity is show that there is no collinearity among the variables as its estimated value is less than 30. BP test show that there is the problem of heteroscedasticity, while the JB test indicate the problem of non-normality. Further the R-squared and F-test are suggesting that the model is valid. Moran's, I provide a significance result which indicate the presence of positive spatial dependence (spatial auto correlation) among the regression residuals. since we have found the significant result of the Moran's, I test which show a positive spatial autocorrelation in the residuals. The test which are show a positive spatial autocorrelation in the residuals, So, the OLS model is not satisfactory because a strong and significance positive spatial autocorrelation. we have clearly indication of a spatial regression models as an alternative

Table 4.1. Results of OLS

Coefficient	Estimate	S. E	t values	p values
Intercept	0.342867	0.012502	27.425	< 2e-16 ***
Income	-0.041458	0.116747	-0.355	0.723255
Finance	-0.018822	0.010733	-1.754	0.082553.
Physical 1	0.012480	0.010521	1.186	0.238341
Physical 2	-0.022715	0.017416	-1.304	0.195121
Health	-0.007277	0.014639	-0.497	0.620225
Energy	-0.065717	0.020275	-3.241	0.001617 **
Communication	-0.032353	0.016259	-1.990	0.049336 *
Education For G	-0.088205	0.020741	-4.253	4.76e-05 ***
Education For B	0.071442	0.019488	3.666	0.000397 ***

Table 4.2. Diagnostic Results of the model estimated by OLS

Test	Value	P-value
R-squared	0.7628	
F-statistic	35.74	< 2.2e-16
Breusch-Pagan	24.55	0.003511
JarqueBera	9.8378	0.007307
Multicollinearity condition number	6.567765	
Moran's, I	1.9013	0.02863
LM-error	1.4157	0.2341
LM-lag	4.01	0.04523

frame work. We have clearly signal of a spatial regression models as another frame work. Lagrange multiplier test is also applied to test spatial impact in residuals of the above estimated model. The results are presented in Table 4.2 which show that LM test statistic is significant for Spatial Lag model whereas LM statistic is insignificant for spatial error mode. However, we estimate the three spatial models, i.e. spatial lag model, spatial error model and spatial General model. Then selection of the model is done on the basis of significance of the parameters representing spatial impact.

4.3. Estimation Results of Spatial Econometric models

As Moran's I test shows that spatial dependence exists in the model, it implies that we have to estimate spatial econometric model. Three types of spatial econometric models are estimated by using maximum likelihood method. Spatial Lag model, spatial error model and spatial general model is estimated and the results are presented in Table 4.3, Table 4.4 and Table 4.5 respectively.

Table 4.3. Results of Spatial Lag model

Coefficient	Estimate	Standard Error	Z-values	P-values
Intercept	0.2754871	0.0324184	8.4979	< 2.2e-16
Income	-0.0903676	0.1092486	-0.8272	0.4081384
Finance	-0.0215988	0.0101175	-2.1348	0.0327771
Physical 1	0.0076511	0.0098428	0.7773	0.4369681
Physical 2	-0.0032103	0.0175081	-0.1834	0.8545134
Health	-0.0077456	0.0137150	-0.5648	0.5722399
Energy	-0.0660891	0.0190476	-3.4697	0.0005211
Communication	-0.0267006	0.0151994	-1.7567	0.0789720
Education For G	-0.0815830	0.0194540	-4.1936	2.745e-05
Education For B	0.0715670	0.0181447	3.9442	8.006e-05
Rho (ρ)	0.20769			0.0232
AIC	-201.91			
BP-test	30.167			0.0004108
JB-test	13.478			0.001184

Table 4.4. Results of Spatial Error Model

Coefficient	Estimate	Standard Error	Z-values	P-values
Intercept	0.34536186	0.01390678	24.8341	< 2.2e-16
Income	-0.07795717	0.11481019	-0.6790	0.4972
Finance	-0.01739132	0.01008833	-1.7239	0.0847
Physical 1	0.00679635	0.01052040	0.6460	0.5182
Physical 2	-0.01443035	0.01783236	-0.8092	0.4183
Health	-0.00010598	0.01387321	-0.0076	0.9939
Energy	-0.07865997	0.02053254	-3.8310	0.0001
Communication	-0.02712072	0.01619098	-1.6751	0.0939
Education For G	-0.08232973	0.02089469	-3.9402	8.141e-05
Education For B	0.06415711	0.01879631	3.4133	0.0006
Lambda (λ)	0.23509			0.15155
AIC	-199.59			
BP-test	26.348			0.001791
JB-test	8.4782			0.01442

