ESSAYS ON POVERTY AND SUSTAINABLE DEVELOPMENT

By

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PIDE 2017 FPHD ECO O4

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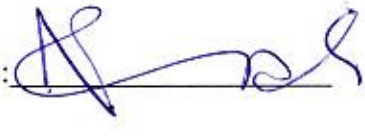
Students/Author Signature: 

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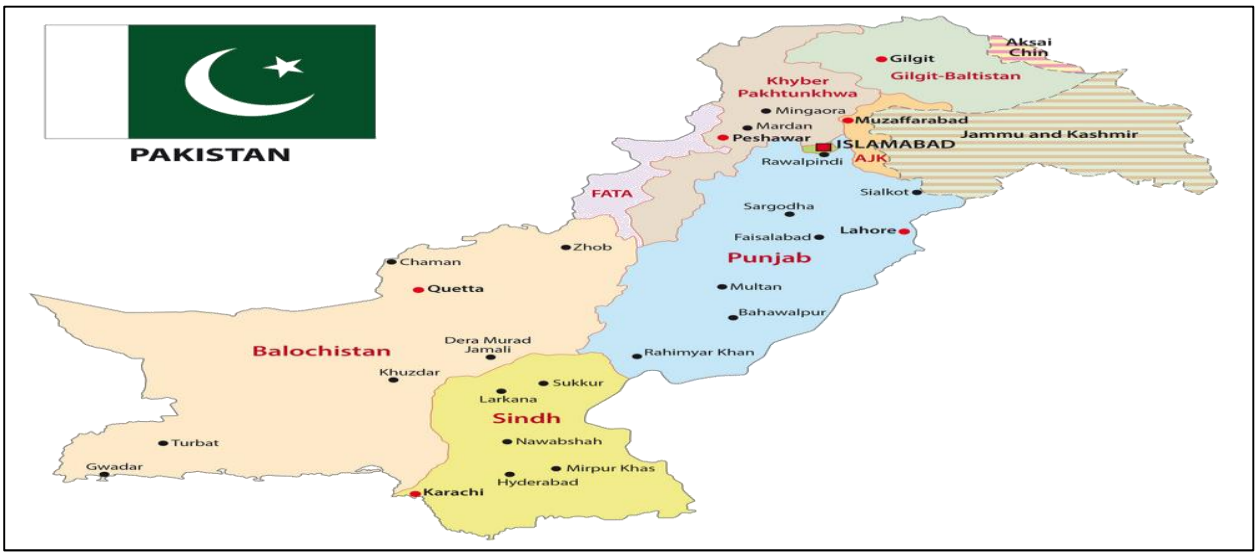
Dedication to

My beloved parents specially, Islam Din and Geo (My grandparents),Dr Abdul Khaliq (MBBS), Shaikh Abdul Hameed Siddiqui USA &Professor Rao Akhter Ali (Limelight personalities, great teachers and mentors).By the saying that

- Strength is the power and weakness is the problem. Take the risk, or lose the chance
- Life is not about expecting, hoping and wishing. It is about doing being and becoming. Continuous improvement is better than delayed perfection
- Work hard, stay disciplined and be patient, your time will come
- People with great passion determination can make the impossible possible. Pakistan is not a poor country but poorly managed country



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ABSTRACT

Primarily, the underlying dissertation keeps focus on three research essays on first three SDGs in Pakistan such as no poverty, zero hunger, and good health & wellbeing in Pakistan. First research essay aims at exploring the impacts of urbanization, and climate change on food insecurity in Pakistan. Second research essay investigates the influences of urbanization, and climate change on households' health outcomes, while third research essay maintains focus on exploring the effects of urbanization and climate change on multidimensional poverty in Pakistan. In all three essays, we have employed the latest round of the PSLM (2019-20), which is national and district representative. Moreover, this survey covers the dimensions and indicators of the SDGs as well. For empirical purpose, we have employed binary Logit, Ordered Logit, and instrumental variable approaches to estimate the aforementioned research objectives of the study.

The findings of first essay demonstrates that urbanization shows negative impacts on food insecurity. The negative sign explains the reduction in food insecurity, but coefficient was too little to carry any economic significance. Then, we use average rainfall and transportation facility as instrument of the urbanization. The findings of instrumental variable approach demonstrates that the impacts of urbanization becomes adverse and carries stronger impact. In addition, we introduced climatic shock as an explanatory variable; the findings highlight its negative impacts on household food insecurity, and it contains non-linear effects on food insecurity. The interactive term of both urbanization and climatic shocks are showing adverse impacts on food insecurity as we have found the case of instrumental variable approach. Likewise, findings from the second research essay also suggest the significant impacts of climatic variation and urbanization on household health demand. The health demand is measured by visit to doctor, types of hospital utilization, and what types of doctors he/she visited. Moreover, the findings from third essay indicates that climatic variables have adverse impacts on multidimensional poverty, but when it interacted with urbanization, we have found significant moderating impacts on multidimensional poverty in Pakistan. All these findings imply that Pakistan needs to design a comprehensive policy to tackle climatic vulnerability, and well-planed urbanization to achieve first three SDGs.

Keyword: SDGs, PSLM (2019-20), Food Insecurity, Health Demand, and MPI

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LIST OF ABBREVIATIONS

ADB	Asian Development Bank	PMD	Pakistan Metrological Depart
AR5	5th Assessment Report of Inter Government Panel on Climate chang	PIDE	Pakistan Institute of Develop Economics
BHC	Basic Health Centers	PSLM	Pakistan Social and Living Measurement Survey
CC	Climate Changes	SDGs	Sustainable Development Go
EIU	Economist Intelligence Unit	SA	South Asia
FS	Food Security	UNDP	United Nation Development Programme
FPC	Family Planning Centers	Ur	Urbanization
FIES	Food Insecurity Experience Scale	UN	United Nation
FAO	Food and Agriculture Organizations	US	United States of America
GFSI	Global Food Security Index	WB	World Bank
GHGs	Green House Gases	WFP	World Food Programme
GOP	Government of Pakistan	WHO	World Health Organization
HD	Health Demand		
HDI	Human Development Index		
IPCC	Intergovernmental Panel on Climate Change		
IV	Instrument Variable		
KPK	Khyber Pakhtunkhwa		
MDGs	Millennium Development Goals		
MM	Millimeter		
MPI	Multidimentional Poverty Index		
OLM	Ordered Logit Model		
PBS	Pakistan Bureau of Statistics		

The underlying Study explore the impact of urbanization and climate shocks on the above first three Sustainable Development Goals in the case of Pakistan.

CHAPTER 1

INTRODUCTION

1.1 Background

The Sustainable Development Goals (SDGs)[1] followed by Millennium Development Goals (MDGs) were committed by the United Nations in 2015. The SDGs seek to complete what the MDGs did not achieve(Charlton, 2016). The Global issues of health, food insecurity and poverty are the common themes in MDGs and their successors SDGs.Sustainable development goals (SDGs) are the framework of the present generation needs without compromising the future generation requirements. The idea of sustainable development is complex and multidimensional; SDGs cover 17 goals, 169 targets and 232 indicators. The goal of general welfare of the nation can be achieved through sustainable development because it is highly correlated with socioeconomic wellbeing. Sustainable Development Goals (SDGs) though ambitious but important agenda for the developing countries.

Out of total 17 SDGs, first four goals are considered unavoidably significant especially for developing countries such as no poverty (SDG-1), zero hunger (SDG-2), good health & wellbeing (SDG-3), and education for all (SDG-4). Primarily, aforementioned SDGs addresses the wellbeing of the households. According to World Bank (2021), virtually one billion people still lives below poverty line, while more than 800 million people do not have enough food to eat and millions of people who are

[1] https://www.undp.org/sustainable-development-goals/no-poverty?gclid=EAIaIQobChMI-7mMyY-p_QIVxO5RCh1G_AlWEAAYAiAAEgKnD_D_BwE

unable to meet good health due to unhealthy environment in developing countries like Pakistan (Ortygia, Kay, & Uhlenbrook, 2018).

Pakistan is among one of those countries, which have adopted the SDGs as its own national development agenda through a unanimous National Assembly Resolution in 2016. Along with parliamentarians, all heads and representatives of local government/administration gather in Islamabad on March 2017 for pledging the achievement of sustainable development agenda by 2030. Pakistan's performance in achieving MDGs prior to SDGs, which can be see through its global ranking. It places122th position out of 157 countries on index measured as baseline for SDGs (Khan and Ali, 2019). According to UNO (2021), Pakistan obtain 55.6 points out of 100 on SDGs global index. This score is lower than the regional (South Asia) average 63.3 points. Country wise comparison demonstrates that Bangladesh holds 56.2 points, whereas India's 58.1, which establishes Pakistan's relatively lower performance as compared to India and Bangladesh respectively due to multiple factors such economic crises, political instability, and demographics factors (World Bank, 2021).

1.2 Motivation of the Study

Despite decline in poverty (64 percent in 2000-01, and 18 percent in 2018-19), still it exists in multiple forms such as food insecurity, malnutrition, multidimensional poverty (MPI) and low level of Human Development Index (HDI). The MPI estimates demonstrate that at national level 38 percent households are suffering from multidimensional nature of poverty in terms of health, education and poor living standards, while provincial disparity in MPI is significantly prevalent—Baluchistan (71%), Sindh (60%), KPK (49%), and Punjab (32.5%) which showcase the higher MPI estimates among the provinces (GOP, 2018). Likewise, other measure of wellbeing is food security and nutrition. As estimates indicate that virtually, 48 percent of population

is food insecure, while 18 percent are victim of hunger (FAO, 2020). Moreover, child nutrition is also becoming one of the colossal challenges. In Pakistan, stunted children are observed 38 percent and childhood wasting is 7 percent. However, some slight improvement has been witnessed, as in 2012-13.45% of children were stunted which dropped to 38 percent in 2017-18, children wasting declined slightly from 11 percent to 7 percent while the prevalence of underweight children decline 30 to 23 percent (GOP, 2018).

Aforementioned estimates exhibit that Pakistan's people are withstanding the worst of MPI, food insecurity, and meager condition of health outcomes, which evidently highlight the complete failure to perform at achieving the first three SDGs. Such failure is reasoned by poor economic situation, political instability, idiosyncratic and covariate shocks (e.g.; Mustafa, 2022; World Bank, 2022; Mustafa et al., 2019; Ahmed et al., 2016). Nonetheless, global literature demonstrate that demographic factors and climatic shocks are also significant factors to influence the households' wellbeing such as rising urbanization, population density, weather shocks, and so on (Asfaw et al., 2017; IPCC, 2020; FAO, 2020). Country like Pakistan who is highly vulnerable to climate change, while it is facing hectic increase in urbanization is expected to be influencing by climatic shocks. Ahmed et al., (2016) has shown that households' wellbeing is being adversely affected by climatic shocks (Mustafa, 2022).

Nonetheless, available literature has no agreement on the effects of the urbanization. One strand shows positive and beneficial impacts of urbanization on households' wellbeing (Chen 2022). They have argued that increase in urbanization brings increase in about expansion in business activities, expansion in physical infrastructure, and employment opportunities, which have significant influences on food security, MPI, and health outcomes. Contrary to this, other strand of the literature

shows argues adverse impacts of urbanization on households' wellbeing. They justify by putting forth reasons that increase urbanization means migration from rural to urban areas reduces the share of agriculture and put pressure on building more health and education infrastructure may influence adversely in countries where the governments have limited financial and fiscal space, and poor political institutions (Abdul and Yu,2020).

In the context of aforementioned discussion, some important research questions arises which needs to conduct further research. Those research questions are outlined as follows.

i. What is the impact of rising urbanization on households' wellbeing in Pakistan given government's limited fiscal space?
ii. What is the impact of urbanization amid rising climatic vulnerability on households' wellbeing in Pakistan?

The underlying research has maintained focus on weaving up research. The detailed description of the research objectives of the study given as follows.

1.3 Objectives of this Study

Primarily, this dissertation comprises three separates but inter related essays on the impact of climate changes and urbanization on households' wellbeing, which are linked with first three SDGs (no poverty, zero hunger, good health and wellbeing) in Pakistan. The description these three research essays is weaved up as follows.

1.3.1 Essay -1: Impact of climate change and urbanization on food insecurity in Pakistan

The essay attempts to evaluate the impact of urbanization and climate shocks on food insecurity in Pakistan. Hence, the specified objectives of essay-1 are outlined as follows:

i. To evaluate the impact of urbanization on food insecurity.

ii. To evaluate the impact of climate change on food insecurity.

iii. To estimate the joint impact of climate change and urbanization on food insecurity.

1.3.2 Essay-2 Health Demand Determinants in Pakistan using Grossman Model

The main objective of this study is to measure the household's health demand in Pakistan. The specific objectives are outlined as follows.

i. To measure the household-specific determinants of health demand.

ii. To estimate the impacts of urbanization, and climatic variations on health demand

1.3.3 Essay-3 Multidimentional Poverty in Pakistan

The core objective of this essay is to evaluate the household multidimentional poverty in the context of urbanization and climate change in Pakistan, which are specified as follows.

i. To investigate the impact of urbanization on multidimensional poverty.

ii. To explore the impact of climate change on multidimensional poverty.

iii. To estimate the joint impact of urbanization and climate change on multidimensional poverty.

In short, the above-mentioned research objectives of this dissertation are to identify the set of key policies to promote sustainable development goals in Pakistan, which would be helpful to trace out the pathways to achieve food security, reduction in multidimentional poverty and to attain the goal of good health and wellbeing in Pakistan up to 2030.

1.4 Significance of the Study

The findings of available literature would provide pathways to achieve first three SDGs as we have discussed already. Apart from policy perspectives related to SDGs, the underlying dissertation contributes in existing literature on households' wellbeing and, climate change, and urbanization by identifying research gap. Firstly, district level analysis helps to localize the SDGs and provincial governments to allocate the resources to address poverty and sustainable development at particular areas at the gross root levels (Padda & Hameed, 2018). The available studies relating to SDGs have used national level data or provincial level and there is no study on the district level. This study is the first attempt to study SDGs at district level (localization of sustainable development goals) by using the recent data set of PSLM 2019-20. Secondly, the present study is an attempt to measure the impact of recent challenge of climate change (Pakistan is the fifth most vulnerable country in the World) and growing urbanization (Pakistan is the highest urbanization country in South Asia) on first three SDGs. The uncertain changes in nature i.e. Changes in precipitation pattern, extremely high and low temperature, cyclone, thunderstorms, variation in water level, purification of air, water and soil have huge effect on food insecurity, health demand and multidimentional poverty (Babar, Amin, & Sciences, 2014).

Previous literature ignores these important variables of climate change and urbanization when studying the household wellbeing. Thirdly, this study uses the new and recent survey data of PSLM 2019-20, in which the questioner of the survey is improved by international and local experts by measuring SDGs in a better way first time in PSLM history, included the area of FATA, better coverage of KPK and Baluchistan, which ignored in previous PSLM data sets. Fourthly, this study suggests some policy options

to improve the SDGs at local level with considering the impact of the new challenges of increasing climatic changes and rapidly growing urbanization in Pakistan.

No major attempts have yet been made in Pakistan at the district level to examine and analyses first three SDGs in a comprehensive manner with incorporating the effect of climate changes and urbanization. In this manner, this study answers the question; what is the impact of climate change and urbanization on first three SDGs independently and jointly at the household level in Pakistan? Moreover, research of this study might be helpful for the policy makers.

1.5 Organization of the Study

The dissertation is divided into 5 chapters. Chapter 1 is the introduction of the underlying study. Chapter 2 presents the over views of sustainable development goals in Pakistan, review of policies, expert opinion and findings of the study discuss with the stake holders.

Chapter 3 (Essay 1) comprises the introduction , the theoretical and empirical literature in the field of food security is explored, Develop a theoretical framework based on the objective of the essay 1,lays on econometric model based on the theoretical model and explain the empirical findings. In the last of the underlying essay, conclude the whole discussion and lays out some policy recommendations based on the findings.

Chapter 4 (Essay 2) comprises the introduction , the theoretical and empirical literature in the field of health demand is explored, Develop a Gross man health demand theoretical framework based on the objective of the essay 2,lays on econometric model based on the theoretical model and explain the empirical findings. In the last of the underlying essay, conclude the whole discussion and lays out some policy recommendations based on the findings.

Chapter 5 (Essay 3) comprises the introduction of the underlying essay , the theoretical and empirical literature in the field of Multidimentional Poverty is explored, Develop a theoretical framework based on the objective of the essay 3,lays on econometric model based on the theoretical framework and explain the empirical findings. In the last of the underlying essay, conclude the whole discussion and lays out some policy recommendations based on the findings.

CHAPTER 2

STYLIZED FACTS AND FIGURES: AN OVERVIEW OF SDGS IN PAKISTAN

2.1 Introduction

The paramount objective of the underlying chapter is to shed light on some stylized facts related to key SGDs— no poverty (SDG-1), zero hunger (SDG-2), good health & wellbeing (SDG-3), climate change and urbanization. Such facts provide the insightful picture of such issues, which Pakistan is facing. In addition, this chapter weaves up brief review of existing policies regarding these SDGs. Moreover, we have visited to the concerned departments and ministries to explore their opinion, and what actions are required to achieve aforementioned SDGs? Therefore, this chapter includes the key findings, which we derived from expert opinions.

Rest of the chapter is organized as follows: Section 2.2 describe the Pakistan's ranks on sustainable development index. Section 2.3, 2.4 and 2.5 explain food insecurity (SDG-2), health demand (SDG-3) and multidimentional poverty (SDG-1) in Pakistan respectively. Section 2.6 and 2.7 demonstrate the climate change and urbanization trends in Pakistan respectively. Section 2.8 present the national food security policy 2017, Section 2.9 and section 2.10 present national health vision 2018-2030 and climate change policy 2012 respectively. Section 2.11 deals with the policy makers and expert opinion, and stakeholders' assessment.

2.2 Pakistan Ranking on SDGs Index

According to sustainable development report of 193 UN member states, the overall performance of Pakistan is ranking on SDGs index has been continuously

decline since previous four years, 115th in 2016 and in 2019 down to 130th as displayed in the following figure below. At the same token, Pakistan most vulnerable country to the climate change in overall (fifth ranking) along with the most urbanized country in South Asia (36.4 urban population).In this context, measuring the impact of urbanization and climate change on first three SDGs in Pakistan is the important and interesting case study.

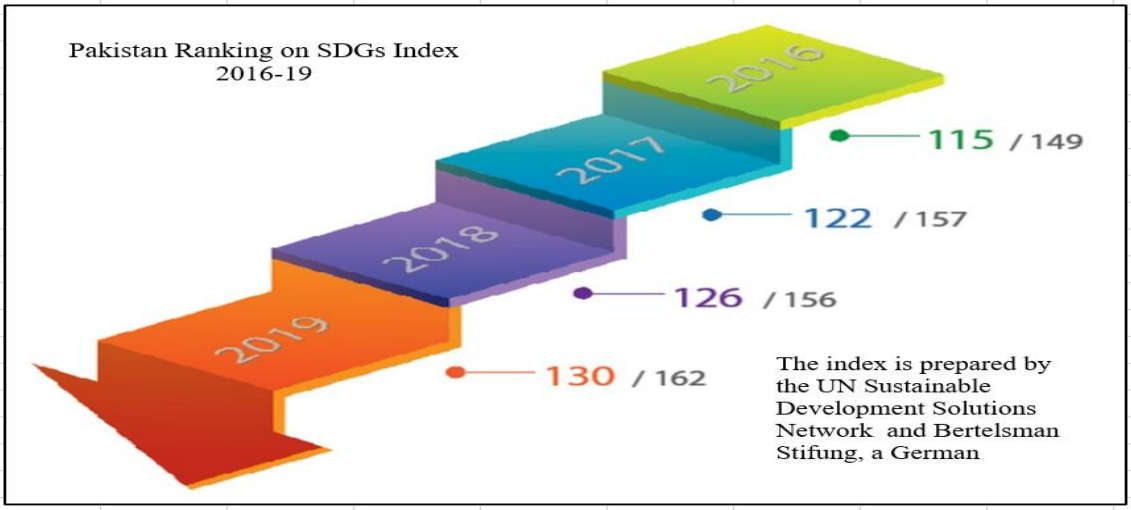


Figure 2.1: ***Pakistan ranks on SDGs ranking (2016-19)***

2.2.1 7th National Finance Commission Award, 18th Amendment and SDGs

After signing, the seventh NFC (National Finance Commission) bulk of resources has been shifted to provinces and by passing the 18th Constitution Amendments through which a wide range of fiscal responsibilities shifted from federal to the provinces. These developments gives the more autonomy to the provinces in performing the various functions such as provision of health and education facilities, infrastructure development and maintenance. Now SDGs have the remained part of the provincial government because 17 ministries including the food, education and health eliminated at federal level and shifted to provinces. Moreover, these amendments open door for greater access to capital finance by the provinces and transfer responsibilities

to provinces. Now such scenario, provinces have the more role to implement the Sustainable Development Goals. The status of first three SDGs in Pakistan along with the climatic and urbanization trends explain in the followings.

2.3 Food security in Pakistan (SDG-1)

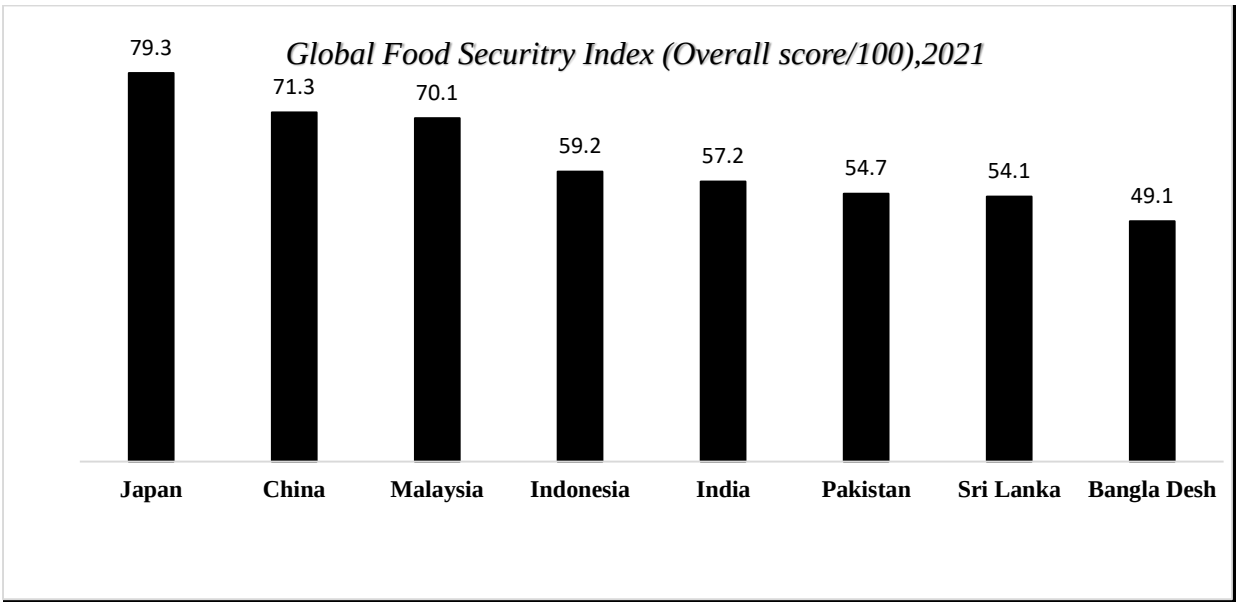
Pakistan is the lower middle-income country and it is World's 5th most populous country with 207.68 million population and it is expected 244 million in 2030, 33rd largest country by area with 881,913 square kilometer and 46th economic position with GDP 299 billion dollar.

Pakistan, is the World's largest food producer in some categories for example 8th in wheat production, 10th in rice production and 5th in production of milk (Sleet & Water Crises, 2020). Moreover, it is the agrarian and food surplus country in some crop but experience high level of food insecurity (according to World Food program 36.9 percent of population of Pakistan experience food insecure). The Global food security index (GFSI) presents the historical picture of food security. GFSI developed by The Economist Intelligence Unit (EIU) in 2012 and regularly updated on annually basis, it measures food security with considering all the four pillars of the food security of 113 countries all over the World. GFSI reports updates the state of food security situation all over the World. Table 2.1, displays the global ranking of food security of Pakistan 2013 to 2021.Lower rank shows the severity of food insecurity.

Table 2. 1 : ***Global Ranking of Pakistan of GFSI (2013 to 2020)***

Pakistan Rank in GFSI 2013 to 2020								
Year	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
GFSI(Ranking)	75th	77th	77th	78th	78th	77th	78th	80th
Overall Score	39.7	45.6	45.7	47.8	47.8	49.1	56.8	52.3
Regional Ranking with the components of food security in 2021								
Country	**Japan**	**China**	**Malaysia**	**Indonesia**	**India**	**Pakistan**	**SLana**	**Bangladesh**
GFSI(Ranking)	1st	6th	7th	13th	14th	16th	17th	22nd
Overall Score	79.3	71.3	70.1	59.2	57.2	54.7	54.1	49.1

Sourses:Different annualy reports of GFSI The Economist Unit (2013-2021



Sourses:Reports of GFSI The Economist Intelegence Unit,2021

Figure 2. 2: ***Regional Global Food Security Index, 2021***

Globally Pakistan ranked 75th in 2013 and it is still consistent on this rank up to 2019 as shown in table 2.1. In 2020, its rank declined to 80th position, which shows food security decreases 5 points in this year. In nine years 2013 to 2020, the overall score of food security lies between 39.7 in 2013 and 52.3 in 2020.The regional ranking of Pakistan is the 16th position behind the India. Moreover, increasing climatic shocks

and continuously growing urbanization make severity of the food security in the country.

2.4 Health in Pakistan (SDG-2)

This section examines and analyzes the health trends. Good health is vital to mankind's wellbeing and happiness that contributes significantly to prosperity and even economic progress, as health of the population is more productive, earns more income and lives longer (GOP, 2018).Access to good health plays a central role in socioeconomic development of the country.

2.4.1 Regional Comparison of Health Indicators

Socioeconomic factors such as health and education are closely related to Human Development Indicators. According to Pakistan Economic Survey 2020-21, Pakistan is improving slightly in health indicators (i.e., life expectancy, infant mortality rate, maternal Mortality ratio, under five-mortality rate and population growth) 2017 to 2019 but still behind the region. Life expectancy has increased from 66.9 years to 67.3 years. Infant mortality rate declines from 58.8 to 55.7 per 1000 live birth. Maternal mortality ratio has declined from 154.0 to 140.0 per 100, 000. Under five mortality rate declines from 71.6 to 67.2 per 1,000 and population growth declines from 2.0 to 1.9 percentage per anum over the three years 2017 to 2019 but still need a huge effort in the health sector. Comparative position over the three years seen in table 2.2.

Table 2. 2: ***Regional Comparison of Basic Health Indicators 2017 to 2019***

Country	Life expectancy at birth (years)			Infant mortality rate Per 1000 live birth			Maternal mortality ratio per 100,000			Under 5 mortality rate per 1000			Population growth in annual (%)		
	2017	**2018**	**2019**	**2017**	**2018**	**2019**	**2017**	**2018**	**2019**	**2017**	**2018**	**2019**	**2017**	**2018**	**2019**
Pakistan	66.9	67.1	67.3	58.8	57.2	55.7	154.0	143.0	140.0	71.6	69.4	67.2	2.0	2.0	1.9
Afghanistan	64.1	64.5	64.8	49.6	48.0	46.5	701.0	673.0	638.0	64.9	62.5	60.3	2.6	2.4	2.3
India	69.2	69.4	69.7	31.4	29.7	28.3	158.0	150.0	145.0	38.5	36.3	34.3	1.0	1.0	1.0
Bangladesh	72.1	72.3	72.6	28.0	26.7	25.6	200.0	186.0	173.0	33.9	32.3	30.8	1.1	1.1	1.0
Sri Lanka	76.6	76.8	77.0	6.7	6.4	6.1	36.0	36.0	36.0	7.8	7.4	7.1	1.1	1.0	0.6
Nepal	70.2	70.5	70.8	27.4	26.5	25.6	236.0	200.0	186.0	33.2	31.9	30.8	1.3	1.7	1.8
Bhutan	71.1	71.5	71.8	25.5	24.7	23.8	203.0	193.0	183.0	30.6	29.6	28.5	1.2	1.2	1.1
China	76.5	76.7	76.9	7.9	7.3	6.8	30.0	29.0	29.0	9.2	8.5	7.9	0.6	0.5	0.4
Indonesia	71.3	71.5	71.7	21.7	20.9	20.2	192.0	184.0	177.0	25.7	24.8	23.9	1.2	1.1	1.1

Source: Pakistan Economic Survey 2020-21

2.4.2 Trends in Registered Medical Personnel 2013 to 2020

Pakistan has shown improvement in work force in health sector but still less than the World Health Organization recommended standard from1.45 to 4.45 doctors per 1000 persons. Health demand in the country increases due to many causes (population growth, urbanization, climate changes, Coved 19, Heatwaves, smog and Dengue etc.), public health services delivery infrastructure should be expanded significantly. Detail presented in table 2.3 and figure 2.3.

Table 2.3*: Trends of Manpower in Heath sector in Pakistan 2013 to 2020*

Health Manpower	2013	2014	2015	2016	2017	2018	2019	2020
Doctors	167,759	175,223	184,711	195,896	208,007	220,829	233,261	245,987
Dentists	13,716	15,106	16,652	18,333	20,463	22,595	24,930	27,360
Nurses	86,183	90,276	94,766	99,228	103,777	108,474	112,123	116,659
Midwives	32,677	33,687	34,668	36,326	38,060	40,272	41,810	43,129
LHV's	14,388	15,325	16,448	17,384	18,400	19,910	20,565	21,361

Source: Pakistan Economic Survey 2020-21

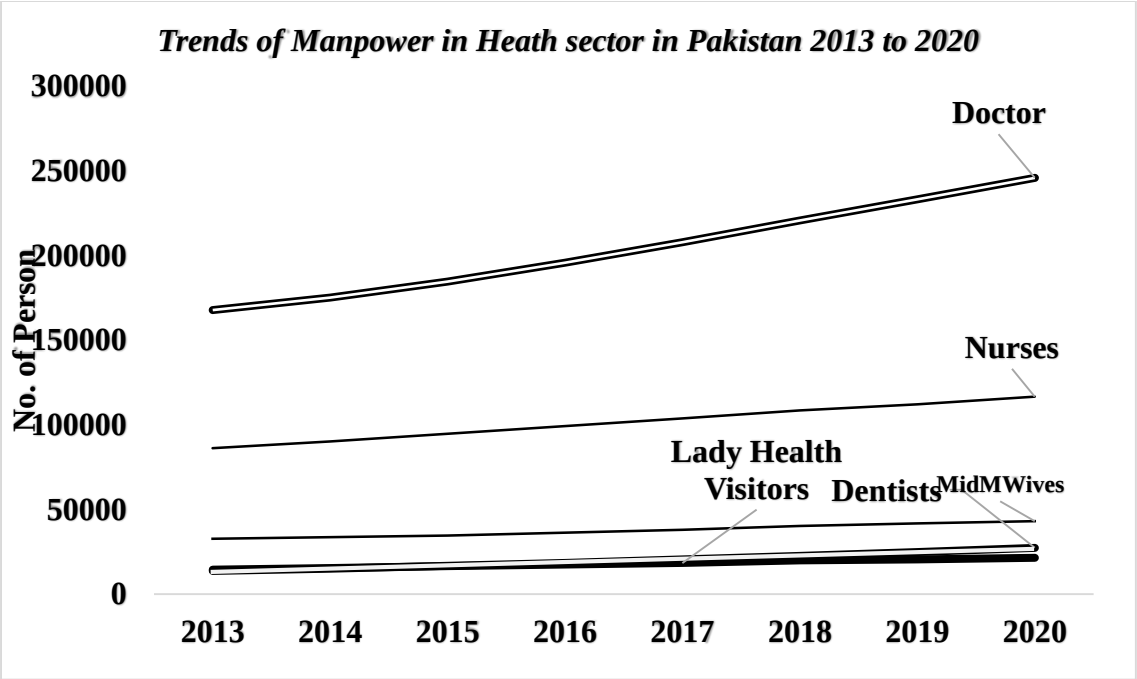


Figure 2. 1: ***Trends of Manpower in Heath sector in Pakistan 2013 to 2020***

2.5 Multidimentional Poverty in Pakistan (SDG-1)

Pakistan has successfully reduced multidimentional poverty from 51 percent to 38.3 percent in ten years 2011 to 2020 but this shows the weak performance to reduce the multidimentional poverty when comparing other neighboring countries. At the same time, Bangladesh reduces its multidimentional poverty from 57.8 to 24.7 percent, China reduces its multidimentional poverty 12.7 to 3.9 percent, and India reduces its multidimentional poverty 55.4 to 27.9 percent. Table 2.5 and figure 2.4 confirms that Pakistan could not handle the poverty issue as successfully as tackled by other nations as well. It concluded that the other neighboring countries more successfully moving progressively to achieving the SDG-1 (no poverty).

Table 2.4*: Regional Comparison of Reduction in Multidimentional Poverty 2011-20*

Country/Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Bangladesh	57.8	57.8	57.8	49.5	49.5	40.7	41.1	41.7	29.2	24.7
China	12.7	12.7	12.7	6.0	5.2	5.2	4.1	4.0	3.9	3.9
India	55.4	53.7	53.7	55.3	55.3	55.3	27.5	27.5	27.9	27.9
Pakistan	51.0	49.4	49.4	45.6	45.6	45.6	43.9	43.3	38.3	38.3

Sources: UNDP Reports 2011 and 2021

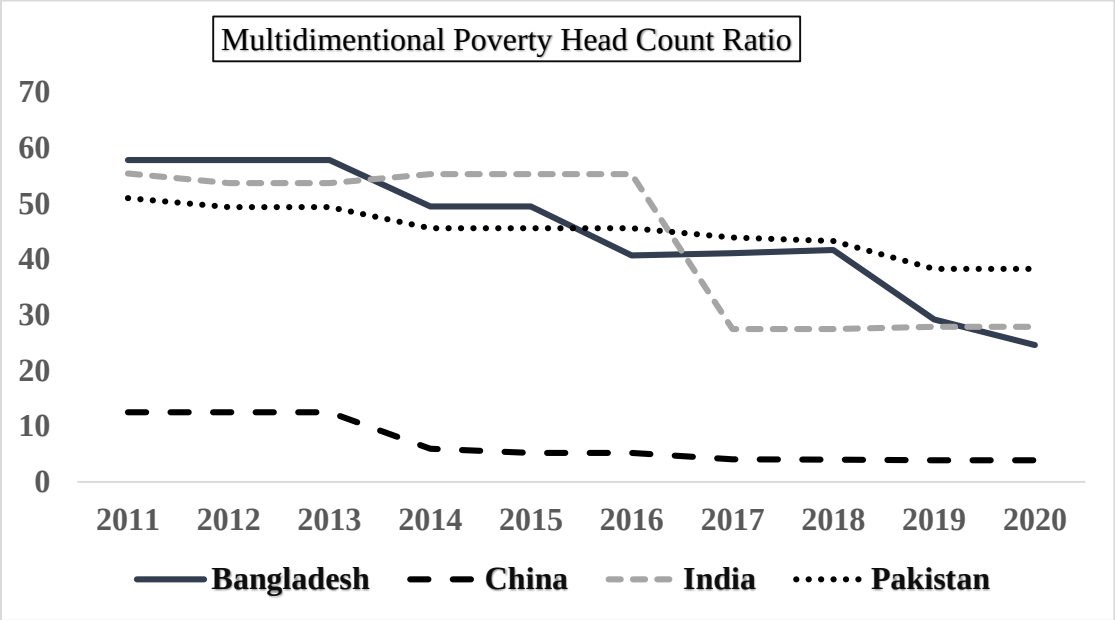


Figure 2.4*: Regional Comparison of Reduction in Multidimentional Poverty trends 2011 to 2020.*

Table 2.5 and figure 2.4 demonstrated that the multidimentional poverty reduction of 2011 to 2020 in percentage of Pakistan, India, China and Bangladesh. China performs best and Pakistan perform poorly to reducing multidimentional poverty.

Table 2.5: ***Falling-off in Multidimentional Poverty 2011 to 2020 in percentage***

Country	**Falling off in MPI 2011-20 (Percentage)**
Bangladesh	57.44
China	68.8
India	49.64
Pakistan	24.9

Sources: Author's own Calculation from UNDP Reports 2011 and 2020

2.6 Climate Change in Pakistan

This section exhibits the historical trends of climate changes (average temperature and average rainfall 2000 to 2019) by graphically.

2.6.1 Climate Change trends in Pakistan

Climate change is a multidimentional phenomenon it has various effects on environment and socioeconomic wellbeing (Paulson et al., 2021).Climate change directly affects society in different ways and society pays economic costs. Specifically, the changes in annual temperature and rainfall, has attracted worldwide attention.

The climate changes severely affected the developing countries like Pakistan as shown in figure, due to more depending on agriculture sector, less capacity of adaptation and mitigation due to fewer resources. Climate change is no longer limited to books or scientific papers it is reality knocking to our doors (Ahsan, Chandio, Fang, & Management, 2020). According to IPCC AR5 global temperature increases by 0.3 to 0.6 ^{0}C in the late 19th century and increases 0.2 to 0.3 ^{0}C in previous few decades, in addition by the end of this century the temperature increases by 1.5 to 4.5 ^{0}C, this will change the atmosphere and ocean circulation, floods, smog, cyclone etc. Generally, climate change refers to a significant change in temperature or rainfall for a decade or a longer period. Variations in climate attributed directly or indirectly by human activity, that changes the composition of the global atmosphere. The Earth's climate has seen much variability over the millennia but the previous centuries have witnessed development of the phenomenon of GHGs, which threatens to change climate in an unprecedented manner (Kiani and Iqbal, 2018). There is a large adverse impact of climate changes on developing countries like as Pakistan because its economy heavily dependents on climate-sensitivity. Numbers of various climatic events like (Droughts 2005, flood 2010 and heat waves in Karachi 2015) highly affected the Pakistan economy. The annual mean temperature in Pakistan consistently and continuously rising changes the pattern and intensity of rainfall. According to Germanwatch Global Climate Risk Index 2021, Pakistan is one of the most affected countries (5th ranked) by

climate change and contribute less than 1 percent World's greenhouse gas emissions. The more alarming thing is that the climate changes in Pakistan expected to continue further in future with poor adaptive and mitigating capacity (Munawar, ul Qamar, Mustafa, Khan, & Joyia, 2020).

Rainfall and temperature graphs demonstrated the huge variability in climate changes in Pakistan. There is irregular and uneven pattern of rainfall occurrence in some year heavy rains (flood) and in some year low rain. Likewise, rainfall, average temperature confirms the high variability in climate (figure-2.6). Average temperature of the country would increase by 3-4^{o}C in subsequent couple of decades and it would rise 5-6^{o}C by the end of this century (Munawar et al., 2020).

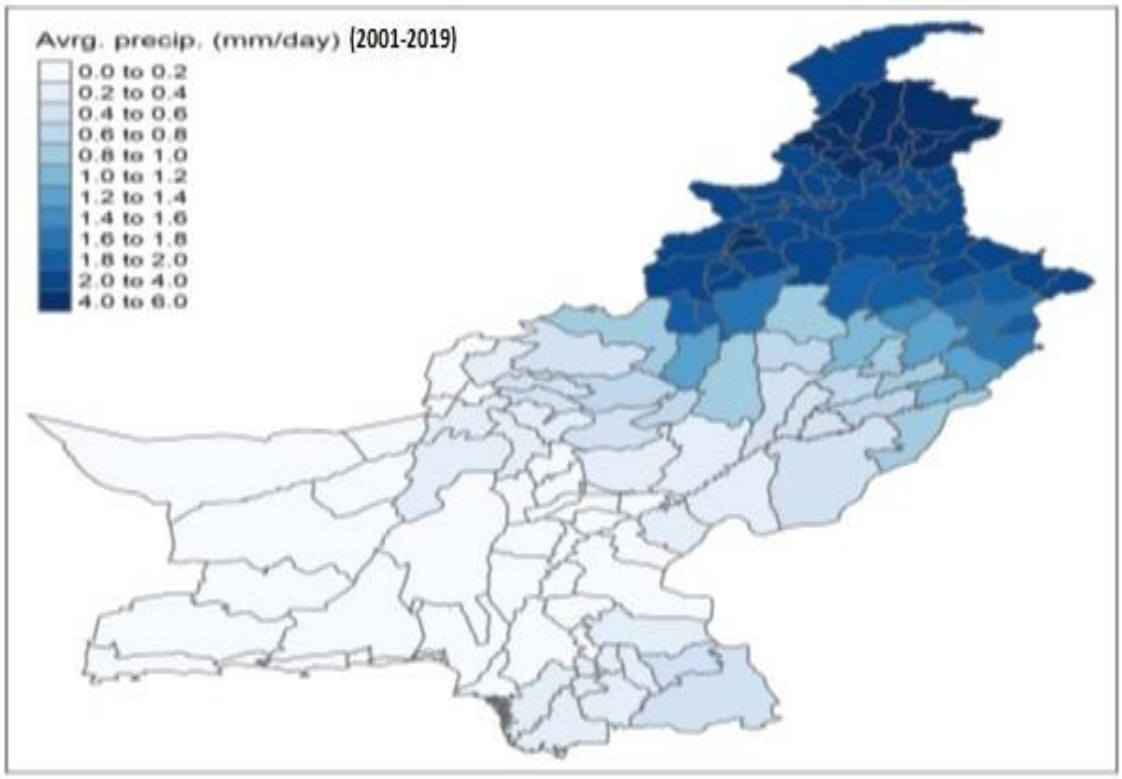


Figure 2. 5: ***Average daily rainfalls (2001-19) in Pakistan***

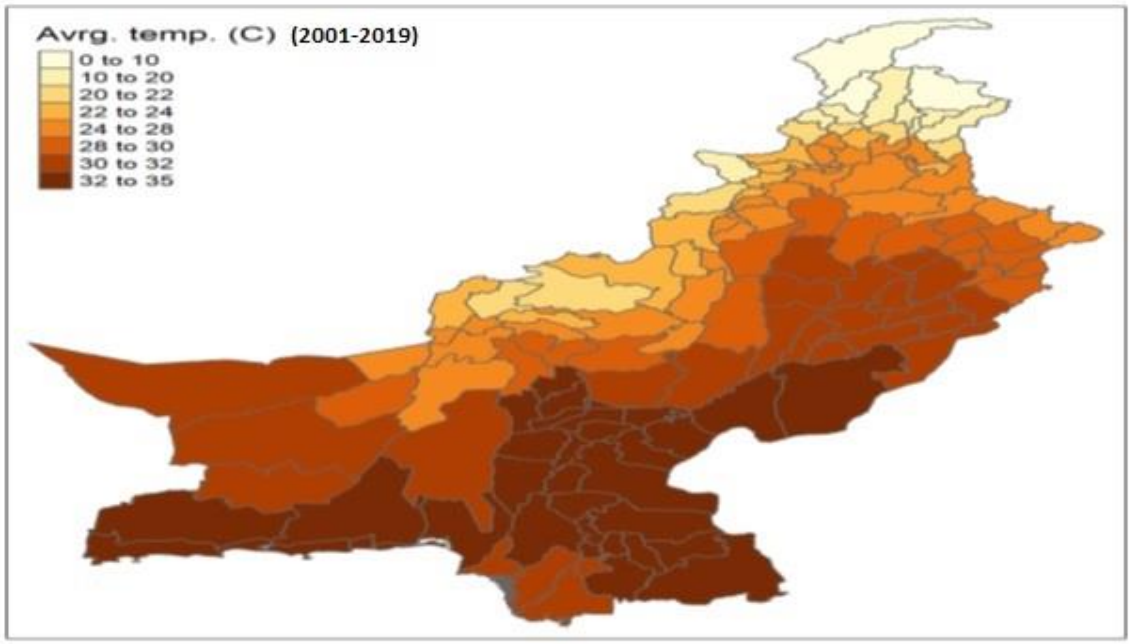


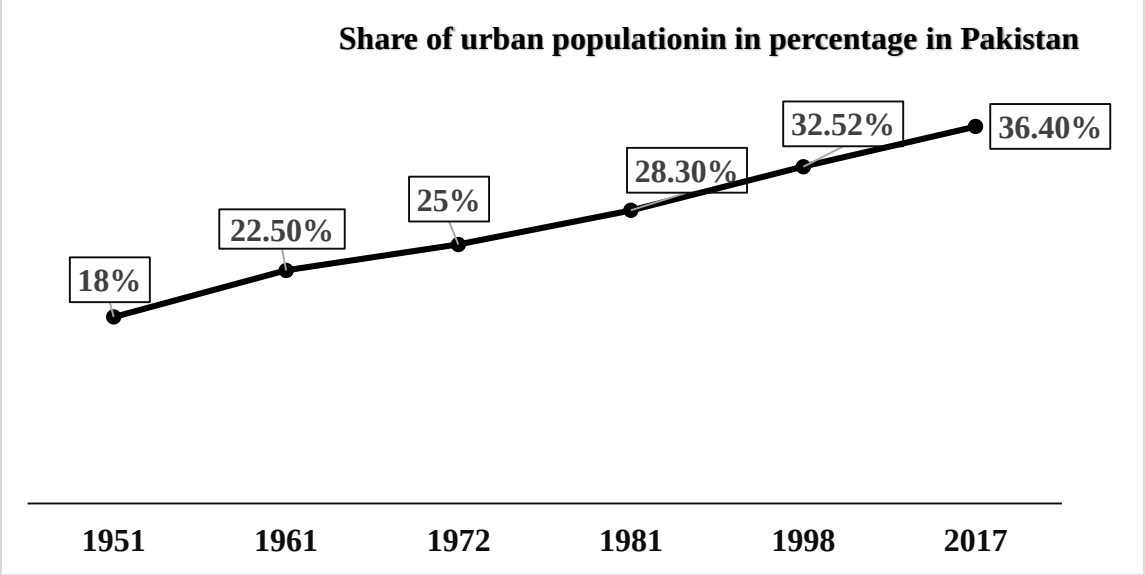
Figure 2.6: Average Daily temperature (2001-2019) in Pakistan

2.7 Urbanization in Pakistan

This section examines the urbanization trends of Pakistan 1951 to 2017 according to the six-population census of Pakistan.

