Effects of Non-Farm Income on Food Security in Pakistan: A Counterfactual Analysis

M.Phil Dissertation

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Dedication

This work is dedicated to my beloved parents, brothers and sisters for their unconditional support during my studies and Kiran Arshad who kept me encouraging and motivating to overcome my hardships**.**

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Abstract

The major objective of this study is to examine the effects of off-farm income on food security by using Treatment Effect Model. The data for 1740 rural households are taken from Pakistan Panel Household Survey (2010). The determinants of off-farm income are also explored and counterfactual analysis of level of food security of both non-farm participants and only farm participants. A food security index is constructed on the basis of the variables that affect the availability and access of food by using Principal Component Analysis (PCA). Food security index indicates that there, almost 55 percent people are food insecure in rural areas of Pakistan. Non-farm participating rural households experience almost 47 percent level of food insecurity while remaining on-farm earning households are facing 58 percent. Descriptive analysis shows that the contribution of farming sector is virtually 80 percent in overall rural employment whereas off-farm income contributes almost only 20 percent which implies that there is need of expansion in off-farm opportunities in rural areas. The empirical results indicate the positive and significant effects of off farm income on food security. Counterfactual analysis reveals that non-farm income earning farmers have higher level of food security than those who are engaged in on-farm activities. Moreover, the significance of the Inverse Mills Ratio confirms the existence of the selection bias. Demographic variables, education, dependency ratio, ownership of livestock, savings of rural households, irrigation and infrastructure variables are found statistically significant which determine both off-farm income and food security. Further, this study analyzes the cohort analysis by disaggregating data into to four age groups of farm households where impact of non-farm income on food security is also found positive.

Key Words: Non-farm, Farm income, Food Security, Treatment Effect Model, Pakistan

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Chapter 1

Introduction

1.1 Background

Pakistan is a country whose almost 65 percent of population resides in rural areas her 45 percent labor force is absorbed by the agriculture sector. Agriculture sector contributes about 21 percent to Gross Domestic Product (GDP) and is a driver of economic growth. Its role to address food insecurity, poverty and creating an environment for sectoral transformation towards industrialization in Pakistan is crucial (GoP, 2012). Risk is highly associated with farming due to changing patterns of the climate and malfunctioning of markets. Sensitivity of the farm income worsens the economic condition of the farmers especially of those which are involved in subsistence farming. Destructive flooding in 2010 and 2011 substantially damaged the livelihood of small farmers in addition to their farm production (GoP, 2012).

Excessive dependence on agriculture causes the increased rural poverty and food insecurity in developing countries (Babatnde and Qaim, 2010; Joo and Mishra, 2013). Therefore, it is necessary to pursue the other sources which are helpful to decrease the dependence on farming and bring diversification in the income of rural households so that they may enjoy a higher standard of living.

Non-farm income has become the prominent source of reducing over-dependence upon farm sector and is also helpful to sustain the revenues of the rural households (Lunjouw *et. al*. 2001; Galuben *et. al.,* 2008). The contribution of the off-farm income has considerably increased from

30 percent to 45 percent in rural areas of the developing countries and moving out from farm activities can be a profitable strategy especially for those farmers who have lack of sufficient farm land and other farm resources to earn income (Rehman, 2013).

The importance of off-farm income in the rural economies of developing countries can be witnessed from many empirical studies (Adam and He, 1995; Benjamin and Kimhi, 2006; Lanjouw *et. al*. 2001; Fatima, 2012). Non-farm participation reduces food insecurity (Babatunde and Qaim, 2010) and it also enhances the farm efficiency and farm income. Further, it also reduces poverty and income inequality in developing countries (Adam and He, 1995; Mishra and Chang, 2012; Tafsey, 2008). Since, agriculture involves a high degree of risk and is vulnerable to a range of climatic and non-climatic stresses, off-farm income is considered to be a weapon to deal with such risks (Mishra and Chang, 2012; Joo and Mishra, 2013).