Table 4.5. Results of Spatial General Model

Coefficient	Estimate	Standard Error	Z-values	P-values
Intercept	0.2713623	0.0445852	6.0864	1.155e-09
Income	-0.0884621	0.1091781	-0.8103	0.4177
Finance	-0.02181855	0.0102269	-2.1331	0.0329
Physical 1	0.0078855	0.0098282	0.8023	0.4223
Physical 2	-0.0030255	0.0185780	-0.1629	0.87063
Health	-0.0085473	0.0137852	-0.6200	0.5352
Energy	-0.0646879	0.0190712	-3.3919	0.0006
Communication	-0.0266966	0.0151866	-1.7579	0.0787
Education For G	-0.0816341	0.0194779	-4.1911	2.776e-05
Education For B	0.0721781	0.0180749	3.9933	6.516e-05
Rho (ρ)	0.21942	0.13024	1.6848	0.092033
Lambda (λ)	-0.027874	0.20022	-0.13922	0.88928

Diagnostic tests of spatial lag model presented in Table 4.3 can be interpreted as follows. Rho parameter represents lag spatial impact which is significant. It indicates that there is significant spatial dependence or autocorrelation among the observation of the dependent variable. The AIC is lower than linear model, indicating a better model fit than general linear model. The BP-test shows that errors are heteroskedastic. Breusch-Pagan test a lso indicates heteroskedasticity in the residuals. Results of diagnostic tests for spatial error model in Table 4.4 can be interpreted as follows. Lambda parameter representing spatial impact in errors is insignificant which indicates no spatial dependence in the error term of the model. The AIC show that the spatial error model is better fit than general linear model, but not if we compare the result of AIC to AIC of the spatial lag model. Errors are declared as heteroskedastic on the basis of BP. Table 4.5 contains results of spatial general model. Both of the parameters representing spatial impact are insignificant. On the basis of both Lag range's Multiplier test as well as significance of spatial parameters, spatial Lag model is selected as the best model in order to capture spatial impact for the phenomenon under consideration in this study.

However, estimation results of spatial lag model presented in Table 4.3 cannot be valid as there is the problem of endogeneity in the sense that the spatial lagged term W_Y is correlated with the disturbance term, thus reveal the endogeneity issue. To tackle endogeneity problem, Spatial lag model is estimated by using 2SLS and the results are presented in Table 4.6.

Table 4.6. Results of Spatial Lag Model By 2SLS

Coefficients	Estimate	S. E	t values	p values
Rho	0.3764873	0.1366646	2.7548	0.0058723
Intercept	0.2207254	0.0460052	4.7978	1.604e-06
Income	-0.130118	0.1190609	-1.0929	0.2744503
Finance	-0.0238554	0.0106956	-2.2304	0.0257213
Physical 1	0.0037264	0.0108075	0.3448	0.7302443
Physical 2	0.0126420	0.0213805	0.5913	0.5543270
Health	-0.0081269	0.0143764	-0.5653	0.5718761
Energy	-0.0663919	0.0199085	-3.3349	0.0008534
Communication	-0.0221066	0.0163915	-1.3487	0.1774439
Education For G	-0.0762007	0.0208255	-3.6590	0.0002532
Education For B	0.0716688	0.0191342	3.7456	0.0001800
JB-test	16	2		3e-04

The above table shows that estimate of spatial autoregressive coefficient (ρ) of the spatially-weighted lag Poverty is 0.376 and is significant ($p < 0.005$). it implies that there is significant positive spatial dependence between the districts w.r.t. poverty in Pakistan. Hence, the estimated spatial econometric model may be considered as valid model. Other estimates may be interpreted as follows.

Coefficient of income infrastructure is insignificant for district poverty, but its negative sign implies that it may help to reduce poverty. Coefficient is insignificant due to the reason that there are usually small industries in rural areas which are not playing significant role in creating employment opportunities. Most of the people residing in rural areas depend upon agriculture, forestry or public sector employment. Coefficient estimate of financial infrastructure is significant and its sign is negative. It implies that development of financial infrastructure in rural areas significantly helps to reduce poverty level. It is because their educations in rural poverty linked to increased credit (commercial bank and online bank) provision in rural areas. these findings suggest that the central banks (state bank of Pakistan) licensing policy enabled the development of an extensive rural branch network, and that this, in turn, allowed rural households to better accumulate capital and to obtain loans for longer term productive investments. Coefficient estimates of both types of Physical infrastructure are insignificant with positive signs. It shows that physical infrastructure including: piped supplied, filtration, sewerage, toilet, bricked street, and bricked drains facilities seems to have no role in reducing poverty level in Pakistan.