2.7.1 Urbanization trends in Pakistan

Urbanization is a process in which population shifted from rural to urban areas and the resultant decrease in the portion of people living in rural areas. Urbanization is both promising and problematic for the developing country like Pakistan (Ahmed, 2021).Cities are main source of employment opportunities, educational instutions,training,skills, industrial development and marketable discipline. On the other hand, if urbanization is not managed properly it creates many economic and environmental problems like burden on existing infrastructure, pollution, increasing crime rate, stress on labour market and failure to address these issues could make urban population less productive for the economy. Pakistan urbanization growth, 3% annually reported as the fastest pace in South Asia (Jabeen, Farwa, & Jadoon, 2017). Pakistan has the highest rate of urbanization in South Asia in which 36.4 percent population lives in urban areas and it is projected that in 2025 50 percent population will be living in urban areas (UNDP, 2019). Urbanization comes with new challenges, especially for developing countries, unfortunately urban population of Pakistan living in serious social, physical and economic hardship (Abdul & Yu, 2020).



Sources: *Author's own calculation from the six-population census from 1951 to 2017*

Figure 2. 72: ***Urbanization share of population (1951-2017)***

The urbanization increasing in Pakistan as shown by the above figure 2.12. In 1951, 18 percent population of the country living in cities and this increasing trend going on and now in 2017 the urban share of the population of the country is 36.4 percent.

2.8 National Food Security Policy 2017

"Policy is the arrangement of decisions, plans, objectives, actions, strategies and road map to achieve some specific goals". After the 18th amendment of the 1973 constitution, Ministry of Food and Agriculture shifted to provinces on 30 June 2011 and at federal level Ministry of National Food Security and Research established on October 2011. The Ministry of National Food Security and Research release the first food security policy in 2017. The main goals of this policy align with the objective of this study:

I. Develop innovations for improving food system for producing healthy and nutritious food.

II. Initiate special Programs for reducing hunger and poverty as per government's commitment towards SDGs.

III. Bridge the yields gap and ensure farm profitability for sustainability agriculture sector.

IV. Augment existing water resource base by promoting efficient use through applying alternative source of energy.

V. Develop climate smart agriculture while focusing on the use of biotechnology, resources conservation and harmonious production package.

These are the main goals of the first national food security policy which initially initiated in 2017.This policy provide comprehensive road map (policy measures) to achieve food security with considering the major challenges climate change and urbanization.

2.9 National Health Policy 2018-30

Health policy of the state are considered as the strategies, actions and resolution, which are necessary to attain some specific health care goals within the state (Asim 2019, Zeb et al, 2021). Six National Health policies are presented in Pakistan up until now; the first one is present in 1990, second in 1997, third in 2001 and fourth health policy presented in 2009. After the 18th constitutional amendment of 1973 constitution, Ministry of health shifted to provinces on 30 June 2011. Federal Ministry of National Health services, Regulation and Coordination established on October 2011. The Ministry release the first policy document National Health Vision 2016-2025 in 2017and in 2018 the Ministry of National Health Services, Regulation and Coordination presented the second policy document National Health Vision 2018-30.

The most recent approved Health Vision 2018-30 aligned with the Sustainable Development Goals-3(Good health and wellbeing) presented here. There are four main objectives of the policy 2018-30 is:

I. To establish a national and provincial health workforce planning and development capability that provides the necessary tools and resources to deliver a health workforce of sufficient size, composition, capability and distribution to meet the health needs of the population.

II. To align investment in human resources for health labor market with the current and future needs of the people and health system to address shortages and improve distribution of quality health workforce, to enable maximum improvements in health outcomes and poverty reduction.

III. To build the capacity of institutions at district, area/ province and national levels for effective and quality pre-service & in-service training and leadership of actions on human resources for health.

IV. To strengthen data collection, processing and dissemination of information related to human resources for health monitoring and ensuring accountability at different levels

2.10 Climate Change Policy 2012

In 2012, government of Pakistan approved its first National Policy of Climate Change (NPCC) and set up the World's first full-fledged National Ministry of Climate Change. The National Climate Change policy provides a comprehensive framework to address all possible challenges of climate change that Pakistan faces or will face in future. The main objectives of this policy align with the objectives of this study:

I. To ensure water security, food security and energy security of the country in the face of the challenges posed by the climate change.

II. To minimize the risks arising from the expected increase in the frequency and intensity of extreme weather events such as floods, droughts and tropical storms.

III. To enhance the awareness, skills and institutional capacity of relevant stake holders.

IV. To promote conservation of natural resources and long-term sustainability.

The national climate change policy 2012 provides the comprehensive root map to overcome the issue of climate change but the policy has not fully delivered due to many other economic and noneconomic reasons.

2.11 Policy makers opinion Expert and stakeholders' assessment

The estimated results of this research, national and international reports, and literature shows that climate change and urbanization significantly affect the Sustainable development goals (food security, poverty and health). Urbanization affects these first three SDGs significantly positive. Climate change affects first three SDGs in nonlinear pattern. The joint impact of climate change and urbanization on these SDGs affect significantly negative. The estimated results of this study and above explain policies discussed with some experts, policy makers, government officials and stakeholders in the current scenario of climate change and urbanization.

The purpose of this discussion with the experts, policy makers, government officials and stakeholders to find out the responses of these queries relating to this research and international reports on SDGs, assess how they respond, how they perceive the challenges of climate change, food insecurity, health , multidimentional poverty, growing urbanization ? Question 1 to 6 replies by the Ali Kemal and his team (chief of SDGs in planning commission of Pakistan). Question 7 to 15 replies by the Imtiaz Ali Gopang (Commissioner Food security, Ministry of National Food Security

and Research) and Dr. Muhammad Ali Talpur, Economic Consultant of Ministry of National Food Security and Research of Pakistan.

The questions are: (1) Why Pakistan cannot implement the mitigation and adaptation policies to reduce the severity of climatic shocks? (2) What are the reasons that Pakistan is still stagnant or declining on international ranking, wherein other countries successfully overcome these issues and improve their ranking, China, Saudi Arab and Bangladesh are the successful examples? 3) Why Pakistan urban population cannot contribute in GDP like other neighbor countries (Pakistan urban population 36.4 percent contribute only 55 percent it's GDP whereas India 30 percent urban population contribute more than 58 percent its GDP) and these countries reduce their multidimentional poverty successfully . (4) Why Pakistan human development index is lowest with the comparisons of other neighboring countries? (5) Why Pakistan fails to assure doctor to patient ratio according to World Health Organization (WHO)? (6) What are the reasons that existing policies did not ensure food security, reduction in poverty, good health and wellbeing? (7) Why our agriculture sector cannot produce sufficient food for domestic requirements of the country. (8) Why per acer yield production in Pakistan is lower than other countries? (9) Why our scientist could not introduce new variety of seeds (climate resilient seeds)? (10) Why we cannot facilitate our agriculture sector as other countries have been doing? (11) What are the main reasons of the backwardness of our agriculture sector? (12) explain the inside and outside gaps of policies. (13) What is the future of the food security in Pakistan? (14) Why we depended on agri imports? (15) What will be the future climate changes in Pakistan?

Policy makers and expert clarify & explain the above queries in the followings.

According to Ali Kamal chief SDGs unit in planning commission of Pakistan and his team, there are some issues and misconceptions in our side and some on the international organizations side. There is no doubt that Pakistan did not perform well in comparison with other neighboring countries to reduce climatic vulnerabilities and poverty, no improvement in food security and human development index. However, there are some issues in data collections and economic limitation: (1) Pakistan cannot implement adaptive and mitigation policies of climate change due to resource constraint. Moreover, the climatic shocks and increasing population are also negatively impacts on food security. (2) Pakistan cannot successfully tackle the climatic shock problem due to its geographically positions, fewer economic resources and government low preferences towards climate changes. After the flood of 2010 when vast area of the country affected ,after this flood the Government of Pakistan establish the ministry of climate change and formulate its first climate change policy 2012. (3) HDI ranking of Pakistan is lowest in the region due to weak infrastructure and less portion of GDP to spend on education and health. Moreover, the ministry of education shifted to the provinces after the 18th amendment and there is no uniform policies between federal and provinces. (4) Urban population of Pakistan cannot create opportunity due to slumps in big cities (Kachhi abadi) and lack of organized urban planning in systematic way (due to the large slumps in cities, actually Pakistanis cities are also rural). (5) Doctor to patient ratio lowest in Pakistan comparison other neighboring countries due to which smaller amount of GDP percentage spending on health sector. Big portion of tax revenue pay in interest payment and as a result small amount of money left for development purposes. (6) There is inconsistency in policies due to political and economic instability, uncertainty, weak institutions and radtapism. Moreover, there are many economic problems as increasing debt burden and defense expenditure, lowest

growth rate and investment, increasing population and unemployment, increasing budget deficit and balance of payment deficit, continuously depreciation of national currency, increasing oil imports due to which less space to spend on development project.

Questions 7 to 15 replies in detail by two officials (Imtiaz Ali Gopang, Food Commissioner and Dr. Muhammad Ali Talpur, Economic Consultant of Ministry of National Food Security and Research of Pakistan. Their responses as:(7) Our agriculture sector cannot produce sufficient food for domestic use due to many reasons for example, no uniform agriculture support price in federal and other provinces. Because after the 18th constitution amendment the agriculture ministry shifted to the provinces. (8) Yield production is low. (9) Local agriculture scientist could not introduce new seeds, new technology and new method of cultivation due to many reasons like low budget allocate for research in agriculture sector. Govt must spend 2 percent of GDP on research but in our country spend only 0.02 percent on research. Govt less prefer to the research at a state level, as a result Pakistan average production lowest to the other countries for example the wheat production per acer only 28 to 30 mun in Pakistan where china average production 60 to 70 mun on per acer and Australia average production 70 to 80 mun on per acer. (10) Govt cannot facilitate agriculture sector due to the resources constraint (very low budget allocates for subsidy to the agriculture sector wherein the developed world like US also allocate subsidy for their farmers and on the other hand side Govt of India allocate 2.56 trillion subsidies to their agriculture sector). Pakistan cannot allocate subsidy to their farmers due to IMF restriction. (11) Agriculture sector is less preferable for the government of Pakistan (Because feudal lords and capitalist are more power full in the state and they formulate laws in the agriculture sector in their interest not for overall wellbeing of the common

farmers). In other words, agriculture is not a preferred sector at state level. (12) Policies are good but their implementation is weak due to weak communication and coordination gap between different ministries, federal and provinces. (13) Food security issue will be harsh in future, if we do not concentrate and focus on climate change, population and agriculture sector inventions, monitoring, reforms and digitization. (14) Ad hack base policies there is no long-term planning and short-sighted vision of the leadership for example (there is no set support price of cotton previous two years), no suggest sustainable solution, lack of awareness, summingling food to Afghanistan and central Asia. Lack of food storage capacity at federal and province level, there is no value addition facility at local level as well. The ground realities not supported the policies because policies made by the guidance of the IMF.There is need to conduct sowing intensing survey annually. (15) Future climate changes in Pakistan will be the serious issue. There is need to harmonization of policies federal to provinces, strong policy implementation process and accountability of climate change. There is urgent need to research on the climate change. More fund allocates for research and development.

Policies formulate at federal level, the main operational responsibility for most of the actions will be at the provincial level, and district level, due to communication and coordination gap policies cannot fully implement. Moreover, policies should be targeted, properly monitoring and evaluation on regular basis. There is need to change in crop system and we fail to manage the new challenges of the current period. There is weak control of state due to bad governess (there is purely management and administrative issue). There is need to set national agenda about food Security, Multidimentional poverty, good health and wellbeing. There are many reasons of this failure like as the gap in policymaking and policy implementation, budget allocation

and corruption, inefficiency and bad governess, coordination gap between different level of government (federal, province and district level) and departments, information gap between government and stakeholders. Policies are made on central level by the direction of the international donor agencies (IMF, WB, ADB, EU, UN etc.) not included the local stake holder's suggestions and not considering the local level economic realities and social background at the local level. The summary of the study findings, existing policies, expert review and recommendations given in the following table 2.6.

Table 2.6*: Short summary*

Study Findings	Existing Policy	Expert Opinion	Recommendations
• Climate change impact in non-linear pattern on the food security, health demand and multidimentional poverty.	• To minimize the risks of extreme weather events such as floods, droughts and tropical storms.	• Poor implementation of policies along with the challenges of governance and coordination. • Increase funding for adaptation and mitigation proposes at all level.	• Strongly implement policies. • More allocate budget for climate change (for example, introduce new variety of seeds; adopt new technology).
•Urbanization beneficial influences on the food security, health and multidimentional poverty.	• To develop land use policy planning to control the conversion of productive agriculture land into towns and cities.	• Introduce intensive use of cultivation and cities expanded vertically. • Revise policy on regular basis and monitoring timely.	• Giving the custom of vertical farming, vertical residence and kitchen gardening. • Include the suggestions of local stakeholders and experts in policy process.
• Joint impact of Climate Change and Urbanization adversely influences food security, health and multidimentional poverty.	• Initiate special Programs for reducing hunger and poverty as per government's commitment towards SDGs.	• To control urban flooding and heat weaves. • Harmonization in policies. • Formulate proper urban policy and strictly implanted.	• In increase social safety net. • More funds allocate for research and development. • Allocate one hour for awareness in prime time (7 to 9 pm) on electronic media.

CHAPTER 3

ESSAY 1: IMPACT OF URBANIZATION AND CLIMATE CHANGE ON FOOD INSECURITY IN PAKISTAN

Abstract

The underlying essay aims to investigate the impacts of urbanization and climate change on food insecurity in Pakistan. For empirical purpose, PSLM 2019-20 survey has been used to explore the specified objectives of the study. Food Insecurity Experience Scale (FIES) has been used to measure food insecurity. The application of binary Logit and ordered Logit model is suggestive of the beneficial impacts of the urbanization on reducing food insecurity, however; the climatic factors such as rainfall and temperature shocks are found to have nonlinear impacts on food insecurity. Hence, the interactive term of the urbanization and climatic shocks are showing adverse impacts on food insecurity reduction. Therefore, as climate and urbanization are continuously changing and affecting the food insecurity in diversified ways, a good measurement of the impacts on food insecurity and smooth adaptations are needed to ensure sustainable development goal 2(zero hunger) in Pakistan.

3.1 Introduction

3.1.1 Background and Statement of the Problem

The World is committed to SDGs 2015, eliminating poverty and ensuring food security of a continuously growing population remains central goals (Niles & Salerno, 2018).Food security is much highlighted international commitments like (MDGs) and now in (SDGs) shows equal importance for both developed and developing countries. The 2030 agenda for sustainable development aims to end hunger and achieve food

security SDGs 2(Ferri & Sedehi, 2018). Principally international development goals more focuses on eradicating poverty and food insecurity because the other goals like education, health and environment based on food security. Operationalizing the SDGs requires evidence-based knowledge for how to combat food insecurity, hunger and malnutrition in the light of emerging future threats from climate change and urbanization (Niles & Salerno, 2018). Food security is increasingly recognized as significant element of sustainable development.

Food insecurity has become a global policy concern due to its important role in sustaining development and while near 25% of the countries faced food insecure (Xu et al., 2019).According to global risk report 2018,food crises is listed as the top seven global risks in terms of impact. Around 815 million people are still chronically under nourished in the world (Bruinsma, 2017, Richardson et al., 2018). To feed about 9 billion people by 2050 world the importance of food security increasing and achieving the goal of zero hunger with the face of climate change and urbanization is a challenging task. Upward trend is observed in the number of under nourished people around the world and the majority of this under nourished population lives in underdeveloped and developing countries. For both the developed and the developing countries food security is an important matter which unfortunately generally is ignored (Sultana, 2020). Moreover, food security is already a daily concern and it becomes a serious issue for the developing world.

There are two recent challenges of climate changes and urbanization, which affect the food security. In the recent years, the debate on the climatic changes has led to a renewed interest in the effects of climatic variability on food security. Climate change potential threat to achieving food security (Richardson et al., 2018). Climate change is the main driver of food security in the developing countries (S. Ali et al.,

2017). Climate change affected the food security due to changes in increasing temperature and unexpected changes in the rain pattern, which affected the agriculture production. Other than climatic variables, non-climatic variables also influence the food security like urbanization. Urbanization affects the food security two folds on one side, cultivation area decreased due to increasing urbanization and on the other hand side the labor shifted rural to urban areas (the share of labor decreased in agricultural sector as the result agri-production affected). Rapid urbanization poses challenges for food security and sustainable development. The global population is projected to rise by 33% from 7.2 billion to 9.6 billion by 2050 and Pakistan population projected to rise 300 million by 2030 (Un-Habitat, 2013)

3.1.2 An overview of Food Insecurity: The Case study of Pakistan

Food insecurity is currently concentrated in developing countries, Asia hosts maximum number of food insecure people and this situation poses serious threats to realization of SDGs 2.1(Ishaq, Khalid, & Ahmad, 2018). Food security has received wide attention in Pakistan for a long time due to rapid increasing urbanization and climatic changes in the country. Under the condition of urbanization and climatic variability, the food scenario has changed, creating major challenge of food insecurity in developing countries.

Like other developing countries, Pakistan also facing food security challenges, half of the population is undernourishment and this undernourished trend is increasing over the time (Meeting & Organization, 2016).Pakistan ranked 77th on the global food insecurity index and India stand on 74th position GFSI (Izraelov & Silber, 2019). Food insecurity and stunting, wasting in under five year age children is reported more than 50% in literature (O'Connor, Boyle, Ilcan, & Oliver, 2017). Malnutration,a later

outcome of chronic food insecurity annually cost is lost GDP 3% in form of lost productivity (Ishaq et al., 2018).

Climate change and urbanization is the known fact and cannot be ignored when studying the food security in Pakistan. Climate changes present high risks to food security in Pakistan because Pakistan is highly vulnerable to climatic change. Climate change is considered as posing the greatest threat to agriculture and food security in 21st century (Al, Orking, & Clima, 2008).Pakistan is the 5th most vulnerable country of the climate change (S. Wasti et al., 2018).Climate shocks repeatedly hits the economy like as droughts, floods and heat waves. On the other hand Pakistan is the most urbanized nation in South Asia where 36.4% population living in urban areas (Ahmad & Farooq, 2010).

It is a challenging to meet the food security due to two opposing issues, increasing demand for food resulting from the population growth and urbanization on one hand and the other hand the adverse impact of climate change (A. Ali, Rahut, & Mottaleb, 2018). Total area under cultivation has decreased due to increase in urbanization. Rapid urbanization in Pakistan poses challenges for food security and sustainable development and the population of Pakistan projected to rise 300 million by 2030 (Donatella Restuccia, Puoci, & Technology, 2013).Previous studies ignore climate change and urbanization variables when studying the food security in Pakistan(Ahmad & Farooq, 2010). The underlying study incorporate these two important variables and bridge up this research gap.

3.1.3 Objective of Essay

This essay attempts to evaluate the impact of urbanization and climate change on food insecurity in Pakistan at household level and district level. Hence, the specified objective of essay 1 are specified as follows.

1) To explore the impact of urbanization on food insecurity.
2) To investigate the impact of climate change on food insecurity.
3) To estimate the joint impact of urbanization and climate change on food insecurity.

3.1.4 Significance of the Study

This study contributes to various ways. SDGs highlights the importance of zero hunger to sustainable development by 2030. This study helps in better allocation of scarce resources to remove food insecurity from the country at local level. The results of this study can be used as a base line scenario to further improvement in food security. This study also provides an important input for the policy makers to promote food security in Pakistan. The formulation of effective policies that promote household food security with considering the emerging challenges of urbanization and climatic changes.

Understanding the significance and nature of both the challenges is of utmost importance for policy makers in the design of food security policy (To achieve the Sustainable Development Goal 2 of zero hunger by 2030). Findings of this study will also be valuable for other scholars who may be sought to further understanding of the food security dynamics in Pakistan. The results of the findings would also be helpful in drawing policy prescriptions to achieve the sustainable development by 2030 with respect to household level and district level. Furthermore, micro data set (household level survey) should be the primal source of data it would be allowed for a better understanding of the impact of climate change and urbanization on multidimentional poverty, as well as household level, regional level and local level.

3.1.5 Scheme of Chapter

Section 3.2 reviews the literature on food security, focusing to explore the impact of climate change and urbanization on food security examples from the developed and the developing countries. A conceptual framework for this study, which highlights the relationship between food security and explanatory variables presented in 3.3, Section 3.4 discusses the empirical model, estimation methods, variable construction and data used in this study. The result obtained from estimation presented in section 3.5.Finally, conclusion and policy implication drawn.

3.2 Literature Review

This section elaborates the relationships between food security, climate change and urbanization through considering the relevant literature. Bulk of literature is available on this issue. However, the literature reviewed in this section has been chosen reverent to the objective of the underlying study. Food security is not a new phenomenon in the World it originated in mid-1970 (J. J. A. Wang & Procedia, 2010).

The World Food Summit in 1996 defined food security "Food security exists when all people, at all the times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life". If people in a country are facing adequate, economic, social or physical access to food then food security exists in that country (Ishaq et al., 2018).Various studies reported that half of the population of Pakistan is the food insecure. Because the supply of food (availability and stability) is badly affected by climate changes and demand of food (accessibility and utilization) is affected by increasing population, urbanization and increasing prices of food staples. Thus, it is important to investigate the food security at local scale in order to identify food security

challenges and formulate mitigation and adaptation policies to facilitate sustainable development goal (zero hunger) in 2030.

Bulk of literature investigates the relationship between climate change and food security of country as well as region and/or world level. The available literature on the climate change and food security nexus conflicting results on the significance and direction. Some studies indicates that climate change has negative impact on agricultural production, food availability and food security (Mahrous & Research, 2018). While others reported that positive and negative impact of climate, change may occur on different crops. Therefore, according to the latter group, the adverse effect of climate change on food security is inconclusive (Al et al., 2008). Climate change and its impact on food security are increasingly recognized in different parts of the world (Masipa, 2017). Recently, the impacts of climatic change on food security have become debatable (Mahrous & Research, 2018).Climate change is considered as posing the greatest threat to agriculture and food security in 21st century (shah et al., 2008; Nelleman et al., 2009).

Climate change will affect four dimensions of food security: Food availability, food accessibility, food utilization and food system stability (J. Wang & Procedia, 2010). Climate change affects food security in a complex way. Climate change may affect food systems in several ways ranging from direct effects on crop production (e.g. changes in rainfall leading to drought or flooding, or warmer or cooler temperatures leading to changes in the growing season), to changes in markets, food prices and supply chain infrastructure (Gregory, Ingram, & Brklacich, 2005). Climate changes present high risks to food security in Pakistan because Pakistan is highly vulnerable to climatic change. Recent years have been marked by droughts 2000, floods 2010 and 2022, heavy unpattern rainfalls in 2011, droughts and heat stroke 2015-2016 was a clear

demonstration of climate change on food security. Climate changes increasing the risk of hunger in the country as it effects the four dimension of food security. Rainfall shortage and excess disrupt the food production in the country and causing food insecurity. Extreme weather is affecting people indirectly through the sequential rather direct depletion of their assets (Weldearegay, Tedla, & Security, 2018).Climate change impacts species composition and functions, interferes with biophysical cycles, impacts resource availability such as water and food security.

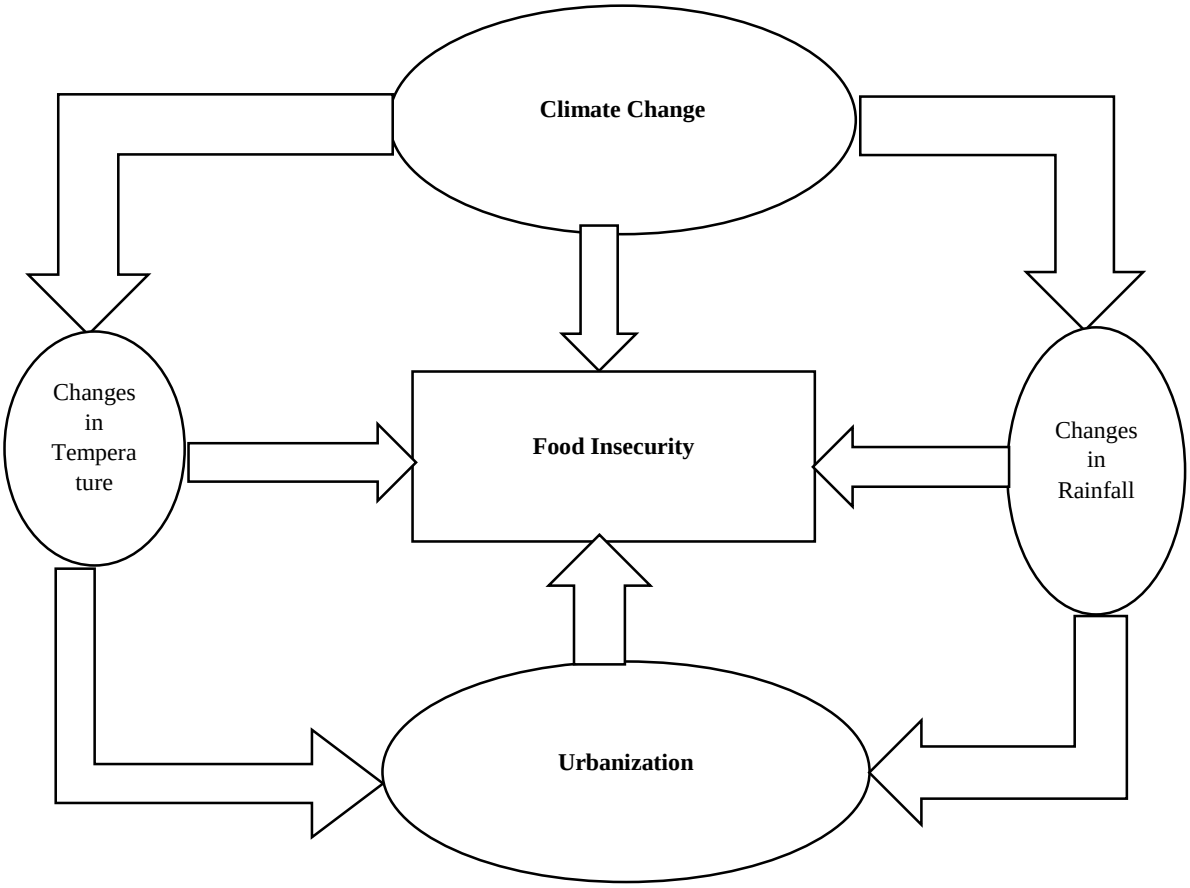
Urbanization is another variable, which affects food security situation in the country. Rapid urbanization poses challenges for food security and sustainable development. Pakistan has experienced rapid urbanization at annual growth rate of 3.1 from 1990 to 2020. The World is presently experiencing rapid urban transitions as well as rapidly changing global climate (Pachauri et al., 2014) .Urbanization and majority of urban population growth at present and projected in future, is markedly different from the past (Basu & Bazaz, 2016).There are many direct and indirect impact of urbanization on food security via climate changes. Understanding and acting the interface of climate change and urbanization is the most pressing and desirable challenge of the 21st Century. Urbanization changes the climate for example heat islands impact. Climate changes further impacts species compositions and functions, interferes with biophysical cycles, impacts resources availability such as water and food impacts on the frequency and the intensity of hazardous occurrence i.e. floods, droughts (Basu & Bazaz, 2016). Furthermore, it is a reality that urbanization and climate changes affect the food security. Urban population increased from 30% in 1950 to 54% in 2014, and it is projected to grow by 2.5 billion people (66%) by 2050. This boom in urbanization if not properly managed, has negative effects on the sustainable development in the region ((Doraiswamy et al., 2014; Cobbinah, 2014)).Climate

change, urbanization and food security is now a subject of global concern. Climate change and urbanization are causing rapid changes to food system (Gregory et al., 2005).

Overview of the literature is presented in this section about the food insecurity, climate change and urbanization. Literature argues that food insecurity exists but the empirical literature is unable to explore this relationship at (national to subnational level) local level with incorporation climate change and urbanization. This provides a room for further exploring food insecurity in Pakistan at local level.

3.3 Conceptual Framework of the Study

Different studies comes up with different conceptual framework but the objective of this study is to develop the theoretical framework of food security incorporating the relationship of climate change and urbanization. Theoretical framework captures; first, the independent influence of climate change and urbanization on food security. Second, the impact of climate change on food security through the impact of urbanization. Food security exist "When all the people, at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life'' (Gitz et al., 2016).There are four important interlinked components of food security fixed in this definition.



Sources: Composed by author

Figure 3. 1: ***Conceptual framework of food security, climate change and urbanization***

Urbanization basically depends on natural resources including land, water and energy (Y.-s. J. S. Wang, 2019). Urbanization decline the quantity and quality of land, increase water shortage for agriculture and departure of agriculture labors to urban areas. Wang et al, 2016 found that due to rapid urbanization the agriculture land decline. Food security is threatened by a decline in agriculture land, shortage of agriculture consumption water and decrease in agriculture labors due to urbanization. The outflow of rural labor force has significantly decreased the quality of agriculture labors (Huang, Ma, Guan, Li, & He, 2019).This outflow of labor force negatively affect the food production. Li found that 1% increase in urbanization would cause a decrease of arable

land more than 140000 hectors in China. With the current rate of population growth expected that the population of Pakistan 300 million in 2030 and doubled by 2050 and this makes the 4th largest populous state of the World from the 5th largest. Thus increasing urbanization growing demand for food on side and on the other side decreases the supply of food (due to increasing land use for housing and outflow of labors).

Climate change has the ability directly and indirectly to affect food security. Climate change defined as "The change in the state of the climate that can be identified by changes in the mean and/or variability of its properties, and that persists for an extended period of time, typically decades or longer. It refers to any change in climate over time, whether due to variability or as a result of human activity'' (Change, 2007). Global mean temperature has increased 0.74 degree Celsius during the last 100 years and the Himalayas glaciers rapidly disintegrating at 12 to 13 m a year (Misra, 2014).

It has been postulated that changes in climate variable would have a vast effect on food production system and that food security might be threatened due to increasing climate change (Islam & Wong, 2017).Climate changes deplete the water resources and increase temperature, reduces the agriculture production. This leads to accelerated food inflation globally as well as food shortages in developing countries where the poor strata of the society are unable to pay high market prices for food (Misra, 2014).

Based on the above highlighted discussion it can be seen that climate change and urbanization directly and indirectly influences the food security. Climate change and urbanization poses significant threats to the food security.

3.4 Data and Variable Description

This section is replete with discussion on data description and variable construction. The detailed discussion is given as follows.

3.4.1 Data Source

Primarily, the underlying study uses multiple data sources (PSLM, PMD and Data4Pakistan portal). Firstly, this study employs household survey micro data of Pakistan Living Standard Measurement (PSLM, 2019-20), which is conducted by Pakistan Bureau of Statistics (PBS). The survey contains the total sample of 160,655 households from all districts of Pakistan. The survey contains the information on households' socioeconomic characteristics of sampled households. Primary, reason to use PSLM (2019-20), is the availability of district level food insecurity experience scale (FIES).

Newly emerged FATA also included in this survey and the better coverage of Balochistan. After adopting SDGs 2015 globally, PBS review and revised PSLM questioner structure for better monitoring of SDGs. Therefore, the newly inclusion FATA, ICT, FIES module, better coverage Balochistan, reviewing and revising questioners the recent PSLM 2019-20 survey do not comparable with the previous surveys of PSLM . Secondly, for climatic variables, the study has collected district level data of rainfall and temperature (1990-2019) from Pakistan Metrological Department (PMD). Thirdly, the data of district level urbanization has been collected from Data4Pakistan portal. For empirical purpose, we have merged district level climatic and urbanization variables with household survey data (PSLM, 2019-20) based on district identification codes. Hence, overall data is cross section of its nature.

3.4.2 Variables Description

This section contains the discussion on defining the variables, which have been utilized by underlying study for empirical purpose. The detailed construction and description of the variables is given as follows.

3.4.2.1 Dependent Variable

3.4.2.1.1 Household Food Insecurity (FI):

It is evident from objectives of the underlying piece of research that household food insecurity is dependent variable. PSLM (2019-20) maintains important differentiated feature that it contains the information on eight questions of Food Insecurity Experience Scales (FIES) suggested by FAO. Table-3.1 contains the detailed description of such eight questions.

From FIES, food insecurity is measured by two ways: i) overall food insecurity; if households respond "yes" in all eight questions regarding FIES, the study considers a household food insecure, and ii) three level of food insecurity is measured by FIES. The construction of overall food insecurity is in binary nature wherein it takes value 1 if the household food insecure and zero for food secure. However, this definition maintains one limitation is that it does not explain the different levels of household food insecurity. Hence, in order to overcome this limitation, the study has decomposed the food insecurity

Table 3. 1: ***Description of Questions Related to Food Insecurity Experience Scales (FIES)***

Q #	Food Insecurity Experience Scales (FIES)
1	You or others in yours household worried about not having enough food to eat because of lack of money or other resources.
2	Still thinking about the last 12 months, was there a time when you or others in your household were unable to eat healthy and nutritious food because of lack of money or other resources?
3	Was there a time when you or others in your household ate only a few kinds of foods because of lack of money or other resources?
4	Was there a time when you or others in your household had to skip a meal because there was not enough money or other resources to get food?
5	Still thinking about the last 12 months, was there a time when you or others in your household ate less than you thought you should because of lack of money or other resources?
6	Was there a time when your household ran out of food because of lack of money or other resources?
7	Was there a time when you or others in your household were hungry but did not eat because there was not enough money or other resources for food?
8	Was there a time when you or others in your household went without eating for a whole day because of lack of money or other resources?

Source: *PSLM (2019-20)*

Into three levels, which are suggested by FAO [2](Food Insecurity Experience Scales (FIES) widely used by FAO and other international organizations to estimate the food insecurity across countries and within a country. First time HIES/PSLM (2019-20) has included FIES 8 indicators. Pakistan Buru of Statistics (PBS) has also computed the same thing from this data.) To explain the food insecurity: mild, medium, and severe. Firstly, mild food insecurity is constructed based on first three questions (1-3)

[2] https://www.fao.org/policy-support/tools-and-publications/resources-details/en/c/1236494/

presented in table.3.1. These questions indicate the households are facing mild food insecurity. Households are still managing food but it is not nutritious and healthy food due to lack of money. Therefore, a binary variable explains that it takes value 1 if the household is mild food insecure and "0" for food secure. Secondly, medium food insecurity is defined based on three questions (4-6) presented in table 3.1 which indicate skipping of the food due to lack of money. It is also constructed in binary nature where it takes value 1 if the household is medium food insecure and "0" for food secure. Thirdly, severe food insecurity is showing hunger or starvation, which is measured by last two questions (7-8), presented in table 3.1

3.4.2.2 Explanatory Variables

This section contains discussion on explanatory variables such as urbanization, and climatic variables.

Urbanization*:* District level urbanization has been constructed as percentage share of urban population with total population of each district. The constructed variable defines the increase in values would demonstrate higher level of urbanization. In addition to this, the study has measured binary variable by taking "1" if household belong to urban area, and "0" otherwise.

Climatic Variables: District level climatic factors such as average temperature and rainfall from 1990 to 2019 are taken as measure of climate change (Ahmed at al., 2016). The study has used two terms linear and non-linear terms for each factor. Growing body of literature is using these terms to indicate the climatic variability. Average of 30 years temperature and rainfall has been taken. Moreover, square terms are utilized to identify the severe or extreme events of the weather patterns (temperature and rainfall).

Control Variables*:* Apart from explanatory variables, following are the control variables, which have been used by ongoing study.

Age and Gender of Household Head: Age of the head is measured in years to data of survey being conducted. Gender of household head is measured in binary form where "1" is assigned to the male-headed household, while "0" otherwise.

Education of Household Head*:* The study has constructed five major categories of education of head such as primary, middle, matriculation, intermediate, and above intermediate. Primary education is measured by assigning "1" if household head has completed levels of primary education, "0" otherwise. Similarly, binary variable for middle education is constructed by assigning "1" if household head middle education, while matriculation is measured if household head has completed his matriculation education. Intermediate or higher secondary is computed if household head has intermediate or completed 12 years education, while above intermediate or tertiary education is measured if household head has education above intermediate.

Employment Status of Household Head: The binary variables are used to define whether household head belongs to agriculture sector, self-employed means a household head owns its own business, and paid-employee, which means household head, is doing job.

TABLE 3. 2: *DESCRIPTION OF THE VARIABLES USED IN THIS RESEARCH*

Variable Name	Dependent Variable	Unit
Food insecurity (FIES)	Food insure=1, otherwise food secure=0	Binary
Mild food insecurity	Mild food insecure=1, otherwise =0	Binary
Medium food insecurity	Medium food insecure=1, otherwise food secure=0	Binary
Sever food insecurity	Sever food insure=1, otherwise food secure=0	Binary
Food Insecurity, Miled FI,medium FI,Severe FI	Food insure=0, Mild food insecure=1, Medium food insecure=2, Sever food insure=3	Categorical Variable
Explanatory variables		
Urbanization	% share of urban population to the total population of districts	%
Area(Urban/Rural)	If household resides in urban area=1, otherwise=0	Binary
Average temperature	30 years average of yearly district level temperature	c^o
extreme temperature	Square of 30 years average of yearly district level temperature	c^o
Average Rainfall	30 years average of yearly district level rainfall	Mm
Extreme rainfall	Square of 30 years average of yearly district level rainfall	mm
Control Variables		
Head age	Age of the head of the household when survey is conducted	Year
Head gender	It takes 1 if household head is male, otherwise 0	Binary
Primary	It takes 1 if household head is primary educated, otherwise 0	Binary
Middle	It takes 1 if household head is middle educated, otherwise 0	Binary
Secondary	It takes 1 if household head is matriculation educated, otherwise 0	Binary
Higher Secondary	It takes 1 if household head is intermediate educated, otherwise 0	Binary
Tertiary	It takes 1 if household head is above intermediate, otherwise 0	Binary
Dependency Ratio	% ratio of non-working (below 15 years+ above 64 years) age group to the working age group (between 15 to 64 years)	%
Self Employed	If household head is self-employed takes 1, otherwise 0	Binary
Paid Employed	If household head is paid-employee takes 1 otherwise 0	Binary
Agriculture Employed	If household head is employed in agriculture takes 1 otherwise 0	Binary
Transport utilization	% of the households which are found utilizing transport facility at district level	%
Agriculture extension	% of the households which are found utilizing agriculture extensions at district level	%

Household Dependency Ratio: Age dependency ratio is the ratio of the sum of non-working age group (sum of household members working below 15 years and household members working above 64 years) to the sum of working age group family members (between 15 years to 64 years) which is multiplied by hundred. **District Level Transport Utilization***:* Percentage (percentage) of the households that are found utilizing the facilities of transport at district level. This variable represents the transport and road infrastructure available at district level, which is hypothesized to have significant influences on food insecurity. **District Level Agriculture Extensions***:* Percentage (percentage) of the households that are found utilizing the facilities of agriculture related departments and other institutions to increase the agriculture productivity at district level. The descriptive statistics of above variables are presented in table 3.3, which is given as.

TABLE 3.3: ***SUMMARY STATISTICS OF THE VARIABLES USED IN THIS RESEARCH***

Variable	Mean	Std. Dev.	Min	Max	Unit
Food insecurity (FI)	0.415063	0.492735	0	1	Binary
Mild food insecurity	0.40648	0.491178	0	1	Binary
Medium food insecurity	0.170278	0.375878	0	1	Binary
Severe food insecurity	0.065351	0.247145	0	1	Binary
Urbanization (%)	30.98235	26.95922	0	100	%
Dependency ratio	0.940118	0.776028	0.028571	15	%
Head gender	0.915291	0.27845	0	1	Binary
Head age	44.25385	13.44415	14	99	Years
Primary level	0.135844	0.342624	0	1	Binary
Middle level	0.11999	0.324951	0	1	Binary
Secondary level	0.153889	0.360843	0	1	Binary
Higher secondary level	0.061529	0.2403	0	1	Binary
Tertiary education level	0.079468	0.270469	0	1	Binary
Paid employee	0.393495	0.488527	0	1	Binary
Self-employed	0.222128	0.415678	0	1	Binary
Agriculture employment	0.181071	0.385078	0	1	Binary
Transportation utilization	0.651296	0.476562	0	1	%
Agriculture extension	0.057247	0.232315	0	1	%

3.5. Empirical Methodology

This section maintains the discussion on application of empirical strategies to estimate the specified objectives. There are different three strategies, which we have implemented in this study. These are discussed as follows.

3.5.1 Empirical Strategy-1: Binary Logit Model

This section has specified that underlying study aim to estimating the impacts of urbanization and climate change on household level food insecurity. For this purpose, we have employed Binary Logit Model, because the dependent variable is binary in nature. The discussion on the specification of the model is given as follows.

A growing body of literature has suggested the application of Logit model whenever we have binary dependent variables (Ahmed et al., 2016; Mustafa et al., 2019) as the case of underlying study we have food insecurity as binary variable. For empirical purpose, first we estimate the impacts of urbanization on food insecurity, which is specified as follows.

$$Y_i = \beta_0 + \beta_1 Ur_i + \gamma_i \Sigma X_i + U_i \quad \text{.....(3.1)}$$

Y_i is the dependent variable which is binary, i) binary food insecurity ("1"= food insecurity, otherwise "0"), ii) mild food insecurity ("1"=mild food insecurity, otherwise "0"), iii) medium food insecurity ("1"=medium food insecurity, otherwise "0") and Severe food insecurity or starvation ("1"=severe food insecurity, otherwise "0"). District level percentage (percentage) of urbanization is explanatory variable where β_1 is its parameter. Similarly, ΣX_i is the vector of control variables, which are given in table 3.2 such as age and gender, education and employment status of household head, household dependency ratio, utilization of transportation at district level, and having

facilities of agriculture extensions at district level, and provincial dummies, and U_i is the error term.

After establishing the impacts of urbanization, the study would introduce the climatic variables such as average rainfall and its non-linear term, and average temperature and non-linear term of temperature. The equation 3.1 would follow the following specification.

$$Y_i = \beta_0 + \beta_1 Ur_i + \beta_2 T_i + \beta_3 T_i^2 + \beta_4 R_i + \beta_5 R_i^2 + \gamma_i \Sigma X_i + U_i \quad \ldots\ldots (3.2)$$

In above equation, T represents average temperature, while T_i^2 indicates its square term to unleash the extreme temperature norms (shocks), R indicates the average rainfall, R_i^2 while denotes square term of the rainfall to estimate the impacts of extreme events of rainfall. Rest of the specification will be similar as presented in equation 3.1.

Next target is to estimate the joint impacts of the urbanization and climate change on food insecurity. For that purpose, we have introduced interaction term of the urbanization and climatic factors in equation 3.2. The specification becomes as follows.

$$Y_i = \beta_0 + \beta_1 Ur_i + \beta_2 T_i + \beta_3 T_i^2 + \beta_4 R_i + \beta_5 R_i^2 + \beta_6 Ur_i * Ti + \beta_7 Ur_i * R_i + \gamma_i \Sigma X_i + U_i \quad \ldots\ldots (3.3)$$

In above equation, $Ur_i * Ti$ is the interaction term, which is measured by the multiplication of urbanization, and average temperature, which estimates the joint impacts of the urbanization, and temperature. Similarly, $Ur_i * R_i$ estimates the joint impact of urbanization and rainfall on food insecurity. Hence, the rest of the specification similar as we have discussed in equation 3.2.