Combating food insecurity has become one of the prime tasks in developing countries and much attention has been given since the food crisis of 1972-73 (Ahmad and Farooq, 2010). In 1996, the World Food Summit, food security is defined as; " *When all people, at all the 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*". From this broad definition, three dimensions of the food security can be extracted which are persistent and physical availability of food, physical and economic access to food and utilization of food (Webb and Rogers, 2003; Khan and Gill, 2009; Ahmed and Farooq, 2010; Arshad and Shafqat, 2012; Berman *et. al*., 2013).

The major components of food availability such as domestic production, import of food commodities, receiving assistance external as well as internal sources to meet the food requirement and environmental risks affect pervasively. Food access is vulnerable to income, food prices, social safety nets and markets and entitlement risks while the utilization of food

comprises dietary practices, nutrition knowledge, health and sanitation, safe water, food quality and social acceptability of the food (Ahmed and Farooq, 2010; Sharma, 2013). Food insecurity travails are immensely hurting human security such as hunger, starvation, diseases and social exclusion (Sulehri and Haq, 2009). Sharma (2013) found that in the world virtually 5 million children die of hunger and inadequate absorption of vitamins and minerals whereas inhabitants of the developing countries have to bear the loss of 220 million years of productive life due to malnutrition or food insecurity.

In 2007, a new food and nutrition security plan was released by specifying the targets as: a country must enhance her self-reliance capabilities for the basic food stuffs and she ought to take steps to improve the nutrition of her inhabitants. A country should improve her capability and safety nets to combat food insecurity that may appear from emergency condition such as disasters and flooding (Sharma, 2013).

In Pakistan food security level is alarmingly showing that 80 out of 120 districts are considered food insecure and Baluchistan is found the most affected province (Sulehri and Haq, 2009). Severe wave of terrorism, worst energy crises and uneven climate changes are the reasons of such a pitiable condition of the aforementioned food insecurity level in Pakistan (Sulehri and Haq, 2009). Non-farm income as a coping strategy is an important policy agenda to redress the economic pains of subsistence farmers (Owusu et. al., 2009; Sharma, 2013).

1.2 Significance of the Study

A considerable number of empirical studies focused on poverty and income inequality related issues (Adam and He, 1995; Lunjouw *et.al.* 2001;Mishra and Chaing, 2012 and Akram *et. al*., 2011). However, relatively less attention has been given to analyze the nexus between off-farm

income and food security. Very few studies have dealt with this issue (Babatunde and Qaim, 2010 and Owusu *et. al.*, 2011). These two studies find positive impacts of off-farm income on food security in Nigeria and Ghana, respectively. To our knowledge, no study is conducted to assess the effects of non-farm income on food security in Pakistan.

Two hypotheses are formulated to test the significance that is non-farm income significantly affects food security and there is a significant difference between the food security level of both non-farm participants and only farm participants. Empirical results find positive and significant results of off-farm income on food security in rural areas of Pakistan. The treatment effect model has been used to conduct empirical analysis and the Inverse Mills Ratio which is known as Lambda has been found significantly which confirms the existence of the selection bias. Value of treatment effect or counterfactual analysis is also observed. Therefore, Treatment Effect Model is preferred to the Heckman selection model (Maddala, 1985).

To compute food security, an index has been constructed by using Principal Component Analysis (PCA). This study has used few agricultural variables, food consumption—converted into kilo calories, and ownership of household assets as variables to create a food security index. Almost 55 percent households are found food insecure whereas 45 percent rural households are food secured. Apart from off-farm income we have used some other important explanatory variables to investigate their effects on the food security.

Further effects of non-farm income on food security are also investigated by analyzing cohort analysis. This analysis is investigated by disaggregating the sample into four age groups of farm households. It could be a contribution of this study to have cohort analysis to see the effects of non-farm income on food security age wise. Findings of this study indicate that off farm income has come out as an important policy agenda to combat food insecurity.

1.3 Objectives of the Study

The main aim of this study is to analyze the impact of off farm income on food security in Pakistan. The specific objectives of the study are given below.