Parameter's estimate of health infrastructure is insignificant with negative sign. It implies that rural health infrastructure like hospital and basic health units, is not playing significant role to reduce poverty. It may be that there is lack of access to basic health care services, lack of health infrastructure. In the rural areas, people live far from hospitals and basic health care units. It is for this reason that most women give birth at home with the assistance of a midwife or lady health worker. Illness pushes the people into poverty through lost wages, high spending for treatment and recurring treatment for their illnesses. Coefficient' estimate of Energy infrastructure is significant with negative sign. It can be interpreted that development of energy infrastructure in rural areas significantly affects poverty reduction in Pakistan. It is because electrification of villages assists with poverty reduction when combined with, manufacturing, lighting, irrigation, refrigeration, health care, education, drinking water, farm mechanization and post-harvest processing.

Coefficient estimate of communication infrastructure is insignificant and its sign is negative. It implies that communication infrastructure in rural areas like metal road and transportation is not playing significant role for poverty reduction in Pakistan. It is due to the lack of communication infrastructure and less quality of metal road, transportation; in rural areas may does not completely help to reduce the poverty.

Coefficients' estimates of education infrastructure for boys and for girls are significant. However, sign of education infrastructure for boys is positive whereas sign of education infrastructure for girls is negative. It implies that education infrastructure like schools, colleges and other professional educational institute significantly affect poverty in Pakistan. However, development of education infrastructure for girls in rural areas significantly helps to reduce district-wise poverty. Positive sign of education infrastructure for boys implies that it causes to raise district-wise poverty level. It is because most of educated males shift their families from rural areas to major cities of Pakistan. The reason is that rural areas are not provided modern facilities of life. Young educated persons prefer to migrate from rural to urban areas due to lack of job opportunities because introduction of labor saving devices in agriculture and bad weather condition has decreased the demand for labor in the agriculture sector. Another one reason for this pattern of migration is that many educated males desire to expand their experiences they may wish to exposed to a greater variety of opportunities, people, culture, art, food, and entertainment. The variety they desire may not be as widely or conveniently available to them in their rural areas as in a city in their country. The migration of educated males from rural areas to urban areas has detrimental effects on the rural economy. on the other side, most of educated females live their life in home towns and they play their role in economic activities which help to reduce poverty level of those areas.

4.4. Conclusion

In this chapter, we conclude that the spatial autocorrelation exists in the sample data on the basis of Moran's I, the LM (test) are utilized for model selection which are spatial autoregressive SAR model selected. The SAR provides better results than OLS, SEM, SAC, but the problem of endogeneity is occurred. So finally, the spatial lag model done by 2SLS method. In particular, it conforms that the percentage of income, physical 1, physical 2, health, communication, have no significant effects on the poverty. The variables of FINANCE, ENERGY, and EDUCATION FOR G, negatively significantly effect on Poverty, while the EDUCATION FOR B are positively significant means that the poverty is increasing in rural area, in the sense that urban areas have more opportunities for educated males as a result they move to urban areas.

Chapter 5

Summary, Conclusion, And Further Research Work

In this chapter, we are going to write down the conclusion, summary, finding of the study, policy implication, of all these research work and further research work. This study is comprising into five chapters. Chapter 1 provides the explanation of our topic and objectives of our study. The core objective of our thesis, to determine the role of physical, health, and education capital in eradication district wise poverty in Pakistan by analyzing spatial analysis, and predict the districts wise spatial pattern of poverty in Pakistan is the estimation of best spatial regression model, the concluding remark about this chapter is that to identified the linkage between the infrastructure and poverty in rural areas of Pakistan.

In chapter 2, are discussed regarding the primary concept of poverty and its link with rural infrastructure, except that existence of a linkage among the reduction of the poverty and rural infrastructure. conducted in developing and developed countries, have undertaken a number of studies to address these issues. However, no studies have yet been found to explore this issue in Pakistan at the districts wise by spatial analysis. In the case of Pakistan, there is no empirical research on this issue, the proposed research is justified. This study provides insight into the role of infrastructure in rural areas of poverty reduction. Furthermore, discussion in this chapter regarding the spatial econometrics analysis for determining the neighboring impact, and clustering of the poverty. for more utilizing this technique is very necessary when we dealing about areal wise data.