3.5.2 Empirical Strategy-2: Application of Ordered Logit Model

In previous section, we have setting for binary dependent variables. Therefore, we have applied binary logit model, but for the sake of further exploration, the study has utilized different levels of food insecurity measured by PSLM 219-20 ,0 is assigned to food secure households, 1 is assigned for mild food insecurity, 2 is assigned to medium food insecurity, and 3 is assigned to the severe food insecurity.

Available literature is suggesting that wherever we have such ordering in dependent variables, Ordered Logit Model is applied (Cameron, AC, 1990). Hence, the ongoing study has used Ordered Logit model on the same setting of independent variables presented in equation 3.1 to 3.3. Only difference will be in the setting of categorical dependent variable rather than setting of binary dependent variables.

3.5.3 Empirical Startegy-3: Tackling Endogenity

In previous models, we did not highlight the problems of endogenity, which comes due to the urbanization. Urbanization is a process, which means there some factors, which influence the urbanization. Due to its endogenous behavior, theoretically it should be correlated with error terms, which have raised the problem of persistence of the issue of endoginity. We have tested by applying Wald-test that has confirmed the presence of endogenity in the models 3.1 to 3.3 discussed in previous sections.

In order to remove this problem, we need some instruments which should be exogenous and do not have correlation with error terms. The literature has used average rainfall and transportation infrastructure as the instrument for urbanization (e.g.; Vokoruwa and AIkudayisi, 2018). Theoretically, rainfall and transportation infrastructure are exogenous which are not determined within the model. Transportation infrastructure is built by public and private partnership, while rainfall is exogenous climatic variable. Hence, these two instruments will be the best available instrument

given the data limitation. Since, we are using the rainfall as instrument; we have ignored specification 3.2 and 3.3. The specification 3.1 will be used to estimate the impacts of instrumented urbanization on food insecurity variables as discussed in equation 3.1.

Hence, for empirical purpose, we have applied instrumental Logit model to deal with the problem of endogenity by using average rainfall and transportation utilization as instruments for percentage urbanization at district level. The setting of the dependent variables has been kept as it is specified in equation 3.1.

3.6 Results and Discussion

This section is replete with discussion on empirically obtained results. In first part, we have discussed percentage distribution of food insecurity is presented, while in second part impacts of urbanization and climatic factors on food insecurity is weaved up.

3.6.1 Percentage Distribution of Food Insecurity

Figure 3.2 contains the percentage (percentage) distribution of food insecurity by provinces during 2019-20. In term of overall food insecurity measured by FIES suggests that Balochistan province is facing 51.2-percentage food insecurity, which is experienced as the highest, while after that Sindh experiences 49.4 percentage, KP observes 42.6 percentage, and Punjab province experiences 37.1-percentage food insecurity among households. These estimates demonstrate that Punjab is the least food insecure province.

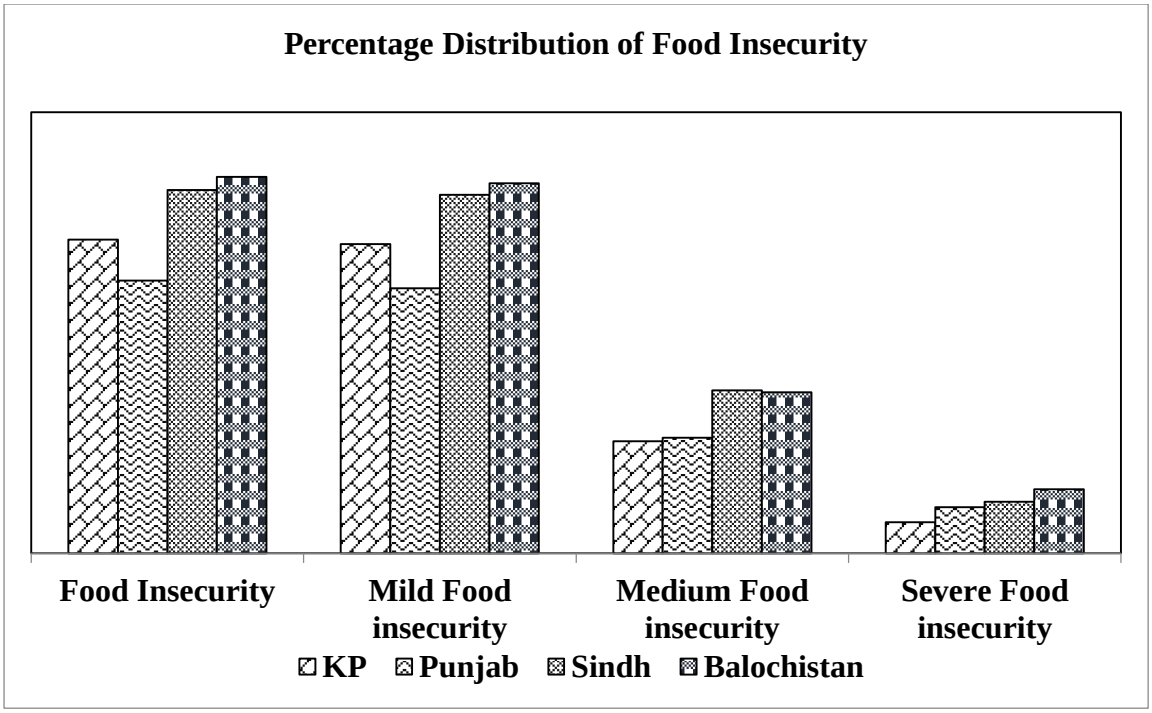


Figure 3. 2: ***Provincial distribution of food insecurity***

Food insecurity is decomposed into three levels of Food Insecurity Experience Scales (Miled, medium and Sever food insecurity). Again, Balochistan finds experiencing 50.3 percentage mild food insecurity which means half of its households are facing problems in eating quality and nutritious food due to lack of money. Estimates of mild food insecurity for other three provinces remain closer to the estimates, we have discussed for overall food insecurity, which is establishing an important aspect that overall food insecurity is affected with mild food insecurity (figure 3.2).

Moreover, in terms of medium food insecurity Sindh province is facing 22.2-percentage medium food insecurity, while Balochistan experiences 21.9-percentage medium food insecurity. It demonstrates Sindh and Balochistan do not encompass big differences between these two provinces. Such estimates explain that around 22 percentage households of these provinces have to skip food some time owing to lack of money. Again, Punjab province has appeared to be the least poor in terms of medium

food insecurity (figure 3.2). Virtually, 9 percentage households of Balochistan province are found facing starvation or severe food insecurity, Sindh (7%), Punjab (6%), and KP (4%).

These estimates demonstrate that Balochistan is facing the highest level of severe food insecurity, while KP province is the least starved province amongst other provinces (figure 3.2). In addition to provincial percentage (percentage) distribution of food insecurity, the study has computed district level food insecurity in terms of different levels of FIES which is presented in appendix-A. The estimates indicate that districts of Balochistan province are found the highly food insecure in terms of FIES as compared to districts of other provinces (see tables 3.4A1 to table 3.4A4 in appendix).

3.6.2 Impact of Urbanization on Food Insecurity: Binary Logit Model

The study has implemented the binary Logit model to trace out the influences of the urbanization on food insecurity. For empirical purpose, dependent variable categorized into four binary variables: i) food insecurity ("1"=food insecure, "0"=otherwise), ii) mild food insecurity ("1"=if household is mild food insecure, "0"= otherwise), iii) medium food insecure ("1"= if household is medium food insecure, "0"=otherwise), and iv) severe food insecurity ("1"= if household is severe food insecure, "0"=otherwise).

Moreover, the study has applied urbanization in two ways separately: i) district wise share of urban population in total population (%) which measures it as urbanization, and ii) binary variable whether household is living in urban area or not (1=urban area, 0=rural area). Hence, due to binary nature of dependent variable (Food Insecurity), the study has applied binary Logit model along with Odd ratios to interpret the coefficient.

Table-3.4 contains the estimated results obtained from application of binary Logit model, while table-3.4(A) comprises the estimation of odd ratios of the variables. The estimated results demonstrate that, other things remaining the same, district level urbanization has statistically significant impacts on the likelihood of prevalence of food insecurity among households. Such significant impacts are found for all categories of Food Insecurity Experience Scale (FIES) as well

Table 3. 4: ***Impact of Urbanization on fi Estimated from Binary Logit Model***

VARIABLES	**Food Insecurity**	**Mild Food Insecurity**	**Medium Food Insecurity**	**Severe Food Insecurity**
Urbanization (*district in %*)	-0.00513***	-0.00507***	-0.00395***	-0.00372***
	(0.000255)	(0.000257)	(0.000336)	(0.000495)
Head age	-0.0126***	-0.0124***	-0.0116***	-0.0105***
	(0.000441)	(0.000443)	(0.000568)	(0.000855)
Head gender	0.348***	0.339***	0.312***	0.370***
	(0.0233)	(0.0234)	(0.0317)	(0.0479)
Primary	-0.273***	-0.277***	-0.264***	-0.302***
	(0.0160)	(0.0160)	(0.0199)	(0.0298)
Middle	-0.593***	-0.596***	-0.597***	-0.644***
	(0.0174)	(0.0174)	(0.0233)	(0.0361)
Secondary	-0.884***	-0.892***	-0.859***	-0.957***
	(0.0163)	(0.0164)	(0.0227)	(0.0366)
Higher secondary	-1.226***	-1.237***	-1.174***	-1.257***
	(0.0250)	(0.0252)	(0.0369)	(0.0618)
Tertiary	-1.760***	-1.796***	-1.729***	-1.679***
	(0.0260)	(0.0265)	(0.0415)	(0.0664)
Dependency ratio	0.178***	0.177***	0.157***	0.165***
	(0.00691)	(0.00692)	(0.00832)	(0.0118)
Self employed	-0.149***	-0.138***	-0.220***	-0.367***
	(0.0194)	(0.0195)	(0.0261)	(0.0391)
Paid employee	0.197***	0.208***	0.0710***	-0.113***
	(0.0180)	(0.0181)	(0.0240)	(0.0357)
Agriculture employed	-0.137***	-0.123***	-0.254***	-0.606***
	(0.0198)	(0.0198)	(0.0262)	(0.0399)
Transport utilization	0.168***	0.170***	-0.0520***	-0.288***
	(0.0115)	(0.0115)	(0.0146)	(0.0214)
Agriculture extension	0.0436*	0.0219	-0.0940***	0.0351
	(0.0233)	(0.0233)	(0.0310)	(0.0471)
Punjab	-0.0341**	-0.0596***	0.252***	0.687***
	(0.0154)	(0.0154)	(0.0207)	(0.0346)
Sindh	0.397***	0.388***	0.595***	0.725***
	(0.0194)	(0.0195)	(0.0253)	(0.0412)

VARIABLES	Food Insecurity	Mild Food Insecurity	Medium Food Insecurity	Severe Food Insecurity
Balochistan	0.424***	0.405***	0.504***	0.862***
	(0.0214)	(0.0214)	(0.0270)	(0.0420)
Constant	0.0542*	0.0242	-1.252***	-2.435***
	(0.0323)	(0.0324)	(0.0400)	(0.0598)
Observations	160,655	160,655	160,655	160,655
Pseudo R2	0.0689	0.0697	0.0481	0.0443
Wald chi2(17)	12810.25***	12862.47***	6171.28***	2892.02***

Note: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

It is evident that all coefficients are negative and significant (table-3.4). Intuitively, it demonstrates the beneficial impacts of rising urbanization on reducing food insecurity or alternatively increasing the level of food security among households in Pakistan. The reason of negative sign of the district level urbanization is due to the rising employment opportunities, and availability of socioeconomic infrastructure of the urban areas has improved the level of food security among the households. Moreover, it could have the positive impacts on the food security at district level as well.

Our findings regarding urbanization are found consistent with existing available literature on urbanization and food insecurity (Liu et al., 2021; Wang et al., 2021). Table-3.4(A) comprises the estimation of odd ratios to interpret the co-efficient of the Logit model. It is evident that all odd ratios for district level urbanization are less than one but closer to "1" which demonstrates that beneficial impacts of urbanization are not much higher as we have discussed earlier case. Such coefficients of odd ratios for four levels of food insecurity (overall, mild, medium, and severe) remain around 0.99, which identify smaller impacts but are beneficial impacts in reducing food insecurity.

Moreover, the underlying study has estimated the result of binary independent variable for urbanization, where "1" is assigned to household if he/she belongs to urban areas and otherwise "0". Table 3.10 and table-3.10A are presented in Appendix B of

this research. The estimated result for binary variable of urbanization has also similar impacts as the case of district level urbanization (percentage) in table-3.4 Nonetheless; binary variable has statistically significant influences on food insecurity. The negative sign applies that other things remaining the same, those households which belong to urban areas has declining likelihood to be the food insecure as compared to the household belongs to rural areas (see table 3.10 in Appendix B). Such findings seem like similar with the findings we have estimated for district level urbanization variable. It further maintains that the impacts of urbanization seem robust which do not change by changing the definition of the independent variable but the magnitude of coefficient is changed. Table 3.10A contains the estimated odd ratios for the Logit model estimated when independent variable is binary urban area.

The estimates of odd ratios are observed for binary urbanization variable differently by changing the classification of the food insecurity. Such includes odd ratios in the food insecurity 0.77 which demonstrates urbanized people lesser likely to be the food insecure by 23 percent while odd ratios for the case of FIES classifications is found such as mild food insecurity (odd ratio=0.771), medium food insecurity (odd ratio=0.85), and severe food insecurity (odd ratio=0.89) vice versa. Apart from urbanization, other factors related to household specific characteristics are also affecting the food insecurity of households.

Such as age of household head has a statistically significant impact on determining food insecurity.

Table 3.4 demonstrates that it contains negative sign which highlights those families whose head are relatively in higher age are less likely to be food insecure. Perhaps they have much experience and having stable source of livelihood, which ultimately affect the likelihood of being food insecure. Similarly, gender of the

household head has significant impacts on food insecurity as well (table-3.4). The education of the household head does have significant impacts on determining food insecurity. The findings reveal that those households whose heads are educated are less likely to be food insecure as compared to those households whose heads are not educated (table-3.4). Moreover, those households which are relatively highly educated are lesser likely to be facing food insecurity in Pakistan. Similarly, employment status of the household head does have statically significant impacts on food insecurity.

Household dependency ratio has statistically significant impacts on food insecurity. The positive sign determines that the increase in dependency ratio leads to increase the level of food insecurity. The reason could be that higher dependency ratio is suggestive that households are burdened with higher number of non-working family members, which put additional pressures on working members. It enhances the likelihood of being food insecure overall. Hence, dependency ratio has adverse impacts on ensuring the food security level. Apart from that, transport utilization, agriculture extensions and provincial dummies also have statistically significant impacts on determining food insecurity.

Specifically, infrastructure related variable transport usage and agriculture extensions have beneficial impacts on reducing food insecurity among households (table 3.4). Transport utilization maintains the connectivity amongst districts and let the people to mobile easily from rural area to urban areas for the sake of better means of livelihood, which ultimately brings about increase the probability of being food secure or reduction in food insecurity. Agriculture extensions also have significant impacts on reducing food insecurity. It boasts the agriculture food productivity, which enhances the level of food self-sufficiency in country. Hence, expansion of agriculture extensions is also one of the important determinants of food security among households.

Table 3.4 A: ***Impact of Urbanization (percentage) on Food insecurity: Odd Ratio***

	Odd ratio	Odd ratio	Odd ratio	Odd ratio
VARIABLES	**Food insecurity**	**Mild Food Insecurity**	**Medium Food Insecurity**	**Severe Food Insecurity**
Urbanization (*district in %*)	0.995***	0.995***	0.996***	0.996***
	(0.000254)	(0.000255)	(0.000334)	(0.000493)
Head age	0.988***	0.988***	0.988***	0.990***
	(0.000436)	(0.000437)	(0.000561)	(0.000846)
Head gender	1.416***	1.403***	1.367***	1.447***
	(0.0330)	(0.0329)	(0.0433)	(0.0693)
Primary	0.761***	0.758***	0.768***	0.739***
	(0.0121)	(0.0121)	(0.0152)	(0.0220)
Middle	0.553***	0.551***	0.551***	0.525***
	(0.00959)	(0.00960)	(0.0128)	(0.0190)
Secondary	0.413***	0.410***	0.424***	0.384***
	(0.00674)	(0.00673)	(0.00960)	(0.0140)
Higher secondary	0.294***	0.290***	0.309***	0.284***
	(0.00734)	(0.00732)	(0.0114)	(0.0176)
Tertiary	0.172***	0.166***	0.178***	0.186***
	(0.00447)	(0.00439)	(0.00737)	(0.0124)
Dependency ratio	1.195***	1.194***	1.170***	1.179***
	(0.00826)	(0.00826)	(0.00973)	(0.0140)
Self employed	0.862***	0.871***	0.802***	0.692***
	(0.0167)	(0.0170)	(0.0210)	(0.0271)
Paid employee	1.217***	1.231***	1.074***	0.893***
	(0.0220)	(0.0223)	(0.0258)	(0.0318)
Agriculture employed	0.872***	0.884***	0.776***	0.545***
	(0.0172)	(0.0175)	(0.0203)	(0.0218)
Transport utilization	1.183***	1.185***	0.949***	0.750***
	(0.0136)	(0.0137)	(0.0139)	(0.0161)
Agriculture extension	1.045*	1.022	0.910***	1.036
	(0.0243)	(0.0239)	(0.0282)	(0.0487)
Punjab	0.966**	0.942***	1.287***	1.987***
	(0.0148)	(0.0145)	(0.0267)	(0.0688)
Sindh	1.487***	1.473***	1.813***	2.064***
	(0.0289)	(0.0287)	(0.0458)	(0.0850)
Balochistan	1.528***	1.499***	1.655***	2.369***
	(0.0327)	(0.0321)	(0.0448)	(0.0995)
Constant	1.056*	1.025	0.286***	0.0876***
	(0.0341)	(0.0332)	(0.0114)	(0.00524)

Note: Robust see form in parentheses *** p<0.01, ** p<0.05, * p<0.1

3.6.2.1 Application of Instrumental Variable Approach

So far, we do not tackle the problem of endogenity that may arise due to the being endogenous of urbanization because it is determines within the model. Urbanization is a process, which means there some factors, which influence the urbanization. Due to its endogenous behavior, theoretically it should be correlated with error terms, which have raised the problem of persistence of the issue of endoginity.

We have tested by applying Wald-test that has confirmed the presence of endogenity in the models. In order to remove this problem, we have used rainfall and transportation infrastructure as instrumental variables for urbanization, which are exogenous. Since, we are using the rainfall and transportation as instrument; we do not include these variables in the model to deal endogenity.

Hence, we have applied instrumental Logit model to tackle endogenity. The estimated results demonstrate that the instrumented urbanization has positive sign, which is statistically significant. The positive sign means, other things remaining same, urbanization raises the likelihood of being food insecure, which is very contrary to the impacts of urbanization we have discussed in previous sections. Such finding establishes one thing that when we take instruments (rainfall and transportation) for urbanization, then beneficial impacts of urbanization becomes adverse.

TABLE 3. 4B*: APPLICATION OF INSTRUMENTAL LOGIT MODEL*

Scale_FI	Coef.	Std. Err.	z	P>z
Urbanization	0.014175	0.000536	26.46	0.000
Head age	-0.00716	0.000245	-29.27	0.000
Head gender	0.204611	0.013024	15.71	0.000
Primary	-0.16268	0.008501	-19.14	0.000
Middle	-0.35131	0.009741	-36.06	0.000
Secondary	-0.49293	0.009511	-51.83	0.000
Higher secondary	-0.67099	0.014507	-46.25	0.000
Tertiary education	-0.94535	0.015104	-62.59	0.000
Dependency ratio	0.092662	0.003657	25.34	0.000
Self employed	-0.0987	0.010778	-9.16	0.000
Paid employee	0.079845	0.009934	8.04	0.000
Agri employment	-0.12175	0.010594	-11.49	0.000
Agriculture extension	0.030911	0.01185	2.61	0.009
Note: instruments of urbanization are average rainfall, and transportation				

3.6.3 Impact of Urbanization and Climatic Changes on FI using Binary Logit Model

Table-3.5 contains the estimated results of the impact of urbanization and climate change on food insecurity obtained from application of binary Logit model, while table-3.5A1 comprises the estimation of odd ratios of the variables. The estimated results demonstrate that, other things remaining the same, urbanization has again significant impacts on food insecurity with negative signs, which has similar implications as we have discussed in previous discussion. Nonetheless, it maintains insignificant impacts medium and severe food insecurity as we introduced climatic variables in the model (table-3.5).

The estimated impacts of average rainfall and average temperature has statistically significant negatively affects the likelihood of prevalence of food insecurity

among households. The negative impacts demonstrate that likelihood of reduction of food insecurity. It determines that linear term of the climatic factors has beneficial impacts on food insecurity as found by Ahmed at al., (2016) the case of Pakistan.

In other words, the linear term of both rainfall and temperature could have the positive impacts on food security. The reason could be the good span of rainfall enhances the agriculture productivity, which leads to increase food security or reducing food insecurity vice versa.

However, the estimated results of non-linear terms of both rainfall square and temperature (square) has demonstrated the presence of non-linear impacts of rainfall and temperature is significantly found with positive signs. Such impacts on the food insecurity, other things remaining the same, demonstrates that square terms have adverse impacts on food insecurity reduction which means happening of extreme events of temperature and rainfall are causing food insecurity among households. It means that, other things remaining the same when temperature and rainfall exceeds after certain threshold level, both variables are adversely affecting the level of food security (table 3.5). Hence, overall impacts of climatic variability (rainfall and temperature) have inverted U-shaped relationship with food insecurity. It establishes that linear terms of the climatic factors do have beneficial impacts in reducing food insecurity among households through the channel of increased agriculture productivity. After certain points, the relationship becomes non-linear which demonstrates the happening of the extreme weather events.

Such events could have disastrous impacts on agriculture sector and physical infrastructure as well which ultimately lead to increase in food insecurity among households. In sum, overall climatic variables have inverted U-shaped relationship with food insecurity. Moreover, the underlying study has estimated the result of binary

independent variable for urbanization, where "1" is assigned to household if he/she belongs to urban areas along with climatic variables.

Table 3.11 and table-3.11A are presented in appendix B. The estimated result for binary variable of urbanization has also similar impacts as the case of district level urbanization (percentage) in table-3.5. Moreover, the impacts of climatic variables also found inverted U-shaped with food insecurity as we have found already. The control variables such as household head age, gender, education, and employment status does have significant impacts on food insecurity. Similarly, other district level indicators also have significant impacts on food insecurity as we have discussed in previous discussion for food insecurity context.

TABLE 3. 5: ***IMPACT OF URBANIZATION AND CLIMATE CHANGE ON FOOD INSECURITY ESTIMATED FROM BINARY LOGIT MODEL***

VARIABLES	Food insecurity	Mild FI	Medium FI	Severe FI
Urbanization (%) district	-0.00232***	-0.00234***	-0.000575	-0.000674
	(0.000293)	(0.000296)	(0.000381)	(0.000551)
Average rainfall	-0.162***	-0.128***	-0.373***	-0.615***
	(0.0249)	(0.0250)	(0.0309)	(0.0480)
Rainfall square	0.0851***	0.0822***	0.0755***	0.0940***
	(0.00432)	(0.00433)	(0.00547)	(0.00936)
Average temperature	-0.0945***	-0.101***	-0.0844***	-0.0605***
	(0.00745)	(0.00746)	(0.00856)	(0.0141)
Temperature square	0.00438***	0.00461***	0.00221***	0.00123***
	(0.000191)	(0.000191)	(0.000224)	(0.000342)
Head age	-0.0107***	-0.0104***	-0.0103***	-0.00879***
	(0.000458)	(0.000459)	(0.000583)	(0.000872)
Head gender	0.313***	0.304***	0.313***	0.342***
	(0.0240)	(0.0241)	(0.0323)	(0.0486)
Primary education	-0.265***	-0.270***	-0.249***	-0.278***
	(0.0165)	(0.0165)	(0.0204)	(0.0303)
Middle education	-0.546***	-0.550***	-0.542***	-0.570***
	(0.0181)	(0.0181)	(0.0240)	(0.0370)
Secondary education	-0.835***	-0.844***	-0.806***	-0.888***
	(0.0172)	(0.0173)	(0.0236)	(0.0380)
Higher secondary	-1.237***	-1.250***	-1.198***	-1.269***
	(0.0268)	(0.0271)	(0.0396)	(0.0659)
Tertiary education	-1.753***	-1.793***	-1.757***	-1.728***
	(0.0277)	(0.0282)	(0.0446)	(0.0716)
Dependency ratio	0.165***	0.165***	0.146***	0.153***
	(0.00710)	(0.00711)	(0.00853)	(0.0121)
Self-employed	-0.117***	-0.104***	-0.212***	-0.351***
	(0.0201)	(0.0202)	(0.0267)	(0.0396)
Paid-employee	0.228***	0.240***	0.0720***	-0.0994***
	(0.0187)	(0.0187)	(0.0244)	(0.0360)

VARIABLES	Food insecurity	Mild FI	Medium FI	Severe FI
Agriculture employment	-0.206***	-0.191***	-0.325***	-0.702***
	(0.0203)	(0.0204)	(0.0265)	(0.0403)
Transportation utilization	0.139***	0.139***	-0.0651***	-0.296***
	(0.0122)	(0.0122)	(0.0155)	(0.0226)
Agriculture extension	0.0214	-0.00184	-0.113***	0.00401
	(0.0236)	(0.0237)	(0.0312)	(0.0473)
Punjab	-0.288***	-0.303***	0.164***	0.459***
	(0.0271)	(0.0272)	(0.0376)	(0.0650)
Sindh	-0.212***	-0.194***	0.188***	0.0469
	(0.0372)	(0.0373)	(0.0481)	(0.0773)
Balochistan	0.617***	0.645***	0.349***	0.413***
	(0.0422)	(0.0423)	(0.0539)	(0.0849)
Constant	-0.867***	-0.950***	-0.406***	-0.973***
	(0.1000)	(0.100)	(0.116)	(0.196)
Observations	150,441	150,441	150,441	150,441

Note: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

TABLE 3.5 A 1*: IMPACT OF URBANIZATION AND CLIMATE CHANGE ON FOOD INSECURITY: ODD RATIO*

VARIABLES	Food insecurity	Mild FI	Medium FI	Severe FI
Urbanization (%) district	0.998***	0.998***	0.999	0.999
	(0.000292)	(0.000295)	(0.000381)	(0.000550)
Average rainfall	0.850***	0.880***	0.689***	0.541***
	(0.0212)	(0.0220)	(0.0213)	(0.0259)
Rainfall square	1.089***	1.086***	1.078***	1.099***
	(0.00471)	(0.00470)	(0.00589)	(0.0103)
Average temperature	0.910***	0.904***	0.919***	0.941***
	(0.00678)	(0.00674)	(0.00787)	(0.0132)
Temperature square	1.004***	1.005***	1.002***	1.001***
	(0.000191)	(0.000192)	(0.000224)	(0.000342)
Head age	0.989***	0.990***	0.990***	0.991***
	(0.000453)	(0.000454)	(0.000577)	(0.000864)
Head gender	1.368***	1.356***	1.367***	1.408***
	(0.0328)	(0.0327)	(0.0442)	(0.0684)
Primary education	0.767***	0.763***	0.779***	0.757***
	(0.0127)	(0.0126)	(0.0159)	(0.0230)
Middle education	0.579***	0.577***	0.581***	0.566***
	(0.0105)	(0.0105)	(0.0139)	(0.0209)
Secondary education	0.434***	0.430***	0.446***	0.411***
	(0.00745)	(0.00743)	(0.0105)	(0.0156)
Higher secondary	0.290***	0.286***	0.302***	0.281***
	(0.00779)	(0.00776)	(0.0120)	(0.0185)
Tertiary education	0.173***	0.167***	0.173***	0.178***
	(0.00480)	(0.00470)	(0.00769)	(0.0127)
Dependency ratio	1.180***	1.179***	1.157***	1.165***
	(0.00838)	(0.00838)	(0.00987)	(0.0141)
Self-employed	0.889***	0.901***	0.809***	0.704***
	(0.0179)	(0.0182)	(0.0216)	(0.0279)
Paid-employee	1.256***	1.272***	1.075***	0.905***
	(0.0234)	(0.0238)	(0.0263)	(0.0326)
Agriculture employment	0.814***	0.826***	0.723***	0.495***
	(0.0165)	(0.0168)	(0.0192)	(0.0200)

VARIABLES	Food insecurity	Mild FI	Medium FI	Severe FI
Transportation utilization	1.149***	1.150***	0.937***	0.744***
	(0.0140)	(0.0140)	(0.0145)	(0.0168)
Agriculture extension	1.022	0.998	0.893***	1.004
	(0.0241)	(0.0237)	(0.0279)	(0.0475)
Punjab	0.750***	0.739***	1.179***	1.582***
	(0.0203)	(0.0201)	(0.0444)	(0.103)
Sindh	0.809***	0.824***	1.206***	1.048
	(0.0301)	(0.0308)	(0.0580)	(0.0810)
Balochistan	1.854***	1.905***	1.417***	1.511***
	(0.0783)	(0.0806)	(0.0763)	(0.128)
Constant	0.420***	0.387***	0.667***	0.378***
	(0.0420)	(0.0388)	(0.0772)	(0.0741)
Observations	150,441	150,441	150,441	150,441

3.6.4 Joint Impact of Urbanization and Climatic Changes on Food Insecurity using Binary Logit Model

Table-3.6 contains the estimated results of the joint impact of urbanization and climate change on food insecurity obtained from application of binary Logit model, while table-3.6A1 comprises the estimation of odd ratios of the variables. The estimated results demonstrate that, other things remaining the same, the joint impact of urbanization and climatic variables has statistically significant positive (coefficient sign) impacts on the likelihood of prevalence of food insecurity among households.

Such results are found for all the types of food insecurity else one in the case of sever food insecurity behaves significantly negative (interaction of urbanization and average temperature). Such findings are very interesting because, in previous discussion, we have found the beneficial impacts (negative sign of coefficients) of urbanization on food insecurity. Nonetheless, here the joint impacts is estimated with positive signs which determines that alone urbanization has beneficial impacts, but it coincides with climatic shocks, the beneficial impacts of the urbanization appears to be the adverse.

In other words, the joint impacts of urbanization and climatic variables are negatively causing the of food security.

Table 3. 6: ***Joint impact of Urbanization and Climate change on food insecurity***

VARIABLES	Food insecurity	Mild FI	Medium FI	Severe FI
Urbanization	-0.0438***	-0.0465***	-0.0532***	0.0171**
	(0.00459)	(0.00463)	(0.00582)	(0.00804)
Average rainfall	-0.365***	-0.328***	-0.565***	-0.692***
	(0.0307)	(0.0308)	(0.0384)	(0.0571)
Interact rainfall& urbanization	0.00448***	0.00455***	0.00475***	0.000919
	(0.000396)	(0.000399)	(0.000486)	(0.000695)
Rainfall square	0.0997***	0.0964***	0.0882***	0.104***
	(0.00456)	(0.00458)	(0.00592)	(0.00961)
Average temperature	-0.0755***	-0.0813***	-0.0642***	-0.0718***
	(0.00780)	(0.00783)	(0.00906)	(0.0139)
Interact temperature & urbanization	0.00120***	0.00129***	0.00157***	-0.000648***
	(0.000141)	(0.000142)	(0.000181)	(0.000251)
Temperature square	0.00336***	0.00354***	0.00109***	0.00164***
	(0.000217)	(0.000218)	(0.000256)	(0.000371)
Head age	-0.0105***	-0.0102***	-0.0101***	-0.00870***
	(0.000459)	(0.000460)	(0.000584)	(0.000872)
Head gender	0.302***	0.294***	0.304***	0.331***
	(0.0240)	(0.0242)	(0.0324)	(0.0487)
Primary education	-0.261***	-0.266***	-0.246***	-0.276***
	(0.0165)	(0.0166)	(0.0204)	(0.0303)
Middle education	-0.537***	-0.541***	-0.533***	-0.568***
	(0.0181)	(0.0182)	(0.0240)	(0.0370)
Secondary education	-0.826***	-0.834***	-0.796***	-0.888***
	(0.0172)	(0.0173)	(0.0236)	(0.0380)
Higher secondary education	-1.229***	-1.242***	-1.188***	-1.267***
	(0.0269)	(0.0271)	(0.0396)	(0.0660)
Tertiary education	-1.745***	-1.784***	-1.745***	-1.731***
	(0.0277)	(0.0282)	(0.0445)	(0.0716)
Dependency ratio	0.165***	0.164***	0.145***	0.153***
	(0.00710)	(0.00711)	(0.00853)	(0.0121)
Self-employed	-0.118***	-0.105***	-0.214***	-0.346***
	(0.0201)	(0.0202)	(0.0267)	(0.0396)
Paid-employee	0.226***	0.239***	0.0680***	-0.0963***
	(0.0187)	(0.0188)	(0.0245)	(0.0360)
Agriculture employment	-0.211***	-0.196***	-0.332***	-0.699***
	(0.0203)	(0.0204)	(0.0266)	(0.0404)
Transportation utilization	0.143***	0.142***	-0.0635***	-0.294***
	(0.0122)	(0.0122)	(0.0155)	(0.0226)
Agriculture extension	0.0139	-0.00994	-0.124***	0.00500
	(0.0237)	(0.0238)	(0.0313)	(0.0474)
Punjab	-0.323***	-0.334***	0.136***	0.390***
	(0.0276)	(0.0277)	(0.0382)	(0.0641)
Sindh	-0.235***	-0.214***	0.164***	-0.0189
	(0.0375)	(0.0376)	(0.0486)	(0.0764)
Balochistan	0.500***	0.532***	0.254***	0.322***
	(0.0438)	(0.0439)	(0.0557)	(0.0865)
Constant	-0.265**	-0.340***	0.228*	-0.853***
	(0.114)	(0.115)	(0.136)	(0.210)
Observations	150,441	150,441	150,441	150,441
Note: Robust see form in parentheses *** p<0.01, ** p<0.05, * p<0.1				

estimated by binary logit model

TABLE 3.6A 1*: JOINT IMPACT OF URBANIZATION AND CC ON FI: ODD RATIOS*

VARIABLES	Food insecurity	Mild FI	Medium FI	Severe FI
Urbanization	0.957***	0.955***	0.948***	1.017**
	(0.00439)	(0.00442)	(0.00552)	(0.00818)
Average rainfall	0.694***	0.720***	0.569***	0.500***
	(0.0213)	(0.0222)	(0.0218)	(0.0286)
Interact rainfall& urbanization	1.004***	1.005***	1.005***	1.001
	(0.000398)	(0.000401)	(0.000488)	(0.000696)
Rainfall square	1.105***	1.101***	1.092***	1.109***
	(0.00504)	(0.00504)	(0.00647)	(0.0107)
Average temperature	0.927***	0.922***	0.938***	0.931***
	(0.00723)	(0.00722)	(0.00850)	(0.0129)
Interact temperature & urbanization	1.001***	1.001***	1.002***	0.999***
	(0.000141)	(0.000143)	(0.000181)	(0.000251)
Temperature square	1.003***	1.004***	1.001***	1.002***
	(0.000218)	(0.000219)	(0.000256)	(0.000372)
Head age	0.990***	0.990***	0.990***	0.991***
	(0.000454)	(0.000455)	(0.000578)	(0.000865)
Head gender	1.353***	1.342***	1.355***	1.392***
	(0.0325)	(0.0324)	(0.0439)	(0.0678)
Primary education	0.770***	0.766***	0.782***	0.759***
	(0.0127)	(0.0127)	(0.0159)	(0.0230)
Middle education	0.584***	0.582***	0.587***	0.567***
	(0.0106)	(0.0106)	(0.0141)	(0.0210)
Secondary education	0.438***	0.434***	0.451***	0.411***
	(0.00753)	(0.00751)	(0.0107)	(0.0156)
Higher secondary education	0.293***	0.289***	0.305***	0.282***
	(0.00786)	(0.00783)	(0.0121)	(0.0186)
Tertiary education	0.175***	0.168***	0.175***	0.177***
	(0.00483)	(0.00474)	(0.00777)	(0.0127)
Dependency ratio	1.179***	1.178***	1.156***	1.165***
	(0.00837)	(0.00838)	(0.00986)	(0.0141)
Self-employed	0.889***	0.900***	0.807***	0.708***
	(0.0179)	(0.0182)	(0.0215)	(0.0280)
Paid-employee	1.254***	1.269***	1.070***	0.908***
	(0.0234)	(0.0238)	(0.0262)	(0.0327)
Agriculture employment	0.810***	0.822***	0.718***	0.497***
	(0.0164)	(0.0168)	(0.0191)	(0.0201)
Transportation utilization	1.153***	1.153***	0.938***	0.745***
	(0.0141)	(0.0141)	(0.0145)	(0.0169)
Agriculture extension	1.014	0.990	0.883***	1.005
	(0.0240)	(0.0236)	(0.0276)	(0.0476)
Punjab	0.724***	0.716***	1.145***	1.476***
	(0.0200)	(0.0199)	(0.0437)	(0.0946)
Sindh	0.790***	0.807***	1.178***	0.981
	(0.0296)	(0.0303)	(0.0572)	(0.0750)
Balochistan	1.649***	1.702***	1.290***	1.380***
	(0.0721)	(0.0746)	(0.0719)	(0.119)

Note: Robust see form in parentheses *** p<0.01, ** p<0.05, * p<0.1

The impacts of only urbanization on food insecurity is similar as we have discussed before (table-3.6), while the estimated results of rainfall and temperature norms is found non-linear impacts on food insecurity as the case of previous discussions. Where, the square terms of rainfall and temperature have demonstrated the significantly positive (signs) impacts on the food insecurity with other things remaining the same.

It means that, other things remaining the same when temperature and rainfall exceeds after certain threshold level, both variables are significantly positive impacts on the food insecurity (food security decreases). Moreover, Table 3.12 and table-3.12A, which is presented in appendix B, are showing that the estimated joint impact of binary urbanization and climatic variables has also similar impacts as the case of district level joint urbanization (percentage) and climatic variables in table-3.6.

The rests of the impacts remain the similar as the case of previous ones. The binary urbanization and climatic factors alone have significant impacts on food insecurity. One important thing is that these impacts are not sensitive to changing the definition of the variables and changing the construction of binary urban area with climatic factors.

3.6.5 Urbanization and Food Insecurity: Application of Ordered Logit Model

In previous sections, we have employed binary variables for food insecurity as dependent variables. Nonetheless, in this section we club those four levels of food insecurity into one categorical variable ("0"= food secure household, "1"= mild food insecure, "2"=medium food insecure, and "3"=severe food insecure) wherein food secure households are kept as reference category. Such classification of variable requires the application of Ordered Logit Model owing to ordering in categorical

variable. Table 3.7 contains the estimated results for the influences of urbanization on households' odds of being higher level of food.

Table 3. 7 : ***Urbanization and Food Insecurity (mild, medium, and severe): OLM***

	Ord. Logit	Odd ratio	Ord. Logit	Odd ratio
Urbanization (%)	-0.00470***	0.995***		
	(0.000244)	(0.000243)		
Region (1=urban, 0=rural)			-0.228***	0.796***
			(0.0127)	(0.0101)
Head age	-0.0122***	0.988***	-0.0123***	0.988***
	(0.000421)	(0.000416)	(0.000421)	(0.000415)
Head gender (1=male)	0.342***	1.408***	0.340***	1.405***
	(0.0233)	(0.0327)	(0.0233)	(0.0327)
Primary	-0.266***	0.766***	-0.261***	0.770***
	(0.0149)	(0.0114)	(0.0149)	(0.0115)
Middle	-0.585***	0.557***	-0.587***	0.556***
	(0.0167)	(0.00927)	(0.0166)	(0.00926)
Secondary	-0.873***	0.418***	-0.872***	0.418***
	(0.0158)	(0.00660)	(0.0158)	(0.00661)
Higher secondary	-1.205***	0.300***	-1.199***	0.302***
	(0.0246)	(0.00736)	(0.0246)	(0.00742)
Tertiary education	-1.742***	0.175***	-1.731***	0.177***
	(0.0257)	(0.00451)	(0.0258)	(0.00458)
Dependency ratio	0.169***	1.184***	0.170***	1.185***
	(0.00643)	(0.00762)	(0.00643)	(0.00762)
Self employed	-0.169***	0.845***	-0.161***	0.851***
	(0.0192)	(0.0162)	(0.0193)	(0.0164)
Paid employee	0.152***	1.164***	0.153***	1.165***
	(0.0178)	(0.0207)	(0.0178)	(0.0208)
Agriculture employment	-0.177***	0.838***	-0.186***	0.830***
	(0.0191)	(0.0160)	(0.0192)	(0.0159)
Transport utilization	0.0977***	1.103***	0.118***	1.125***
	(0.0112)	(0.0123)	(0.0111)	(0.0125)
Agriculture extension	0.00516	1.005	0.00841	1.008
	(0.0211)	(0.0212)	(0.0211)	(0.0212)
Punjab	0.0418***	1.043***	-0.00195	0.998
	(0.0142)	(0.0148)	(0.0138)	(0.0138)
Sindh	0.421***	1.523***	0.335***	1.398***
	(0.0176)	(0.0268)	(0.0161)	(0.0225)
Balochistan	0.431***	1.539***	0.422***	1.525***
	(0.0192)	(0.0296)	(0.0192)	(0.0293)
/cut1	-0.0618**	0.940**	-0.0198	0.980
	(0.0305)	(0.0287)	(0.0304)	(0.0298)
/cut2	1.226***	3.407***	1.267***	3.551***
	(0.0307)	(0.105)	(0.0307)	(0.109)
/cut3	2.376***	10.76***	2.417***	11.21***
	(0.0317)	(0.341)	(0.0316)	(0.355)

Note: Robust see form in parentheses *** p<0.01, ** p<0.05, * p<0.1

Insecurity. Model (1) contains the results when urbanization is district level of urbanization (percentage), while model (2) encompasses the binary variable of urban area. The estimated results indicate that urbanization has significant negative (sign) impacts on being higher level of food insecurity. It implies that urbanization brings about decrease the chances of households to fall in higher levels food insecurity (from mild to severe), other things remaining same. Binary urban area is also showing the negative and significant impacts on categorical food insecurity as we have already discussed. By summing up the discussion, the application of ordered Logit establishes the previous findings for urbanization on food insecurity.

Table-3.13 presented in appendix B contains the estimation along with climatic variables. The estimated results remain similar, as we have obtained from binary Logit model. Climatic variables have non-linear relationship with odds of being higher level of food insecure.

There is inverted U-shaped relationship demonstrates that linear terms of the rainfall and temperature has beneficial impacts which demonstrates that linear term reduces the odds of being higher food insecure while the square term indicates that after some point's climatic factors (rainfall, and temperature) raise the odds of being higher level of food insecure in Pakistan. Table 3.14 presented in appendix B encompasses the estimated results for the interaction terms of urbanization and climatic factors temperature and rainfall on the odds of being higher level of food insecure households. Like the findings of binary Logit model, these findings are found similar. These results confirm the previous findings that when urbanization coincides with climatic factors, the beneficial effects of the urbanization converts into the adverse impacts.

It implies that the happening of extreme events of rainfall and temperature bring about disastrous impacts on agriculture and infrastructure at local levels specially in the

vulnerable places which ultimately enhances the perils of being food insecure on the whole in country especially in the urban areas as well.

By concluding the whole the discussion, findings of instrumented urbanization and interaction term of urbanization with climatic factors appear to be same where the beneficial impacts of urbanization become adverse.

3.7 Conclusion and Policy Implication

3.7.1 Concluding Remarks

Food security has been deemed as the one of key policy agenda in developing countries. Sustainable Development Goal (SDG-2) maintains focus on zero hunger by the end of 2030, which is committed by global community in 2015. Pakistan is also amongst those countries, which have been targeting the reduction of food insecurity for the last couple of decades. However, the goal to achieve zero hunger is intimidated due to multiple factors— economic, social, and political. During the last couple of years, Pakistan is facing a parallel rise of urbanization and happening of climatic and environmental calamities, which have raised several other challenges including feeding the rising population in both urban and rural areas. To design inclusive and effective policy agenda to tackle such problem, we need to gather empirical evidence on relationship among urbanization, climatic shocks and food insecurity.

Therefore, the underlying piece of research aims to explore: i) the influences of urbanization and climatic shocks on food insecurity, ii) what happens to food insecurity when urbanization and climatic shocks coincides together in Pakistan. For empirical purpose, PSLM (2019-20) data set has been employed to gather household level information: households' socioeconomic characteristics and specifically the dependent variable food insecurity has been measured by using the module of Food Insecurity Experience Scale (FIES).