1. To assess the impacts of off farm income on food security in Pakistan.
2. To compare the food security levels of both farm income and off-farm income earners.
3. To analyze the determinants of the food security.
4. To analyze the determinants of the off-farm income.
5. Give recommendations based on the results obtained from above mentioned objectives.

1.3 Organization of the Study

The remaining part of the thesis comprises four chapters. The literature review is discussed in chapter two. Chapter three deals with the theoretical framework of the study, definitions of the variables, data set and methodology while chapter four covers descriptive analysis and results and discussion of empirical findings. Chapter five provides conclusion of the study and policy implications.

Chapter 2

Literature Review

In Pakistan, a few researchers including Adam and He (1995), Fatima (2012) and Akram *et. al*. (2011) has analyzed the factors determining the off-farm income and its relationship with poverty. To the best of our knowledge, we could not find a study on impact of off-farm income on food security in Pakistan. However, some work on the issue is found in other countries such as Babatunde and Qaim (2010) and Owusu *et. al.* (2011) analyzed the data from Nigeria and Ghana, respectively.

This thesis classifies the literature into three sub-sections. The first section deals with the literature regarding off-farm income related issues (i.e. factors determining off-farm income), the second section provides literature on food security and its nexus with off-farm income. The third section presents the work on the determinants of food security other than off farm income.

2.1 Literature on Off-Farm Income

Adams and He (1995) have found the association of off-farm income to poverty and income inequality in Pakistan. Three year survey (1986-89) of 727 rural households has been used and the objective of that survey was to identify the factors which affect poverty in Pakistan. The study found five major sources of income including non-farm income, livestock, farm income, income from rents and income obtained from transfer payments. Non-farm income was one of the major sources of income of rural households that was playing an important role in reducing poverty and income inequality. Further, about 40% of the total income of households received from non-farm income was twice the other rural income sources. The literature however shows

no consensus over the impact of off farm on income inequality as Chinn (1979) and HO (1979) in Taiwan showed the positive impact of off-farm income on income inequality, while Akram et. al., (2011) found the negative relationship.

Satriawan and Swinton (2007) investigated the effects of human capital on off-farm and on-farm income activities in Pakistan. Two sets of the data—cross sectional and panel data collected by International Food Policy Research Institute (IFPRI) 1986-1989 have been used to examine the comparison, and for cross sectional data 1986 year was used. It was found that education had a minor influence on the farm earnings but the experience had strong positive effects on farm income, while human capital was positively affecting non-farm income. Further, they investigated that the effects of education were overstated in the case of cross sectional data due to absence of fixed effects.

De Janvry *et. al.* (2005) studied the impact of non-farm activities on poverty and income inequality in China. The study used a survey data and employed Heckman two stage selection model to observe the selection bias, and the sign of the Inverse Mills Ratio has been interpreted as counterfactual analysis. It was found that the off-farm income has been contributing tremendously to reduce inequality as well as poverty as compared to only farm income. Skills variable also contributed to the household's decision making about participation in off-farm activities. Non-farm income also helped to increase farm production. The significance of the selection hazard confirmed the presence of selection bias and positive sign of the Lemda interpreted as that those households who took part in off-farm activities were less poor as compared to non-participants. Education of the households has been found as an important variable that has a negative impact on poverty and positive on off-farm income. The parameters

of the land per capita, dependency ratio and infrastructure variables were significant and having positive effects on farm income. These variables also helped to narrow the inequality.

Blank and Erickson (2007) investigated the role of off-farm income in reducing the degree of risk involved in farming by using the portfolio model and they used a survey based data. Off-farm income has been found helpful to cope with risk and vulnerability of the agricultural sector. It has a positive impact on farm income and it increased the overall income of a farmer which ultimately helped the farmers to mitigate risk. We could find another study, done by Gedikoglu and McCann (2007) and they found the impact of off-farm income on conservative practices in Columbia. The conclusion of the study showed that the effects of non-farm income on adoption of new technologies were positive by utilizing the behavioral model. The study further argued that off-farm income helped to adopt new technology and the households replaced new technology over conservative practices.