In chapter 3 we are discussed regarding the specification of the model, interpretation of indices, these indices are poverty index (is the dependent variable), communication, physical, energy, health, education, and financial infrastructure index. Furthermore, about this chapter are the interpretation of the variables, Motivation for using spatial analysis, spatial econometrics models, and Data source, material and methodology. other than that, the transformation of simple regression to spatial regression. In this transformation, the result of the LISA cluster map, Moran's scatter plot, and local Moran's I statistics is the main contribution. Furthermore, the decision rule for the selection of the best spatial models. Further discussion about the connection between the rural infrastructure and poverty incidence.

Chapter 4, Reveals the result and discussion, we analyzed that if the data are areal wise or geocoded then it is necessary to deal kind of this data by spatial analysis. our results are suggesting that the spatial autocorrelation exists in the sample data according to global Moran's I, statistics and Lagrange Multiplier also telling us about spatial dependence, but for our purpose LM (test) are utilized for model selection which are selected the SAR model. The spatial autoregressive model provides better results than OLS, but the problem of endogeneity is occurred. So finally, the spatial lag model done by two stage least square technique.

From the final result, we analyzed that the indication of positive and significant spatial autoregressive coefficient Rho (ρ) denotation that a higher level of Poverty in a Districts significantly increases Poverty in the neighboring Districts of Pakistan. Therefore, there exists a positive spatial interaction between Districts Poverty of surrounding regions. Furthermore, we concluded from the interpreted coefficients.

The coefficient of the infrastructure for income is not significant for poverty in the regions, but it is negative. indicates that it may help to reduce poverty. The coefficient is insignificant given that small industries are usually in rural areas that do not play an important role in job creation.

Estimate of the financial infrastructure coefficient is significant, and a negative sign. This means that the financial infrastructure development in rural areas helps significantly reduce the level of poverty. because the reductions in rural poverty are associated with increased credit facilities (commercial banks and online banks) in rural areas.

Estimates of the coefficient of both types of physical infrastructure are not significant and a Positive sign. Physical infrastructures, including piping, filtration, drainage, toilet and brick streets, and built-up sanitation facilities appear to have no role in minimizing the rural Poverty in Pakistan.

The parameter estimation of the health infrastructure is insignificant with a negative sign. This means that rural health infrastructure such as hospitals and basic health units do not play an important role in poverty reduction. Due to the lack of health facilities and males, females stop.

Estimate of the coefficient of energy infrastructure is significant with a negative sign. It can be explained that the development of rural energy infrastructure has a significant impact on poverty reduction in Pakistan.

Coefficient estimate of communication infrastructure is insignificant and its sign is negative. This means that rural communication infrastructure such as road and road transport does not play an important role in poverty reduction in Pakistan.

Estimates of the coefficient of education infrastructure for boys and for girls are significant. However, the sign of education infrastructure for boys is positive, while the reference to girls' educational infrastructure is negative sign. The reason is that rural areas are not provided modern facilities of life for educated persons. Because, Young educated persons prefer to migrate from rural to urban areas and also may be this reason, due to lack of job opportunities.

From the above discussion, we are able to make some recommendations to ensure that poverty in rural areas of Pakistan is reduced through expansion of the facilities of infrastructure. The Specific policy and recommendations are set out below.

1. if government should give the opportunity, industries creation, and other source of income to rural areas. Then the educate people should never be migrate to urban areas,
2. our research work suggests that the financial, energy, and social infrastructure is strongly negative and significant impact on poverty, so it is necessary for the government of Pakistan to increase these infrastructure in rural areas.

For Further Research, this work can be extended to Bayesian spatial econometrics. furthermore, spatial panel model, Bayesian spatial model, spatial statistics, and Bayesian spatial statistics, is my next ambition.