Moreover, district level data of 30 years averages of rainfall and temperature has been used. Finally, district level climatic factors are merged with PSLM (2019-20) by identifying the district codes. For econometric purpose, binary Logit model, Ordered Logit model and instrument variable approach has been implemented, rainfall and transportation has been used as instrument for urbanization to deal endogenity arises due to urbanization in the model. The estimated findings indicate that urbanization has beneficial and significant impacts on food insecurity reduction, while climatic factors have shown non-linear influences on food insecurity. The non-linear impacts demonstrate that linear term of rainfall and temperature has shown beneficial impacts while non-linear term contains adverse effects on food security. Nonetheless, when both urbanization and climatic factors coincide, the beneficial impacts of urbanization become adverse impacts on food security. Moreover, the instrumented urbanization also indicates the adverse impacts on food insecurity contrary to the non-instrumented urbanization variable.

By concluding the whole discussion, findings of instrumented urbanization and interaction term of urbanization with climatic factors appear to be same wherein the beneficial impacts of urbanization become adverse and they start causing increasing the likelihood of the level of food insecurity among households in Pakistan.

3.7.2 Policy Implication

Overall, the findings of the underlying research have demonstrated that urbanization has significant and beneficial influences on food insecurity reduction, but rising climatic shocks such as occurring of extreme events of rainfall and temperature is likely to devastate the advantageous effects of urbanization. Such finding has the following implications, which need to be considered as policy agenda regarding achieving the SDG-2 in Pakistan.

- A well-designed policy regarding dealing climatic change is needed to achieve food security because it has negatively impacts on food insecurity.
- A well planned and inclusive urban management is required which should be promptly responsive to the rainfall and temperature shocks.

3.7.3 Limitations of the Study

We have made our best efforts to conduct the underlying research essay, but still it can be improved further if we would have tackled following limitations.

- We have district level information of Food Insecurity Experience Scale (FIES) only in PSLM (2019-20), if the data of FIES had been available for previous surveys; we would have utilized it also, which further could give us analysis for over the years.
- We could not use the other measures of food insecurity like food diversity score, calorie intakes, and nutrition related information due to the unavailability of data at district level in PSLM (20219-20). Such information can be taken from HIES (2019-20) but that is not district level representative.
- The income (or expenditure on food) which cannot be used in the model because such information can be taken from HIES (2019_20) but this is not district level representative.

To us, if we could incorporate the above-mentioned limitations, the underlying study would be more comprehensive. Finally, it is important to note that with all the limitations, this type of research is still necessary to investigate the impacts of climate change and urbanization on food insecurity in Pakistan. There is a hope that this research opens the new opportunity for other researchers. Future research should

incorporate more climatic variables in order to wide assess the climate impact on food insecurity in Pakistan.

CHAPTER 4

ESSAY 2

HEALTH DEMAND DETERMINANTS IN PAKISTAN USING GROSSMAN MODEL

ABSTRACT

The underlying essay aims to explore the household determinants of health demand in Pakistan using Grossman Model. For empirical purpose, PSLM 2019-20 survey has been used to explore the specified objectives of the underlying essay. Grossman model (1972, 2000) has been used to measure the determinants of health demand in Pakistan. The application of Grossman model is suggestive for the beneficial impacts of the urbanization on health demand, however; the climatic factors such as rainfall, temperature shocks and education of household are found to have non-linear impacts on health demand.

4.1 Introduction

4.1.1 Background & Motivation

Ensuring quality health is considered one of the key policy goal for the governments in developing countries. Therefore, SDG-3 addresses this issue (Jean et al, 2018). Health is regarded as the most important feature of human well-being. Health is widely considered as an important component of human capital (Zhao & Studies, 2008). Better health actually improves the quality of human capital. Health status of the residents reflect the physical quality of life enjoyed by its members (Alam, & Weekly, 1997).Health care services are a prerequisite to transform population as human capital.

Good health contributes positively to poverty reduction strategies and producing factors such as job and income losses due to illness (Arega & Ababa, 2003).On the other hand, households have been experiencing manifolds diseases and health related issues such as limited provision of health facilities, cost of receiving healthcare, and so on.

Nonetheless, researchers who work on households' health related issues face problem in defining indicators, which determine households' health status due to limited availability of information on it. Health status of Pakistan is extremely low even in the comparisons with the other neighboring countries. One in every ten children born in Pakistan died before reaching the age of five year and woman have a one in eighty chances of dying of maternal health causes during their reproductive life (Organization, 2010; Afzal & Yusuf, 2013). Pakistan has not succeeded to reduce significantly both the maternal mortality and child mortality rates over the time (N. Iqbal & Nawaz, 2017). Despite efforts to improve the health status of the country is still facing infant mortality rate with low life expectance rate (Bhutta, Soofi, Zaidi, Habib, & Hussain, 2011,Abbas & Awan, 2018; Organization, 2015).

The seminal work of Grossman's model (1972) of health demand has become the standard model to study health demand and health determinants (Zhao , 2008). Grossman model was designed in 1972 for analysis of demand for health at micro level. Grossman highlighted that health is an important part of human capital (L. Iqbal, Awan, & Tayyab). The economists and researchers most commonly used the Grossman's health demand model(Zhao & Studies, 2008). According to this model, health is viewed as a stock of human capital and it depreciates over the time. Health can be maintained by investing in health for example, nutritious and healthy food, routine exercise, owns time, increase demand care or other market care. While smoking, excess alcohol and drug consumption accelerate the depreciation of the health capital. Existing literature

suggested multiple determinants of health demand (gender, education, and income, etc.) and locational factors like urbanization, climatic-factors, and so on (N. Iqbal & Nawaz, 2017).The importance of analysis of demand for health care in the formulation of policies and strategies for the health sector can be exaggerated (Howlader, Routh, Hossain, Saha, & Khuda, 2000).

Pakistan is a country which is striving hard to achieve Sustainable Development Goals (SDGs) which are set by the United Nations in 2015 for all the Nations by 2030.The progress of health sector in Pakistan could not be ignored since the time of independence 1947 (Kurji, Premani, & Mithani, 2016). The health status of an individual affects social, economic, demographic and environment conditions of the country (Abbas & Awan, 2018). The purpose of this study is to provide emerging insights on the demand for health in Pakistan at local level in order to better health policies formulation and implementation of SDG 3 (good health and wellbeing).

No major attempts have been made yet so far in Pakistan to examine the demand for health using Grossman's health demand model in a comprehensive manner with incorporating the effects of climate change and urbanization. An important policy question remains unanswered that what are the social, economic, and demographic and environment factors affect the health status of the country. Although, numbers of studies on health in Pakistan (Abbas & Awan, 2018, N. Iqbal & Nawaz, 2017 ,Afzal & Yusuf, 2013).But there is no study incorporated the couple of challenges of climate change and urbanization on health demand of Pakistan. The present study attempts to fill this research gap in empirically health demand analysis at district level by using the latest micro data set PSLM 2019-20.

4.1.2 Objectives of the study

The main objective of this study is to measure the household's health demand determinants in Pakistan. The specific objectives are outlined as follows.

I. To measure the household-specific determinants of health demand.

II. To estimate the impacts of urbanization, and climatic variations on health demand

4.1.3 Significance of the Study

This research contributes to various avenues and provides policy recommendations to help the policy makers in formulating better policies to attain the time bounded SDGs (Sustainable Development Goals) by 2030 at the local level. This study differs from the other studies at least in fifth ways. First, the available studies relating to subject have used national level data or provincial level and there is no study on recent micro level data set. This study is a first attempt at district level (localization of sustainable development goals).Second; the present study is an attempt to explore the household determinants of the health demand. The uncertain changes in nature i.e. Changes in precipitation pattern, extremely high and low temperature have made challenges issue in Pakistan because the previous literature ignores these important variables. Third, this study uses the latest micro data set (PSLM, 2019-20). Fourth, this study suggests some policy to improve the health sector in Pakistan. Moreover, the comprehensive knowledge might be helpful for the policy makers to assess the good health and wellbeing.

4.1.4 Scheme of the Chapter

Section 4.2 reviews the literature on focusing to explore the household specific determinants of health demand. The conceptual framework for this essay, which highlighted the relationship between the health demand and the explanatory variables

presented in 4.3, Section 4.4 discusses the empirical model, estimation methods, variable construction and data used in this study. The results obtained from estimating the model is presented and analyzing in section 4.5. Conclusion and policy implication draw in the section 4.6.

4.2 Literature Review of Health Demand

Health is a unique market and it has distinguished featured as compared to other goods and products markets. Factors that affect health status of the country have remained an interesting and stimulating policy debate (Abbas & Awan, 2018). The health market is influenced by many factors like as demographic, climate changes and other socioeconomic elements.

There are two types of costs of medical service, indirect cost and direct cost, the direct costs are the cash paid for medical examination, medicines and transport. The indirect costs are opportunity cost of traveling, distance home to hospital, waiting time to get the required medical service. The first and probably the most significant cost element is the price of medical service. Theoretically, other things remaining the same, the actual cost for consuming a health service should act as a determining factor of usage of health care services. However, the empirical literature presents contradictory results regarding the significance of price affect. First group advocate that prices are not important elements of medical consumption (Arega & Ababa, 2003).

The other studies like (Alderman & Gertler, 1988)and (Mariko & medicine, 2003)conclude that prices are dominant element of the demand for health care. According to Gartler, Locy and Sanderson (1987) most of the studies concluded that price as an insignificant factor of health care demand because price as being independent of income. However, researcher's claims that such models are inconsistent with utility maximization, when health treated as normal "good" and they derived a

discrete choice specification from a theoretical model in which income can affect the choice of providers. Gartler, Locy and Sanderson (1987) model consistent with utility maximization, Sahn et al (2002) in the study of demand for health care service in Tanzania found that price of medical treatment as a significant element that determines the demand for health care. By the same token, Getler and (Gertler & Gaag, 1990) also found similar results for Peru. The second cost element is linked with distance traveling to get the medical service.

Theoretically, the physical availability of healthcare suppliers is exclusive factor that characterizes the medical market. As a result, the consumer of medical services usually gives value to the time spend on traveling to get health facilities(Senauer, Garcia, & Change, 1991), present distance as an important factor that determines the demand for medical care. Similarly, (Mwabu, Ainsworth, & Nyamete, 1993)report that distance negatively impact on choice of health care supplier even than the effect is statistically insignificant. Distance has strongly negative significant impact on the demand for health care (Hotchkiss, 1994), and they use transportation cost and opportunity cost of traveling time as a proxy for distance.

Third cost element is the opportunity cost of waiting time to reach the required medical service. (Akin, Griffin, Guilkey, & Popkin, 1985)confirm that waiting period is not an important reason to determine the demand for health care. In contrast (Acton, 1975) a study of New York City Hospital show that waiting time and traveling time negatively affect the demand for health. In addition, this study shows that employed persons and higher opportunity cost of time people less time intensive medical care. Similarly, (Bitran & McInnes, 1993)concluded that people have preferred private health supplier to public health supplier due to shorter waiting time at private health provider. Education of the housel head plays a central role to demand for health. Mirowsky and

Ross (2003) argues that education influences the health demand though occupation and income.

Education ⟶ Occupation ⟶ Income ⟶ Health Demand

Income of the household plays a central role in choosing health care services (Mwabu, 1993; Peter, 2000). Puig et al, (2002) concluded that income of individuals is a major significant factor that affects the demand for health care services. The amount that a household can spend on health is mainly depending on the household's income and wealth. Awiti (2014) examined the effect of income on health seeking behavior, individual choices for health care and health expenditure and finds the positive relationship.

It is a general perception that households with more favorable income situation enjoys better health (Shams, 2014). Numbers of studies investigated the relationship between health and income and concluded that the income inequality negatively affects health of the lower income groups (Mellor and Milyo, 2002; Shams, 2014; Smith, 1999; Wagstaff and Van Doorslaer, 2000). Huda et.al, (2011) investigated the socio-economic disparities in Baluchistan using multivariate analysis. Shams (2013) used various socioeconomic factors like gender, education, income and age to measure health.

Furthermore, in addition gender and age of the household head may also plays central role in the demand for health care service. Theoretically, there is a U-shaped relationship between age and health care demand because infants and the aged probably to have a high level of health care demands (Akin et al., 1985).Children are more vulnerable to infective diseases due to immature immune system and degenerative diseases which are common in old age. However, the relationship between age and health care demand has no significant economic impact on health care demand because

both groups (children and elders) are dependent on others. Human capital theory states that households may prefer to invest scarce resources in the health of high return family members (younger and more productive).On the other hand, other studies reported that age has not significantly affect the demand for health care (Peter, 2000;Junoy et. al, 2002; Jume et. al, 2002).

Dependence ratio is an additional demographic characteristic that may explain the demand for health care services. Theoretically, it is not possible to articulate the effect of household dependence ratio on the demand for health care. More dependency ratio more resources require for health demand with more people and this may lower the level of nourishment for each member and lower consumption of health care services per person. On the other side, larger families supply more adults, who can enhance the household income that will ease the resource constraint and may increase the demand for health care services. In contrast to this study, (Gertler & Gaag, 1990)explore that household with fewer adults and more children to seek more demand for health care services. Both the authors further explain that more adults in the household allow more time to better care for sick individual at home and having more children affects the less time to take care of ill.

Lot of literature is available to understand the objectives of this study in developing as well as developed countries. These studies are deficient to consider the new challenges of health demand like as climatic challenges and urbanization. Moreover, the impact of household specific determinants along with climate changes and urbanization on health demand in case of Pakistan is missing. The current study is being initiated to explore the nature of determinants of health demand in Pakistan by using the micro data set of Pakistan Social and Living Standard Measurement Survey (PSLM), 2019-20 collected and published by the Federal Bureau of Statistics Pakistan.

By using current data set, the underlying research directly highlights the present scenario of health demand at household level and indirectly provide the guidelines to what extent SDG-3 (Good health and Wellbeing) have been successfully achieved by 2030.Additionally, this research estimating the distribution of, public health care demand vs private health care demand.

Therefore, this study, measure the household specific determinants of health demand in Pakistan at household level with a comprehensive approach by using the Grossman model. Bluck of literature investigates the health demand of country as well as cross-country level and/or world level but there is scarce to consider the new challenges of climatic shocks and growing urbanization in Pakistan this study fills this literature gap.

4.3 Conceptual Framework of Health Demand

Grossman proposed the first formal model of demand for health in 1972.Grossman-defined health as a durable capital stock that is inherited and depreciate over time. Health is an endogenous variable; people can improve it through medical care, diet and exercise. The standard model of Grossman (1972, 2000) assumes that the utility function of a represented consumer is as:

$$U = f(\text{Ø}_t H_t, Z_t), t=0, 1, 2, 3\ldots n \quad (4.1)$$

Where H_t denotes the stock of health capital at time t, Ø_t is the benefit produced by one unit of health capital, $\text{Ø}_t H_t$ is the health consumed at time t and Zt is the consumption of other goods at time" t". The initial stock of health capital H_0 is exogenous, $H_t$is another time and n are the length of time (life) which is endogenous. Change in the health capital:

$$\Delta H_t = H_{t+1} - H_t = I_t - \delta_t H_t \quad (4.2)$$

Where I_t is the investment in health and δt is the depreciation rate of health capital at time t. δt (Depreciation rate) changes with age. It and Zt produced by the following functions:

$$I_t = f(M_t, TH_t, E) \qquad (4.3)$$

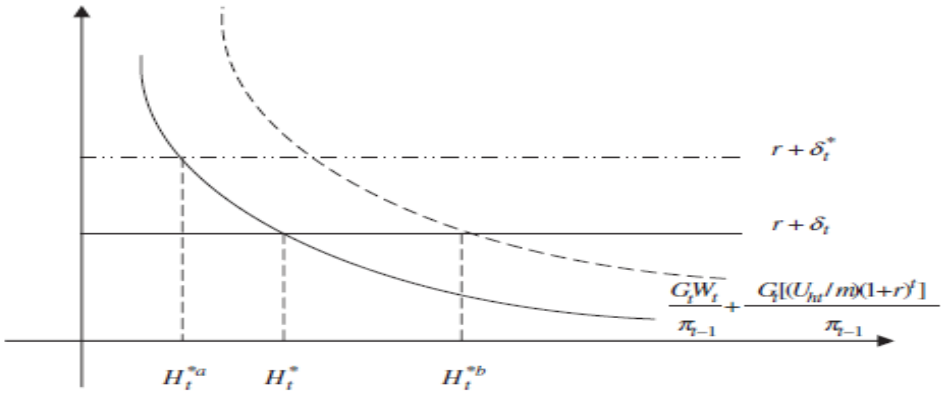
$$Z_t = f(X_t, T_t, E) \qquad (4.4)$$

Equation 4.3, Mt (health care services), is the market goods used to produce investment in health. THt is the time allocated to improve health and E is the other exogenous components of health capital. Equation (4.4) is the home production function of other consumption goods Z_t, it produced with the use of X_t (market goods), T_t (time), E (other human capital) .Moreover, the consumer faces the following budget constraint:

$$\sum_{t=0}^{n}\cdot\left[\frac{\mathrm{PtMt+QtXt}}{(1+r)t}\right] = \sum_{t=0}^{n}\cdot\left[\frac{\mathrm{WtTwt}}{(1+r)t}\right] + (\mathrm{A0}) \qquad (4.5)$$

Where Pt and Qt are prices, Wt is the wage rate, TWt is the working hour and $A0$ is the initial wealth with the budget constraint. The consumer also needs to meet the time constraint Ω. $TWt + TLt + THt = \Omega$ (4.6)

Where TWt is the working time, TLt time loss due to illness and TH_t time allocated to improve health other than T_t.



Source: (Zhao , 2008)

Figure 4. 1: ***Conceptual framework of Grossman health demand model***

Equation (4.1) to (4.6) jointly determines the demand for health. Based on the above model, therefore two approaches to study the demand for health. First, one is the pure investment model and second is the pure consumption model. Grossman (2000) more emphasized on the estimation of the investment model rather pure consumption model because investment model generates powerful prediction from simple analysis with feasible assumptions. Due to this valid reason, this study uses pure investment model. The optimal conditions of this model is:

$$\frac{\mathrm{Gtwt}}{\Pi t-1}+\frac{\mathrm{Gt}[\left(\frac{\mathrm{Uht}}{m}\right)(1+\mathrm{r})\mathrm{t}]}{\Pi t-1}=\mathrm{r}+\delta t \qquad (4.7)$$

Where $\mathrm{Gt}=\frac{\partial \mathrm{TLt}}{\partial Ht}$ the marginal product of health capital is, $\mathrm{Uht}=\frac{\partial \mathrm{u}}{\partial Ht}$ is the marginal utility directly produced by health? M is the marginal utility produced by monetary income and $\Pi t-1$is the shadow price of health determined by the cost of health (i.e. Cost of health care services, the wage rate etc.).Equation (4.7) shows the optimal condition:

$$\mathrm{MB\ (marginal\ benefit)}=\mathrm{MC\ (marginal\ cost)}$$

There are two types of marginal benefit; first, one is the monetary benefit $\frac{\mathrm{Gtwt}}{\Pi t-1}$ and $\frac{\mathrm{Gt}[\left(\frac{\mathrm{Uht}}{m}\right)(1+\mathrm{r})\mathrm{t}]}{\Pi t-1}$ utility gain directly from health. The cost of health is the same as the cost occurred in other standard investment including interest (r) and depreciation (δt).The crossing point of the health benefit curve and the cost curve (in figure 4.1) determine the optimal demand for health (H_t^*). In literature, depreciation (δt) is the focal point. Depreciation rate increases as age increases.

If δt increases to δt^* the demand for health will reduce from (H_t^*) to (H_t^{*a}). Education is another variable, which influences the health. Increase in the education level will improve the health. More educated consumer will produce health at lower

cost and will lower the shadow price of health (health demand increases $H_t^* \; to \; H_t^b$.If the price of health care services increases it means that the cost of the health increases and this will decrease the demand for health.

If Price of health↑→Cost of health ↑→ Demand for health↓

Wage rate reflects the value of time. If the wage rate increases it increasing the earning of worker on the other hand production of health takes time (i.e. negatively affect the health) but generally believed that wage rate positively affects the health. In really the effect of wage rate on health demand is ambiguous.

If Wage rate↑→ earnings ↑→ Production of health takes time↑→Demand for health↑↓ (inconclusive)

The time constraint also has testable constraint. If working hour increasing so there is less time for to improve health due to this health demand will decline.

If working hour↑→ Time for health↓→Demand for health↓

This study will test the above theoretical model empirically. Theoretical literature highlighted that demand for health is a function age, wage rate, work time, health price and education, Climate changes, urbanization and transport facility.

$$Health\ demand = f(Household\ specific\ and\ District\ Level\ Variables) \quad 4.8$$

$$Health\ demand f(age, wage\ rate, worktime, health\ price, education, CC, Ur, Tr) \quad 4.9$$

By using the theoretical framework, the econometrics transformation of the model given in equation (4.10) is as under:

$$\text{Health } Demand = a_1 + b_1 age + b_2 Wage\ rate + b_3 Work\ time + b_4\, Health\ price + b_5 Education + b_6 CC + b_7 UR + b_8 TrCCU_{it} \quad (4.10)$$

Many proxies, which are being widely used to measure the health demand by the households. Out of those, health expenditures are one of the common proxies to measure the health demand. Household demographic indicators such as age, gender, and education of the household head, and dependency ratio are also one of the important household-specific characteristics.

Households' monthly income (PKR) is taken as the proxy of the wage rate, which is earned from all sources whether from business, job, and other sources. The PSLM (2019-20) does not contain the households' expenditures. But, contains information regarding the distance in kilo meters from the home to health facility, and so it may indicate the household' health cost. Because, travelling not measure the monetary cost, but time cost also. Hence, the underlying study has used distance in kilometers from home to the hospital or basic health center as the proxy for the capturing health cost. The brief description of the variables is presented in table 4.2.

4.4 Data and Variable Construction

4.4.1 Data Source

Primarily, the underlying study maintains focus on using the PSLM (2019-20) household survey. As we have mentioned in first section, the objective of the on-going research is to explore what are household-specific determinants of the household health demand. Therefore, the PSLM (2019-20) provides us the information of households, and in addition, district level information can be plucked out this survey.

The total sample size 160,654 households from all over Pakistan that is specifically district representative household survey. Nonetheless, the district level climatic variables such as rainfall and temperature norms are taken from Pakistan Metrological Department as discussed in previous chapter as well.

4.4.2 Variable Construction

The construction of the variables is being used is discussed in this section, which are presented as follows.

4.4.2.1 Health Demand (Depended Variable)

There are many proxies, which are being widely used to measure the health demand by the households. Out of those, health expenditures are one of the common proxies to measure the health demand. Actually, households' expenditures represent their preferences what types of health facilities are demanded or whether households prefer to visit the doctors or not. Nonetheless, PSLM 2019-20 provides us opportunity to pluck out the important proxies, for health demand by households. The underlying study uses such indicators of health demand:

i) whether household visited any doctor or not when needed,

ii) whether household visited Basic Health Center (BHC),

iii) whether household visited family planning centers (FPC),

iv) whether household visited hospitals or other health clinics,

v) Households' number of visits

vi) What sector of health center a household has visited (private or public sector).

In nutshell, all these indicators denote for the health demand by households in Pakistan. Moreover, these indicators are used separately for regression analysis to estimate the household-specific and district level determinants of the health demands. The construction of these indicators is demonstrated in table 4.2.

Table-4.1 comprises the descriptive analysis of the indicators of the health demand, which we have discussed. The percentage points for overall country highlight that on average, 10 percent households respond they never visited hospital, while 15

percent households are found visiting the hospitals occasionally, 56 percent households demonstrate that they often visited, and 17.63 percent households have visited the hospitals when they are needed. Likewise, 67 percent households have not visited basic health center (BHC) not at all, while only 4.5 percent households visited BHC always when they needed. The discussion concludes that households prefer to the hospitals over BHC.

Table 4. 1 ***: Percentage (percentage) Distribution of the Visits to Health Care Centers***

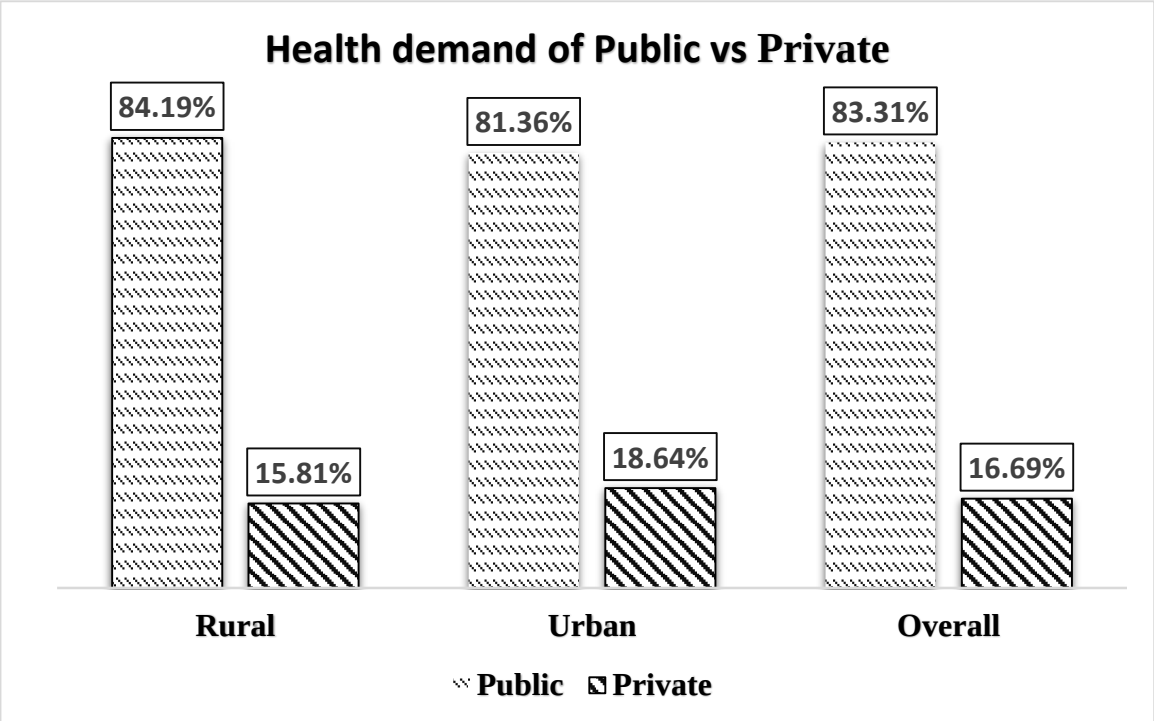
Visits	Hospital	Basic Health Centers	Family Planning Centers
Overall Pakistan (%)			
Not at all	10.2	67.23	92.3
Once in a while	15.31	9.86	3.31
Often	56.87	18.41	3.88
Always	17.63	4.5	0.5
	100%	100%	100%
Rural Area (%)			
Not at all	11.29	57.1	91.69
Once in a while	16.6	12.9	3.49
Often	56.71	24.37	4.32
Always	15.4	5.64	0.5
	100%	100%	100%
Urban Area (%)			
Not at all	7.78	89.68	93.66
Once in a while	12.44	3.13	2.91
Often	57.21	5.21	2.91
Always	22.56	1.98	0.53
	100%	100%	100%

Source: *Author's own calculation from PSLM 2019-20*

Rural and urban differences are evidently observable. In rural areas 15.4 percent households always visited the hospitals, while in urban areas 22.56 percent households

are found visiting always. These differences highlight evidently that households living in urban areas are relatively more tending to visit hospitals as compared to the rural households. Nonetheless, rural households are more prone to visit basic health centers as compared to the hospitals.

Apart from these, the figure 4.2 demonstrates the percentage distribution of the household's preferences to the sector of health care services providers. Evidently, households are showing their higher visits to the government or public health care centers as compared to the private sector hospitals. Above 80 percent, households are showing that they have visited the public sector health institutions. More or less, it does



not matter

Figure 4. 2*: Health Demand Of Public Vs Private*

Whether households are dwelling in urban (81.36%) or rural (84%) areas, they prefer to the public sector hospitals. The above discussion concludes that health demand indicators are helping to depict households' preferences related to the health outcomes. ***Health Cost*:** the Grossman model for health demand function has shown that health cost is also one of the important factors to determine households' demand. The PSLM (2019-20) does not contain the households' expenditures. But, contains information regarding the distance in kilo meters from the home to health facility, and so it may indicate the household' health cost. Because, travelling not measure the monetary cost, but time cost also. Hence, the underlying study has used distance in kilometers from home to the hospital or basic health center as the proxy for the capturing health cost. **Wage Rate:** households' monthly income (PKR) is taken as the proxy of the wage rate, which is earned from all sources whether from business, job, and other sources. **Clean Drinking Water:** clean drinking water is also one of the important factors, which influence the households' health directly. Hence, a binary variable takes value 1 if household is using the clean drinking water, while "0" for otherwise. **Rooms Availability:** total number of rooms per person is the measure of housing quality, which also has direct effects on households' health.

The underlying study has measured it through dividing the total number rooms with family size. **Households' Demographic Variables:** household demographic indicators such as age, gender, and education of the household head, and dependency ratio are also one of the important household-specific characteristics. The brief description is presented in table 4.2. **District Level Factors:** district level variables such as urbanization, climatic factors (rainfall and temperature), and transport utilization are used. We have discussed their description in the sections of other research objectives as well.

Table 4. 2 ***: Brief Description of Variables used in this research***

Variables	Description of the variables	Units
Indicators for Measuring Health Demand		
Number of Visits to Hospital	Total number of visits to hospitals, clinics, and other health centers by household members	Discrete
Visit Consultant	A binary variable is used to measure whether household visit to doctor or not whenever they needed (1=yes, and 0=no)	Binary
Sector of Hospital	Whether households visit private or public health care centers or hospitals. A variable takes 1 for private and 0 for public	Binary
Visit to BHC	A categorical variable where 0=household member not at all visited to basic health centers (BHC), 1=once, 2=often, and 3= always visited to basic health centers when needed	Categorical
Visit to Family Planning	A categorical variable where 0=household member not at all visited to family planning centers, 1=once in a while, 2=often, and 3= always visited to family planning centers when needed	Categorical
Visit to Hospitals	A categorical variable where 0=household member not at all visited to hospitals, 1=once in a while, 2=often, and 3= always visited to hospitals when needed	Categorical
Household-Specific Factors		
Age of Head	Age is measured in total number of years till survey	Years
Gender of Head	1 is assigned for male, and 0 is assigned for female	Binary
Education of Head	Different levels of education are measured through binary variables where 1 taken for education. Such binary variables are constructed for primary, middle, secondary, post-secondary, and tertiary education.	Binary
Monthly Income	Monthly income of all family members is taken as the proxy for measuring the wage rate or earning of the households	PKR
Dependency Ratio	Ratio of non-working age cohort to the working age group of households. Sum of non-working age group (below 15 years+ above 64 years) is divided by working age group (between 15 to 64 years).	Ratio
Health Cost	Health cost of households is measured through the distance in kilo meters from home to hospital, and basic health center, and other health centers	Kilo Meters
Clean Drinking Water	1= households using clean drinking water, and 0= not using	Binary
Rooms per person	Total number of rooms is divided by family size	Ratio
District Level Factors		
Urbanization	Total urban population share to the total population	%
Rainfall	Average norms of rainfall and its square terms	Mm
Temperature	Average norms of temperature and its square terms	C^{o}
Transport facility	Percentage of the households utilizing transport facility	%

Table 4. 3 A ***: Summary Statistics of Variables used in this research***

Variable	Mean	Std. Dev.	Min	Max	Units
Indicators for Measuring Health Demand					
Number of visits to Hospital	.655	1.369	0	35	Discrete
Visit Consultant	.284	.451	0	1	Binary
Sector of Hospital	.782	.413	0	1	Binary
Visit to BHC	1.602	.937	1	4	Categorical
Visit to Family Planning	1.126	.467	1	4	Categorical
Visit to Hospital	2.819	.839	1	4	Categorical
Household Specific Factors					
Head age	44.254	13.444	14	99	Years
Head gender	.915	.278	0	1	Binary
Primary	.136	.343	0	1	Binary
Middle	.12	.325	0	1	Binary
Secondary	.154	.361	0	1	Binary
Higher secondary	.062	.24	0	1	Binary
Tertiary	.079	.27	0	1	Binary
Depency ratio	.94	.776	.029	15	Ratio
Monthly income	10.123	.839	-1.386	15.464	PKR
Clean Drinking Water	.087	.281	0	1	Binary
Rooms Per Person	.517	.4	.024	12	Ratio
Health Cost	3.376	1.495	0	5	Kilometers
District Level Factors					
Urbanization	30.983	26.959	0	100	%
Rainfall Average	1.773	1.437	.191	5.369	Mm
Temperature Average	27.953	5.066	1.578	34.166	C^o
Transportation Facility	.651	.477	0	1	%

4.5 Methodology

This section maintains the discussion on application of empirical strategies to estimate the specified objectives, which are discussed as follows. As we have discussed that, the underlying study aims to estimate the household-specific determine the health demand by household. For this purpose, we have implemented different techniques,

largely depending on the nature of dependent variables. So, the description of the methodological schemes is presented as follows.

4.5.1 Empirical Strategy 01: Binary Logit Model

As it is discussed in previous section, the underlying study has used different proxy variables to estimate the health demand. Out of those variables, few are binary variables such as whether household has visited the health care centers or not where 1 is assigned if yes, while 0 for not. Second variable is the sector of the health care centers where, "1" is for private sector, while "0" for public/government sector.

Given such setting of the dependent variables, a growing body of literature has suggested the application of Logit model whenever we have binary dependent variables (e.g. Ahmed et al., 2016; Mustafa et al., 2019). Hence, the underlying study has applied binary Logit Model to estimate the modified Grossman model for health demand. It comprises

$$Y_i = \beta_0 + \beta_1 \Sigma X_i + \gamma_i \Sigma Z_i + U_i \qquad (4.11)$$

In above equation, Y_i is showing binary dependent variables: i) whether household has visited doctor or not when needed ("1"= yes, "0"= otherwise), and ii) sector of health centers (private= "1" and "0"=public). Similarly, ΣX_i is the vector of household-specific factors, which include age of head, gender, and education of the head, dependency ratio, clean drinking water usage, health cost, household income, and rooms per person. Moreover, ΣZ_i indicates the district level factors such as transportation facility, urbanization, climatic changes; having facilities of agriculture extensions, provincial dummies, and Ui is the error term.

4.5.2 Empirical Strategy 02: Ordered Logit Model

Empirical strategy 01 contains the binary variables as dependent variables where we have applied binary Logit model. However, in this strategy, we have three categorical variables separately for usage of each health care centers such as basic health centers, hospitals, and family planning centers. The settings of these three facilities have categorical settings such as "0"=never visited, "1"=once, "2"=often, and "3"= always usage. Given such settings, the literature recommends the application of the Ordered Logit Model (OLM), which is the alternative of Multinomial Logit Model (MLM).

In the case of ordering in categories, OLM is suggested as the most appropriate available technique to estimate the models in these settings. Hence, the underlying study employs the equation 4.1 by changing the only settings of the dependent variables, nonetheless, independent variables are similar we have used in equation 4.11. In the light of previously mentioned discussion, the model specification for empirical strategy 2 is given as follows.

$$Y_i = \beta_0 + \beta_1 \Sigma X_i + \gamma_i \Sigma Z_i + U_i \qquad (4.12)$$

In above equation, Y comprises three categorical variables as:

i) Household visited hospitals,

ii) Basic health centers, and

iii) Family planning.

These three variables are categorical variables with ordering as we have discussed above. The remaining setting of equation 4.12 is as same as the settings given in 4.11. In nutshell, Ordered Logit Model (OLM) has been applied to estimate the determinants of the health demand by households.

4.5.2 Empirical Strategy 3: Poisson and Negative Binomial Regression

The third setting of the dependent variable we have is discrete where number of days visited to the doctors is taken as proxy for the health demand. The whole specification of the model formulation is similar to the previously described equations (4.11 & 4.12), while only the nature of dependent variable is different.

In the case of discrete variable, available literature is suggesting the implementation of the Poisson regression model. However, Poisson distribution is based on some properties, which seem very difficult to meet in real world or you could say which may be met by chance—mean and variance of the estimators are equal. If such property is not met, Negative Binomial Regression is used as solution or alternative to the Poisson regression model in the case of discrete variables. Hence, the underlying study has employed both models to explore the sensitivity of the results.

4.6 Results and Discussion

The paramount focus of the on-going research is to explore the determinants of the households' health demand. Hence, the section is furnished with the discussion on estimated findings related to the previously mentioned research objectives. We have used different proxies to observe health demand by households. So, the results according to each proxy variable are presented as follows.

4.6.1 Estimated Results for Number of Visits to the Doctors (Poisson and Negative Binomial Regression)

Number of visits to the health consultants or doctors is discrete variable in nature. To estimate household-specific determinants of this proxy for health demand, this study employed the techniques of discrete variables such as Poisson model is applied. While Negative Binomial regression models is also used to trace out the sensitivity analysis.

4.6.1.1 Household-Specific Determinants

Table 4.3 encompasses estimated results for the household-specific and district level determinants of the health demand. The findings demonstrate that household-specific characteristics such as demographic variables related to household head are playing statistically significant role in determining the household demand. Age of the household head is found playing significant role in determining the number of visits of the household to the health doctors or consultant whenever they required. The head age is indicator of the experience of the household head. The experienced and mature household head is supposed to take more care of visiting the doctors whenever family member is found ill. As the given dependent variable is discrete in nature, the study has applied Poisson regression. The findings suggested that co-efficient for age is very small, but positive and statistically significant. It suggests that with the rise of household head age, the chances of visiting to doctor or health consultant increase, other things remaining constant. Moreover, in order to check sensitivity, we have applied Negative Binomial regression to estimate the impacts of age; nonetheless, the findings are still positive and significant as the case of Poisson regression. Household gender is also found to have significant influences on determining the households' decision to visit doctors whenever they needed.

The estimated results are suggestive that those households, which are male-headed, are more likely to increase the number of visits to health doctors as compared to female-headed households, other things remaining same. These influences are found consistent even though Negative Binomial regression (table-4.3).

Moreover, the education of the household head is also found to be the statistically significant factor. To estimate its impacts on household health demand in terms of number of visits to the doctors, different levels of education are used while no

education has kept as the reference group. These levels are primary, middle, matriculation or secondary education, and intermediate or higher level of secondary education, and above intermediate or tertiary level of education of household head. The findings are suggestive that as the level of education of head is increasing, the probability to visit doctors is also increasing whenever they needed.

Table 4. 4: ***Health Determinants of Visit to Doctors***

Number of visits	**(1)**	**(2)**	**(3)**	**(4)**
VARIABLES	**Poisson**	**Poisson**	**NBREG**	**NBREG**
District Level Factors				
Urbanization (%)	0.00544***	0.00607***	0.00528***	0.00586***
	(0.000248)	(0.000259)	(0.000251)	(0.000264)
Avg. rainfall (mm)	0.115***	0.0484**	0.112***	0.0386
	(0.0175)	(0.0229)	(0.0169)	(0.0256)
Rainfall square (mm)	0.00613*	-0.0331***	0.00540	-0.0374***
	(0.00349)	(0.00375)	(0.00334)	(0.00420)
Avg. temperature (C^{o})	0.0409***	0.0567***	0.0261***	0.0499***
	(0.00845)	(0.00695)	(0.00713)	(0.00720)
Temperature square (C^{o})	-5.58e-05	-0.00104***	0.000236	-0.000995***
	(0.000179)	(0.000180)	(0.000164)	(0.000189)
Transport facility (%)	0.0564***	0.0337***	0.0465***	0.0256**
	(0.0122)	(0.0121)	(0.0121)	(0.0122)
Household-Specific Characteristics				
Head age	0.0128***	0.0127***	0.0129***	0.0130***
	(0.000409)	(0.000408)	(0.000415)	(0.000416)
Head gender (1=male,)	0.159***	0.153***	0.174***	0.171***
	(0.0206)	(0.0206)	(0.0211)	(0.0211)
Primary	0.0871***	0.103***	0.0912***	0.105***
	(0.0160)	(0.0160)	(0.0161)	(0.0161)
Middle	0.0623***	0.0802***	0.0643***	0.0828***
	(0.0176)	(0.0175)	(0.0175)	(0.0176)
Secondary	-0.0432**	-0.0357**	-0.0475***	-0.0394**
	(0.0172)	(0.0171)	(0.0170)	(0.0172)
Higher secondary	-0.0775***	-0.0811***	-0.0622**	-0.0663**
	(0.0259)	(0.0258)	(0.0260)	(0.0261)
Tertiary	-0.196***	-0.207***	-0.197***	-0.209***
	(0.0247)	(0.0247)	(0.0244)	(0.0246)
Dependency ratio	0.122***	0.124***	0.150***	0.153***
	(0.00612)	(0.00613)	(0.00709)	(0.00712)
Log monthly income	0.0331***	0.0384***	0.0309***	0.0364***
	(0.00729)	(0.00727)	(0.00727)	(0.00729)
Drinking clean water	-0.0328	-0.0414*	-0.0454**	-0.0434*
	(0.0232)	(0.0235)	(0.0231)	(0.0237)
Per person rooms	-0.569***	-0.543***	-0.480***	-0.459***
	(0.0222)	(0.0221)	(0.0233)	(0.0232)
Health cost (km)	-0.00863**	-0.0122***	-0.0104***	-0.0145***
	(0.00371)	(0.00375)	(0.00381)	(0.00388)

Number of visits	(1)	(2)	(3)	(4)
VARIABLES	**Poisson**	**Poisson**	**NBREG**	**NBREG**
Punjab		-0.628***		-0.680***
Sindh		-0.614***		-0.651***
Balochistan		-1.010***		-1.082***
Constant	-2.776***	-1.621***	-2.638***	-1.443***
	(0.135)	(0.118)	(0.119)	(0.122)
Observations	135,418	135,418	135,418	135,418

Note: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1, **NBREG**=Negative Binomial Reg

However, such increase is witnessed until secondary education, after that the higher the level of education, the lower level of probability to visit the doctors is experienced by households whenever they needed. The reason could be the highly educated households may adopt the self-medication for normal diseases except serious diseases. Alternatively, other reason could be they visited quality doctor, and followed the instruction of doctors properly which helped them to visit lesser to doctors and the consultants. Therefore, the negative sign or impacts of the higher education are perhaps justifiable. Hence, the impacts demonstrate other fact also that education has non-linear impacts on the number of visits to doctors. On average, households are more inclined to number of visits to doctors initially, but higher secondary education, households are less likely to increase their visits to the medical doctors (table-4.3).

Similarly, other significant demographic factor is dependency ratio, which have positive and significant impacts on number of visits. The findings show, other things remaining same, those families that are experiencing higher level of dependency ratio are more likely to visit the doctors. The higher dependency means households are having more ratio of non-working age cohort family members as compared to the working age cohort. These positive and significant impacts are not sensitive to the changing of the techniques (table-4.3). Household income is considered one of the most important factors, which contain the statistically significant effects on the determination of health demand. The findings of household monthly income that is the proxy of

household monthly wage rate are found with positive signs in all models presented in table 4.3. It implies that other things remaining constant, the increase in household monthly income caused increase in household visits to doctor. Other household-specific factors such as clean drinking water and housing related variables are considered as the significant factors to affect the household health demand. The negative sign suggests that other things remaining same, as the uses of clean drinking water increases, households are less likely to visit the hospital. Health cost is another important factor, which demonstrates important implication.

The underlying study has measured it through the distance from home to hospital or health clinics in kilometers. The estimated results indicate that impacts of health cost are estimated as statistically significant. The negative sign suggests that other things remaining same, as the distance increases, households are less likely to visit the hospital. In short, we could say that the increase in health cost would bring down the probability of visits to hospital.

In "Appendix C "Table 4.3 (a) the models has also been estimated to capture the effects of ICT index (Information Communication Technology) on health demand. It has been found that the probability of getting visit to the doctor decreases with the advent in ICT's. It is further stated that by using the ICT index the other results of the model are as robust as these were before the inclusion of the ICT index. The results are attached at appendix C.

4.6.1.2 District Level Determinants of Health Demand

In above discussion, the study has discussed household-specific factors, which influence the health demand in terms of total number of visits to doctors. The next task is to identify the district level factors, which influence the health demand. Table 4.3 demonstrates that urbanization (percentage) at district level contains the positive and

statistically significant impacts on determining the health demand in terms of number of visits to hospitals or doctors. Although, the coefficients are relatively smaller, nonetheless the impacts of urbanization are significant and positive. It implies that, all other factors being same, the increase in the share of urban population, would raise the health demand in sampled districts. The positive impacts are justifiable, because the increase in urban population increase the demand of health infrastructure. Moreover, the hectic increase in urbanization may cause some health-related issues that instigate the population to visit more to the doctors. These positive impacts of the urbanization are robust even though we change the econometric techniques. Moreover, the results remain same even we drop the provincial dummies or not.