Akram *et al.* (2011) explored the relationship between rural income inequality and income sources. Primary data were collected from the tehsile Sumandri district, Faisalabad. They have used co-efficient of variation to compute income inequality. It has been found that the distribution of land was more skewed as compared to income and livestock ownership. Positive relationship between off-farm income and income inequality has been found. For empirical purpose, Semi Log multiple regression model has been used. The education was found to be an important variable for household to reduce poverty because education as human capital could have its positive effects on the income of rural household.

Briggman (2011) worked on the importance of non-farm income to pay back farm debt and the effects of unemployment on rural households' ability to repay the debt in the USA. It was found that off-farm income was an important variable to increase overall income of the household and

to repay his farm debts due to improved farm efficiency. Similarly, Bojnec and Ferto (2011) analyzed the effects of off-farm income on farm efficiency or farm performance by employing Stochastic Frontier Analysis (SFA) model using the Translog specification. Fixed effects model was undertaken by using panel data 2004-08 which was collected from Slovenian Farm Accountancy Data Network (FADN). It was found that off-farm income improved the farm efficiency.

Mishra and Chang (2012) investigated the influence of off-farm income on safety nets in USA. Agricultural Resource Management Study (ARMS) have been used in this study. Probit and Heckman two stage models were used. The study showed that farm size, dependency ratio, age, education, experience proxies by human capital, infrastructure related variables significantly determined the off-farm income and positive effects of non-farm income has been found. Further findings show that those farmers who were engaged in off-farm activities, they spent more on their health care and possessed higher retirement savings as compared to farmers those depend only on farm income. Other than non-farm income many independent variables which were the operators and spouses' characteristics related variables, i.e. age, farming experience, education of both operator and spouse, farm and household related variables like land tenure, farm size and payments received from government, and infrastructure related variables were found to be significantly affecting expenditures on health.

Khan *et al.,* (2012) examined the factors determining off-farm income in district Noshehra of North West Pakistan. A survey was conducted to collect data, and the Logit model was employed to find empirical results. The findings of this work indicated that farm size, household, farm employment, education, and income earned from other sources by households were the main factors affecting the off-farm income. It was observed that the farmers in developed areas

devoted more time to off-farm employment because of improved infrastructure. This study also showed that most of small farmers were engaged in off-farm activities, e.g. labor, trade, commerce jobs, and part time jobs in some private firms. Overall there was a gradual transition of livelihood activities. In rural areas of Pakistan, most people were involved in farm activities but now off-farm income became a means to escape from poverty. They also discovered that farm size negatively impacted off-farm income because greater the farm size higher is the farmer's ability to earn more farm income. There have been other important factors that significantly affect the off-farm livelihood sector which are farm income, farm unemployment, and education, age of a household, livestock holding in number and income from other sources.

Fatima (2012) assessed the link between rural incomes and non-farm activities in Pakistan. The main objective of this study was to investigate the effects of non-farm participation in rural income by using PSLM and HIES, 2007-08 data. For empirical purpose Heckman model was employed to explore the effects of non-farm activities on farm activities. Education, household size, and land ownership were the main determinants of participation of the local population in non-farm activities. Off-farm income improved the living standard of rural households. A rural household who was engaged with off-farm income had a higher level of income than those who were not part of these activities.

Bjornsen and Mishra (2012**)** investigated the relationship between farm efficiency and off-farm income activities of both operator and spouse in the USA. They used panel data for Norwegian farm households from the period 1989-2008 collected by the Norwegian Agricultural Research Institute. First, they analyzed the factors which determined the off-farm work decision of both operator and spouse were analyzed by using two stages Tobit model. Then, the relationship between off-farm of both operator and spouse was gauged by employing two stage GLS fixed

effect model to seek this nexus. The findings of the study were quite interesting. It was found that farm efficiency had positively and negatively influenced in operator and spouse participation in off-farm activities respectively. Because farm efficiency motivates farmer to engage more in farming and it provided an opportunity to spouse to enhance off-farm activities. This study also found that the subsidy has a negative and positive impact on non-farm income of both households respectively. At the end, the main result that could be inferred from this study was an existence of the dynamic relationship between off-farm work and farm efficiency. Further off-farm income has a positive impact on farm efficiency but in the second stage, negative effects have been found on agricultural efficiency.