Appendix

Table: A: Neighboring pattern of Districts

DISTRICTS	DISTRICTS NAMES	Serial numbers of neighboring districts
1	Quetta	2,4,6,9
2	Pishin	1,3,9,10,13
3	Qilah Abdullah	2,13
4	Nushki	1,5,20,21,14
5	Chagai	4,24,25
6	Sibi	1,7,9,10,17,20
7	Kohlu	6,8,10,12,17,82
8	DeraBugti	7,15,16,17,82,108,109
9	Ziarat	1,2,6,10
10	Loralai	2,6,7,9,11,12,13,14
11	Musakhel	10,12,14,82
12	Barkhan	7,10,11,82
13	Qila Saifullah	2,3,10,14
14	Zhob	10,11,13
15	Jafarabad	8,16,18,108
16	Nasirabad(At deramurad)	8,15,17,18
17	Bolan	6,7,8,16,18,20,21,22
18	JhalMagsi	15,16,17,22
19	Lasbela	22,23,27,92,93,110
20	Mastung	1,4,6,17,21
21	Kalat	4,17,20,22,24,25
22	Khuzdar	17,18,19,21,23,25,92
23	Awaran	19,22,25,26,27,28
24	Kharan	4,5,21,25
25	Washuk	5,21,22,23,24,28
26	Kech(Turbat)	23,27,28
27	Gwadar	19,23,26
28	Panjgur	23,25,26
29	Peshawer	30,31
30	Nowshera	29,31,32,33,34,55
31	Charsadda	29,30,32,52
32	Mardan	30,31,33,48,52
33	Swabi	30,32,42,48,55
34	Kohat	30,35,36,55,74
35	Hango	34,36
36	Karak	34,35,39,40,74
37	D.I.Khan	38,40,74,75,82,84
38	Tank	37,40

DISTRICTS	DISTRICTS NAMES	Serial numbers of neighboring districts
39	Bannu	36,40
40	Lakimarwat	36,37,38,39,74
41	Abbottabad	42,43,54
42	Haripur	33,41,43,47,48,53,54,55
43	Mansehra	41,42,44,45,47
44	Battagram	43,45,47
45	Kohistan	43,44,46,47
46	Swat	45,47,48,49,50,51,52
47	Shangla	42,43,44,45,46,48
48	Buner	32,33,42,46,47,52
49	Chitral	46,50
50	Upper Dir	49,49,51
51	Lower Dir	46,50,52
52	Malakand	31,32,46,48,51
53	Islamabad	42,54
54	Rawalpindi	41,42,53,55,56,57
55	Attock	30,33,34,42,54,57,74
56	Jhelum	54,57,60,61,72,73
57	Chakwal	54,55,56,73,74
58	Gujranwala	59,60,61,62,63,67
59	Hafizabad	58,61,67,68,69,71,72
60	Gujrat	56,58,61,62
61	Mandi Bahauddin	56,58,59,60,72
62	Sialkot	58,60,63
63	Narowal	58,62,67
64	Lahore	65,67
65	Kasur	64,66,67,68
66	Okara	65,68,69,79,80,87
67	Sheikhupura	58,59,63,64,65,68
68	Nankana	59,65,66,67,69
69	Faisalabad	59,66,68,70,71,79
70	Toba Tek Singh	69,71,79,81
71	Jhang	59,69,70,72,73,75,81,84,85
72	Sargodha	56,59,61,71,73
73	Khushab	56,57,71,72,74,75
74	Mianwali	34,36,37,40,55,57,73,75
75	Bhakkar	37,71,73,74,84
76	Multan	77,81,85,86
77	Lodhran	76,78,81,86
78	Vehari	77,79,80,81,86,87
79	Sahiwal	66,69,70,78,80,81

DISTRICTS	DISTRICTS NAMES	Serial numbers of neighboring districts
80	Pakpattan	66,78,79,87
81	Khanewal	70,71,76,77,78,79,85
82	Dera Ghazi Khan	7,8,11,12,37,83,84,85,109
83	Rajanpur	82,85,88,101,109
84	Layyah	37,71,75,82,85
85	Muzaffargarh	71,76,1,82,83,84,86,88
86	Bahawalpur	76,77,78,85,87,88
87	Bahawalnagar	66,78,80,86
88	Rahim Yar Khan	83,85,86,101
89	Hyderabad	90,91,93,94,95,96,99
90	Badin	89,91,94,96,97,98
91	Thatta	89,90,93,94,110
92	Dadu	19,22,93,103,104
93	Jamshoro	19,89,91,92,95,103,110
94	TandoAllahyar	89,90,91
95	Matiari	89,93,99,103
96	Tando Muhammad Khan	89,90,97,99
97	Mirpur Khas	90,96,98,99
98	Tharparkar	90,97
99	Sanghar	89,95,96,97,102,103
100	Sukkur	101,102,107,109
101	Ghotki	83,88,100,109
102	Khairpur	99,100,103,104,107
103	Nawabshah	92,93,95,99,102,104
104	NaushahroFeroze	92,102,103
105	Larkana	106
106	Shahdadkot	105
107	Shikarpur	100,102,108,109
108	Jacobabad	8,15,107,109
109	Kashmore	8,82,83,100,101,107,108
110	Karachi	19,91,93

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