Likewise, climatic factors such as district level rainfall and temperature norms also have statistically significant impacts on health demand in terms of the number of visits. In order to check the non-linear impacts of the climatic factors, we introduce the square terms of the rainfall and temperature respectively. The estimated impacts are suggestive that climatic factors have non-linear impacts when provincial dummies are introduced, while without provincial dummies, the impacts of rainfall and temperature are linearly positive and significant. The reason could be due to the provincial dummies capture the action of the provincial governments and other provincial factors related to the locational heterogeneity (see table 4.3).

On the whole, impacts are suggestive that rainfall and temperature shocks may cause some health-related issues, the longer and extreme spells of the rainfall and temperature directly and indirectly impact the health-related issues to the households which ultimately fostering them to visits more to the doctors. In short, climatic factors have significant impacts on health demand. Similarly, district level transport facility important factor, which has influenced the health demand significantly. The positive

and significant impacts estimated from all models are suggesting that other things remaining the same, on average the higher level of transport utilization facilitates the households to visits more to the hospitals, which indicates the road infrastructure and district wise connectivity related indicator. Moreover, the provincial dummies also showing the significant impacts, which captures the provincial heterogeneity.

4.6.2 When Health Demand is a Binary Variable: Binary Logit Model

The previous discussion on the determinants of the health demand in terms of number of visits to doctors when the variable was in discrete form, so next task is what happens to findings when health demand is measured in binary form; whether household visited health consultant or not when they needed (1=yes, 0=no). Due to the binary nature of dependent variables, the study has implemented binary Logit model to estimate the determinants of the health demand.

Table 4.4 encompasses the estimated results along with estimation of the odd ratios to interpret the magnitude of the coefficient. Household-specific factors have more or less similar sort of the findings as we have discussed in last section even though we change the nature of dependent variable. For example, age of the household head is found significant and positive to have effects on the likelihood of consultation to the doctors when households needed, other things remaining the same. As we have discussed above, the head age is indicator of the experience of the household head, which means the experienced household head is more likely to take their family members to visit the doctors for consultation whenever family member is found ill. Likewise, household gender is also found to having significant influences on determining the likelihood of consultation from doctors. The estimated results are suggestive that those male-headed household are more likely to consult doctors as compared to female-headed households, other things remaining the same. In addition

to household gender, the education of the household head is also found to be the statistically significant factor, which is more likely to leave non-linear impacts on the probability of consulting doctors when they needed. It implies that on average, households are more inclined to consult doctors initially, but higher secondary education, households are less likely to consult the doctors or other health consultants (table-4.4).Moreover, dependency ratio has positive and significant impacts on the likelihood of consulting the doctors when households required. The findings demonstrate that, other things remaining the same, those families, which are experiencing higher level of dependency ratio, are more likely to visit the doctors for consultation. The higher dependency means households are having more ratios of non-working family members relative to the working age group. Another factor is household income, which is considered as one of the most important factors to determine health demand in terms of consulting the doctors.

Other household-specific factors such as clean drinking water and housing related variables are considered as the significant factors to affect the household health demand. Like above mentioned household-specific factors, health cost is also significant factor. The underlying study has measured it through the distance from home to hospital or health clinics in kilometers. The estimated results indicate that impacts of health cost are estimated as statistically significant. The negative sign suggests that other things remaining same, as the distance increases, households are less likely to visit the hospital for consultation.

Table 4. 5: ***When Health Demand is Binary VARIABLE ;(Consult Doctor =1, OTHERWISE =0)***

VARIABLES	Logit	Odd Ratio	Logit	Odd Ratio
District Level Factors				
Urbanization (%)	0.00383***	1.004***	0.00528***	1.005***
	(0.000282)	(0.000283)	(0.000292)	(0.000293)
Avg. rainfall (mm)	0.0735***	1.076***	0.0434	1.044
	(0.0197)	(0.0212)	(0.0275)	(0.0287)
Rainfall square (mm)	0.0217***	1.022***	-0.0354***	0.965***
	(0.00401)	(0.00410)	(0.00467)	(0.00451)
Avg. temperature (C^o)	0.0688***	1.071***	0.0775***	1.081***
	(0.00947)	(0.0101)	(0.00817)	(0.00882)
Temperature square (C^o)	-0.000739***	0.999***	-0.00145***	0.999***
	(0.000203)	(0.000203)	(0.000213)	(0.000212)
Transport facility (%)	0.0995***	1.105***	0.0683***	1.071***
	(0.0134)	(0.0148)	(0.0135)	(0.0144)
Household-Specific Characteristics				
Head age	0.0137***	1.014***	0.0140***	1.014***
	(0.000474)	(0.000480)	(0.000476)	(0.000483)
Head gender (1=male)	0.198***	1.219***	0.180***	1.197***
	(0.0229)	(0.0279)	(0.0230)	(0.0276)
Primary	0.0761***	1.079***	0.107***	1.113***
	(0.0182)	(0.0197)	(0.0184)	(0.0204)
Middle	0.0468**	1.048**	0.0832***	1.087***
	(0.0196)	(0.0205)	(0.0197)	(0.0214)
Secondary	-0.0637***	0.938***	-0.0473**	0.954**
	(0.0186)	(0.0174)	(0.0187)	(0.0179)
Higher secondary	-0.0927***	0.911***	-0.0942***	0.910***
	(0.0277)	(0.0253)	(0.0279)	(0.0254)
Tertiary	-0.211***	0.809***	-0.226***	0.798***
	(0.0265)	(0.0215)	(0.0267)	(0.0213)
Dependency ratio	0.161***	1.175***	0.167***	1.182***
	(0.00794)	(0.00932)	(0.00799)	(0.00944)
Log monthly income	0.0225***	1.023***	0.0303***	1.031***
	(0.00795)	(0.00813)	(0.00801)	(0.00826)
Drinking clean water	-0.0421*	0.959*	-0.0678***	0.934***
	(0.0240)	(0.0230)	(0.0244)	(0.0228)
Per person rooms	-0.593***	0.553***	-0.557***	0.573***
	(0.0235)	(0.0130)	(0.0234)	(0.0134)
Health cost (km)	0.0132***	1.013***	0.00546	1.005
	(0.00415)	(0.00421)	(0.00422)	(0.00424)
Punjab			-0.989***	0.372***
Sindh			-0.959***	0.383***
Balochistan			-1.263***	0.283***
Constant	-3.495***	0.0303***	-2.100***	0.122***
Observations	135,418	135,418	135,418	135,418

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 4.4 also demonstrates that urbanization (percentage) at district level contains the positive and statistically significant impacts on determining the health demand in terms of visits to hospitals. It implies that, all other factors being same, the increase in the share of urban population, would raise the health demand in sampled districts. Likewise, district level rainfall and temperature norms also have statistically significant impacts on health demand in terms of visits for consultation. The estimated impacts are suggestive that climatic factors have non-linear impacts when provincial dummies are introduced, while without provincial dummies, the impacts of rainfall and temperature are linearly positive and significant. In addition, transport facility has positive and significant impacts on visits for consultation to the hospitals. Moreover, the provincial dummies also showing the significant affects which captures the provincial heterogeneity as in previous discussion.

In "Appendix C "Table 4.4 (a) the models has also been estimated to capture the effects of ICT (Information Communication Technology) on health demand. ICT has been found significant and negative effects on the likelihood of consultation to the doctors when households needed, other things remaining the same. It has been found that the probability of getting visit to the doctor decreases with the arrival of ICT's. It is further stated that by using the ICT variable the other results of the model are as robust as these were before the inclusion of the ICT. The results are attached at appendix C.

4.6.2.1 Application of Instrumental Variable Approach

So far, we do not tackle the problem of endogenity that may arise due to the being endogenous of urbanization because it is determines within the model. Urbanization is a process, which means there some factors, which influence the

urbanization. Due to its endogenous behavior, theoretically it should be correlated with error terms, which have raised the problem of persistence of the issue of endoginity.

We have tested by applying Wald-test that has confirmed the presence of endogenity in the models. In order to remove this problem, we have used rainfall and distance to hospital as instrumental variables for urbanization, which are exogenous. Since, we are using the rainfall and distance to hospital as instrument; we do not include these variables in the model to deal endogenity.

Hence, we have applied instrumental Logit model to tackle endogenity. The estimated results demonstrate that the instrumented urbanization has positive sign, which is statistically significant. The positive sign means, other things remaining same, urbanization raises the more likely of being health demand. Which is same as to the impacts of urbanization we have discussed in previous sections because the coefficient of urbanization increases. Such finding establishes one thing that when we take instruments (rainfall and distance to hospital) for urbanization, then beneficial impacts of urbanization becomes greater.

TABLE 4. 4 A: Application of Instrumental Binary Logit Model

Consult Doctor =1,Otherwise =0)	Coef.	Std. Err.	z	P>z
Urbanization	0.046307	0.0006106	7.58	0.000
Head age	0.007482	0.00031	24.14	0.000
Head gender	0.0131892	0.0148795	0.89	0.375
Primary	0.0860493	0.0123385	6.79	0.000
Middle	0.092279	0.0131861	7.00	0.000
Secondary	0.0474212	0.0126615	3.75	0.000
Higher secondary	0.0434533	0.0186259	2.33	0.000
Tertiary education	0.0034645	0.017897	0.19	0.847
Dependency ratio	0.0876751	0.0053176	16.49	0.000
Log monthly income	0.0698323	0.0053166	13.13	0.000
Drinking clean water	-0.0584243	0.0174402	-3.35	0.001
Per person rooms	-0.2736778	0.0125015	-21.89	0.000
Transportation	0.1036848	0.0089437	11.59	0.000
Note: instruments of urbanization are average rainfall, and distance to hospital				

4.6.3 When Visit to Doctors is Ordered Variables: Ordered Logit Model (OLM)

In last section, dependent variable was whether household consulted to doctor or not. Nonetheless, the underlying section discusses multiple scenarios of visit to consult: i) never consulted, ii) once in a while, iii) often consulted, and finally household consulted to doctors always whenever needed.

These ordered categories are set for three sort of the health facility place separately: i) basic health center (BHC), ii) family planning center, and iii) district hospitals or clinics. Hence, Ordered Logit Model (OLM) has been applied to estimate

the regression models for these mentioned three health institutions separately. Table 4.5 encompasses the estimated results for ordered categorical variables while table 4.6 comprises the estimation of odd ratios for these respective models. Estimated results demonstrate that age of household head has negative and significant impact on the odds of consulting higher category in the case of BHC and family planning centers while positive and significant impact on odds of consulting the higher category in the case of hospitals.

These results are demonstrating that relatively older households are less likely to move on higher level of consultation in BHC and family planning centers, which means higher age of households tends them to fewer moves on always visit for consulting the doctors in these two centers. In contrast to these, they are more likely to move on the higher level of odds of consulting always-visiting hospitals.

Table 4. 6 ***: Household-Specific and District Determinants of Health Facility; Ordered LM***

VARIABLES	BHC	BHC	FPC	FPC	Hospital	Hospital
District Level Factors						
Urbanization (%)	-0.0217***	-0.0198***	-0.00947***	-0.00825***	0.00623***	0.00257***
	(0.000378)	(0.000388)	(0.000591)	(0.000620)	(0.000281)	(0.000293)
Avg. rainfall (ml)	-0.338***	-0.720***	-0.210***	-0.546***	0.364***	0.210***
	(0.0197)	(0.0281)	(0.0348)	(0.0684)	(0.0165)	(0.0249)
Rainfall square (ml)	0.0654***	0.123***	0.0150**	0.135***	-0.0538***	-0.0166***
	(0.00403)	(0.00523)	(0.00760)	(0.0156)	(0.00291)	(0.00386)
Avg. temperature (C°)	0.0661***	0.0744***	0.130***	0.132***	0.0293***	0.109***
	(0.00869)	(0.0101)	(0.0182)	(0.0349)	(0.00509)	(0.00651)
Temperature square (C°)	-0.00124***	-0.00132***	-0.00368***	-0.00263***	-0.000921***	-0.00394***
	(0.000182)	(0.000221)	(0.000354)	(0.000676)	(0.000144)	(0.000198)
Transport facility (%)	-0.150***	-0.171***	0.430***	0.445***	-1.948***	-1.943***
	(0.0141)	(0.0141)	(0.0241)	(0.0244)	(0.0167)	(0.0167)
Household-Specific Characteristics						
Head age	-0.000243	-0.000336	-0.0122***	-0.0122***	0.00247***	0.00165***
	(0.000455)	(0.000457)	(0.000810)	(0.000817)	(0.000435)	(0.000437)
Head gender (1=male)	0.0544**	0.0708***	0.334***	0.359***	-0.0747***	-0.0224
	(0.0219)	(0.0221)	(0.0417)	(0.0422)	(0.0196)	(0.0197)
Primary	0.0459***	0.0488***	0.198***	0.192***	0.131***	0.0792***
	(0.0175)	(0.0175)	(0.0297)	(0.0297)	(0.0170)	(0.0172)
Middle	-0.0151	-0.0212	0.245***	0.224***	0.194***	0.136***
	(0.0197)	(0.0198)	(0.0315)	(0.0317)	(0.0180)	(0.0181)
Secondary	-0.110***	-0.0959***	0.185***	0.199***	0.179***	0.141***
	(0.0188)	(0.0188)	(0.0302)	(0.0303)	(0.0171)	(0.0172)
Higher secondary	-0.222***	-0.184***	0.102**	0.159***	0.254***	0.223***
	(0.0285)	(0.0285)	(0.0451)	(0.0453)	(0.0255)	(0.0258)
Tertiary	-0.410***	-0.384***	0.174***	0.230***	0.172***	0.152***
	(0.0280)	(0.0281)	(0.0410)	(0.0414)	(0.0240)	(0.0242)
Dependency ratio	0.0732***	0.0665***	0.256***	0.249***	-0.0169**	-0.0180**
	(0.00764)	(0.00768)	(0.0111)	(0.0112)	(0.00741)	(0.00746)
Log monthly income	-0.0391***	-0.0558***	0.210***	0.187***	0.0366***	0.0405***
	(0.00779)	(0.00779)	(0.0136)	(0.0138)	(0.00728)	(0.00733)
Drinking clean water	0.243***	0.305***	0.518***	0.574***	0.192***	0.236***
	(0.0240)	(0.0244)	(0.0353)	(0.0358)	(0.0259)	(0.0261)
Per person rooms	-0.456***	-0.466***	-0.746***	-0.786***	-0.0549***	-0.0967***
	(0.0229)	(0.0230)	(0.0428)	(0.0435)	(0.0162)	(0.0162)
Health cost (km)	0.121***	0.113***	0.00252	-0.00468	-0.0227***	-0.000833
	(0.00436)	(0.00442)	(0.00690)	(0.00696)	(0.00394)	(0.00401)
Punjab		-0.164***		0.708***		1.107***
Sindh		-0.811***		-0.165**		1.388***
Balochistan		-0.412***		0.893***		0.414***
/cut1	0.577***	-0.0549	4.820***	6.040***	-11.39***	-10.82***
/cut2	1.112***	0.484***	5.458***	6.682***	-2.156***	-1.574***
/cut3	2.972***	2.350***	7.597***	8.824***	1.438***	2.062***

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1, BHC=basic health centers, FPC=family planning centers

These results conclude that higher age group households are more prone to visit hospitals rather than BHCs. Similarly, the male-headed households are having higher level of odds of being fall in higher level of consultation in BHCs and family planning centers while female-headed households relative to male-headed are having higher level of odds of consulting the doctors in district level hospitals.

Household education has again appeared to be the important factor. Those households that are having below intermediate education are more likely to visit higher ordered of consultation in three types of health institutions relative above intermediate education. Moreover, the higher levels of education holding households are more likely to visit hospitals and lesser probability to visit basic health centers. Moreover, similarly the odds of being in higher ordered for hospitals is higher relative to odds of being in high level of ordered categories in BHCs. The higher level of ordered categories is often visit and always visits to the respective institutes. Moreover, those households that have higher level of dependency ratio are more likely to visit BHCs and less probability to visit in hospitals in higher categories of consultation. Monthly household income has found again the significant factor that enables household to move hospitals and their visit becomes at higher ordered category whenever they needed.

Table 4. 7: *Odd Ratios for Ordered Logit Model; Health Facility*

VARIABLES	BHC	BHC	FPC	FPC	Hospital	Hospital
District Level Factors						
Urbanization (%)	0.979***	0.980***	0.991***	0.992***	1.006***	1.003***
	(0.000369)	(0.000380)	(0.000585)	(0.000615)	(0.000283)	(0.000293)
Avg. rainfall (ml)	0.713***	0.487***	0.810***	0.579***	1.439***	1.233***
	(0.0140)	(0.0137)	(0.0282)	(0.0396)	(0.0237)	(0.0307)
Rainfall square (ml)	1.068***	1.130***	1.015**	1.145***	0.948***	0.984***
	(0.00430)	(0.00592)	(0.00772)	(0.0179)	(0.00276)	(0.00380)
Avg. temperature (C°)	1.068***	1.077***	1.139***	1.142***	1.030***	1.116***
	(0.00928)	(0.0108)	(0.0208)	(0.0398)	(0.00524)	(0.00726)
Temperature square (C°)	0.999***	0.999***	0.996***	0.997***	0.999***	0.996***
	(0.000182)	(0.000221)	(0.000353)	(0.000674)	(0.000144)	(0.000197)
Transport facility (%)	0.861***	0.843***	1.537***	1.560***	0.143***	0.143***
	(0.0121)	(0.0119)	(0.0370)	(0.0381)	(0.00239)	(0.00240)
Household-Specific Characteristics						
Head age	1.000	1.000	0.988***	0.988***	1.002***	1.002***
	(0.000455)	(0.000457)	(0.000800)	(0.000807)	(0.000436)	(0.000438)
Head gender (1=male)	1.056**	1.073***	1.396***	1.431***	0.928***	0.978
	(0.0231)	(0.0237)	(0.0582)	(0.0604)	(0.0181)	(0.0193)
Primary	1.047***	1.050***	1.219***	1.212***	1.141***	1.082***
	(0.0183)	(0.0184)	(0.0362)	(0.0360)	(0.0194)	(0.0186)
Middle	0.985	0.979	1.277***	1.251***	1.214***	1.145***
	(0.0194)	(0.0193)	(0.0403)	(0.0396)	(0.0218)	(0.0208)
Secondary	0.896***	0.909***	1.203***	1.220***	1.196***	1.152***
	(0.0168)	(0.0171)	(0.0363)	(0.0370)	(0.0204)	(0.0198)
Higher secondary	0.801***	0.832***	1.108**	1.173***	1.289***	1.250***
	(0.0228)	(0.0237)	(0.0499)	(0.0531)	(0.0329)	(0.0323)
Tertiary	0.663***	0.681***	1.190***	1.258***	1.187***	1.164***
	(0.0186)	(0.0191)	(0.0488)	(0.0521)	(0.0285)	(0.0282)
Dependency ratio	1.076***	1.069***	1.292***	1.283***	0.983**	0.982**
	(0.00822)	(0.00820)	(0.0144)	(0.0144)	(0.00729)	(0.00733)
Log monthly income	0.962***	0.946***	1.233***	1.206***	1.037***	1.041***
	(0.00749)	(0.00737)	(0.0167)	(0.0167)	(0.00755)	(0.00763)
Drinking clean water	1.275***	1.356***	1.678***	1.775***	1.211***	1.266***
	(0.0306)	(0.0331)	(0.0592)	(0.0636)	(0.0314)	(0.0331)
Per person rooms	0.634***	0.628***	0.474***	0.456***	0.947***	0.908***
	(0.0145)	(0.0144)	(0.0203)	(0.0198)	(0.0153)	(0.0147)
Health cost (km)	1.129***	1.120***	1.003	0.995	0.978***	0.999
	(0.00492)	(0.00495)	(0.00692)	(0.00693)	(0.00385)	(0.00400)
Punjab		0.849***		2.031***		3.026***
Sindh		0.444***		0.848**		4.007***
Balochistan		0.662***		2.443***		1.513***
/cut1	1.781***	0.947	124.0***	420.0***	1.13e-05***	2.00e-05***
/cut2	3.041***	1.622***	234.6***	798.0***	0.116***	0.207***
/cut3	19.53***	10.48***	1,991***	6,797***	4.211***	7.859***

Note: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1, BHC=basic health centers, FPC=family planning

Likewise, health cost unleashes its impacts on those households, which have higher level of health cost are more likely to visits BHCs as compared to the hospitals (table 4.6). The findings obtained from district level of urbanization indicates that with the increase of households are more likely to visit the hospitals as compared to the BHCs. The reason to visit always in hospitals is due to the prevalence and expansion of the health infrastructure. Unlike to this the impacts of climatic variables such as temperature and rainfall are much different from urbanization. The increase in climatic shocks would lead you to fewer visits to the BHCs and lesser chances to visit higher level of ordered categories of BHCs. However, the chances to visit hospitals are increasing due to climatic shocks. In addition, the impacts of transport utilization are showing that households are having lesser probability to visit a BHCs and hospitals. The reason is that higher utilization of transport enables the households visit not in higher level of ordered category (table 4.6).

In "Appendix C" Table-4.5(a) and 4.5(b) contains the estimation of the effect of ICT index on health demand. The estimated results demonstrate that, other things remaining the same, the impact of ICT index has statistically significant negative (coefficient sign) impacts on the likelihood of health demand among households. It is further stated that by using the ICT variable the household lesser probability to visit to BHC and FPC and visit to hospitals, other results of the model are as robust as these were before the inclusion of the ICT. The results are attached at appendix C

4.6.4 Households' Health Demand; Private VS Public Sector (Binary Logit Model)

In previous sections, we have focused on health demands in terms of number of visits etc. Nonetheless, this section weaves up discussion on results obtained for the sector of health demanded. The dependent variable is in binary form where "1" for private sector while "0" for public sector health centers. To estimate it, we have applied Logit Model. Table 4.7 suggests that again age of the household head has positive and significant impacts on households' decision to choose whether go for private or public hospital and clinics. The positive impact means that those households that have relatively higher level of age years are more likely to visit private hospitals as compared to the public hospitals.

Likewise, gender of head is also playing important and significant role where male-headed households are more likely to go to private hospitals as compared to the female-headed. The education of household head has shown the positive and significant impact on decision to choose private or public hospitals. The findings imply that educated households relative to uneducated are more likely to choose private hospitals as compared to public hospitals. Moreover, dependency ratio has shown its positive and significant impacts on the likelihood of choosing private hospitals as compared to the public hospitals.

Table 4. 8: ***Determinants of Private VS Public Health Facility (*****1=Private, 0=Public)**

VARIABLES	Logit	Odd Ratio	Logit	Odd Ratio
District Level Factors				
Urbanization (%)	0.00447***	1.004***	0.00565***	1.006***
	(0.000321)	(0.000323)	(0.000330)	(0.000332)
Avg. rainfall (ml)	0.194***	1.214***	-0.0242	0.976
	(0.0231)	(0.0280)	(0.0326)	(0.0318)
Rainfall square (ml)	-0.0212***	0.979***	-0.0371***	0.964***
	(0.00473)	(0.00463)	(0.00560)	(0.00539)
Avg. temperature (C^{o})	0.0939***	1.098***	0.117***	1.125***
	(0.0117)	(0.0129)	(0.0105)	(0.0118)
Temperature square (C^{o})	-0.00129***	0.999***	-0.00243***	0.998***
	(0.000250)	(0.000250)	(0.000266)	(0.000266)
Transport facility (%)	0.180***	1.197***	0.148***	1.159***
	(0.0161)	(0.0192)	(0.0161)	(0.0187)
Household-Specific Characteristics				
Head age	0.0127***	1.013***	0.0127***	1.013***
	(0.000562)	(0.000569)	(0.000563)	(0.000570)
Head gender (1=male)	0.0543**	1.056**	0.0515*	1.053*
	(0.0273)	(0.0288)	(0.0273)	(0.0288)
Primary	0.129***	1.137***	0.146***	1.157***
	(0.0217)	(0.0246)	(0.0217)	(0.0252)
Middle	0.122***	1.129***	0.139***	1.149***
	(0.0231)	(0.0261)	(0.0232)	(0.0266)
Secondary	0.0596***	1.061***	0.0741***	1.077***
	(0.0220)	(0.0234)	(0.0220)	(0.0237)
Higher secondary	0.0846***	1.088***	0.0959***	1.101***
	(0.0321)	(0.0350)	(0.0322)	(0.0355)
Tertiary	0.0361	1.037	0.0390	1.040
	(0.0305)	(0.0316)	(0.0306)	(0.0318)
Dependency ratio	0.149***	1.160***	0.150***	1.161***
	(0.00896)	(0.0104)	(0.00901)	(0.0105)
Log monthly income	0.120***	1.127***	0.119***	1.127***
	(0.00969)	(0.0109)	(0.00972)	(0.0110)
Drinking clean water	-0.0389	0.962	-0.0299	0.971
	(0.0283)	(0.0273)	(0.0287)	(0.0278)
Per person rooms	-0.541***	0.582***	-0.524***	0.592***
	(0.0287)	(0.0167)	(0.0287)	(0.0170)
Health cost (km)	-0.0197***	0.980***	-0.0261***	0.974***
	(0.00486)	(0.00476)	(0.00492)	(0.00479)
Provincial dummies			Yes	Yes
Constant	-5.284***	0.00507***	-3.930***	0.0196***
Observations	135,418	135,418	135,418	135,418

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Similarly, household monthly income has positive and significant impacts on sector choosing. Other things remaining same, on average, the higher level of income increases the likelihood of households choosing private hospitals as compared to the public hospitals. Contrary to this, clean drinking water and room availability per person has negative impacts on the likelihood of choosing private relative public hospitals (table 4.7). Moreover, health cost has also negative influences on the probability of choosing private sector hospitals, which demonstrates that those households that have higher level of health cost are less likely to go private hospitals for treatment or checkups as compared to public sector hospitals.

District level factors demonstrate that urbanization has positive and significant impacts on the likelihood of choosing private sector of health relative to the public sector. The reason could be due to the availability of lots of private clinics and hospitals. Moreover, the linear term of climatic variables causing to increase the likelihood of choosing private hospitals while non-linear term has negative impacts on the likelihood of private hospitals (table 4.7). Additionally, the transport utilization has positive and significant impacts on the likelihood of choosing private sector hospitals relative to public sector.

The "Appendix C" Table-4.6(a) contains the estimation of the effect of ICT index and affects households' decision to choose whether go for private or public hospital. The estimated results demonstrate that, other things remaining the same, the impact of ICT index has statistically significant negative (coefficient sign) impacts on the likelihood of the decision on whether go for private or public. The negative impact means that those households that have relatively higher level of ICT are more likely to visit public hospitals as compared to the private hospitals. Other results of the model

are as robust as these were before the inclusion of the ICT. The results are attached at appendix C.

4.7 Conclusion and Policy Implication

4.7.1 Concluding Remarks

Good health and wellbeing have been deemed as one of the key policy agenda in developing countries. Sustainable Development Goal (SDG)-3 maintains focus on health by the end of 2030, which is committed by global community in 2015. Pakistan is also amongst those countries, which have been targeting to insure good health for the last couple of decades. However, the goal to achieve health is intimidated due to multiple factors economic, social, environmental, geographical, locational, demographic and political. During the last couple of years, Pakistan is facing parallel rise of urbanization and happening of climatic and environmental calamities, which have raised several other challenges including health related issues of the rising population in both urban and rural areas. To design inclusive and effective policy agenda to tackle such problem, we need to gather empirical evidence on relationship among urbanization, climatic shocks, and health demand.

Therefore, the underlying piece of research aims to explore: 1) to measure what are the household-specific determinants of health demand, 2) to estimate what are the locational determinants of the health demand. 3) What happens when urbanization and climatic shocks happen together on health demand in Pakistan? For empirical purpose, PSLM (2019-20) dataset has been employed to gather household level information: households' socioeconomic characteristics and specifically the dependent variable health demand has been measured. Moreover, the district level data of 30 years averages of rainfall and temperature has been used.

Finally, district level climatic factors are merged with PSLM (2019-20) by identifying the district codes. For econometric purpose, binary Logit model, Ordered Logit model, Poisson and Negative Binomial regression models are applied is also used to trace out the sensitivity analysis approach has been implemented. The estimated findings indicate that urbanization has beneficial and significant impacts on health demand, while climatic factors have also shown beneficial and significant impacts on health demand and show non-linear influences when provincial dummies incorporated in the model. The non-linear impacts demonstrate that linear term of rainfall and temperature has shown beneficial impacts while non-linear term contains adverse effects on health demand. Nonetheless, household monthly income, transport utilization, age and gender of household head, dependence ratio show the positive and the significant impact on household health demand.

While clean drinking water, room availability and health cost show negative and significant impact on household health demand. Furthermore, head of household education impact nonlinear ways in low education is positive and in higher education is negative on the health demand.

4.7.2 Policy Implication

Overall, the findings of the underlying research have demonstrated that urbanization has significant and beneficial influences on health demand, but rising climatic shocks such as occurring of extreme events of rainfall and temperature is likely to devastate the advantageous effects of urbanization. Such finding has following implications, which need to be considered as policy agenda regarding achieving the SDG-3 in Pakistan.

- A well-designed policy regarding dealing climatic shocks is needed to achieve good health and wellbeing up to 2030.

- A well planned and inclusive urban management is required which should be promptly responsive to the rainfall and temperature shocks.

4.7.3 Limitations of the Study

We have done our best to conduct the underlying research essay, but still it can be improved further if we would have tackled the following limitations.

- We have used temperature and rainfall as a climate variable the other climatic variables like fog, Smog, GHS, CO2, humidity etc.; are not used due to data limitations.
- We could not use the other measures of health demand due to the unavailability of data at district level in PSLM (20219-20). Such information can be taken from HIES (2018-19) but that is not district level representative.

To us, if we could incorporate the above-mentioned limitations, the underlying study would be more comprehensive. Finally, it is important to note that with all the limitations, this type of research is still necessary to investigate the impacts of climate change and urbanization on health demand.

There is a hope that this research opens the new opportunity for other researchers. Future research should incorporate more climatic variables in order to wide assess the climatic impact on health demand.

CHAPTER 5

ESSAY 3 MULTIDIMENSIONAL POVERTY IN PAKISTAN

ABSTRACT

The underlying essay aims to investigate the impacts of urbanization and climate change on multidimentional poverty in Pakistan. For empirical purpose, PSLM 2019-20 survey has been used to explore the specified objectives of this study. The application of binary Logit model and district level fixed effect model is suggestive that urbanization has its advantageous influences on the multidimensional wellbeing of the households while at the same time climatic shocks have harmonious but non-linear U-shaped impacts of the rainfall and temperature on poverty. The joint occurrences of both the rainfall and the urbanization have shown the harmonious effects on the determination of multidimensional poverty in Pakistan.

5.1 Introduction

5.1.1 Background and Motivation of the underlying Essay

Poverty is the incapability of individual to satisfy their basic needs (Idrees & Baig, 2017). Poverty is the key problem for the developing countries. Now poverty becomes a major challenge in the history for the developing world, due to its widespread impacts on the developing process (Mahmood & Hussain, 2020). Poverty is more than income or consumption based. In fact poverty is a multidimensional phenomenon, and it shows the incapability of the individuals to satisfy their basic needs like education, health and living standard (F. Khan & Akram, 2018).The seminal work by Alkire and Foster (2009) is a new milestone setting study in the measurement of

multidimentional poverty (Idrees & Baig, 2017). Multidimentional poverty included the non-monetary dimensions like education, health and living standard. Income based or consumption based poverty is unable to present the true picture of deprivation because poverty is more in its magnitude than income. Countries are increasingly interested in having an official statistics on multidimensional poverty index (Worldwide 14 countries uses with an official MPI to monitor the evolution of poverty in multidimensional way) due to the growing consensus regarding the limitations of the income poverty measures as standalone indicator (Santos, 2019). Poverty level of the country is understood in the more depth by the use of MPI and it was developed in 2010 by OPHI and UNDP, many countries including Pakistan have adopted this methodology as an official estimate. Multidimensional poverty provides useful analysis and information for reducing poverty and inequality. Reduction of multidimensional poverty is one of the core objectives of Pakistan and it is reflected in SDG1 (no poverty) by 2030 as well. The pattern of global poverty, especially in developing countries attracts global concerns, which is reflected in MDGs and now in SDGs agenda. Moreover, one of the targets of Sustainable Development Goal (SDGs) is to reduce multidimensional poverty 6% to 19% by 2023 and at least 50% by 2030 but poverty reduction is not an easy target to achieve.

Urbanization is the important factor which affect the multidimensional poverty especially in recent years the world urbanization developed quickly ((Li, Wang, Liu, & Long, 2014, K.-M. Chen, Leu, & Wang, 2019)). Nearby 80%, population of many developed countries is in urban and in case of developing world, the urban share is lower but urbanization process increasing remarkably (17.6% in 1950 and 46.5% in 2011). In developing countries, urbanization is lower and urban growth is higher. By the end of this century, the world's 20 most populous cities from Euro-USA to

developing world. However, there is poverty in urban areas too, nearly half of the urban population living in slum houses and one fifth of the urban population lives below their national poverty lines (Jeremić, Sachs, & Review, 2014).The acceleration speed of urbanization could alter the dynamics of multidimentional poverty over the recent decades. Generally, it is considered that poverty reduction is a natural byproduct of the urbanization process but there is still disagreement consideration in the academia and policy literature regarding the impact of urbanization on the poverty.

Climate shocks and stress affects the individuals or household's prosperity and it is believed the serious challenge to poverty reduction efforts around the globe. Climatic changes severely affected the poverty in the developing countries because the intensity of climate variability is high, lack of sufficient financial resources and technical capacities to manage increasing climate risk. In this background, climate changes are considered a serious challenge to poverty reduction efforts around the globe.

Yet, these two significant factors, climate change and urbanization are apparent cause for the lack of attaining SDG goal 1 by 2030. Therefore, this study aims to address this gap in previous studies by examine the nexus between multidimensional poverty, climate change and urbanization in Pakistan

5.1.2 An Overview of Multidimentional Poverty: The Case Study of Pakistan

Multidimentional poverty has largely remained unexplored in Pakistan (Idrees & Baig, 2017). In Pakistan 4 out of 10 Pakistanis are multidimensional poor (means that 39% population lives in Multidimentional poverty) and it declines 55% to 39% from 2004 to 2015(S. Wasti, 2015). Moreover, the earlier two decades, Pakistan has made significant progress in fighting poverty, reducing it more than half since 2000.

Climate change and urbanization is the known fact and cannot be ignored when studying poverty in Pakistan. Natural disasters like as floods, droughts, cyclone and heat waves etc.; commonly come from the climatic changes in the annual temperature and rainfall. Such natural events most probably affect the multidimensional poverty in urban areas. Pakistan is going through rapid unplanned urbanization which can lead to many socioeconomic challenges (Q. Wang et al., 2019).The process of urbanization can influence Multidimentional poverty. The average urbanization growth rate 3.56% from 1971 to 2018 indicates the rapid urbanization trend in Pakistan with 14.97 million urban population in 1971 increased 77.80 million in 2018 (Ritchie & Roser, 2018). Pakistan is most urbanized nation in South Asia where 36.4% population living in urban areas (Ahmad & Farooq, 2010).

So when study poverty in Pakistan the urbanization and climate change is the most important variable, Previous studies (Idrees & Baig, 2017, N. Iqbal & Nawaz, 2017,A. U. Khan et al., 2016; F. Khan & Akram, 2018) ignore these two important variables but this study incorporates these variables at district level. How to achieve the SDG1 (no poverty) successfully by 2030 along with the challenges of climate change and urbanization is the prime focus of the policy makers. However, at the local scale how to investigate the separate effect of urbanization and climate change on poverty in Pakistan remains a serious challenge. It is, therefore, important to examine the current impact of climatic changes and urbanization on poverty in Pakistan at local scale.

5.1.3 Objective of the Study

The underlying essay aims to understand and measure the impact of urbanization and climate change on multidimentional poverty in Pakistan at household level by using the latest micro data set PSLM 2019-20. Hence, the specified objective of the underlying essay is specified as follows.

I. To investigate the impact of urbanization on multidimensional poverty.

II. To explore the impact of climate changes on multidimensional poverty.

III. To estimate the joint impact of urbanization and climate change on multidimensional poverty.

5.1.4 Significance of the Study

For several reasons, Pakistan is an interesting case to look at the nexus between climate change, urbanization and multidimentional poverty. Firstly, there is dynamic condition of poverty in Pakistan during the recent decade. Secondly, Pakistan is the fifth most vulnerable country of the climate change. Thirdly, Pakistan is the highest urban growth country in South Asia. Fourthly, Pakistan trying to achieve the SDG goal and the deadline to meet these goals is the 2030. By considering the impact of climate change and urbanization on poverty as well as achieving the poverty eradicating goal, substantial literature helps to analyze the hurdles on the way of prosperity and to analyze all issues more appropriate. Moreover, this study helps in better allocation of scarce resources to remove poverty from the country. The results of this study can be used as a base line scenario to further improvement in eradicating the poverty. This study also provides an important input for the policy makers to reduce poverty in Pakistan.

5.1.6 Scheme of the Chapter

Section 5.2 reviews the literature, focusing to explore the impact of climate change and urbanization on poverty examples from developed and developing countries. A conceptual framework for this essay, which highlighted the relationship between poverty and explanatory variables presented in 5.3, Section 5.4 discuss the empirical model, estimation methods, variable construction and data used in this study.

The result obtained from estimating the model presented and analyzing in section 5.5. Conclusion and policy implication draw in the section 5.6.

5.2 Literature Review

This section elaborates the relationships between multidimensional poverty, climate change and urbanization through considering the relevant empirical literature. Bulk of literature is available on this issue. However, the literature reviewed in this section has been chosen reverent to the objectives of this research essay. Multidimensional poverty is defined as "the poverty beyond income or consumption including some other non-monetary dimensions for example education, health and living standard". This definition is adopted by from Alkire. S and it is based on the Amartya Sen's Capability Approach. Recently, the impacts of climatic change on poverty have become debatable. The available literature on the climate change and poverty nexus conflicting results on the significance and direction. Some studies indicated that climate change has negative impact on poverty. While others reported that climate change effect the poverty in both ways, positively and negatively (Hallegatte, 2014; Leichenko & Silva, 2014). Therefore, according to the latter group, the adverse effect of climate change on poverty is inconclusive. This section reviews major empirical studies carried out in this field relevance to the objective of this study. Climate change more effect poverty with different channels. Poor are more vulnerable to climate change and they face difficulties to fulfil their basic needs. Climate is the driver of the great concern, claiming more attentions around the world as time goes by (María, García-del-Amo, & Reyes-García, 2020).It is fact that temperature increasing and rainfall pattern changing which shows that climate changes is a serious problem, it is urgent need to deal with today.

Rapid urbanization poses challenges for multidimensional poverty and sustainable development. The World is presently experiencing rapid urban transitions as well as rapidly changing global climate (Change, 2014).Urbanization and majority of urban population growth at present and projected in the future, is markedly different from the past (Basu & Bazaz, 2016).There are many direct and indirect impact of urbanization on multidimensional poverty via climate changes. Understanding and acting the interface of urbanization on multidimentional poverty is the most pressing and desirable challenge of the 21st Century. Urbanization changes the climate for example heat islands affects, floods, droughts etc. Climate changes further impacts species compositions and functions, interferes with biophysical cycles, impacts resources availability such as water and food impacts the frequency and intensity of hazard occurrence i.e. floods, droughts (Basu & Bazaz, 2016).The changing form of urban economic system and altered resource endowment and flows are equally responsible of their contribution to climate change. Moreover, climate variability is also expected to affect the timing and intensities of regular rains and adversely multiply urban impacts through water, food, health, migration connections (Revi & urbanization, 2008). Furthermore, it is a reality that urbanization changes climate and climate effect the food security. There are conflicting findings, about urbanization-poverty nexus. Some studies explored that, urbanization negatively affected the poverty (G. Chen, Glasmeier, Zhang, & Shao, 2016; Cuong, 2014; Davis & Wang, 2009). Some other studies finds the significantly positively effect of urbanization on poverty (Cali & Menon, 2009; Ravallion, Chen, Sangraula, & review, 2007).Where some studies finds that the urbanization both positively and negatively affect the poverty (Liddle, 2017; María del Rosario, 2020).So the effect of urbanization on poverty is unknown a prior.

Although research and studies have been conducted on the measuring the of multidimentional poverty, there is a dearth of research to explore the impact of climate change and urbanization on multidimentional poverty in the context of Pakistan. Most of the studies focused only measuring the multidimentional poverty using different dimensions of wellbeing. However, some studies explore the impact of climate change on multidimentional poverty and someone explore the impact of urbanization on multidimentional poverty. There is not a single study, which incorporated the both emerging challenges of climate change and urbanization to measure the multidimentional poverty at district level in the context of Pakistan. Finally, this study differentiates the previous studies by incorporating the emerging challenges of climate change and urbanization to measure the multidimentional poverty and this fill this research gap

5.3 Conceptual Framework of the Study

Different studies come up with different conceptual framework but the objective of this study is to develop the theoretical framework of multidimensional poverty incorporating the relationship between climate change and urbanization. Theoretical framework captures;

Table 5.0: ***Transmission Channels of MPI***

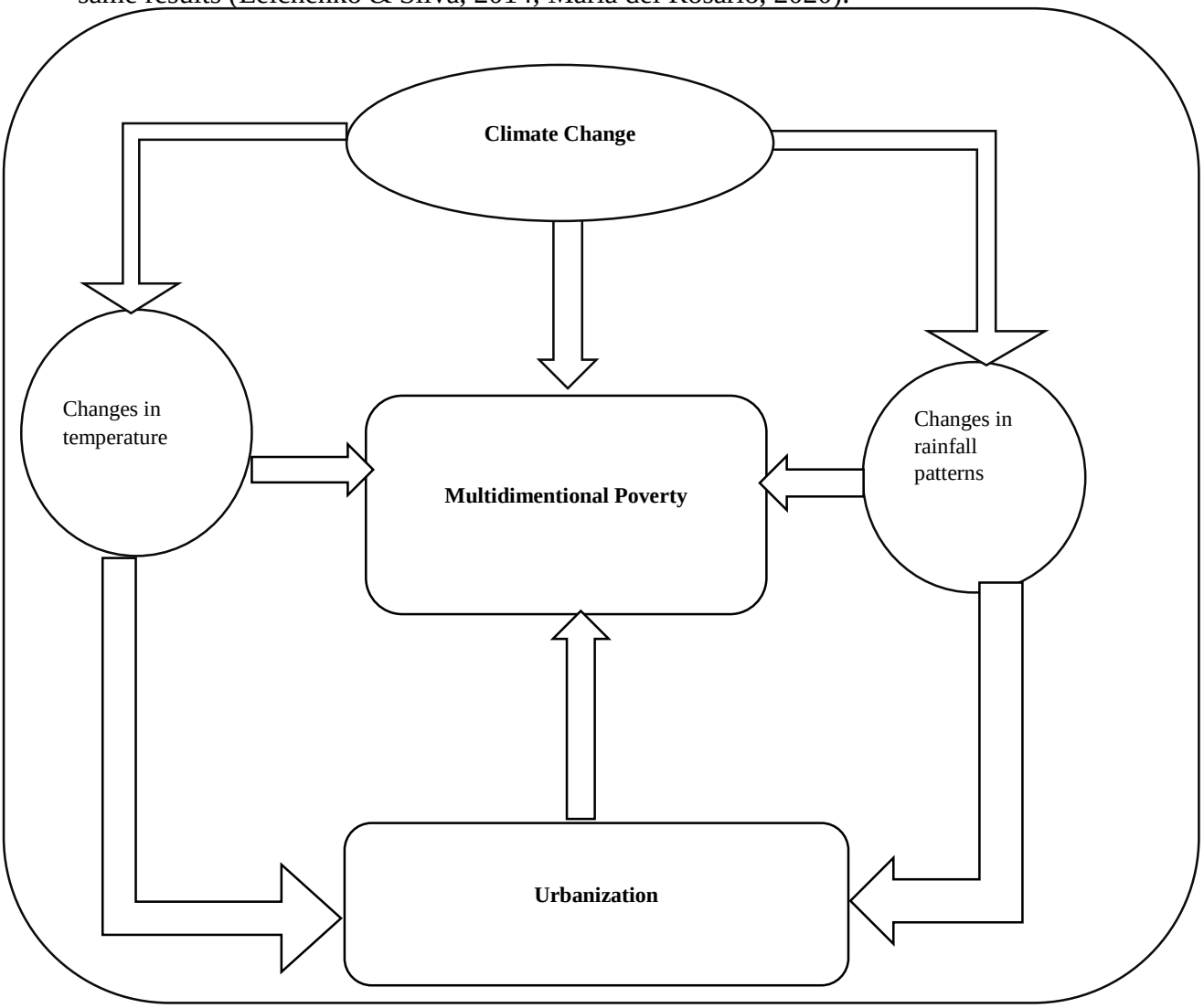
Main Channel	**Mechanism**	**Specific Channel**	**Direct/Indirect**	**Examples**
Consumption	Changes in prices	Food prices	Direct Channel	Climate changes increase prices and as a result, poverty will increase.
		Energy prices, Land prices	Indirect Channel	
Assets	Loss of Assets	Physical asset loses	Direct Channel	Due to climate changes loss in property, education and health
		Heath and education	Indirect Channel	
Productivity	Productivity effected by climate changes	Agri-production, profit and Wages	Direct Channel	Climate changes effected agri production and as a result poverty will increase
		Labour productivity and wages	Indirect Channel	
Opportunity	Climate change constraint the opportunity	Economic Growth	Indirect Channel	Economic growth, structural changes and opportunity negatively affected by climate changes.
		Structural Changes		
		Migration		

Sources: Own elaboration information from literature.