Ali and Khan (2013) examined the importance of non-farm income and its role to mitigate poverty and achieving higher welfare of the rural household in Pakistan, a case study of Southern Punjab. They employed Propensity Score Matching (PSM) technique to observe the selection bias using primary data by conducting a survey. Education has been found as an important factor having a positive impact on the decision to participate in the off-farm activities while farm size, family size, age of household, access to credit and ownership of assets are other significant variables that determine non-farm income participation. It has been also found that off-farm income increase the welfare of the household and was helpful to reduce poverty. A household, who was not involved in off-farm activities, would face constraints of low income and higher poverty as compared to those farmers who were undertaking off-farm activities. Off-farm income proved to be a vital instrument to reduce the vulnerability of the farm sector.

Rehman (2013) examined the factors those affect decision to participate in off-farm activities in Bangladesh. For this purpose, a survey of 150 farmers was carried out. Descriptive statistics revealed that the services sector was one of the major contributors. Logistic regression was used

to assess the factors empirically. This study pointed out that low farm income was the reason to participate in off-farm activities. The education and farm size were inversely related to participation in non-farm labor force. Small business activities were popular among households having less education. Empirical evidence revealed that farm size, organizational participation of households and improvements in infrastructure has been significant determinants of non-farm income.

The above review shows that there are a number of important determinants which determine the household's decision to participate in off-farm activities. The latter was also proved to be an important instrument to deal with poverty related issues. Education or human capital, farming experience, some demographic variables, livestock and access to credit market have been found important variables which determine off-farm income in Pakistan. The results regarding the relationship between off-farm income and income inequality have been found conflicting—some studies found off-farm income reduces inequality, while some others argued it enhances the income gap (Adams and He, 1995 and Akram *et. al*., 2011). It can be concluded that there is a gap in literature regarding the effects of off-farm income and food security in Pakistan.

2.2 Literature on Linkage between Off-Farm Income and Food Security

This section reviews literature on off-farm income and food security related issues, which are discussed below.

Owusu and Abdulai (2009) analyzed the impact of off-farm income on food security in Ghana by applying propensity score matching. They discussed gender heterogeneity and impact of off-farm income on household overall income as well as food security. It was concluded that the non-agricultural activities increased the income of farm households that ultimately led to a better

access to consumption of food commodities to improve the food security level. Propensity Score Matching method was used to control the self-selection that normally arises when non-farm work was not random. The Northern part of the Ghana was poor, arid area and households have not been food secure. The findings of the study showed that the male had higher off-farm income level than that of the females because the males had more opportunities to earn off-farm income than women who faced low wages and fewer opportunities to earn off-farm income. Hence, male households were found more participating in non-farm income activities which are important sources to reduce food insecurity. Females face some other constraints as well which were restricted them to improve their levels of food security.

Babatunede and Qaim (2010**)** analyzed the impact of off-farm income on food security and nutrition in Nigeria. They used structural regressions for estimation using survey data from rural areas. It was found that the off-farm mechanism had a significant and positive impact on food security and nutrition level. Initially, OLS technique was used but due to endogeniety problem and structural set of equations it gave biased results. To avoid this econometric problem, instrumental variables have been generated to abstain from it and 2SLS technique was employed as a remedy. The findings of the study showed that non-farm as well as farm income was increasing the food security of a rural housed in Nigeria.

Babatunde *at al*. (2010) observed the positive relationship between income and calorie intake by using average per parametric and non-parametric approach. They conducted a survey to collect primary data to gauge that relationship. It was concluded that per capita calorie intake was less than the required calories that means there was poor condition of food security in study areas. The income elasticity which was found less elastic that showed calorie intake did not increase

substantially as income increased. They also concluded that farm size was found positive and had significant effects on calorie intake.