Firstly, the independent impact of climate change on multidimensional poverty. Secondly, the impact of climate change on multidimensional poverty through the impact of urbanization. Some of these are the direct and some are indirect brief description given below. Direct and indirect channels of climate change effect the multidimentional poverty.

As above table explain that there are four transmission channels can affect the poverty indirect and direct ways. All the channels show that how climate change harmful to

Poverty. Every channel negatively affect the poverty and other studies also reported the same results (Leichenko & Silva, 2014; María del Rosario, 2020).



Sources: Composed by Author

Figure 5. 1: ***Conceptual framework of multidimentional poverty, climate change and urbanization***

Urbanization can affect the multidimentional poverty. Laquian 2004, Naseem 2012 and Khan et al 2015 reported that high rate of urbanization, unskilled labour, high population growth and frequently occurring climatic shocks responsible for poverty in Pakistan. Liddle 2015 explore that urbanization significantly positive effect the poverty due to more economic opportunities and infrastructure in cities. On the other argument is that urbanization can have positive effect on human capital such as transfer of

information and advanced knowledge about production skills and technology (McKenzie & Sasin, 2007).However, in Pakistan the poverty rate has been decreasing and while the urbanization has happened rapidly over the last two decades. Urbanization can increase the wages of rural workers. Firms and industrial units generally established in cities and their wages are higher than rural areas, they attract rural workers. In this way rural labour supply decrease and as a result the rural labour wages increasing. Urbanization can lead to increase nearby cities rural land prices. Higher land prices increase the income of the rural household (Cali & Menon, 2009).

Urbanization often involves migration from rural to urban areas for better economic opportunities. Migration is expected to increase income of migrants as well as their household (Cuong, 2014).Migration can have numerous impact on household poverty. The direct impact of migration is the increase income through remittances (McKenzie & Sasin, 2007).Positive impact of remittances on household welfare and poverty reduction are found in many studies like (Adam, 2006; Adams Jr & Page, 2005). On the other hand there are several empirical studies which do not find poverty reduction effect of migration (Azam & Gubert, 2006; Y. P. Wang, 2004).

5.4 Data and Variable Description

5.4.1 Data Source

Primarily, the underlying research employs two types of the data household survey data, and district level data. To measure the impacts of urbanization and climatic factors on households' multidimensional poverty, the study has used the most recent available household survey, PSLM (2019-20), which is conducted by Pakistan Bureau of Statistics (PBS)[3]. Household-specific variables and multidimensional poverty are

[3] https://www.pbs.gov.pk/content/pslm-district-level-survey-2019-20-microdata

generated from the PSLM (2019-20), while district level variables are collected from *Data4Pakistan*[4] and provincial development statistics from 2008 to 2018-19. The climatic variables are taken from Pakistan Metrological Department (PMD) from 1990 to 2019. In nut shell, the analysis is based on PSLM 2019-20 cross section data, while the second part of the analysis is pooled data set of the districts of Pakistan where we excluded the newly merged district of FATA (previously known) into KP, because their data is missing for 2014-15, 2012-13, 2010-11, and 2008-09 while available for 2019-20. Hence, district level pooled data is used for all previously mentioned years without using the districts of previously known as FATA.

5.4.2 Variable Construction

5.4.2.1 Multidimensional Poverty Index (MPI)

The main dependent variable of this research is multidimensional poverty index (MPI). The study has constructed this variable by using Alkire and Santos (2010 & 2014), which is widely used by researchers. The MPI has been constructed by using three dimensions such as education, health, and living standards. These three dimensions include further indicators, which are given in table-5.1. All these dimensions and cut-offs, and weights are set by the Government of Pakistan to keeping in view the priorities, which are the part of their national plans. Table 5.1 comprises the identification and cut-offs of deprivation by indicators. For household level MPI, a binary variable is computed by using the deprivation of all the indicators of the MPI, which has been the dependent variable in household level analysis. Moreover, for pooled data analysis, we have constructed district level MPI by using data of PSLM

[4] https://www.pass.gov.pk/Document/Downloads/Eng%20Brief%20Data4Pakistan_Mar10.pdf
https://www.pass.gov.pk/Detail0e43003a-4534-48a2-aede-b3f312e87fde

2019-20, while the information of previous years for sampled districts has been plucked from the government published reports[5].

Table 5. 1: ***Pakistan's National Multidimensional Poverty Index (MPI), Deprivations and Weights***

Dimension	Indicators	Deprivation Cut-off	Weight
Education	Years of Schooling	Household is deprived if no man *OR* no woman above 10 years of age has completed 5 years of schooling	1/6
	Child school attendance	Household is deprived if any school aged child is not attending school between 6 and 11 years of age	1/8
	School quality	Deprived if any child is not going to school because of quality issues	1/24
Health	Access to health facilities	Deprived if health facilities such as basic health units etc. are not used at all.	1/6
	Immunization	Deprived if any child <5 is not fully immunized according to the vaccinations calendar	1/18
	Ante-natal care	Household is considered deprived if any woman who has given birth in the last three years did not receive ante-natal check-ups	1/18
	Assisted delivery	Households are deprived if any woman has given birth in the last 3 years attended by untrained personnel such as family member, friend, traditional birth attendant, etc.	1/8
Standard of Living	Water	Household is deprived if the households have no access to an improved level of source of water such as tap water, hand pump, motor pump, protected well, and mineral water	1/21
	Sanitation	A household is considered as deprived if she/she has no access to adequate sanitation such as flush system etc.	1/21
	Walls	A household is deprived if he/she has no improved walls	1/42
	Overcrowding	A household is deprived if the household has 4 or more people per room	1/42
	Electricity	A household is deprived if she/she has no access to electricity	1/21
	Cooking fuel	A household is deprived if he/she has solid cooking fuels for cooking	1/21
	Assets	"A household is considered as deprived if he/she does not have more than two small assets (radio, TV, iron, fan, sewing machine, video cassette player, chair, watch, air cooler, bicycle) OR no large asset (refrigerator, air conditioner, tractor, computer, motorcycle), AND has no car".	1/21
	Land and livestock (rural)	"Deprived if the household is deprived in land AND deprived in livestock, i.e.: a) Deprived in land: the household has less than 2.25 acres of non-irrigated land AND less than 1.125 acres of irrigated land b) Deprived in livestock: the household has less than 2 cattle, fewer than 3 sheep/goats, fewer than 5 chickens AND no animal for transportation (urban households are considered non-deprived)"	1/21

Source: *Government of Pakistan*

[5] https://www.ophi.org.uk/wp-content/uploads/Multidimensional-Poverty-in-Pakistan.pdf

Multidimentional Poverty Index (MPI) measured by the methodology of Alkire and Foster (2011).This is a new method for assessing the poverty in a broader sense (by considering both incidence and intensity of poverty).

Mathematically MPI is as:

MPI=H*A

Where "H" is the incidence of poverty and "A" is the intensity of the poverty. There are two identification steps of MPI (Multidimentional Poverty) first; one is the identification of the deprivation of each indicators with comparing the achievements of each individual cut-off by the Head Count Ratio (Incidence of poverty).

$$H = \frac{q}{n}$$

Where "q" is the multidimentional poor and "n" is the total number of population**.**

Second is the, Multidimentional poor with comparing individual deprivation scores to the given poverty threshold (intensity of poverty).

$$A = \frac{\sum_{i=1}^{n} C_i(k)}{q}$$

$C_i(k)$ is the censored deprivation score across the poor .Finally ,multidimentional poverty is the product of the incidence of poverty "H" and the intensity of the poverty "A"

MPI=H*A

5.4.2.2 Urbanization and Population Density

The share of urban population to the total population by each district of Pakistan, which is computed from PSLM 2019-20. Likewise, district population density

is taken from the portal *Data4Pakistan*. The inverse of population density measures the backwardness of the districts while without inverse it measures how the sampled district is developed.

5.4.2.3 Climatic Variables

We have discussed the construction of climatic variables in detail in chapter 03. The climatic variables include rainfall and temperature. The long run averages and their square terms of rainfall and temperature are taken as the indicators of climatic shocks.

5.4.2.4 District Level Control Variables

District level infrastructure related variables are used as the control variables such as police access, road infrastructure, health infrastructure, government extension, and bank facility are the variables. Apart from infrastructure, related variables there are some other variables, which have been used as control variables such as net enrollment in primary schooling, which indicates the literacy rate, dependency ratio, and irrigated area.

A brief description of previously mentioned variables is presented in table 5.2.

Table 5. 2 : ***Construction of District Level Control Variables***

Variables	**Brief Description**	**Data Source**
Police access	% of people having access to police whenever need	PSLM
Road facility	% of people are utilizing the facility of main roads	PSLM
Agriculture extension	% of people having the access to agriculture extensions	PSLM
Bank facility	% of people having access to banking facility	PSLM
Literacy rate	% net enrollment in primary schooling	*Data4Pakistan*
Health infrastructure	% of people are enjoying the health facilities	PSLM
Road length	Length of roads in kilometers	PDS
Irrigated area	Total irrigated area out of cultivated area (000 hectors)	PDS
Low dependency	% households If dependency ratio is less than 1	PSLM
Medium dependency	% households If dependency ratio is equal to 1	PSLM
Severe dependency	% households If dependency ratio is greater than 1	PSLM

PDS= Provincial Development Statistics

Table 5. 3 A: ***Description of the variables***

Variable Name	Brief Description of the Variable	Units
Dependent Variable		
MPI for Household	Variable is a binary in nature where "1" is assigned if household is multidimensional poor and "0" otherwise.	Binary
MPI for pooled Data	Construct District Level MPI index by using data set PSLM 2019-20	%
Explanatory variables		
Urbanization	% share of urban population to the total population of districts	%
Average temperature	30 years average of yearly district level temperature	c^o
extreme temperature	Square of 30 years average of yearly district level temperature	c^o
Average Rainfall	30 years average of yearly district level rainfall	Mm
Extreme rainfall	Square of 30 years average of yearly district level rainfall	mm
Control Variables For Household Analysis		
Head age	Age of the head of the household when survey is conducted	Year
Head gender	It takes 1 if household head is male, otherwise 0	Binary
Dependency Ratio	% ratio of non-working (below 15 years+ above 64 years) age group to the working age group (between 15 to 64 years)	%
Transport utilization	% of the households which are found utilizing transport facility at district level	%
Agriculture extension	% of the households which are found utilizing agriculture extensions at district level	%
Police Access	% of people having access to police whenever need	%
Bank Facility	% of people having access to banking facility	%
Control Variables For District Level		
Health Infrastructure	% of people are enjoying the health facilities	%
Road Length	Length of roads in kilometers	KM
Net Enrollment Primary	% net enrollment in primary schooling	%
Irrigated to Cultivated Area	Total irrigated area out of cultivated area (000 hectors)	Hectors
Low Dependency Ratio	% households If dependency ratio is less than 1	%
Medium Dependency Ratio	% households If dependency ratio is equal to 1	%

Table 5. 4 B: ***Summary statistics of the Variables***

Variable	Mean	Std. Dev.	Min	Max
Dependent Variable				
MPI	.568	.495	0	1
MPI percentage	39.966	16.045	0	100
Explanatory Variables				
Urbanization (%)	30.98235	26.95922	0	100
Average temperature	27.953	5.066	1.578	34.166
Tempe seq	807.052	240.352	2.491	1167.308
Average Rainfall	1.773	1.437	.191	5.369
Rainfall seq	5.21	7.056	.036	28.83
Control Variables For Households				
Head age	44.254	13.444	14	99
Head gender	.915	.278	0	1
Depency ratio	.94	.776	.029	15
Transportation Facility	.651	.477	0	1
Agriculture Extension	.057	.232	0	1
Police Access	.127	.333	0	1
Bank Facility	.391	.488	0	1
District Level Characteristics				
Health Infrastructure	364.901	634.441	6.583	4225.1
Road Length	1639.39	1103.698	130	4153.23
Net enrollment Primary	68.736	13.702	11.6	93.3
Irrigated to Cultivated Area	83.19701	51.02239	2.638606	576.7677
Low Dependency Ratio	48.09483	8.464731	12.4114	70.3911
Medium Dependency Ratio	13.6349	2.020133	6.76329	22.4265
Population Density	1108.7	1531.99	1	6278.94

5.5 Empirical Methodology

This section maintains the discussion on application of empirical strategies to estimate the specified objectives, which are discussed as follows. As we have discussed that, the underlying study aims to estimate the impacts of urbanization and climate

change on multidimensional poverty in Pakistan. For this purpose, we implemented household survey data to obtain the said objectives. In addition to this, the study has used district level pooled data to measure as well. Hence, to obtain evidence from household data, we have applied binary Logit Model, because the dependent variable is a binary in nature where "1" is assigned if household is multidimensional poor and "0" otherwise. Likewise, to estimate objectives by using district level pooled data requires the implementation of panel data techniques such as district fixed effect and random effect. Therefore, to capture district level heterogeneity, the study has applied district fixed effect model. The discussion on the specification of the model is given as follows.

5.5.1 Empirical Strategy 01: Binary Logit Model

A growing body of literature has suggested the application of Binary Logit model whenever we have binary dependent variables (e.g. Ahmed et al., 2016; Mustafa et al., 2019) as the case of underlying study we have multidimensional variable as binary variable for household survey data setting. For empirical purpose, first we would estimate the impacts of urbanization on multidimentional poverty, which is specified as follows.

$$Y_i = \beta_0 + \beta_1 Ur_i + \gamma_i \Sigma X_i + U_i \qquad (5.1)$$

In above equation Y_i is showing dependent variable which is binary in nature where "1"= if household is multidimensional poor, otherwise 0. District level (percentage) of urbanization is explanatory variable where β_1 is its parameter. Similarly, ΣX_i is the vector of control variables, which are given in equation 5.1 such as age, and gender of household head, household dependency ratio, utilization of transportation at district level, and having facilities of agriculture extensions, police facility, and

availability of commercial banks at district level, and provincial dummies, and Ui is the error term. After establishing the impacts of urbanization, the study would introduce the climatic variables such as average rainfall and its non-linear term, and average temperature and non-linear term of temperature. The equation 5.1 follows the following specification.

$$Y_i = \beta_0 + \beta_1 Ur_i + \beta_2 T_i + \beta_3 T_i^2 + \beta_4 R_i + \beta_5 R_i^2 + \gamma_i \Sigma X_i + U_i \qquad (5.2)$$

In above equation, T represents average temperature, while T^2 indicates its square term to unleash the extreme temperature norms (shocks); R indicates the average rainfall, while R^2 denotes square term of the rainfall to estimate the impacts of extreme events of rainfall. Rests of the specification will be similar as presented in equation 5.1. Next target is to estimate the joint impacts of the urbanization and climate change on multidimentional poverty. For that purpose, we have introduced interaction term of the urbanization and climatic factors in equation 5.2. The specification becomes as follows.

$$Y_i = \beta_0 + \beta_1 Ur_i + \beta_2 T_i + \beta_3 T_i^2 + \beta_4 R_i + \beta_5 R_i^2 + \beta_6 Ur_i * T_i + \beta_6 Ur_i * R_i + \gamma_i \Sigma X_i + U_i \qquad (5.3)$$

In above equation, $Ur_i * T_i$ is the interaction term, which is measured by the multiplication of urbanization, and average temperature, which estimates the joint impacts of the urbanization, and temperature. Similarly, $Ur_i * R_i$ estimates the joint impact of urbanization and rainfall on multidimensional poverty. Hence, the rests of the specification are similar, as we have discussed in equation 5.2.

5.2.2 Empirical Strategy 02: District Fixed Effect Model

The above-discussed empirical strategy is based on merging the household survey data with district level urbanization and climatic shocks. The next task is to

measure the evidence from district level pooled data for 2008-09, 2010-11, 2012-13, 2014-15, and 2019-20. For this purpose, we applied the district level fixed effect model to capture the unobservable heterogeneity across districts. Therefore, the equation 5.1 forms in following form.

$$Y_{it} = \beta_i + \beta_1 Ur_{it} + \gamma_i \Sigma X_{it} + U_{it} \quad (5.4)$$

Here, the dependent variable is percentage prevalence of multidimensional poverty, while subscript *i* indicates district, and *t* indicates time. The X is vector of other variables that affect the multidimensional poverty except urbanization as well such includes literacy rate, dependency ratio, irrigated area, police access, bank facility, agriculture extension, health facility, and road length at district levels. The rest of the setting is as same as in 5.1. The next target is to include climatic variables

$$Y_{it} = \beta_i + \beta_1 Ur_{it} + \beta_2 T_{it} + \beta_3 T_{it}^2 + \beta_4 R_{it} + \beta_5 R_{it}^2 + \gamma_i \Sigma X_i + U_i \quad (5.5)$$

The above given setting is similar to the equation 5.4 only additional information of climatic factors such as rainfall (R) and temperature (T) are included to see through the impacts of rainfall and temperature shocks on multidimensional poverty. These equations are estimated by using district fixed effect models to obtain objectives.

5.6 Results and Discussion

This section is furnished with discussion on empirically obtained findings. Firstly, the study estimates the impacts of urbanization and climate change on multidimensional poverty by using the PSLM (2019-20), while subsequently the evidences are estimated by using the district level panel fixed effect. The main objective of this essay is to explore the impacts of urbanization and climate change on households

and after that, it is to estimate what happens the relationship if we employ the district level pooled data.

5.6.1 Impact of Urbanization on Households' Multidimensional Poverty (MP)

In order to estimate the influences of urbanization on households' multidimensional poverty the study has implemented the Binary Logit model, when multidimensional poverty is in binary form whether household is poor or not. Likewise, we have used OLS estimator when dependent variable is multidimensional poverty index (MPI). Table 5.3 indicates that urbanization has statistically significant and negative impacts on households' multidimensional poverty. Here, negative sign estimated by Logit model demonstrates that other things remaining same; the increase in urbanization brings about decline in the likelihood of households' multidimensional poor. In order to interpret the coefficients, the study has computed the odd ratio, which is estimated as 0.969, which means almost 3 percent chances of being multidimensional poor are declined owing to increase in urbanization, other things remaining constant.

Nonetheless, the application of OLS on continuous variable, MPI is suggested that influences of urbanization on multidimensional poverty are negative because with the increase of urbanization, the MPI falls by 0.006 percent. It demonstrates that although urbanization has almost brought about decline in MPI by almost 0 percent, but the impacts are beneficial overall. The application of Logit demonstrates relatively stronger impacts than that of OLS. Hence, overall, it is concluded that urbanization has beneficial effects on households' multidimensional wellbeing or causing to reduce multidimensional poverty (table 5.3).

Despite urbanization, there are other factors, which have impacts on households' multidimensional poverty: household-specific and locational variables. Table 5.3 demonstrates that age of household head has statistically significant impacts

on poverty. The negative sign demonstrates that those households whose heads are relatively older are less likely to be poor. Similarly, the gender of the head of household has significant impacts where positive sign demonstrates that those households whose heads are male seem more likely to be poor as compared to those who are female-headed. The dependency ratio is also one of the important factors, which have significant impacts on determining the

Table 5. 5: ***Impact of Urbanization on Multidimensional Poverty in Pakistan***

VARIABLES	**(1)**		**(2) OLS**
	logit	**Odd Ratio**	**Log of MPI**
Urbanization	-0.0307***	0.970***	-0.00616***
	(0.000433)	(0.000401)	(6.96e-05)
Head age	-0.00154***	0.998***	0.000202***
	(0.000438)	(0.000444)	(7.75e-05)
Head gender	0.230***	1.258***	0.0774***
	(0.0205)	(0.0260)	(0.00369)
Log of monthly income	-0.224***	0.800***	-0.0561***
	(0.00749)	(0.00622)	(0.00130)
Depency_ratio	0.222***	1.249***	0.0766***
	(0.00782)	(0.0104)	(0.00134)
Transportation Facility	0.318***	1.375***	0.0828***
	(0.0126)	(0.0172)	(0.00223)
Agriculture Extension	0.477***	1.612***	0.0819***
	(0.0267)	(0.0419)	(0.00444)
Police Access	-0.244***	0.783***	-0.0319***
	(0.0180)	(0.0141)	(0.00320)
Bank Facility	-0.263***	0.768***	-0.0860***
	(0.0125)	(0.00959)	(0.00223)
Health infrastructure	0.000244***	1.000***	7.06e-05***
	(1.54e-05)	(1.54e-05)	(2.43e-06)
Net_enrol_primary	-0.0134***	0.987***	-0.00467***
	(0.000527)	(0.000539)	(9.11e-05)
Road_lenghth	8.17e-05***	1.000***	8.59e-06***
	(7.69e-06)	(7.71e-06)	(1.39e-06)
Punjab	0.185***	1.203***	-0.00265
	(0.0217)	(0.0266)	(0.00398)
Sindh	0.611***	1.842***	0.160***
	(0.0251)	(0.0453)	(0.00445)
Balochistan	0.870***	2.386***	0.203***
	(0.0276)	(0.0658)	(0.00462)
Constant	3.438***	31.11***	4.419***
	(0.0842)	(2.694)	(0.0147)
Observations	150,701	150,701	148,630

Note: Robust0standard errors in parentheses *p<0.1, **p<0.05, and ***p<0.01

Households' multidimensional poverty, which has adverse impacts, which means the increase in dependency ratio increases the chances of the households to be poorer.

Locational factors include physical and social infrastructure related variables have significant impacts on the determination of the multidimensional poverty among households. Social infrastructure includes police accessibility has significant impacts which beneficial influences. The physical infrastructure includes transport facilities, agriculture extensions, and facilities of commercial banks are the significant factors, which are found influencing the multidimensional poverty of households. Moreover, the provincial dummies are also included in the models, which have significant impacts on multidimensional poverty (table 5.3).

The results of the model using ICT are given in the Appendix-D table 5.3(a). It shows that by including the ICT the over-all performance of the model does not change. The behavior of the model is the same as it was before the inclusion of the ICT. The odds of getting more ICT reduces the MPI.

5.6.2 Urbanization, Climate Change, and Households' Multidimensional Poverty

Likewise, last section, the study has employed the same models by including climatic factors to unleash the impacts of urbanization and climatic factors on the determination of the multidimensional poverty among households. Table 5.4 estimates two sorts of the models: with and without temperature along with rainfall. The study has used district level climatic factors such as temperature and rainfall. The estimated results demonstrate that again the impacts of urbanization are found negative and significant, as we have discussed in previous section. Nonetheless, impact of the linear term of the rainfall has negative and significant effects, which mean that the increase in

rainfall linearly, the chances of being multidimensional poor declined. The non-linear term has indicated positive and significant impacts on poverty.

The significance of the non-linear term with positive sign has suggested the persistence of non-linear impacts of the rainfall. The estimated relationship is U-shaped which exhibit that initially the rainfall is causing the decline in multidimensional poverty, while after certain level of rainfall, the chances of being poor start increasing. Such relationship looks justifiable because the beneficial linear impacts may be because of increase in productivity specifically agriculture, which contributes positively in economic growth, and it would ultimately enable governments to spend more on development programs. The non-linear impacts indicate the shocks in rainfall, which encompasses the occurrence of intense and extreme events of the rainfall patterns, which could turn into the urban flooding, and disaster in the physical and social infrastructure of the location. Such harmonious rainfall episodes could bring about the increase in the probability of multidimensional poverty among household

Similar to the rainfall, the study has estimated models by including the temperature shocks in the model along with the rainfall. The estimated results are showing again the persistence of the non-linear impacts of the temperature shocks on multidimensional poverty are found (table 5.4). Nonetheless, the influences of rainfall more intense as compared to the temperature. Moreover, the table 5.5 encompasses the joint impacts of the climatic shocks and urbanization on multidimensional poverty among the households. Here the main concern remains on occurrence of rainfall shocks. The results demonstrate that the joint impacts rainfall and urbanization are found statistically significant. Overall, the increase in both urbanization and rainfall simultaneously turn the beneficial impacts of the urbanization into adverse impacts, other things remaining same. However, without interaction term, the impacts of

urbanization are documented beneficial, but the joint impacts are not beneficial on the prevalence of multidimensional poverty among households. These results have implication that alone urbanization seems beneficial and advantageous outcome which fosters country grow economically through increase in economic activities and industrial productivity, but the threats of climatic shocks especially the extreme and uneven patterns of rainfall are hurting the positive impacts of the urbanization.

Hence, by concluding the whole discussion, urbanization has its advantageous influences on the multidimensional wellbeing of the households; while at the same climatic shocks have harmonious but non-linear U-shaped impacts of the rainfall and temperature on poverty. The joint occurrences of the both rainfall and urbanization have shown the harmonious effects on the determination of multidimensional poverty in Pakistan (tables 5.4 & 5.5). Likewise, previous section, the factors such as household-specific and district level social and physical infrastructure has significant effects on the determination of the multidimensional poverty among households.

The results of the model using ICT are given in the Appendix-D table 5.4(a). It shows that by including the ICT the over-all performance of the model does not change. The behavior of the model is the same as it was before the inclusion of the ICT. The odds of getting more ICT reduces the MPI.

Table 5. 6: ***Impact of Urbanization and climate change on Multidimentional poverty***

	Binary Logit Model		OLS	Binary Logit Model		OLS
VARIABLE	**Logit**	**Odd Ratio**	**Log MPI**	**Logit**	**Odd Ratio**	**Log MPI**
urbanization	-0.0289***	0.972***	-0.00649***	-0.0278***	0.973***	-0.00613***
	(0.000499)	(0.000465)	(8.39e-05)	(0.000513)	(0.000494)	(8.44e-05)
precip_avg	-0.537***	0.584***	-0.170***	-0.175***	0.839***	-0.0856***
	(0.0263)	(0.0155)	(0.00458)	(0.0316)	(0.0278)	(0.00530)
rainfall_seq	0.0634***	1.065***	0.0216***	0.0507***	1.052***	0.0160***
	(0.00467)	(0.00500)	(0.000820)	(0.00506)	(0.00557)	(0.000875)
temp_avg				-0.135***	0.874***	-0.0380***
				(0.00830)	(0.00770)	(0.00136)
tempe_seq				0.00451***	1.005***	0.00110***
				(0.000224)	(0.000230)	(3.54e-05)
Head age	-0.000815*	0.999*	0.000329***	-0.000497	1.000	0.000417***
	(0.000446)	(0.000452)	(7.78e-05)	(0.000447)	(0.000453)	(7.76e-05)
Head gender	0.191***	1.211***	0.0695***	0.178***	1.195***	0.0660***
	(0.0207)	(0.0253)	(0.00368)	(0.0207)	(0.0250)	(0.00367)
log_income	-0.208***	0.812***	-0.0533***	-0.201***	0.818***	-0.0517***
	(0.00761)	(0.00641)	(0.00131)	(0.00762)	(0.00647)	(0.00131)
Depency_ratio	0.219***	1.245***	0.0746***	0.220***	1.246***	0.0750***
	(0.00794)	(0.0105)	(0.00133)	(0.00795)	(0.0105)	(0.00133)
Transportation Facility	0.289***	1.335***	0.0690***	0.263***	1.301***	0.0611***
	(0.0129)	(0.0172)	(0.00227)	(0.0130)	(0.0169)	(0.00227)
Agriculture_extens	0.466***	1.593***	0.0780***	0.442***	1.556***	0.0689***
	(0.0268)	(0.0415)	(0.00438)	(0.0269)	(0.0406)	(0.00437)
Police Access	-0.280***	0.756***	-0.0391***	-0.273***	0.761***	-0.0378***
	(0.0181)	(0.0135)	(0.00318)	(0.0181)	(0.0136)	(0.00316)
Bank Facility	-0.261***	0.771***	-0.0900***	-0.258***	0.772***	-0.0884***
	(0.0128)	(0.00983)	(0.00225)	(0.0128)	(0.00985)	(0.00225)
Health infrastructure	0.000223***	1.000***	8.38e-05***	0.000194***	1.000***	7.37e-05***
	(1.65e-05)	(1.63e-05)	(2.68e-06)	(1.67e-05)	(1.66e-05)	(2.70e-06)
Net_enrol_primary	-0.00376***	0.996***	-0.00184***	-0.00414***	0.996***	-0.00191***
	(0.000653)	(0.000671)	(0.000111)	(0.000660)	(0.000692)	(0.000110)
Road_lenght h	4.60e-05***	1.000***	-1.42e-06	4.23e-05***	1.000***	-2.49e-06*
	(7.91e-06)	(7.86e-06)	(1.39e-06)	(7.96e-06)	(7.93e-06)	(1.39e-06)
Punjab	-0.224***	0.799***	-0.105***	-0.192***	0.825***	-0.0988***
	(0.0310)	(0.0253)	(0.00561)	(0.0311)	(0.0262)	(0.00559)
Sindh	-0.178***	0.837***	-0.0609***	-0.133***	0.876***	-0.0518***
	(0.0399)	(0.0337)	(0.00702)	(0.0401)	(0.0354)	(0.00701)
Balochistan	0.171***	1.186***	0.0206***	0.828***	2.290***	0.144***
	(0.0391)	(0.0474)	(0.00671)	(0.0510)	(0.123)	(0.00796)
Constant	3.728***	41.62***	4.537***	3.171***	23.83***	4.558***
	(0.0866)	(3.697)	(0.0149)	(0.129)	(3.261)	(0.0219)
Observations	142,148	142,148	140,553	142,148	142,148	140,553
R-squared			0.248			0.253

The household-specific factors include age of household head, gender of head, and dependency ratio. The dependency ratio implies that the higher dependency ratio demands higher requirement of health, education, and household assets, and living standards of the households. Therefore, it has adverse impacts on determining the poverty among households. Similarly, the infrastructure related factors such as transport facility, police access, and agriculture extension, and facilities of banks are the significant factors (table 5.4 & 5.5).

The results of the model using ICT are given in the Appendix-D table 5.5(a). It shows that by including the ICT the over-all performance of the model does not change. The behavior of the model is the same as it was before the inclusion of the ICT. The odds of getting more ICT reduces the MPI.

Above discussion is based on evidences obtained from household survey data, which encompasses the influences of urbanization and climatic shocks on the prevalence of multidimensional poverty among households. However, we need to explore further by using the district level pooled data by using the district fixed effect, so that the sensitivity of the relationship may be estimated.

Moreover, District level aggregation of the data would capture the regional differences in order to measure the relationship. The next section is furnished with the discussion on district level climatic shocks, urbanization, and their influences on the prevalence of multidimensional poverty at district level.

Table 5. 7: ***Interaction of Urbanization and Rainfall and Its Impacts on Multidimensional Poverty***

	Binary Logit Model		**OLS**
VARIABLES	**Logit**	**Odd Ratio**	**Log MPI**
Urbanization	-0.0232***	0.977***	-0.00560***
	(0.000503)	(0.000462)	(8.28e-05)
precip_avg	-0.250***	0.779***	-0.119***
	(0.0272)	(0.0214)	(0.00453)
rainfall_seq	0.0160***	1.016***	0.0137***
	(0.00479)	(0.00488)	(0.000807)
int_rainfall_region	-1.445***	0.236***	-0.209***
	(0.0221)	(0.00540)	(0.00358)
int_rainfa_seq_region	0.249***	1.283***	0.0362***
	(0.00623)	(0.00801)	(0.00102)
Head age	-0.00166***	0.998***	0.000226***
	(0.000462)	(0.000467)	(7.61e-05)
Head gender	0.222***	1.248***	0.0726***
	(0.0215)	(0.0270)	(0.00360)
Log of monthly income	-0.175***	0.839***	-0.0476***
	(0.00786)	(0.00679)	(0.00128)
Depency_ratio	0.207***	1.230***	0.0712***
	(0.00821)	(0.0107)	(0.00130)
Transportation Facility	0.305***	1.356***	0.0688***
	(0.0134)	(0.0181)	(0.00222)
Agriculture extension	0.278***	1.321***	0.0535***
	(0.0269)	(0.0345)	(0.00429)
Police Access	-0.258***	0.773***	-0.0336***
	(0.0187)	(0.0143)	(0.00310)
Bank Facility	-0.173***	0.841***	-0.0763***
	(0.0133)	(0.0111)	(0.00221)
Health index	0.000519***	1.001***	0.000125***
	(1.74e-05)	(1.73e-05)	(2.68e-06)
Net_enrol_primary	-0.00489***	0.995***	-0.00195***
	(0.000670)	(0.000686)	(0.000108)
Road_lenghth	4.37e-05***	1.000***	-3.29e-07
	(8.31e-06)	(8.34e-06)	(1.37e-06)
Punjab	-0.0890***	0.915***	-0.0802***
	(0.0325)	(0.0309)	(0.00550)
Sindh	-0.0750*	0.928*	-0.0321***
	(0.0414)	(0.0390)	(0.00688)
Balochistan	0.294***	1.342***	0.0503***
	(0.0405)	(0.0562)	(0.00657)
Constant	3.169***	23.80***	4.425***
	(0.0897)	(2.187)	(0.0147)
Observations	142,148	142,148	140,553

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

5.6.3 Urbanization and Multidimensional Poverty: District Fixed Effect

Table 5.6 comprises the estimated influences of urbanization on the prevalence of multidimensional poverty at district level, which are obtained through the application of district fixed effect. To observe sensitivity analysis, we have estimated district level random effect as well. Nonetheless, the focus will be on the results measured through fixed effect models.

The estimated results are again showing that urbanization has negative and significant impacts on prevalence of poverty at district level. The findings demonstrate that other things remaining same, with the increase in urbanization, there will be 2 to 3 percent decline in the prevalence of multidimensional poverty at sampled district level. It implies that the increase in urbanization is beneficial for districts. The reason could be put forth that increase in urbanization enhances the economic activities such as business; entrepreneurship etc. and expansion in provision of government extensions could raise the district level wellbeing, which ultimately could be the reason to the deterioration of multidimensional poverty. Moreover, the application of fixed effect model with time dummies indicate that impact of urbanization becomes insignificant which implies that there is no time effect in the impacts of urbanization. However, without time dummies, the relationship becomes statistically significant. Overall, such beneficial role of urbanization is observed to be consistent even though we have applied random effect with and without time dummies. Another demographic factor such as district population density is also showing the negative and significant relationship with poverty. The higher the population density, the lower will be the prevalence of multidimensional poverty. These advantageous effects could be due to the increase in government extensions and the provision of other facilities. Moreover, district dependency ratio is showing that those districts where relatively lower dependency ratio

is found are relatively experiencing lower level of poverty. Other than dependency ratio, district level literacy rate is also emerged as the important and statistically significant determinant of the multidimensional poverty (table 5.6). Other factors such as district level availability of health infrastructure have also statistically significant impact on the prevalence of multidimensional poverty, although the coefficients are very small (almost equal to zero percent) but the relationship is significantly negative in both district level fixed and random effects models (table 5.6). The influences of road infrastructure are found beneficial but are not statistically significant. In addition to this, the cultivated area is showing the statistically significant impacts on poverty.

Table 5. 8 : Impact of Urbanization on Multidimensional Poverty: District Level Analysis

Multidimensional Poverty (%)	Without time Random Effects	With time Random Effects	Without time Fixed Effects	With time Fixed Effects
Urbanization (%)	-0.0186**	-0.00234	-0.0276**	-0.00268
	(0.00859)	(0.00418)	(0.0121)	(0.00658)
Health infrastructure	-0.00938***	-0.00912***	-0.00866***	-0.00825***
	(0.00210)	(0.00185)	(0.00293)	(0.00201)
Road length (km)	-0.00149	-0.00104	-0.00147	-0.000743
	(0.00107)	(0.00104)	(0.00204)	(0.00187)
Net enrollment primary	-0.728***	-0.708***	-0.583***	-0.578***
	(0.0531)	(0.0509)	(0.0669)	(0.0624)
Irrigated per cultivated	0.0114	0.00437	0.00412	-0.00172
	(0.0130)	(0.0109)	(0.0110)	(0.00936)
Low dependency ratio	-0.565***	-0.654***	-0.399***	-0.508***
	(0.0951)	(0.103)	(0.0984)	(0.111)
Medium dependency	0.107	0.174	0.244	0.279
	(0.263)	(0.238)	(0.299)	(0.265)
Population density	-0.0007***	-0.0007***	-0.0007***	-0.0006***
	(0.0001)	(7.76e-05)	(0.0001)	(7.22e-05)
2010.year		-8.177***		-7.456***
		(0.958)		(0.994)
2012.year		-7.429***		-7.524***
		(0.987)		(1.016)
2014.year		-10.25***		-10.10***
		(1.017)		(1.030)
2019.year		0.444		0.806
		(2.063)		(2.108)
Constant	135.1***	141.6***	116.6***	124.5***
	(5.884)	(5.928)	(7.576)	(7.455)
R-squared	0.6339	0.670	0.352	0.463
Observations	550	550	550	550
Number of district	111	111	111	111

5.6.4 Urbanization, Climatic Shocks, and Multidimensional Poverty: District Fixed Effect

In previous discussion, we have established the negative and significant relationship of the urbanization on poverty without the inclusion of climatic shocks. This section weaves up discussion on the results obtained for climatic shocks on multidimensional poverty at district level (see table 5.7). After establishing the relationship, the study has estimated the joint effect of urbanization and climatic shocks (see table 5.8).

Table 5. 9: ***Impact of urbanization and climatic factors on multidimensional poverty***

Multidimensional Poverty (%)	(1)	(2)	(3)	(4)
	Random Effects	Random Effects	Fixed Effects	Fixed Effects
Urbanization (%)	-0.0197**	-0.00445	-0.0289**	-0.00541
	(0.0087)	(0.0044)	(0.011)	(0.0065)
Average rainfall	-1.183	-0.783	3.032	2.967
	(0.989)	(1.091)	(2.688)	(2.759)
Rainfall shock	4.434***	2.446*	3.953***	1.846
	(1.225)	(1.352)	(1.329)	(1.394)
Average temperature	-0.386*	-0.292	0.538	0.548
	(0.226)	(0.245)	(0.584)	(0.623)
Health infrastructure	-0.0089***	-0.0089***	-0.0089***	-0.0086***
	(0.00217)	(0.0019)	(0.0029)	(0.0021)
Road length	-0.00124	-0.000881	-0.00197	-0.00124
	(0.00112)	(0.00108)	(0.00219)	(0.00199)
Net enrollment primary	-0.726***	-0.710***	-0.587***	-0.581***
	(0.0548)	(0.0515)	(0.0659)	(0.0619)
Irrigated to cultivated area	0.0105	0.00427	-0.000259	-0.00503
	(0.0124)	(0.0108)	(0.0107)	(0.00919)
Low dependency ratio	-0.571***	-0.660***	-0.430***	-0.533***
	(0.0972)	(0.105)	(0.102)	(0.114)
Medium dependency ratio	0.163	0.201	0.260	0.267
	(0.265)	(0.245)	(0.284)	(0.259)
Population density	-0.00076***	-0.00071***	-0.00067***	-0.00061***
	(0.000148)	(9.46e-05)	(0.00016)	(8.39e-05)
2010.year		-8.029***		-7.428***
		(0.996)		(1.012)
2012.year		-6.627***		-6.869***
		(1.105)		(1.100)
2014.year		-9.551***		-9.565***
		(1.166)		(1.135)
2019.year		0.421		0.677
		(2.059)		(2.060)
Constant	146.5***	150.3***	99.18***	106.8***
	(7.806)	(8.578)	(21.54)	(23.43)

Multidimensional Poverty (%)	(1)	(2)	(3)	(4)
	Random Effects	Random Effects	Fixed Effects	Fixed Effects
Observations	550	550	550	550
R-squared	0.649	0.679	0.381	0.473
Number of districts	111	111	111	111

Estimated results are showing that impact of the linear term of the rainfall has negative and but statistically insignificant effects Nonetheless, the non-linear term has indicated positive and significant impacts on poverty. The significance of the non-linear term with positive sign has suggested the persistence of non-linear impacts of the rainfall. As in the case of household survey data analysis, climatic factors are again demonstrating the U-shaped which indicate that initially the rainfall is causing the decline in multidimensional poverty at district level, while after certain level of rainfall, the chances of being poor start increasing at district level.

The non-linear impacts demonstrate the shocks in rainfall or extreme rainfall patterns, which could bring about the increase in the probability of multidimensional poverty at district level (table 5.7). Nonetheless, table 5.8 encompasses the joint impacts of the climatic shocks and urbanization on multidimensional poverty at district level. The findings demonstrate that the joint impacts rainfall and urbanization are found statistically significant. Overall, the increase in both urbanization and rainfall brings about adverse impacts, other things remaining same. Hence, by concluding the whole discussion, urbanization has its advantageous influences on the multidimensional wellbeing at district level or alternatively reducing the multidimensional poverty in Pakistan at district level as well. Similar to the last section, all other factors such as district level population density is also showing the negative and significant relationship with poverty, and dependency ratio is also again showing that the districts which have relatively lower dependency ratio is found to be relatively experiencing lower level of

multidimensional poverty. Similarly, district level literacy rate is also found statistically significant determinant of the multidimensional poverty.

Likewise, district level availability of health infrastructure has also statistically significant impact on the prevalence of multidimensional poverty, although the coefficients are almost equal to zero percent but the relationship is significantly negative in both district level fixed and random effects models. In short, the influences of urbanization and climatic shocks are found similar as we have estimated it in previous a section, which establishes one important fact that these relationships are robust and not sensitive to the definition and techniques.

Table 5. 10: ***Joint Impact of Urbanization and Climatic Shocks on Multidimensional Poverty***

VARIABLES	**(1)**	**(2)**	**(3)**	**(4)**
	Random Effects	**Random Effects**	**Fixed Effects**	**Fixed Effects**
Urbanization (%)	-0.0321	0.0106	-0.0797***	-0.0157
	(0.0223)	(0.0258)	(0.0256)	(0.0301)
Average rainfall	-1.370	-0.552	2.433	2.847
	(1.113)	(1.237)	(2.709)	(2.814)
Rainfall shock	4.494***	2.343*	4.162***	1.908
	(1.211)	(1.341)	(1.318)	(1.393)
Interact rain & urbanization	0.00638	-0.00761	0.0260**	0.00519
	(0.0102)	(0.0122)	(0.0112)	(0.0135)
Average temperature	-0.396*	-0.278	0.524	0.546
	(0.233)	(0.251)	(0.579)	(0.624)
Health infrastructure	-0.00906***	-0.00884***	-0.00910***	-0.00866***
	(0.00223)	(0.00192)	(0.00308)	(0.00213)
Road length	-0.00124	-0.000882	-0.00184	-0.00122
	(0.00113)	(0.00108)	(0.00220)	(0.00200)
Net enrollment primary	-0.726***	-0.708***	-0.587***	-0.581***
	(0.0550)	(0.0514)	(0.0655)	(0.0619)
Irrigated to cultivated area	0.0105	0.00414	-0.000158	-0.00496
	(0.0124)	(0.0107)	(0.0107)	(0.00921)
Low dependency	-0.569***	-0.663***	-0.427***	-0.531***
	(0.0976)	(0.106)	(0.101)	(0.114)
Medium dependency	0.159	0.208	0.233	0.261
	(0.263)	(0.248)	(0.278)	(0.260)

VARIABLES	(1)	(2)	(3)	(4)
	Random Effects	Random Effects	Fixed Effects	Fixed Effects
Population density	-0.000755***	-0.000727***	-0.00063***	-0.00061***
	(0.000147)	(0.000100)	(0.000149)	(8.53e-05)
2010.year		-8.114***		-7.376***
		(1.003)		(1.023)
2012.year		-6.751***		-6.790***
		(1.132)		(1.128)
2014.year		-9.701***		-9.469***
		(1.195)		(1.187)
2019.year		0.370		0.702
		(2.061)		(2.063)
Constant	147.1***	149.5***	101.0***	107.1***
	(8.220)	(8.927)	(21.51)	(23.55)
Observations	550	550	550	550
R-squared overall	0.6493	0.6801	0.385	0.473
Number of district	111	111	111	111

Note: Robust standard errors in parentheses *p<0.1, **p<0.05, and ***p<0.01

5.6.5 Endogenous Urbanization: Instrumental Variable District Fixed Effect

The study also uses the instrumental variable approach when urbanization is endogenous. For that purpose, rainfall is taken as the instrument of the urbanization as the literature has suggested which is the best available exogenous and linked with household wellbeing. The estimated results are showing that the effects of urbanization are with positive and significant sign in the case of district fixed effect model. It indicates that the increase in urbanization brings about increase in multidimensional poverty when urbanization is instrumented with rainfall (table 5.9). These results are the validation of the previous findings we have discussed for rainfall on multidimensional poverty at district level.

Table 5. 11: ***Application of Instrumental Variable Approach: District Level Panel Analysis***

Multidimensional Poverty (%)	**(1)**	**(2)**	**(3)**	**(4)**
	IV Random Effects	**IV Random Effects**	**IV Fixed Effects**	**IV Fixed Effects**
Urbanization (%)	-0.000899	-0.000354	0.0136**	0.0118**
	(0.00307)	(0.00316)	(0.00662)	(0.00511)
Health infrastructure	-0.000326***	-0.000332***	-0.000375***	-0.000341***
	(8.43e-05)	(7.98e-05)	(0.000134)	(0.000109)
Road length	-5.41e-05**	-5.10e-05**	-0.000173*	-0.000115
	(2.66e-05)	(2.56e-05)	(9.99e-05)	(7.49e-05)
Net enrollment primary	-0.0160***	-0.0156***	-0.0147***	-0.0136***
	(0.00114)	(0.00107)	(0.00393)	(0.00313)
Irrigated to cultivated area	0.000740*	0.000573	-0.000291	-0.000417
	(0.000410)	(0.000408)	(0.000808)	(0.000681)
Low dependency ratio	-0.0141***	-0.0149***	-0.00320	-0.00776
	(0.00261)	(0.00237)	(0.00593)	(0.00487)
Medium dependency ratio	0.00342	0.00530	0.00594	0.00864
	(0.00915)	(0.00873)	(0.0186)	(0.0153)
Population density	-3.84e-05***	-3.80e-05***	-4.09e-05***	-3.72e-05***
	(6.39e-06)	(6.01e-06)	(1.45e-05)	(1.18e-05)
2010.year		-0.152***		-0.278***
		(0.0564)		(0.103)
2012.year		-0.153**		-0.377***
		(0.0705)		(0.120)
2014.year		-0.217**		-0.516***
		(0.0883)		(0.148)
2019.year		0.0604		0.0939
		(0.0438)		(0.0834)
Constant	5.749***	5.817***	4.875***	5.188***
	(0.257)	(0.218)	(0.446)	(0.374)
Observations	550	550	550	550
Number of _ID	111	111	111	111
District RE	YES	YES		
District FE			YES	YES
Instrumented Variable: Urbanization **Instruments**: Average rainfall, and rainfall shocks				

Note: Robust standard errors in parentheses *p<0.1, **p<0.05, and ***p<0.01

5.7 Conclusion and Policy Implication

5.7.1 Concluding Remarks

Poverty reduction has been deemed as one of the key policy agenda in developing countries. Pakistan also targeting the reduction of poverty for the last couple of decades. During the last couple of years, Pakistan is facing parallel rise of urbanization and happening of climatic and environmental calamities, which have raised several other challenges including feeding the rising population in both the urban and the rural areas. To achieve sustainable development goals by 2030 with considering the adverse impact of climatic shocks and urbanization in Pakistan at the local scale is a challenging task because Pakistan is the fourth most climate vulnerable country in the World according to Global Climate Risk Index report 2021 and highly urbanized country in South Asia, 36.4 percent. To design inclusive and effective policy agenda to tackle such problem, we need to gather empirical evidence on relationship among urbanization, climatic shocks, and poverty. The underlying piece of research aims to explore: i) the influences of urbanization and climatic shocks on multidimentional poverty, ii) what happens to multidimentional poverty when urbanization and climatic shocks coincides together in Pakistan? For empirical purpose, PSLM (2019-20) data set has been employed to gather household level information: households' socioeconomic characteristics and specifically the dependent variable multidimentional poverty has been measured by using the module of Alkire and Foster methodology. Moreover, district level data of 30 years averages of rainfall and temperature has been used. Finally, district level climatic factors are merged with PSLM (2019-20) by identifying the district codes. For econometric purpose, binary Logit model and instrument approach has been implemented wherein rainfall and transportation has been used as instrument for urbanization to deal endogenity arises due to urbanization in the model.

The estimated findings indicate that urbanization has beneficial and significant impacts on multidimentional poverty reduction, while climatic factors have shown non-linear influences on multidimentional poverty. The non-linear impacts demonstrate that linear term of rainfall and temperature has shown beneficial impacts while non-linear term contains adverse effects on multidimentional poverty reduction. When both urbanization and climatic factors coincide, the beneficial impacts of urbanization becomes adverse on multidimentional poverty reduction. Moreover, the instrumented urbanization also indicates the adverse impacts on multidimentional poverty contrary to the non-instrumented urbanization variable.

5.7.2 Policy Implication

The results of this research are important in terms of recommendations for making economic policies to attain the SDG-1 (no poverty) by 2030. An important intervention to reduce multidimentional poverty would be the implementation of effective mitigation and adaptation strategies to reduce the adverse effect of climate change. Overall, the findings of the underlying research essay have demonstrated that urbanization has significant and beneficial influences on multidimentional poverty, but rising climatic shocks such as occurring of extreme events of rainfall and temperature is likely to devastate the advantageous effects of urbanization. Policy makers must consider climate change seriously and act accordingly with their impact on multidimentional poverty, especially if they desire to achieve the SDG-1(no poverty) up to 2030. Such finding has following implications, which need to be considered as policy agenda regarding achievement of the SDG-1 in Pakistan.

- A well-designed policy regarding dealing climatic shocks is needed to achieve reduction in multidimentional poverty because it has direct and indirect impacts on multidimentional poverty: rising urban flooding,

impacts on agriculture productivity and heat waves in urban areas. Therefore, the government must expand climate mitigation and adaptation strategy to overcome the vulnerabilities.

- A well planned and inclusive urban management is required which should be promptly responsive to the rainfall and temperature shocks.
- There is a lot of effort will be needed to improve the knowledge about SDGs and recent challenges of climate change and urbanization both at the government level and local level.

Moreover, existing policies are unable to cope with the growing challenges of climate change and urbanization.

5.7.3 Limitations of the Study

We have made our best efforts to conduct the underlying research essay, but still it can be improved further if we would have tackled the following limitations.

- PSLM (2019-20) first time, include the FATA, more coverage of Balochistan, KPK and insert new variables align with the SDGs requirement with the recommendation of national and international experts, if this type of data was available for the previous PSLM surveys, we would have utilized it also, which further could give us analysis for over the years.
- We could not use the other measures of multidimentional poverty related information due to the unavailability of data at district level in PSLM (20219-20). Such information can be taken from HIES (2018-19) but that is not district level representative.

- Other variables of climate change could not be use due the data limitations like as CO_2, Fog, forest cover area and humidity. If the underlying research could incorporate the above-mentioned variables then, the underlying study would be more comprehensive.

Finally, it is important to note that with all the limitations, this type of research is still necessary to investigate the impacts of climate change and urbanization on multidimentional poverty. There is a hope that this research opens the new opportunity for other researchers. Future research should incorporate more climatic variables in order to wide assess the climate impact on multidimentional poverty.

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Appendix A: (Distribution of FI District Wise)

TABLE 1 : *Percentage Distribution of Food Insecurity by District of KPK*

District	Food Insecurity (FI)	Mild FI	Medium FI	Severe FI
Abbottabad	55.31281	54.91559	11.12214	1.886792
Bajur	37.74012	37.51412	16.72316	2.259887
Bannu	52.16837	50.38266	21.81122	8.801021
Batagram	51.67224	51.00334	30.93645	13.8796
Bunair	41.69231	41.23077	16.92308	2.153846
Charsada	55.22273	54.76191	10.59908	2.995392
Chitral	21.94745	21.79289	11.90108	4.791345
D.I. Khan	11.45485	10.61873	7.107023	4.013378
Hangu	41.29213	41.15168	2.949438	0.5617977
Haripur	58.19672	57.5592	12.84153	3.369763
Karak	26.16372	24.07705	10.43339	6.099518
Khyber	42.8035	42.8035	2.252816	0.6257823
Kohath	26.16202	25.89642	11.95219	0.3984064
Kohistan	68.8269	68.74487	23.05168	1.47662
Kurram	53.44506	53.44506	12.84916	1.675978
Lakki marvat	49.08789	48.09287	14.75954	4.145937
lower di	27.00782	27.00782	23.16986	10.37669
Malakand	34.92723	33.67983	6.444906	1.871102
Mansehra	54.49202	53.73636	8.396306	3.106633
Mardan	49.21287	48.87064	12.8679	3.080082
Mohmand	69.64286	69.04762	28.1746	4.960318
North Waziristan	50.57283	50.08183	25.20458	1.145663
Nowshera	30.70399	30.2799	7.2095	2.205259
Orakzai	66.97675	66.97675	4.651163	1.395349
Peshawar	39.36087	38.58145	7.950117	2.650039
Shangla	21.75732	19.03766	5.857741	2.51046
South Waziristan	37.10575	37.10575	33.76624	11.13173
Swabi	33.99239	33.68821	6.692015	2.129278
Swat	30.61412	30.52246	24.93126	9.624198
Tank	42.66667	42.44444	38.22223	12
Tor garh	55.37757	54.91991	15.33181	0.4576659
Upper Dir	26.94444	26.2963	20.18518	7.962963

TABLE 2: *Percentage Distribution of Food Insecurity by District of Punjab*

District	Overall (FI)	Mild FI	Medium FI	Severe FI
Attock	19.05312	18.7067	6.581986	1.847575
Bahawalnagar	39.71487	37.75967	22.97352	17.92261
Bahawalpur	67.3564	66.83138	14.54602	9.326745
Bhakhar	56.50534	56.37963	10.99937	4.148335
Chakwal	34.47332	33.92613	14.97948	4.99316
Chiniot	26.6055	26.29969	13.3792	6.574924
D.G. khan	51.55162	50.98164	26.02913	4.939836
Faisalabad	16.8008	16.43863	8.511066	4.225352
Gujranwala	27.52534	26.51193	10.65708	5.524681
Gujrat	13.14421	12.81324	5.01182	1.79669
Hafiz Abad	27.07838	25.73238	10.84719	4.988123
Islamabad	18.72714	17.41039	10.2414	4.242867
Jhelum	35.22205	34.30322	22.43492	10.49005
jhang	38.07107	37.42501	24.22704	7.52192
Kasur	55.8296	54.93274	29.29746	10.20179
khanewal	53.99548	50.92551	31.87359	18.05869
khushab	34.33509	34.03456	10.66867	3.380917
Lahore	40.09859	39.26568	18.61295	6.323305
Layyah	45.52352	45.52352	32.77694	2.124431
Lodhran	40.01501	38.58859	23.64865	11.78679
Mandi bahudin	22.49576	21.56197	12.13922	4.75382
Mianwali	43.67176	43.3936	5.702364	1.32128
Multan	44.21143	43.2347	19.07498	9.709854
Muzaffargarh	47.98248	46.88771	23.36566	16.07757
Nankana	27.87307	27.27273	13.46484	3.259005
Narowal	23.24984	22.6718	12.58831	7.707129
Okara	26.04712	23.75654	5.759162	1.767016
Pakpattan	47.28682	44.96124	10.07752	4.05486
Rahim yar khan	46.77419	44.95967	19.39516	7.983871
Rajanpur	50.03791	49.05231	21.45565	2.729341
Rawalpindi	25.56612	24.36594	10.30344	4.64221
Sahiwal	44.6273	42.64279	9.002904	3.291384
Sargodha	44.07022	43.46112	13.43604	5.947689
Sheikhupura	44.08521	43.59072	14.98669	3.34728
Sialkot	20.37862	19.48775	9.020044	5.289532
T.T.Sing	29.84166	29.04994	16.19976	3.65408
Vehari	41.74455	38.31776	17.6947	5.794393

TABLE 3: *Percentage Distribution of Food Insecurity by District of Sindh*

District	Food Insecurity (FI)	Mild FI	Medium FI	Severe FI
Badin	74.22758	73.02185	37.15147	14.6948
Dadu	39.08985	38.50642	25.2042	2.217036
Ghotki	37.42373	35.38983	16.20339	4.000
Hyderabad	53.63448	52.90758	22.11838	5.036345
Jacobabad	38.81773	37.24138	22.36453	16.15764
Jamshoro	77.25322	76.96709	43.06152	8.154507
Karachi	24.07199	22.94713	9.486314	4.911886
Karachi	24.60419	24.26187	10.52632	5.477108
Karachi	25.55205	24.52681	12.06625	1.419558
Karachi	32.47717	32.07763	10.04566	2.511415
Karachi	34.61183	34.33456	12.52311	3.18854
kashmore	34.8	34.53333	32.4	10
khairpur	52.80374	51.92108	35.82555	21.75493
Korangi	22.92432	22.26304	9.257898	3.232917
Larkana	30	29.78261	21.5942	1.449275
Matiari	64.84018	64.23135	25.87519	6.544901
Mir pur	69.64952	68.97838	17.44967	2.386279
Nowshero	27.29682	26.67845	8.657244	1.501767
Sanghar	50.18315	50.18315	14.28572	9.74359
shahdadkot	35.14286	34.76191	26	1.142857
Shaheed	51.78963	51.4244	17.23886	12.8561
Shikarpur	61.48301	60.96807	22.76004	4.016478
Sujawal	56	55.48387	17.16129	10.58065
Sukkur	36.51079	35.2518	15.91727	3.597122
Tando Allayar	74.51791	74.38017	34.29752	12.80992
Tando Muhammad	75.58962	74.88208	32.07547	10.61321
Tharpark	91.01852	90.46297	24.44444	2.12963
Thatta	56.26881	55.3661	28.78636	10.33099
Umer kot	80.61617	79.97433	38.25417	10.26958

Table 4: *Percentage Distribution of Food Insecurity by District of Balochistan*

District	Food Insecurity(FI)	Mild FI	Medium FI	Severe FI
Awaran	97.06667	97.06667	30.93333	12
Barkhan	98.49056	98.49056	45.84906	40.75472
Dera bughti	80.52631	80.17544	28.24561	20.87719
Gwadar	37.12121	36.36364	8.333334	0
Harnai	6.040268	4.9217	4.474273	4.474273
Jaffarabad	86.45358	84.7793	40.48706	19.17808
Kachhi	56.27377	56.27377	21.673	17.30038
Kalat	37.72727	36.36364	27.87879	10
Kech/tur	50.96154	50.27472	22.25275	1.923077
Kharan	65.97222	65.79861	21.18056	1.736111
Khuzdar	81.4628	80.58007	29.7604	6.935688
Kohlu	29.5858	28.99408	15.97633	6.508876
Lasbela	42.49292	42.20963	14.73088	2.549575
Loralai	58.34863	57.06422	16.88073	6.055046
Mastung	19.14063	17.77344	17.38281	10.74219
Nasirabad	90.42553	89.9696	31.61094	15.19757
Nushki	38.42593	38.19445	15.97222	1.851852
Pishin	34.29637	30.6617	22.73998	12.48835
Qilla Abdullah	41.85249	39.79417	22.29846	14.75129
Qilla saifullaha	66.40471	66.40471	6.286837	0.3929273
Quetta	35.61381	34.52686	16.36829	10.35806
Shaheed	58.22368	55.92105	35.52631	7.56579
Sherani	10	9.523809	5.714286	2.380952
Sibbi	48.32	48.16	6.24	1.6
Sohbatpur	78.36539	76.92308	51.44231	6.25
Washuk	25.76576	25.04505	20.9009	3.423423
Ziarat	29.24282	27.41514	13.05483	3.394256

Appendix B: Estimations FI with binary urbanization

Table 1; *Impact of Urbanization (Binary) on Food Insecurity Estimated from Binary Logit Model*

VARIABLES	(FI)	Mild FI	Medium FI	Severe FI
Region (1=urban, 0=rural)	-0.261***	-0.260***	-0.161***	-0.111***
	(0.0131)	(0.0132)	(0.0172)	(0.0256)
Head age	-0.0127***	-0.0124***	-0.0118***	-0.0108***
	(0.000441)	(0.000442)	(0.000567)	(0.000855)
Head gender (1=male)	0.345***	0.336***	0.312***	0.371***
	(0.0233)	(0.0235)	(0.0317)	(0.0479)
Primary	-0.267***	-0.271***	-0.261***	-0.300***
	(0.0160)	(0.0160)	(0.0198)	(0.0298)
Middle	-0.593***	-0.596***	-0.601***	-0.651***
	(0.0174)	(0.0174)	(0.0233)	(0.0361)
Secondary	-0.881***	-0.889***	-0.863***	-0.967***
	(0.0163)	(0.0164)	(0.0227)	(0.0366)
Higher secondary	-1.217***	-1.228***	-1.176***	-1.267***
	(0.0250)	(0.0253)	(0.0370)	(0.0619)
Tertiary	-1.744***	-1.780***	-1.730***	-1.693***
	(0.0260)	(0.0265)	(0.0417)	(0.0666)
Dependency ratio	0.178***	0.178***	0.159***	0.167***
	(0.00691)	(0.00692)	(0.00831)	(0.0118)
Self employed	-0.138***	-0.127***	-0.218***	-0.371***
	(0.0195)	(0.0196)	(0.0262)	(0.0392)
Paid employee	0.198***	0.209***	0.0695***	-0.117***
	(0.0181)	(0.0182)	(0.0240)	(0.0357)
Agriculture employment	-0.150***	-0.136***	-0.256***	-0.602***
	(0.0198)	(0.0199)	(0.0263)	(0.0400)
Transport utilization	0.189***	0.191***	-0.0352**	-0.271***
	(0.0114)	(0.0115)	(0.0145)	(0.0213)
Agriculture extension	0.0458**	0.0240	-0.0881***	0.0443
	(0.0233)	(0.0233)	(0.0310)	(0.0470)
Punjab	-0.0802***	-0.105***	0.211***	0.641***
	(0.0149)	(0.0150)	(0.0203)	(0.0340)
Sindh	0.306***	0.299***	0.516***	0.638***
	(0.0177)	(0.0178)	(0.0233)	(0.0389)
Balochistan	0.414***	0.395***	0.492***	0.848***
	(0.0214)	(0.0214)	(0.0270)	(0.0419)
Constant	0.0102	-0.0192	-1.287***	-2.468***
	(0.0322)	(0.0323)	(0.0399)	(0.0597)
Observations	160,655	160,655	160,655	160,655

Robust seeform in parentheses *** p<0.01, ** p<0.05, * p<0.1

TABLE 2: *Impact of Urbanization (Binary) on Food insecurity: Odd Ratio*

VARIABLES	Food Insecurity	Mild Food Insecurity	Medium Food Insecurity	Severe Food Insecurity
Region (1=urban, 0=rural)	0.770***	0.771***	0.851***	0.895***
	(0.0101)	(0.0102)	(0.0146)	(0.0229)
Head age	0.987***	0.988***	0.988***	0.989***
	(0.000435)	(0.000437)	(0.000560)	(0.000846)
Head gender (male=1, 0=female)	1.413***	1.400***	1.367***	1.449***
	(0.0330)	(0.0328)	(0.0433)	(0.0694)
Primary	0.766***	0.763***	0.770***	0.741***
	(0.0122)	(0.0122)	(0.0153)	(0.0221)
Middle	0.553***	0.551***	0.548***	0.521***
	(0.00959)	(0.00960)	(0.0128)	(0.0188)
Secondary	0.414***	0.411***	0.422***	0.380***
	(0.00676)	(0.00675)	(0.00957)	(0.0139)
Higher secondary	0.296***	0.293***	0.308***	0.282***
	(0.00741)	(0.00740)	(0.0114)	(0.0174)
Tertiary	0.175***	0.169***	0.177***	0.184***
	(0.00455)	(0.00448)	(0.00739)	(0.0122)
Dependency ratio	1.195***	1.195***	1.172***	1.182***
	(0.00826)	(0.00826)	(0.00974)	(0.0140)
Self employed	0.871***	0.880***	0.804***	0.690***
	(0.0170)	(0.0173)	(0.0211)	(0.0271)
Paid employee	1.219***	1.232***	1.072***	0.890***
	(0.0220)	(0.0224)	(0.0258)	(0.0318)
Agriculture employment	0.861***	0.873***	0.774***	0.548***
	(0.0171)	(0.0174)	(0.0204)	(0.0219)
Transport utilization	1.209***	1.210***	0.965**	0.763***
	(0.0138)	(0.0139)	(0.0140)	(0.0162)
Agriculture extension	1.047**	1.024	0.916***	1.045
	(0.0243)	(0.0239)	(0.0284)	(0.0492)
Punjab	0.923***	0.901***	1.234***	1.899***
	(0.0138)	(0.0135)	(0.0250)	(0.0645)
Sindh	1.358***	1.348***	1.675***	1.893***
	(0.0241)	(0.0240)	(0.0390)	(0.0736)
Balochistan	1.513***	1.485***	1.636***	2.335***
	(0.0324)	(0.0318)	(0.0442)	(0.0979)
Constant	1.010	0.981	0.276***	0.0848***
	(0.0326)	(0.0317)	(0.0110)	(0.00506)
Observations	160,655	160,655	160,655	160,655

Note: Robust seeform in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Table 3: *Impact of Urbanization and CC on Food Insecurity Estimated from Binary Logit Model*

VARIABLES	Food Insecurity	Mild Food Insecurity	Medium Food Insecurity	Severe Food Insecurity
Region (1=urban, 0=rural)	-0.207***	-0.208***	-0.0792***	-0.0458*
	(0.0137)	(0.0138)	(0.0176)	(0.0260)
precip_avg	-0.172***	-0.137***	-0.373***	-0.618***
	(0.0249)	(0.0250)	(0.0309)	(0.0478)
rainfall_seq	0.0871***	0.0842***	0.0757***	0.0946***
	(0.00431)	(0.00432)	(0.00545)	(0.00934)
temp_avg	-0.0968***	-0.104***	-0.0847***	-0.0612***
	(0.00741)	(0.00742)	(0.00853)	(0.0140)
tempe_seq	0.00445***	0.00467***	0.00223***	0.00125***
	(0.000190)	(0.000190)	(0.000223)	(0.000341)
head age	-0.0104***	-0.0102***	-0.0102***	-0.00874***
	(0.000458)	(0.000460)	(0.000584)	(0.000873)
head_gender1	0.306***	0.296***	0.310***	0.340***
	(0.0240)	(0.0241)	(0.0323)	(0.0486)
Primary	-0.258***	-0.263***	-0.247***	-0.276***
	(0.0165)	(0.0166)	(0.0204)	(0.0303)
Middle	-0.535***	-0.540***	-0.537***	-0.568***
	(0.0181)	(0.0182)	(0.0240)	(0.0370)
Secondary	-0.818***	-0.827***	-0.798***	-0.885***
	(0.0172)	(0.0173)	(0.0237)	(0.0381)
higher secondary	-1.212***	-1.226***	-1.186***	-1.264***
	(0.0269)	(0.0272)	(0.0397)	(0.0661)
Tertiary	-1.717***	-1.756***	-1.739***	-1.721***
	(0.0278)	(0.0284)	(0.0447)	(0.0718)
depency_ratio	0.161***	0.161***	0.144***	0.152***
	(0.00711)	(0.00711)	(0.00854)	(0.0121)
self-employed	-0.0983***	-0.0850***	-0.203***	-0.347***
	(0.0202)	(0.0203)	(0.0267)	(0.0397)
paid employee	0.234***	0.247***	0.0753***	-0.0982***
	(0.0187)	(0.0188)	(0.0245)	(0.0360)
Agriculture	-0.232***	-0.217***	-0.336***	-0.707***
	(0.0204)	(0.0205)	(0.0267)	(0.0404)
Transportation	0.145***	0.145***	-0.0642***	-0.294***
	(0.0121)	(0.0122)	(0.0154)	(0.0225)
agriculture extension	0.0136	-0.00960	-0.117***	0.00286
	(0.0236)	(0.0237)	(0.0312)	(0.0472)
Punjab	-0.296***	-0.310***	0.168***	0.454***
	(0.0267)	(0.0268)	(0.0374)	(0.0646)
Sindh	-0.226***	-0.207***	0.195***	0.0393
	(0.0362)	(0.0363)	(0.0472)	(0.0760)
Balochistan	0.619***	0.647***	0.355***	0.411***
	(0.0423)	(0.0424)	(0.0540)	(0.0848)
Constant	-0.865***	-0.948***	-0.412***	-0.971***
	(0.0998)	(0.1000)	(0.116)	(0.195)
Observations	150,441	150,441	150,441	150,441

Note: Robust seeform in parentheses*** p<0.01, ** p<0.05, * p<0.1

Table 4: *Impact of Urbanization and CC on Food insecurity: Odd Ratio*

VARIABLES	**Food Insecurity**	**Mild Food Insecurity**	**Medium Food Insecurity**	**Severe Food Insecurity**
Region (1=urban, 0=rural)	0.813***	0.812***	0.924***	0.955*
	(0.0111)	(0.0112)	(0.0162)	(0.0248)
precip_avg	0.842***	0.872***	0.689***	0.539***
	(0.0210)	(0.0218)	(0.0213)	(0.0258)
rainfall_seq	1.091***	1.088***	1.079***	1.099***
	(0.00470)	(0.00470)	(0.00588)	(0.0103)
temp_avg	0.908***	0.902***	0.919***	0.941***
	(0.00672)	(0.00669)	(0.00783)	(0.0132)
tempe_seq	1.004***	1.005***	1.002***	1.001***
	(0.000191)	(0.000191)	(0.000224)	(0.000341)
head age	0.990***	0.990***	0.990***	0.991***
	(0.000454)	(0.000455)	(0.000578)	(0.000866)
head_gender1	1.357***	1.345***	1.363***	1.405***
	(0.0326)	(0.0325)	(0.0441)	(0.0683)
Primary	0.772***	0.769***	0.782***	0.759***
	(0.0128)	(0.0127)	(0.0159)	(0.0230)
Middle	0.585***	0.583***	0.584***	0.567***
	(0.0106)	(0.0106)	(0.0140)	(0.0210)
Secondary	0.441***	0.437***	0.450***	0.413***
	(0.00760)	(0.00758)	(0.0107)	(0.0157)
higher secondary	0.297***	0.293***	0.305***	0.282***
	(0.00801)	(0.00797)	(0.0121)	(0.0187)
Tertiary	0.180***	0.173***	0.176***	0.179***
	(0.00500)	(0.00490)	(0.00786)	(0.0129)
depency_ratio	1.175***	1.175***	1.155***	1.164***
	(0.00835)	(0.00835)	(0.00986)	(0.0141)
self-employed	0.906***	0.918***	0.816***	0.707***
	(0.0183)	(0.0186)	(0.0218)	(0.0281)
paid employee	1.264***	1.280***	1.078***	0.906***
	(0.0236)	(0.0240)	(0.0264)	(0.0326)
Agriculture	0.793***	0.805***	0.715***	0.493***
	(0.0162)	(0.0165)	(0.0190)	(0.0199)
Transportation	1.156***	1.156***	0.938***	0.745***
	(0.0140)	(0.0141)	(0.0144)	(0.0168)
agriculture extension	1.014	0.990	0.890***	1.003
	(0.0240)	(0.0235)	(0.0278)	(0.0474)
Punjab	0.744***	0.733***	1.183***	1.575***
	(0.0199)	(0.0197)	(0.0443)	(0.102)
Sindh	0.798***	0.813***	1.215***	1.040
	(0.0289)	(0.0295)	(0.0574)	(0.0790)
Balochistan	1.858***	1.909***	1.426***	1.509***
	(0.0785)	(0.0809)	(0.0770)	(0.128)
Constant	0.421***	0.388***	0.662***	0.379***
	(0.0420)	(0.0387)	(0.0767)	(0.0740)
Observations	150,441	150,441	150,441	150,441

Table 5: *Joint impact of Ur and CC on food insecurity Estimated from Binary Logit Model*

VARIABLES	Food Insecurity	Mild FI	Medium FI	Severe FI
Region (1=urban, 0=rural)	-1.728***	-1.750***	-2.598***	-0.166
	(0.209)	(0.211)	(0.309)	(0.361)
Rainfall	-0.231***	-0.195***	-0.445***	-0.652***
	(0.0264)	(0.0264)	(0.0331)	(0.0495)
int_rainfall_region	0.138***	0.138***	0.197***	0.0649*
	(0.0192)	(0.0193)	(0.0270)	(0.0350)
rainfall_seq	0.0915***	0.0885***	0.0811***	0.0978***
	(0.00437)	(0.00438)	(0.00559)	(0.00935)
temp_avg	-0.0880***	-0.0949***	-0.0714***	-0.0618***
	(0.00754)	(0.00756)	(0.00885)	(0.0139)
int_temp_region	0.0451***	0.0458***	0.0763***	0.00122
	(0.00631)	(0.00637)	(0.00936)	(0.0109)
tempe_seq	0.00406***	0.00429***	0.00167***	0.00123***
	(0.000197)	(0.000198)	(0.000236)	(0.000342)
head age	-0.0103***	-0.0101***	-0.0101***	-0.00864***
	(0.000459)	(0.000460)	(0.000585)	(0.000874)
head_gender1	0.303***	0.295***	0.310***	0.334***
	(0.0240)	(0.0242)	(0.0324)	(0.0487)
Primary	-0.257***	-0.262***	-0.246***	-0.274***
	(0.0165)	(0.0166)	(0.0204)	(0.0304)
Middle	-0.532***	-0.536***	-0.534***	-0.565***
	(0.0181)	(0.0182)	(0.0240)	(0.0370)
Secondary	-0.814***	-0.823***	-0.794***	-0.882***
	(0.0172)	(0.0173)	(0.0237)	(0.0381)
higher secondary	-1.209***	-1.223***	-1.182***	-1.262***
	(0.0269)	(0.0272)	(0.0397)	(0.0661)
Tertiary	-1.711***	-1.750***	-1.730***	-1.719***
	(0.0278)	(0.0284)	(0.0447)	(0.0718)
dependency ratio	0.161***	0.161***	0.144***	0.152***
	(0.00711)	(0.00711)	(0.00854)	(0.0121)
self-employed	-0.0999***	-0.0867***	-0.207***	-0.346***
	(0.0202)	(0.0203)	(0.0267)	(0.0397)
paid employee	0.234***	0.246***	0.0722***	-0.0969***
	(0.0187)	(0.0188)	(0.0245)	(0.0360)
Agriculture	-0.235***	-0.219***	-0.338***	-0.711***
	(0.0204)	(0.0205)	(0.0267)	(0.0405)
transportation	0.147***	0.147***	-0.0626***	-0.293***
	(0.0121)	(0.0122)	(0.0154)	(0.0225)
agriculture extension	0.0114	-0.0119	-0.121***	0.00188
	(0.0237)	(0.0237)	(0.0312)	(0.0473)
Punjab	-0.300***	-0.314***	0.167***	0.434***
	(0.0268)	(0.0269)	(0.0377)	(0.0644)
Sindh	-0.226***	-0.208***	0.196***	0.0206
	(0.0363)	(0.0364)	(0.0474)	(0.0757)
Balochistan	0.589***	0.618***	0.325***	0.383***
	(0.0426)	(0.0427)	(0.0546)	(0.0853)
Constant	-0.713***	-0.798***	-0.235*	-0.888***

Table 6: *Joint impact of Ur and CC on food insecurity Estimated from Binary Logit (Odd ratio)*

VARIABLES	**FI**	**Mild F I**	**Medium F I**	**Severe F I**
Region (1=urban, 0=rural)	0.178***	0.174***	0.0745***	0.847
	(0.0371)	(0.0367)	(0.0230)	(0.306)
rainfall_avg	0.794***	0.823***	0.641***	0.521***
	(0.0209)	(0.0218)	(0.0212)	(0.0258)
int_rainfall_region	1.148***	1.148***	1.218***	1.067*
	(0.0220)	(0.0222)	(0.0329)	(0.0374)
rainfall_seq	1.096***	1.093***	1.084***	1.103***
	(0.00479)	(0.00479)	(0.00606)	(0.0103)
temp_avg	0.916***	0.910***	0.931***	0.940***
	(0.00691)	(0.00688)	(0.00824)	(0.0131)
int_temp_region	1.046***	1.047***	1.079***	1.001
	(0.00660)	(0.00667)	(0.0101)	(0.0109)
Tempe seq	1.004***	1.004***	1.002***	1.001***
	(0.000198)	(0.000199)	(0.000236)	(0.000343)
head age	0.990***	0.990***	0.990***	0.991***
	(0.000454)	(0.000456)	(0.000579)	(0.000866)
head_gender1	1.354***	1.343***	1.363***	1.397***
	(0.0326)	(0.0324)	(0.0441)	(0.0680)
Primary	0.773***	0.769***	0.782***	0.760***
	(0.0128)	(0.0127)	(0.0159)	(0.0231)
Middle	0.588***	0.585***	0.586***	0.569***
	(0.0106)	(0.0106)	(0.0141)	(0.0210)
Secondary	0.443***	0.439***	0.452***	0.414***
	(0.00763)	(0.00761)	(0.0107)	(0.0158)
higher secondary	0.298***	0.294***	0.307***	0.283***
	(0.00804)	(0.00800)	(0.0122)	(0.0187)
Tertiary	0.181***	0.174***	0.177***	0.179***
	(0.00503)	(0.00493)	(0.00793)	(0.0129)
Dependency ratio	1.175***	1.174***	1.155***	1.164***
	(0.00835)	(0.00835)	(0.00986)	(0.0141)
self-employed	0.905***	0.917***	0.813***	0.708***
	(0.0183)	(0.0186)	(0.0218)	(0.0281)
paid employee	1.263***	1.279***	1.075***	0.908***
	(0.0236)	(0.0240)	(0.0263)	(0.0327)
Agriculture	0.791***	0.803***	0.713***	0.491***
	(0.0161)	(0.0164)	(0.0190)	(0.0199)
Transportation	1.158***	1.158***	0.939***	0.746***
	(0.0141)	(0.0141)	(0.0145)	(0.0168)
agriculture extension	1.011	0.988	0.886***	1.002
	(0.0239)	(0.0235)	(0.0277)	(0.0473)
Punjab	0.741***	0.731***	1.182***	1.544***
	(0.0199)	(0.0197)	(0.0446)	(0.0995)
Sindh	0.797***	0.812***	1.217***	1.021

	(0.0289)	(0.0295)	(0.0577)	(0.0772)
Balochistan	1.803***	1.854***	1.384***	1.467***
	(0.0768)	(0.0792)	(0.0755)	(0.125)
Constant	0.490***	0.450***	0.790*	0.411***
	(0.0506)	(0.0465)	(0.0950)	(0.0824)
Observations	150,441	150,441	150,441	150,441

Robust see form in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 7: *Impact of Ur and CC on Food Insecurity: Application of Ordered Logit*

VARIABLES	**Ord. Logit**	**Odd ratio**	**Ord. Logit**	**Odd ratio**
Urbanization (%)	-0.00182***	0.998***		
	(0.000281)	(0.000281)		
Region (1= urban, 0=rural)			-0.166***	0.847***
			(0.0132)	(0.0112)
Average rainfall	-0.304***	0.738***	-0.311***	0.733***
	(0.0237)	(0.0175)	(0.0237)	(0.0173)
Rainfall square	0.0865***	1.090***	0.0880***	1.092***
	(0.00425)	(0.00464)	(0.00424)	(0.00463)
Average temperature	-0.0659***	0.936***	-0.0677***	0.935***
	(0.00706)	(0.00661)	(0.00703)	(0.00657)
Temperature square	0.00297***	1.003***	0.00302***	1.003***
	(0.000173)	(0.000174)	(0.000173)	(0.000173)
Head age	-0.0104***	0.990***	-0.0101***	0.990***
	(0.000434)	(0.000429)	(0.000434)	(0.000430)
Head gender	0.314***	1.369***	0.307***	1.360***
	(0.0238)	(0.0326)	(0.0238)	(0.0324)
Primary	-0.255***	0.775***	-0.249***	0.779***
	(0.0154)	(0.0119)	(0.0154)	(0.0120)
Middle	-0.532***	0.587***	-0.523***	0.593***
	(0.0173)	(0.0102)	(0.0173)	(0.0103)
Secondary	-0.818***	0.441***	-0.804***	0.448***
	(0.0165)	(0.00729)	(0.0166)	(0.00742)
Higher secondary	-1.207***	0.299***	-1.186***	0.305***
	(0.0261)	(0.00780)	(0.0262)	(0.00799)
Tertiary education	-1.728***	0.178***	-1.697***	0.183***
	(0.0272)	(0.00483)	(0.0273)	(0.00501)
Dependency ratio	0.157***	1.170***	0.154***	1.166***
	(0.00660)	(0.00772)	(0.00660)	(0.00770)
Self employed	-0.144***	0.866***	-0.128***	0.880***
	(0.0198)	(0.0172)	(0.0199)	(0.0175)
Paid employee	0.172***	1.188***	0.178***	1.195***
	(0.0183)	(0.0217)	(0.0183)	(0.0219)
Agriculture employment	-0.241***	0.785***	-0.262***	0.770***
	(0.0195)	(0.0153)	(0.0195)	(0.0150)
Transport utilization	0.0698***	1.072***	0.0742***	1.077***
	(0.0118)	(0.0127)	(0.0118)	(0.0127)
Agriculture extension	-0.0189	0.981	-0.0251	0.975
	(0.0213)	(0.0209)	(0.0213)	(0.0208)
Punjab	-0.206***	0.814***	-0.211***	0.810***
	(0.0264)	(0.0215)	(0.0261)	(0.0212)
Sindh	-0.204***	0.815***	-0.214***	0.807***
	(0.0354)	(0.0288)	(0.0346)	(0.0280)
Balochistan	0.341***	1.406***	0.343***	1.410***
	(0.0383)	(0.0539)	(0.0383)	(0.0540)
/cut1	0.254***	1.289***	0.251**	1.285**
/cut2	1.564***	4.778***	1.562***	4.767***
/cut3	2.703***	14.92***	2.701***	14.89***

Robust see form in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 8: *Impact of Interaction Ur and CC on Food Insecurity: Apply Ordered Logit*

VARIABLES	Ord. Logit	Odd ratio	Ord. Logit	Odd ratio
Urbanization (%)	-0.0501***	0.951***		
	(0.00443)	(0.00422)		
Region (1=urban, 0=rural)			-2.149***	0.117***
			(0.219)	(0.0255)
Average rainfall	-0.503***	0.605***	-0.374***	0.688***
	(0.0288)	(0.0174)	(0.0250)	(0.0172)
Interact rainfall & urban	0.00473***	1.005***		
	(0.000372)	(0.000373)		
Interact rainfall & region			0.163***	1.177***
			(0.0194)	(0.0229)
Rainfall square	0.101***	1.106***	0.0928***	1.097***
	(0.00453)	(0.00501)	(0.00432)	(0.00474)
Average temperature	-0.0460***	0.955***	-0.0571***	0.944***
	(0.00737)	(0.00704)	(0.00718)	(0.00678)
Interact temperature & Urban	0.00142***	1.001***		
	(0.000137)	(0.000137)		
Interact temperature & region			0.0596***	1.061***
			(0.00661)	(0.00701)
Temperature square	0.00190***	1.002***	0.00256***	1.003***
	(0.000194)	(0.000194)	(0.000179)	(0.000180)
Head age	-0.0102***	0.990***	-0.0101***	0.990***
	(0.000434)	(0.000430)	(0.000435)	(0.000430)
Head gender (1=male)	0.303***	1.354***	0.307***	1.359***
	(0.0239)	(0.0323)	(0.0239)	(0.0324)
Primary	-0.251***	0.778***	-0.249***	0.780***
	(0.0154)	(0.0120)	(0.0154)	(0.0120)
Middle	-0.523***	0.593***	-0.520***	0.595***
	(0.0173)	(0.0103)	(0.0173)	(0.0103)
Secondary	-0.808***	0.446***	-0.800***	0.449***
	(0.0165)	(0.00737)	(0.0166)	(0.00745)
Higher secondary	-1.197***	0.302***	-1.182***	0.307***
	(0.0261)	(0.00789)	(0.0262)	(0.00803)
Tertiary education	-1.719***	0.179***	-1.691***	0.184***
	(0.0272)	(0.00487)	(0.0274)	(0.00504)
Dependency ratio	0.156***	1.169***	0.153***	1.166***
Self employed	-0.145***	0.865***	-0.131***	0.878***
Paid employee	0.170***	1.186***	0.177***	1.193***
Agriculture employment	-0.247***	0.781***	-0.264***	0.768***
Transportation	0.0719***	1.075***	0.0756***	1.079***
Agriculture extension	-0.0288	0.972	-0.0285	0.972
Punjab	-0.237***	0.789***	-0.213***	0.808***
Sindh	-0.225***	0.798***	-0.213***	0.809***
Balochistan	0.240***	1.271***	0.317***	1.373***
/cut1	-0.358***	0.699***	0.0911	1.095
/cut2	0.954***	2.595***	1.403***	4.065***
/cut3	2.093***	8.110***	2.542***	12.70***

Note: Robust see form in parentheses *** p<0.01, ** p<0.05, * p<0.1

Appendix C :(Essay 2 Estimations with ICT)

Table 1: *Household-specific and District level Determinants of visit to doctor with ICT*

No. of Visits	**Poisson**	**Poisson**	**NBREG**	**NBREG**
Urbanization (%)	0.00303***	0.00390***	0.00303***	0.00390***
	(0.000188)	(0.000192)	(0.000188)	(0.000192)
Avg. rainfall (mm)	0.0521***	0.0115	0.0521***	0.0115
	(0.0139)	(0.0190)	(0.0139)	(0.0190)
Rainfall square (mm)	0.0149***	-0.0201***	0.0149***	-0.0201***
	(0.00282)	(0.00316)	(0.00282)	(0.00316)
Avg. temperature (C^{o})	0.0501***	0.0530***	0.0501***	0.0530***
	(0.00700)	(0.00587)	(0.00700)	(0.00587)
Temperature square (C^{o})	-0.000568***	-0.00104***	-0.000568***	-0.00104***
	(0.000149)	(0.000151)	(0.000149)	(0.000151)
Transport facility (%)	0.0654***	0.0457***	0.0654***	0.0457***
	(0.00913)	(0.00908)	(0.00913)	(0.00908)
Head age	0.00938***	0.00942***	0.00938***	0.00942***
	(0.000309)	(0.000307)	(0.000309)	(0.000307)
Head gender (1=male,)	0.112***	0.102***	0.112***	0.102***
	(0.0161)	(0.0160)	(0.0161)	(0.0160)
Primary	0.0624***	0.0806***	0.0624***	0.0806***
	(0.0121)	(0.0121)	(0.0121)	(0.0121)
Middle	0.0491***	0.0700***	0.0491***	0.0700***
	(0.0131)	(0.0131)	(0.0131)	(0.0131)
Secondary	-0.0144	-0.00689	-0.0144	-0.00689
	(0.0129)	(0.0128)	(0.0129)	(0.0128)
Higher secondary	-0.0179	-0.0236	-0.0179	-0.0236
	(0.0198)	(0.0197)	(0.0198)	(0.0197)
Tertiary	-0.0625***	-0.0799***	-0.0625***	-0.0799***
	(0.0201)	(0.0200)	(0.0201)	(0.0200)
Dependency ratio	0.0846***	0.0892***	0.0846***	0.0892***
	(0.00495)	(0.00494)	(0.00495)	(0.00494)
Log monthly income	0.0306***	0.0342***	0.0306***	0.0342***
	(0.00555)	(0.00552)	(0.00555)	(0.00552)
Drinking clean water	-0.0232	-0.0372**	-0.0232	-0.0372**
	(0.0166)	(0.0168)	(0.0166)	(0.0168)
Per person rooms	-0.383***	-0.361***	-0.383***	-0.361***
	(0.0177)	(0.0176)	(0.0177)	(0.0176)
Health cost (km)	0.00746***	0.00232	0.00746***	0.00232
	(0.00281)	(0.00284)	(0.00281)	(0.00284)
ICT index	-0.00420***	-0.00377***	-0.00420***	-0.00377***
	(0.000354)	(0.000353)	(0.000354)	(0.000353)
Punjab		-0.617***		-0.617***
Sindh		-0.605***		-0.605***
Balochistan		-0.836***		-0.836***
Constant	-3.136***	-2.119***	-3.136***	-2.119***
Observations	135,418	135,418	135,418	135,418

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 2: *When health demand is binary variable (Consult doctor=1, otherwise=0) with ICT*