Remittances are also an important component of off-farm income and it also enhances off-farm income of a household that ultimately leads to improve the food security level. So, Babatunde and Qaim (2010) organized a study to seek out the impacts of remittances on food security and nutrition in rural Nigeria. The findings of the study showed that remittances have a positive impact on food security and a remittance-receiving household contained higher food consumption owing to increase in total income. They employed four indicators for food security namely; calorie supply, dietary quality, micronutrient supply and child nutritional status. Calorie supply was measured by diet and energy supply that specified as a good indicator of overall household food security. Total household caloric supply divided by seven days and number of adult equivalent to attain daily calorie supply per capita. Dietary quality is measured in two ways, firstly, the amount of the calorie supply that has been extracted from fruits, vegetables and livestock etc. and secondly, by a number of food groups, out of seven from which household acquired food over seven days recall period. Thirdly, micronutrient supply, they kept focusing on iron and vitamin. OLS technique has been used but it bequeathed biased results due to the presence of the endogeniety problem. This problem was tackled by using an instrumental variable approach to seek unbiased results.

Zearai and Gebreegziabher (2011) found the linkage between off-farm income and food security in Ethopia and it has been concluded that there was a positive relationship between off-farm income and food security by using Heckman selection (two stage) model and firstly decision equation was regressed on land size, demographic variables, special skills, access to credit, infrastructure variables and most significant variable was irrigation and off-farm earner

household was more food secure than not earner. They used primary data to see through empirical analysis and they gathered information from 151 households by conducting a questionnaire. The value of the Lamda has been found positive and significant which confirmed the existence of selection bias.

Fan (2012) organized a study to assess how liberalization and commercialization of agricultural market did affect the food security in rural china. He used a simultaneous equation system to seek his objective and he employed 3SLS technique to estimate the model by utilizing the data collected from the China Health and Nutrition Survey (CHNS) and also gauged if commercialization and liberalization improved the welfare of rural households which was measured by average share of calories from non-staples. Effects of local market liberalization have been assessed by counting how much local market reveals the world prices. It has been concluded that market liberalization brought about commercialization among rural farmers which causes higher off-farm income of rural households and it made improve the food security level in China. That commercialization further diversified the farmers' farm oriented activities and household income level in China.

Joo and Mishra (2013) assessed the influence of non-farm income on food consumption in Korea and a survey has been conducted to collect data. Heckman selection model was undertaken to find the empirical evidences and to observe the selection bias. The presence of the selection bias was confirmed due to the significant value of the Lamda. Empirical findings indicated that non-farm income earners consumed higher food commodities than those of only farm income earner households. Further income elasticity of food commodities of non-farm income households has been found lower as compared farm households. Sign of the Inverse Mills Ratio was found positive and significant.

2.3 Literature on Food Security and its Determinants

Qureshi (2007) created an index to assess the food insecurity in Bolivia. The used household level data collected during 2005 and 2006. The main concerns of the study were to find the differences between food security and insecurity on the basis of the demographic and their anthropometric variations and compare both periods by virtue of creating an index. Some agricultural related variables, representing the availability of food, were used. This list included cultivated area, planting major food crops, storing major food crops from last harvest and stored seeds. But consumption based variables which would be related to purchasing of food commodities, representing accessibility of food. The value of modern assets owned by the household was also representing the access to food-- wealth can cope with shocks. The more weights were given to availability of food and accessibility to food.

Tesfaye *et al* (2008) assessed the impacts of small scale irrigation on food security in Ethopia by using the Heckman selection model to detect selection bias. It was found that 70 percent households who used irrigation were food secure, while only 20 percent were food secure in the category of those who were non-user of small scale irrigation. Due to off-farm income households were able to adopt new techniques that would ultimately bring about an increase in production. Here, the food security index was constructed using a survey data. This study found that non-farm income has a spillover effect and increases the overall income of households that improves the welfare of rural household and food security.