VARIABLES	Logit	Odd Ratio	Logit	Odd Ratio
Urbanization (%)	0.00469***	1.005***	0.00582***	0.00582***
	(0.000328)	(0.000328)	(0.000335)	(0.000340)
Avg. rainfall (mm)	0.195***	1.216***	-0.0249	-0.0249
	(0.0231)	(0.0282)	(0.0326)	(0.0343)
Rainfall square (mm)	-0.0214***	0.979***	-0.0369***	-0.0369***
	(0.00473)	(0.00470)	(0.00560)	(0.00609)
Avg. temperature (C^o)	0.0944***	1.099***	0.118***	0.118***
	(0.0117)	(0.0129)	(0.0105)	(0.0115)
Temperature square (C^o)	-0.00131***	0.999***	-0.00247***	-0.00247***
	(0.000250)	(0.000249)	(0.000267)	(0.000281)
Transport facility (%)	0.179***	1.196***	0.147***	0.147***
	(0.0161)	(0.0190)	(0.0161)	(0.0160)
Head age	0.0128***	1.013***	0.0128***	0.0128***
	(0.000563)	(0.000561)	(0.000564)	(0.000556)
Head gender (1=male)	0.0456*	1.047*	0.0447	0.0447
	(0.0273)	(0.0285)	(0.0274)	(0.0273)
Primary	0.133***	1.143***	0.149***	0.149***
	(0.0217)	(0.0248)	(0.0218)	(0.0218)
Middle	0.129***	1.137***	0.144***	0.144***
	(0.0232)	(0.0264)	(0.0232)	(0.0233)
Secondary	0.0722***	1.075***	0.0840***	0.0840***
	(0.0223)	(0.0239)	(0.0223)	(0.0223)
Higher secondary	0.106***	1.112***	0.113***	0.113***
	(0.0327)	(0.0363)	(0.0328)	(0.0328)
Tertiary	0.0764**	1.079**	0.0715**	0.0715**
	(0.0326)	(0.0350)	(0.0327)	(0.0325)
Dependency ratio	0.140***	1.151***	0.143***	0.143***
	(0.00923)	(0.0108)	(0.00928)	(0.00942)
Log monthly income	0.127***	1.136***	0.125***	0.125***
	(0.00996)	(0.0112)	(0.00999)	(0.00986)
Drinking clean water	-0.0360	0.965	-0.0271	-0.0271
	(0.0283)	(0.0275)	(0.0287)	(0.0287)
Per person rooms	-0.515***	0.598***	-0.504***	-0.504***
	(0.0300)	(0.0154)	(0.0300)	(0.0258)
Health cost (km)	-0.0203***	0.980***	-0.0265***	-0.0265***
	(0.00486)	(0.00483)	(0.00492)	(0.00498)
ICT index	-0.00198***	0.998***	-0.00159***	-0.00159***
	(0.000568)	(0.000578)	(0.000570)	(0.000581)
Punjab			-0.661***	-0.661***
			(0.0312)	(0.0335)
Sindh			-0.884***	-0.884***
			(0.0450)	(0.0480)
Balochistan			-1.142***	-1.142***
			(0.0535)	(0.0564)
Constant	-5.341***	0.00479***	-3.978***	-3.978***
	(0.185)	(0.000881)	(0.169)	(0.181)
Observations	135,418	135,418	135,418	135,418

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 2: *Household-Specific and Locational Determinants of Health Facility; OLM, (ICT)*

VARIABLES	BHC	BHC	FPC	FPC	Hospital	Hospital
Urbanization (%)	-0.0204***	-0.0186***	-0.00937***	-0.00811***	0.00571***	0.00225***
	(0.000379)	(0.000389)	(0.000598)	(0.000623)	(0.000285)	(0.000295)
Avg. rainfall (ml)	-0.328***	-0.717***	-0.210***	-0.546***	0.359***	0.209***
	(0.0198)	(0.0283)	(0.0349)	(0.0686)	(0.0165)	(0.0249)
Rainfall square (ml)	0.0638***	0.123***	0.0150**	0.136***	-0.0532***	-0.0167***
	(0.00406)	(0.00531)	(0.00760)	(0.0157)	(0.00291)	(0.00386)
Avg. temperature (C^o)	0.0696***	0.0809***	0.130***	0.134***	0.0283***	0.108***
	(0.00880)	(0.0103)	(0.0183)	(0.0351)	(0.00508)	(0.00649)
Temperature square (C^o)	-0.00135***	-0.00152***	-0.00369***	-0.00266***	-0.000895***	-0.00389***
	(0.000184)	(0.000225)	(0.000355)	(0.000681)	(0.000144)	(0.000198)
Transport facility (%)	-0.160***	-0.181***	0.429***	0.444***	-1.945***	-1.941***
	(0.0141)	(0.0142)	(0.0241)	(0.0244)	(0.0167)	(0.0167)
Household-Specific Characteristics						
Head age	0.000245	0.000118	-0.0121***	-0.0122***	0.00222***	0.00149***
	(0.000458)	(0.000459)	(0.000812)	(0.000819)	(0.000436)	(0.000438)
Head gender (1=male)	0.00951	0.0281	0.330***	0.353***	-0.0537***	-0.00868
	(0.0220)	(0.0222)	(0.0419)	(0.0423)	(0.0197)	(0.0198)
Primary	0.0722***	0.0731***	0.200***	0.194***	0.121***	0.0725***
	(0.0175)	(0.0176)	(0.0297)	(0.0298)	(0.0171)	(0.0172)
Middle	0.0242	0.0159	0.247***	0.228***	0.178***	0.125***
	(0.0198)	(0.0198)	(0.0316)	(0.0317)	(0.0181)	(0.0182)
Secondary	-0.0434**	-0.0311	0.190***	0.205***	0.150***	0.121***
	(0.0190)	(0.0190)	(0.0304)	(0.0306)	(0.0173)	(0.0175)
Higher secondary	-0.112***	-0.0752***	0.111**	0.171***	0.204***	0.190***
	(0.0290)	(0.0291)	(0.0457)	(0.0460)	(0.0260)	(0.0263)
Tertiary	-0.202***	-0.179***	0.190***	0.253***	0.0763***	0.0872***
	(0.0296)	(0.0297)	(0.0435)	(0.0439)	(0.0258)	(0.0260)
Dependency ratio	0.0263***	0.0201**	0.253***	0.244***	0.00458	-0.00338
	(0.00796)	(0.00800)	(0.0116)	(0.0117)	(0.00772)	(0.00777)
Log monthly income	-0.00247	-0.0197**	0.213***	0.192***	0.0201***	0.0293***
	(0.00802)	(0.00802)	(0.0138)	(0.0141)	(0.00742)	(0.00747)
Drinking clean water	0.255***	0.318***	0.519***	0.575***	0.185***	0.231***
	(0.0241)	(0.0245)	(0.0353)	(0.0359)	(0.0259)	(0.0261)
Per person rooms	-0.331***	-0.344***	-0.734***	-0.769***	-0.103***	-0.128***
	(0.0230)	(0.0231)	(0.0451)	(0.0457)	(0.0168)	(0.0169)
Health cost (km)	0.117***	0.111***	0.00224	-0.00496	-0.0213***	-3.07e-05
	(0.00436)	(0.00443)	(0.00690)	(0.00696)	(0.00395)	(0.00401)
ICT index	-0.0117***	-0.0115***	-0.000907	-0.00130	0.00459***	0.00311***
	(0.000558)	(0.000559)	(0.000864)	(0.000870)	(0.000465)	(0.000469)
Punjab		-0.134***		0.714***		1.097***
		(0.0304)		(0.0689)		(0.0264)
Sindh		-0.778***		-0.160**		1.377***
		(0.0401)		(0.0782)		(0.0385)
Balochistan		-0.400***		0.897***		0.412***
		(0.0405)		(0.0817)		(0.0469)

VARIABLES	BHC	BHC	FPC	FPC	Hospital	Hospital
/cut1	0.819***	0.212	4.844***	6.085***	-11.51***	-10.90***
	(0.142)	(0.163)	(0.280)	(0.498)	(0.586)	(0.589)
/cut2	1.355***	0.752***	5.481***	6.727***	-2.275***	-1.656***
	(0.143)	(0.163)	(0.281)	(0.499)	(0.0974)	(0.110)
/cut3	3.216***	2.620***	7.620***	8.869***	1.321***	1.980***
	(0.143)	(0.163)	(0.284)	(0.500)	(0.0968)	(0.109)
Observations	135,417	135,417	135,418	135,418	135,418	135,418

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 3: *Odd Ratios for Ordered Logit; Health Facility with the inclusion of Information Communication Technology (ICT)*

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	**BHC**	**BHC**	**FPC**	**FPC**	**Hospital**	**Hospital**
District Level Factors						
Urbanization (%)	0.980***	0.982***	0.991***	0.992***	1.006***	1.002***
	(0.000373)	(0.000385)	(0.000557)	(0.000587)	(0.000280)	(0.000290)
Avg. rainfall (ml)	0.720***	0.488***	0.811***	0.579***	1.431***	1.232***
	(0.0135)	(0.0133)	(0.0252)	(0.0287)	(0.0246)	(0.0321)
Rainfall square (ml)	1.066***	1.131***	1.015**	1.145***	0.948***	0.983***
	(0.00393)	(0.00532)	(0.00640)	(0.0108)	(0.00319)	(0.00431)
Avg. temperature (C^o)	1.072***	1.084***	1.139***	1.143***	1.029***	1.114***
	(0.00806)	(0.00925)	(0.0153)	(0.0213)	(0.00687)	(0.00820)
Temperature square (C^o)	0.999***	0.998***	0.996***	0.997***	0.999***	0.996***
	(0.000168)	(0.000208)	(0.000288)	(0.000412)	(0.000156)	(0.000195)
Transport facility (%)	0.852***	0.835***	1.536***	1.559***	0.143***	0.144***
	(0.0113)	(0.0111)	(0.0361)	(0.0369)	(0.00205)	(0.00207)
Household-Specific Characteristics						
Head age	1.000	1.000	0.988***	0.988***	1.002***	1.001***
	(0.000460)	(0.000462)	(0.000815)	(0.000820)	(0.000444)	(0.000446)
Head gender (1=male)	1.010	1.028	1.391***	1.424***	0.948**	0.991
	(0.0222)	(0.0228)	(0.0580)	(0.0596)	(0.0198)	(0.0208)
Primary	1.075***	1.076***	1.221***	1.215***	1.128***	1.075***
	(0.0189)	(0.0190)	(0.0367)	(0.0367)	(0.0197)	(0.0189)
Middle	1.024	1.016	1.281***	1.256***	1.195***	1.133***
	(0.0200)	(0.0199)	(0.0408)	(0.0402)	(0.0225)	(0.0215)
Secondary	0.958**	0.969*	1.209***	1.228***	1.161***	1.129***
	(0.0180)	(0.0182)	(0.0372)	(0.0380)	(0.0205)	(0.0201)
Higher secondary	0.894***	0.928***	1.117**	1.187***	1.227***	1.209***
	(0.0256)	(0.0267)	(0.0513)	(0.0548)	(0.0319)	(0.0317)
Tertiary	0.817***	0.836***	1.209***	1.288***	1.079***	1.091***
	(0.0239)	(0.0246)	(0.0536)	(0.0574)	(0.0277)	(0.0282)
Dependency ratio	1.027***	1.020**	1.288***	1.276***	1.005	0.997
	(0.00825)	(0.00824)	(0.0168)	(0.0168)	(0.00788)	(0.00786)
Log monthly income	0.998	0.981**	1.237***	1.212***	1.020***	1.030***
	(0.00796)	(0.00786)	(0.0178)	(0.0176)	(0.00776)	(0.00790)
Drinking clean water	1.290***	1.374***	1.680***	1.777***	1.203***	1.259***
	(0.0308)	(0.0331)	(0.0593)	(0.0636)	(0.0275)	(0.0291)
Per person rooms	0.718***	0.709***	0.480***	0.463***	0.902***	0.879***
	(0.0148)	(0.0147)	(0.0202)	(0.0197)	(0.0146)	(0.0143)
Health cost (km)	1.125***	1.117***	1.002	0.995	0.979***	1.000
	(0.00473)	(0.00474)	(0.00700)	(0.00699)	(0.00388)	(0.00401)
ICT_index	0.988***	0.989***	0.999	0.999	1.005***	1.003***
	(0.000537)	(0.000538)	(0.000871)	(0.000872)	(0.000457)	(0.000460)

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	**BHC**	**BHC**	**FPC**	**FPC**	**Hospital**	**Hospital**
Provincial Dummies						
Punjab		0.875***		2.042***		2.996***
Sindh		0.459***		0.852**		3.963***
Balochistan		0.671***		2.451***		1.510***
/cut1	2.267***	1.236	126.9***	439.3***	1.00e-05***	1.84e-05***
/cut2	3.876***	2.121***	240.1***	834.7***	0.103***	0.191***
/cut3	24.93***	13.73***	2,038***	7,109***	3.746***	7.243***
Observations	135,417	135,417	135,418	135,418	135,418	135,418

Seeform in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 4: *Determinants of Private VS Public*

1=Private, 0=Public	Without Province		With Province	
VARIABLES	**Logit**	**Odd Ratio**	**Logit**	**Odd Ratio**
District Level Factors				
Urbanization (%)	0.00449***	1.004***	0.00582***	1.006***
	(0.000287)	(0.000289)	(0.000296)	(0.000300)
Avg. rainfall (ml)	0.0775***	1.081***	0.0429	1.044
	(0.0197)	(0.0205)	(0.0275)	(0.0294)
Rainfall square (ml)	0.0211***	1.021***	-0.0352***	0.965***
	(0.00402)	(0.00389)	(0.00467)	(0.00459)
Avg. temperature (C^{o})	0.0704***	1.073***	0.0803***	1.084***
	(0.00947)	(0.00907)	(0.00817)	(0.00898)
Temperature square (C^{o})	-0.000795***	0.999***	-0.00154***	0.998***
	(0.000203)	(0.000188)	(0.000213)	(0.000215)
Transport facility (%)	0.0951***	1.100***	0.0645***	1.067***
	(0.0134)	(0.0146)	(0.0135)	(0.0143)
Household-Specific Characteristics				
Head age	0.0140***	1.014***	0.0143***	1.014***
	(0.000475)	(0.000476)	(0.000477)	(0.000480)
Head gender (1=male)	0.173***	1.188***	0.158***	1.171***
	(0.0230)	(0.0271)	(0.0231)	(0.0269)
Primary	0.0898***	1.094***	0.118***	1.126***
	(0.0183)	(0.0200)	(0.0184)	(0.0207)
Middle	0.0676***	1.070***	0.101***	1.106***
	(0.0197)	(0.0211)	(0.0198)	(0.0219)
Secondary	-0.0270	0.973	-0.0151	0.985
	(0.0188)	(0.0183)	(0.0190)	(0.0187)
Higher secondary	-0.0306	0.970	-0.0393	0.962
	(0.0282)	(0.0273)	(0.0284)	(0.0272)
Tertiary	-0.0935***	0.911***	-0.121***	0.886***
	(0.0283)	(0.0256)	(0.0284)	(0.0251)
Dependency ratio	0.136***	1.145***	0.144***	1.155***
	(0.00817)	(0.00930)	(0.00823)	(0.00945)
Log monthly income	0.0436***	1.045***	0.0491***	1.050***
	(0.00817)	(0.00852)	(0.00824)	(0.00863)
Drinking clean water	-0.0338	0.967	-0.0593**	0.942**
	(0.0240)	(0.0233)	(0.0244)	(0.0230)
Per person rooms	-0.520***	0.594***	-0.494***	0.610***
	(0.0242)	(0.0127)	(0.0241)	(0.0130)
Health cost (km)	0.0115***	1.012***	0.00415	1.004
	(0.00415)	(0.00424)	(0.00422)	(0.00427)
ICT index	-0.00590***	0.994***	-0.00525***	0.995***
	(0.000498)	(0.000500)	(0.000501)	(0.000504)
Provincial Dummies				
Punjab			-0.975***	0.377***
			(0.0279)	(0.0107)
Sindh			-0.943***	0.390***
			(0.0399)	(0.0159)
Balochistan			-1.261***	0.283***
			(0.0460)	(0.0133)
Constant	-3.647***	0.0261***	-2.240***	0.106***
	(0.149)	(0.00360)	(0.136)	(0.0146)

Seeform in parentheses *** p<0.01, ** p<0.05, * p<0.1

Appendix D :(Essay 3 Estimations with ICT)

Table 1: *Impact of urbanization on MPI with the inclusion of Information Communication Technology (ICT)*

VARIABLES	Logit	Odd Ratio	OLS
Urbanization (%)	-0.0194***	0.981***	-0.00180***
	(0.000777)	(0.000777)	(1.47e-05)
Head age	0.0104***	1.010***	-0.000234***
	(0.00191)	(0.00173)	(2.41e-05)
Head gender (1=male)	0.0122	1.012	0.0188***
	(0.0823)	(0.0820)	(0.00117)
Dependency ratio	-0.254***	0.776***	0.0224***
	(0.0293)	(0.0232)	(0.000489)
Transport facilities	0.404***	1.497***	0.0249***
	(0.0483)	(0.0721)	(0.000715)
Agriculture extension	0.839***	2.314***	0.0269***
	(0.210)	(0.486)	(0.00134)
Police accessibility	0.0265	1.027	-0.00268***
	(0.0716)	(0.0727)	(0.00100)
Bank facilities	-0.233***	0.792***	-0.0342***
	(0.0475)	(0.0375)	(0.000693)
ICT index	-0.0388***	0.962***	-0.00259***
	(0.000890)	(0.000882)	(2.10e-05)
Punjab	-0.802***	0.448***	-0.0160***
	(0.120)	(0.0534)	(0.000935)
Sindh	-0.833***	0.435***	0.0533***
	(0.126)	(0.0552)	(0.00123)
Balochistan	0.774***	2.169***	0.0854***
	(0.237)	(0.516)	(0.00133)
Constant	6.624***	752.7***	0.459***
	(0.164)	(121.1)	(0.00195)

Seeform in parentheses *** p<0.01, ** p<0.05, * p<0

Table 2: *Impact of Climate Change and Urbanization on MPI*

	Logit Model		OLS
VARIABLES	**Logit**	**odd ratio**	**Log MPI**
urbanization	-0.0209***	0.979***	-0.00455***
	(0.000910)	(0.000856)	(5.60e-05)
Rainfall	-0.347***	0.707***	-0.164***
	(0.114)	(0.0778)	(0.00425)
Rainfall_seq	-0.0746***	0.928***	0.0295***
	(0.0236)	(0.0228)	(0.000609)
Temp avg	-0.597***	0.550***	-0.0120***
	(0.155)	(0.0709)	(0.00113)
Tempe seq	0.00866***	1.009***	0.000230***
	(0.00276)	(0.00233)	(2.84e-05)
Head age	0.0111***	1.011***	4.92e-05
	(0.00217)	(0.00198)	(7.39e-05)
Head_gender1	-0.0503	0.951	0.0417***
	(0.0931)	(0.0875)	(0.00361)
Depency_ratio	-0.291***	0.747***	0.0401***
	(0.0325)	(0.0249)	(0.00132)
Transportation	0.345***	1.413***	0.0484***
	(0.0565)	(0.0804)	(0.00219)
Agriculture extension	0.809***	2.245***	0.0560***
	(0.211)	(0.474)	(0.00333)
Police	0.000487	1.000	-0.00920***
	(0.0759)	(0.0759)	(0.00296)
Bank	-0.325***	0.722***	-0.0753***
	(0.0556)	(0.0402)	(0.00215)
ICT index	-0.0414***	0.959***	-0.00748***
	(0.00100)	(0.00101)	(8.05e-05)
Province	-0.553***	0.575***	0.0405***
	(0.0760)	(0.0459)	(0.00223)
Constant	18.32***	9.044e+07***	4.004***
	(2.230)	(1.707e+08)	(0.0170)

Seeform in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 3: *Impact of interaction of Climate Change with Urbanization on MPI*

VARIABLES	**Logit Model**		**OLS**
	Logit	**odd ratio**	**Log MPI**
Urbanization	-0.0321***	0.968***	-0.00786***
	(0.00220)	(0.00202)	(0.000120)
Rainfall_avg	-1.313***	0.269***	-0.272***
	(0.186)	(0.0469)	(0.00451)
Rainfall_seq	0.179***	1.196***	0.0426***
	(0.0386)	(0.0453)	(0.000763)
Int_rainfall_urbanization	0.0156***	1.016***	0.00529***
	(0.00224)	(0.00227)	(0.000122)
Int_rainfall_seq_urbanization	-0.00311***	0.997***	-0.00120***
	(0.000651)	(0.000658)	(2.72e-05)
Head age	0.0131***	1.013***	0.000288***
	(0.00217)	(0.00199)	(7.31e-05)
Head gender	-0.151	0.860	0.0308***
	(0.0926)	(0.0792)	(0.00358)
Depency ratio	-0.291***	0.747***	0.0406***
	(0.0319)	(0.0247)	(0.00130)
Transportation	0.369***	1.446***	0.0511***
	(0.0567)	(0.0826)	(0.00214)
Agriculture extension	0.745***	2.106***	0.0500***
	(0.211)	(0.445)	(0.00328)
Police	-0.114	0.892	-0.0212***
	(0.0764)	(0.0681)	(0.00290)
Bank Facility	-0.322***	0.725***	-0.0732***
	(0.0560)	(0.0405)	(0.00212)
ICT_index	-0.0391***	0.962***	-0.00709***
	(0.00103)	(0.00102)	(7.91e-05)
Punjab	-1.511***	0.221***	-0.169***
	(0.196)	(0.0389)	(0.00518)
Sindh	-2.090***	0.124***	-0.100***
	(0.261)	(0.0292)	(0.00677)
Balochistan	-0.716**	0.489**	-0.0223***
	(0.301)	(0.142)	(0.00652)
Constant	9.093***	8,893***	4.161***
	(0.305)	(2,495)	(0.00923)

Seeform in parentheses *** p<0.01, ** p<0.05, * p<0.1

Appendix E: Name of Experts and Stake Holders

Table 1: Name of policy makers, Experts, Govt officials and Stakeholders

No.	Name	Designation	Organization
1	M Ali Kamal	Chief of SDGS unit	Planning Commission of Pakistan ,Islamabad
2	Dr. M Ali Talpur	Economic Consultant	Ministry of National Food Security and Research, Islamabad
3	Mr. Imtiaz Ali Gopang	Food Security Commissioner	Ministry of National Food Security and Research, Islamabad
4	Dr.Muhammad Jawad	Federal SDGs support unit Data Science/Analyst	Planning Commission Pakistan ,Islamabad
5	Dr.Rizwan Ahmad	Monitoring Officer	Ministry of National Food Security and Research
6	Dr.Shabbir Ahmed	Lecturer	(Govt.Islamia Graduate College Kasur) Punjab Higher Education Commission, Lahore
7	Dr.Rehan Hameed	Assistant Professor	(Govt.Graduate College Wahdat Road Lahore) PHEC,Lahore
8	Shahid Imdad	Research Officer	Planning Commission of Pakistan, Islamabad
9	DR Mian Muhammad Akram	Ex.Principal	(Govt.Graduate College Wahdat Road Lahore) PHEC,Lahore
10	Muhammad Zaman Bhatti	Research Officer	Planning Commission of Pakistan, Islamabad

Appendix F: Essay 1 Estimation with the inclusion of Log of Monthly Income

Table 1: *Impact of urban on food insecurity with income estimated from binary logit model*

VARIABLES	FI	Miled FI	Medium FI	Severe FI
Urbanization	-0.00347***	-0.00337***	-0.00227***	-0.00194***
	(0.000256)	(0.000258)	(0.000339)	(0.000501)
heads age	-0.00563***	-0.00533***	-0.00543***	-0.00440***
	(0.000461)	(0.000463)	(0.000583)	(0.000866)
Primary	-0.233***	-0.237***	-0.227***	-0.260***
	(0.0162)	(0.0163)	(0.0201)	(0.0301)
Middle	-0.517***	-0.519***	-0.521***	-0.562***
	(0.0176)	(0.0177)	(0.0235)	(0.0364)
Secondary	-0.756***	-0.763***	-0.733***	-0.819***
	(0.0166)	(0.0167)	(0.0230)	(0.0369)
higher secondary	-1.023***	-1.032***	-0.978***	-1.046***
	(0.0254)	(0.0256)	(0.0374)	(0.0622)
Tertiary	-1.394***	-1.426***	-1.370***	-1.300***
	(0.0267)	(0.0271)	(0.0421)	(0.0670)
head_gender1	0.367***	0.358***	0.337***	0.402***
	(0.0238)	(0.0239)	(0.0319)	(0.0479)
depency_ratio	0.113***	0.112***	0.0933***	0.0942***
	(0.00714)	(0.00715)	(0.00853)	(0.0121)
self-employed	0.0660***	0.0806***	0.0109	-0.112***
	(0.0199)	(0.0201)	(0.0270)	(0.0404)
paid employee	0.329***	0.343***	0.222***	0.0605*
	(0.0185)	(0.0186)	(0.0246)	(0.0366)
log income	-0.516***	-0.523***	-0.487***	-0.498***
	(0.00833)	(0.00835)	(0.00915)	(0.0123)
Agriculture	-0.0420**	-0.0260	-0.157***	-0.497***
	(0.0203)	(0.0205)	(0.0270)	(0.0408)
Transportation	0.170***	0.173***	-0.0523***	-0.288***
	(0.0117)	(0.0117)	(0.0148)	(0.0215)
agriculture extension	0.137***	0.115***	-0.0185	0.114**
	(0.0239)	(0.0240)	(0.0317)	(0.0477)
Punjab	-0.0949***	-0.123***	0.195***	0.627***
	(0.0156)	(0.0156)	(0.0209)	(0.0348)
Sindh	0.211***	0.198***	0.415***	0.533***
	(0.0198)	(0.0199)	(0.0257)	(0.0416)
Balochistan	0.378***	0.358***	0.458***	0.815***
	(0.0216)	(0.0216)	(0.0272)	(0.0421)
Constant	4.824***	4.865***	3.206***	2.102***
	(0.0844)	(0.0846)	(0.0923)	(0.124)
Observations	160,654	160,654	160,654	160,654

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 2:

VARIABLES	FI	Miled FI	Medium FI	Severe FI
urbanization	0.997***	0.997***	0.998***	0.998***
	(0.000255)	(0.000257)	(0.000339)	(0.000500)
head age	0.994***	0.995***	0.995***	0.996***
	(0.000459)	(0.000461)	(0.000580)	(0.000862)
Primary	0.792***	0.789***	0.797***	0.771***
	(0.0129)	(0.0128)	(0.0160)	(0.0232)
Middle	0.596***	0.595***	0.594***	0.570***
	(0.0105)	(0.0105)	(0.0140)	(0.0208)
secondary	0.470***	0.466***	0.481***	0.441***
	(0.00780)	(0.00780)	(0.0110)	(0.0163)
higher secondary	0.359***	0.356***	0.376***	0.351***
	(0.00913)	(0.00913)	(0.0141)	(0.0218)
Tertiary	0.248***	0.240***	0.254***	0.273***
	(0.00662)	(0.00652)	(0.0107)	(0.0182)
head_gender1	1.443***	1.431***	1.401***	1.496***
	(0.0343)	(0.0342)	(0.0447)	(0.0716)
depency_ratio	1.119***	1.118***	1.098***	1.099***
	(0.00799)	(0.00799)	(0.00936)	(0.0133)
self-employed	1.068***	1.084***	1.011	0.894***
	(0.0213)	(0.0218)	(0.0273)	(0.0361)
paid employee	1.389***	1.409***	1.249***	1.062*
	(0.0256)	(0.0262)	(0.0308)	(0.0389)
log income	0.597***	0.593***	0.615***	0.608***
	(0.00497)	(0.00495)	(0.00562)	(0.00746)
agriculture	0.959**	0.974	0.854***	0.609***
	(0.0195)	(0.0199)	(0.0230)	(0.0248)
transportation	1.186***	1.188***	0.949***	0.749***
	(0.0138)	(0.0139)	(0.0140)	(0.0161)
agriculture extension	1.147***	1.122***	0.982	1.120**
	(0.0274)	(0.0269)	(0.0311)	(0.0534)
Punjab	0.909***	0.885***	1.216***	1.871***
S	(0.0142)	(0.0138)	(0.0254)	(0.0651)
Sindh	1.235***	1.219***	1.515***	1.703***
	(0.0245)	(0.0243)	(0.0390)	(0.0708)
Balochistan	1.460***	1.430***	1.581***	2.258***
	(0.0315)	(0.0310)	(0.0430)	(0.0952)
Constant	124.4***	129.7***	24.69***	8.180***
	(10.50)	(10.98)	(2.278)	(1.011)
Observations	160,654	160,654	160,654	160,654

Robust seeform in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 3: *Impact of urbanization and CC on FI with income estimated from binary logit model*

VARIABLES	FI	Miled FI	Medium FI	Severe FI
urbanization	-0.00110***	-0.00109***	0.000647*	0.000650
	(0.000295)	(0.000297)	(0.000385)	(0.000557)
precip_avg	-0.157***	-0.121***	-0.364***	-0.613***
	(0.0252)	(0.0253)	(0.0313)	(0.0487)
rainfall_seq	0.0854***	0.0824***	0.0748***	0.0940***
	(0.00435)	(0.00436)	(0.00551)	(0.00949)
temp_avg	-0.0851***	-0.0921***	-0.0779***	-0.0547***
	(0.00748)	(0.00749)	(0.00861)	(0.0143)
tempe_seq	0.00404***	0.00428***	0.00190***	0.000892***
	(0.000192)	(0.000193)	(0.000227)	(0.000346)
head age	-0.00412***	-0.00381***	-0.00445***	-0.00295***
	(0.000478)	(0.000479)	(0.000599)	(0.000882)
Primary	0.106**	0.121**	0.216***	0.465***
	(0.0486)	(0.0500)	(0.0752)	(0.113)
Middle	0.0788	0.108	0.244**	0.688***
	(0.0782)	(0.0806)	(0.123)	(0.186)
Secondary	0.00916	0.0446	0.247	0.781***
	(0.100)	(0.103)	(0.159)	(0.242)
higher secondary	-0.169	-0.128	0.120	0.794***
	(0.122)	(0.126)	(0.194)	(0.295)
Tertiary	-0.315**	-0.287*	-0.0202	0.905***
	(0.147)	(0.151)	(0.228)	(0.340)
head_gender1	0.338***	0.330***	0.343***	0.375***
	(0.0244)	(0.0245)	(0.0325)	(0.0485)
depency_ratio	0.102***	0.101***	0.0847***	0.0845***
	(0.00733)	(0.00733)	(0.00872)	(0.0124)
self-employed	0.0838***	0.101***	0.00666	-0.109***
	(0.0206)	(0.0207)	(0.0274)	(0.0408)
paid employee	0.353***	0.368***	0.215***	0.0650*
	(0.0190)	(0.0191)	(0.0250)	(0.0369)
log income	-0.494***	-0.502***	-0.473***	-0.486***
	(0.00853)	(0.00856)	(0.00942)	(0.0127)
agriculture	-0.114***	-0.0962***	-0.233***	-0.596***
	(0.0208)	(0.0209)	(0.0272)	(0.0412)
transportation	0.149***	0.149***	-0.0584***	-0.290***
	(0.0124)	(0.0124)	(0.0156)	(0.0228)
agriculture extension	0.117***	0.0936***	-0.0391	0.0805*
	(0.0243)	(0.0244)	(0.0320)	(0.0480)
Punjab	-0.264***	-0.278***	0.206***	0.507***
	(0.0277)	(0.0278)	(0.0379)	(0.0650)
Sindh	-0.276***	-0.258***	0.150***	0.00749
	(0.0379)	(0.0381)	(0.0488)	(0.0778)
Balochistan	0.640***	0.669***	0.381***	0.449***
	(0.0430)	(0.0431)	(0.0545)	(0.0856)
Constant	3.633***	3.621***	3.923***	3.481***
	(0.127)	(0.128)	(0.145)	(0.229)
Observations	150,440	150,440	150,440	150,440

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table4: *Impact of urbanization and CC on FI with income estimated from binary logit model (Odd Ratio)*

VARIABLES	Food Insecurity	Miled FI	Medium FI	Severe FI
urbanization	0.999***	0.999***	1.001*	1.001
	(0.000294)	(0.000297)	(0.000385)	(0.000558)
precip_avg	0.855***	0.886***	0.695***	0.542***
	(0.0215)	(0.0224)	(0.0218)	(0.0264)
rainfall_seq	1.089***	1.086***	1.078***	1.099***
	(0.00474)	(0.00474)	(0.00594)	(0.0104)
temp_avg	0.918***	0.912***	0.925***	0.947***
	(0.00687)	(0.00684)	(0.00797)	(0.0135)
tempe_seq	1.004***	1.004***	1.002***	1.001***
	(0.000193)	(0.000194)	(0.000227)	(0.000346)
head age	0.996***	0.996***	0.996***	0.997***
	(0.000476)	(0.000477)	(0.000596)	(0.000879)
Primary	1.112**	1.129**	1.241***	1.591***
	(0.0540)	(0.0564)	(0.0933)	(0.180)
Middle	1.082	1.114	1.276**	1.989***
	(0.0846)	(0.0898)	(0.157)	(0.371)
Secondary	1.009	1.046	1.280	2.185***
	(0.101)	(0.108)	(0.203)	(0.528)
higher secondary	0.845	0.880	1.127	2.212***
	(0.103)	(0.111)	(0.218)	(0.654)
Tertiary	0.730**	0.751*	0.980	2.473***
	(0.107)	(0.114)	(0.224)	(0.842)
head_gender1	1.403***	1.391***	1.409***	1.456***
	(0.0342)	(0.0341)	(0.0458)	(0.0705)
depency_ratio	1.108***	1.106***	1.088***	1.088***
	(0.00812)	(0.00812)	(0.00949)	(0.0135)
self-employed	1.087***	1.107***	1.007	0.897***
	(0.0224)	(0.0230)	(0.0276)	(0.0366)
paid employee	1.423***	1.446***	1.240***	1.067*
	(0.0271)	(0.0277)	(0.0311)	(0.0394)
log_income	0.610***	0.605***	0.623***	0.615***
	(0.00521)	(0.00518)	(0.00587)	(0.00781)
agriculture	0.892***	0.908***	0.792***	0.551***
	(0.0186)	(0.0190)	(0.0216)	(0.0227)
transportation	1.160***	1.161***	0.943***	0.748***
	(0.0143)	(0.0144)	(0.0147)	(0.0170)
agriculture extension	1.124***	1.098***	0.962	1.084*
	(0.0273)	(0.0268)	(0.0308)	(0.0521)
Punjab	0.768***	0.757***	1.229***	1.660***
	(0.0213)	(0.0210)	(0.0465)	(0.108)
Sindh	0.759***	0.773***	1.162***	1.008
	(0.0288)	(0.0294)	(0.0567)	(0.0784)
Balochistan	1.896***	1.952***	1.463***	1.566***
	(0.0814)	(0.0841)	(0.0798)	(0.134)
Constant	37.84***	37.39***	50.53***	32.50***
	(4.821)	(4.775)	(7.323)	(7.445)
Observations	150,440	150,440	150,440	150,440

Robust see form in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 5: *Joint impact of urbanization and CC on FI with income estimated from binary logit model*

VARIABLES	FI	Miled FI	Medium FI	Severe FI
urbanization	-0.0444***	-0.0471***	-0.0531***	0.0175**
	(0.00462)	(0.00467)	(0.00588)	(0.00819)
precip_avg	-0.354***	-0.317***	-0.550***	-0.686***
	(0.0310)	(0.0312)	(0.0389)	(0.0579)
int_rainfall_urbanization	0.00443***	0.00450***	0.00463***	0.000784
	(0.000400)	(0.000404)	(0.000490)	(0.000703)
rainfall_seq	0.0993***	0.0959***	0.0866***	0.103***
	(0.00460)	(0.00462)	(0.00598)	(0.00972)
temp_avg	-0.0646***	-0.0704***	-0.0557***	-0.0647***
	(0.00786)	(0.00789)	(0.00919)	(0.0142)
int_temp_urbanization	0.00126***	0.00135***	0.00162***	-0.000611**
	(0.000142)	(0.000143)	(0.000183)	(0.000256)
tempe_seq	0.00298***	0.00316***	0.000717***	0.00127***
	(0.000220)	(0.000221)	(0.000261)	(0.000381)
head age	-0.00392***	-0.00361***	-0.00425***	-0.00293***
	(0.000478)	(0.000480)	(0.000600)	(0.000882)
primary	-0.224***	-0.229***	-0.211***	-0.237***
	(0.0168)	(0.0168)	(0.0206)	(0.0306)
middle	-0.469***	-0.472***	-0.465***	-0.494***
	(0.0183)	(0.0184)	(0.0242)	(0.0373)
secondary	-0.704***	-0.711***	-0.675***	-0.758***
	(0.0175)	(0.0176)	(0.0240)	(0.0383)
higher secondary	-1.033***	-1.044***	-0.997***	-1.062***
	(0.0272)	(0.0275)	(0.0401)	(0.0664)
tertiary	-1.392***	-1.427***	-1.398***	-1.364***
	(0.0283)	(0.0289)	(0.0451)	(0.0722)
head_gender1	0.331***	0.323***	0.338***	0.372***
	(0.0245)	(0.0246)	(0.0326)	(0.0485)
depency_ratio	0.102***	0.100***	0.0840***	0.0855***
	(0.00733)	(0.00733)	(0.00872)	(0.0124)
self-employed	0.0826***	0.0996***	0.00331	-0.105**
	(0.0206)	(0.0208)	(0.0275)	(0.0408)
paid employee	0.349***	0.364***	0.210***	0.0663*
	(0.0190)	(0.0192)	(0.0251)	(0.0369)
log_income	-0.495***	-0.504***	-0.475***	-0.488***
	(0.00852)	(0.00855)	(0.00941)	(0.0127)
agriculture	-0.119***	-0.102***	-0.240***	-0.593***
	(0.0209)	(0.0210)	(0.0273)	(0.0413)
transportation	0.153***	0.153***	-0.0557***	-0.286***
	(0.0124)	(0.0124)	(0.0156)	(0.0228)
agriculture extension	0.109***	0.0845***	-0.0524	0.0798*
	(0.0244)	(0.0245)	(0.0321)	(0.0482)
Punjab	-0.299***	-0.310***	0.177***	0.435***
	(0.0282)	(0.0283)	(0.0384)	(0.0642)
Sindh	-0.302***	-0.281***	0.119**	-0.0725
	(0.0382)	(0.0383)	(0.0493)	(0.0771)
Balochistan	0.523***	0.556***	0.283***	0.347***
	(0.0445)	(0.0447)	(0.0565)	(0.0873)
Constant	4.238***	4.234***	4.556***	3.607***
	(0.139)	(0.140)	(0.162)	(0.241)
Observations	150,440	150,440	150,440	150,440

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table: 6: *A Joint impact of urbanization and CC on FI with income estimated from binary logit model (Odd Ratio)*

VARIABLES	FI	Miled FI	Medium FI	Severe FI
urbanization	0.957***	0.954***	0.948***	1.018**
	(0.00442)	(0.00446)	(0.00558)	(0.00833)
precip_avg	0.702***	0.729***	0.577***	0.504***
	(0.0218)	(0.0227)	(0.0224)	(0.0292)
int_rainfall_urbanization	1.004***	1.005***	1.005***	1.001
	(0.000402)	(0.000406)	(0.000492)	(0.000704)
rainfall_seq	1.104***	1.101***	1.090***	1.109***
	(0.00508)	(0.00508)	(0.00652)	(0.0108)
temp_avg	0.937***	0.932***	0.946***	0.937***
	(0.00737)	(0.00736)	(0.00869)	(0.0133)
int_temp_urbanization	1.001***	1.001***	1.002***	0.999**
	(0.000142)	(0.000144)	(0.000183)	(0.000255)
tempe_seq	1.003***	1.003***	1.001***	1.001***
	(0.000220)	(0.000221)	(0.000261)	(0.000382)
head age	0.996***	0.996***	0.996***	0.997***
	(0.000476)	(0.000478)	(0.000597)	(0.000879)
primary	0.799***	0.795***	0.810***	0.789***
	(0.0134)	(0.0134)	(0.0167)	(0.0241)
middle	0.626***	0.623***	0.628***	0.610***
	(0.0115)	(0.0115)	(0.0152)	(0.0228)
secondary	0.495***	0.491***	0.509***	0.469***
	(0.00865)	(0.00864)	(0.0122)	(0.0180)
higher secondary	0.356***	0.352***	0.369***	0.346***
	(0.00969)	(0.00967)	(0.0148)	(0.0230)
tertiary	0.249***	0.240***	0.247***	0.256***
	(0.00704)	(0.00693)	(0.0111)	(0.0184)
head_gender1	1.392***	1.381***	1.403***	1.451***
	(0.0340)	(0.0340)	(0.0457)	(0.0704)
depency_ratio	1.107***	1.105***	1.088***	1.089***
	(0.00811)	(0.00811)	(0.00949)	(0.0135)
self-employed	1.086***	1.105***	1.003	0.900**
	(0.0224)	(0.0229)	(0.0276)	(0.0368)
paid employee	1.418***	1.440***	1.233***	1.069*
	(0.0270)	(0.0276)	(0.0309)	(0.0394)
log_income	0.609***	0.604***	0.622***	0.614***
	(0.00519)	(0.00516)	(0.00585)	(0.00778)
agriculture	0.888***	0.903***	0.787***	0.553***
	(0.0185)	(0.0189)	(0.0215)	(0.0228)
transportation	1.165***	1.165***	0.946***	0.751***
	(0.0144)	(0.0145)	(0.0148)	(0.0171)
agriculture extension	1.115***	1.088***	0.949	1.083*
	(0.0272)	(0.0267)	(0.0305)	(0.0522)
Punjab	0.742***	0.734***	1.194***	1.545***
	(0.0209)	(0.0208)	(0.0459)	(0.0993)
Sindh	0.739***	0.755***	1.127**	0.930
	(0.0282)	(0.0289)	(0.0555)	(0.0717)
Balochistan	1.687***	1.744***	1.327***	1.415***
	(0.0751)	(0.0779)	(0.0749)	(0.124)
Constant	69.25***	69.02***	95.19***	36.86***
	(9.659)	(9.669)	(15.41)	(8.881)
Observations	150,440	150,440	150,440	150,440

Robust seeform in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 7: *Impact of urbanization on food security (miled,medium and severe) ordered logit model*

VARIABLES	Ord logit	Odd Ratio	Ord logit	Odd Ratio
Region (1=urban,0=rural)			-0.145***	0.865***
			(0.0128)	(0.0111)
urbanization	-0.00302***	0.997***		
	(0.000246)	(0.000245)		
head age	-0.00535***	0.995***	-0.00541***	0.995***
	(0.000436)	(0.000434)	(0.000436)	(0.000434)
primary	-0.226***	0.797***	-0.223***	0.800***
	(0.0151)	(0.0121)	(0.0151)	(0.0121)
middle	-0.510***	0.601***	-0.510***	0.600***
	(0.0169)	(0.0101)	(0.0169)	(0.0101)
secondary	-0.746***	0.474***	-0.746***	0.474***
	(0.0160)	(0.00760)	(0.0161)	(0.00762)
higher secondary	-1.009***	0.365***	-1.005***	0.366***
	(0.0249)	(0.00907)	(0.0249)	(0.00912)
tertiary	-1.382***	0.251***	-1.374***	0.253***
	(0.0263)	(0.00661)	(0.0264)	(0.00669)
head_gender1	0.359***	1.431***	0.358***	1.430***
	(0.0235)	(0.0336)	(0.0235)	(0.0336)
depency_ratio	0.104***	1.110***	0.105***	1.110***
	(0.00658)	(0.00730)	(0.00658)	(0.00731)
self-employed	0.0480**	1.049**	0.0537***	1.055***
	(0.0196)	(0.0206)	(0.0197)	(0.0208)
paid employee	0.286***	1.331***	0.287***	1.332***
	(0.0181)	(0.0241)	(0.0181)	(0.0241)
log income	-0.508***	0.601***	-0.510***	0.600***
	(0.00760)	(0.00457)	(0.00760)	(0.00456)
agriculture	-0.0883***	0.915***	-0.0937***	0.911***
	(0.0195)	(0.0178)	(0.0196)	(0.0178)
transportation	0.0916***	1.096***	0.105***	1.110***
	(0.0113)	(0.0124)	(0.0112)	(0.0124)
agriculture extension	0.0866***	1.091***	0.0891***	1.093***
	(0.0214)	(0.0233)	(0.0214)	(0.0234)
Punjab	-0.0141	0.986	-0.0426***	0.958***
	(0.0143)	(0.0141)	(0.0139)	(0.0133)
Sindh	0.240***	1.271***	0.184***	1.202***
	(0.0179)	(0.0227)	(0.0163)	(0.0196)
Balochistan	0.383***	1.467***	0.377***	1.457***
	(0.0193)	(0.0283)	(0.0193)	(0.0281)
/cut1	-4.770***	0.00848***	-4.758***	0.00858***
	(0.0773)	(0.000655)	(0.0775)	(0.000665)
/cut2	-3.450***	0.0317***	-3.439***	0.0321***
	(0.0768)	(0.00244)	(0.0770)	(0.00247)
/cut3	-2.283***	0.102***	-2.272***	0.103***
	(0.0770)	(0.00785)	(0.0772)	(0.00796)
Observations	160,654	160,654	160,654	160,654

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1