Khan and Gill (2009) investigated the determinants of food security in Pakistan by using data collected by SDPI in 2009. They estimated three components of food security, i.e. availability, accessibility and absorption of food. It was found that food crops and land ownership positively

affect food availability, and female and the male literacy rate, and electrification was important factors to determine access to food. Further findings of the study showed that child immunization, safe drinking water, facility of hospitals and ownership of domestic assets were important determinants of food absorption in Pakistan. Molnar (1999) considered cultural as well as social factors to be important factors for food security. Cultural factors were assessed through education and human capital. Corruption and failure of social organizations hurt food security since they cause malfunctioning social networks. Sheikh (2007) Concluded that food prices were the major factors which affect food security while in Ethopia, farm size, ownership of livestock, education of head, availability of fertilizer, per capita production and family size were important factors which influence food security significantly While Mongid and Tahir (2008) have hatched importance of the banking industry to increase the agricultural production. They were of the view that credit access makes the farmer in a position to adopt new technology that ultimately led to expansion in agricultural production. Access to credit market was an important factor which may affect significantly and influence positively on food security.

Carter *et. al*. (2010) assessed the relationship between rural savings and food security through the channel of consumption and bearing risk in Mozambique. A survey was conducted to collect data and Propensity Score Matching technique was employed to find empirical evidences. The formal institutions of rural savings have been found efficient and the findings suggested that formal savings were the vehicles to enhance food security and mitigating the risk involved in farming. But Shaw and Romero (2011) segregated the savings into formal and informal savings. Formal savings were the holding livestock, farm and domestic assets while formal institutions were banking and national savings scheme. They also found positive effects of both savings but

informal has strong positive effects on food security while informal savings were moderately affecting the food security level of rural households.

Sultana and Kiani (2011) analyzed the determinants of food security at household level in Pakistan using a logistic regression procedure. For empirical analysis, they used Social and Living Standard Measurement Survey (PSLM) for the year of 2007-08. They employed the logit model. Five main variables used to assess their impact on food security included place of residence, dependency ratio, social capital, employment status and educational attainment level of the head of household. The results showed that the place of residence, dependency ratio and educational attainment level of the head of household were significant, while the remaining were not statistically significant variables. Place of residence and dependency ratio has negative impact on food security, while education beyond the intermediate level positively influenced food security. Cost of Calories Approach (CCA) was used to calculate the food security and almost 50 percent level food insecurity was observed.

Faiz *et al.* (2012) revealed the importance of improving the rural roads and basic infrastructure and their effects on sustainability and livability. Their study concentrated on the outcomes of construction of environmentally friendly roads and infrastructure that would lay down a strong foundation to revitalize the whole society. It was found that there was a close synergy between rural access and livelihoods and it broke the grounds of job opportunities for rural households, increases in income of rural households and reduction in poverty. Rural access brought awareness among people of remote areas and made them capable to design their strategies to cope with covariant shocks. Further results showed that rural access enhanced the farm as well as off-farm income of rural household and it was helpful for the rural families to mitigate their food insecurity.

Adoo *et. al.* (2013) carried out a study to identify the factors those affect the food security in Ghana and a survey was conducted to collect data of 100 households. Logistic estimation was employed to deduce the determinants of food security. Empirical evidences showed that off-farm income, land size and easy access to credit markets were significant and positive elements which affected food security. Non-farm income was the highly affecting positively amongst other variables. Further findings indicated that material status and household size were the significant factors and study recommended that off-farm business activities as well as the rural credit market must have enhanced and expanded to address food security.

Ali and khan (2013) investigated the impacts of ownership of livestock on food security in Pakistan. They carried out a comprehensive survey to collect data from Hafizabad, Gujranwala and Shekhupur by employing the Poission Regression Analysis to assess the determinants of ownership of livestock. It has been found that education has negative signs, farm size, demographic variables, ownership of farm and household assets and infrastructure were the important and significant variables to determine ownership of livestock in Pakistan. Further, Propensity Score Matching technique has also been applied to seek out the impacts of livestock ownership on food security and analyze the comparison between those who own livestock and not owners. The findings of the study suggested that livestock ownership affected positively and significantly the food security in Pakistan and moreover, comparison disclosed that a household was more food secure as compare to those who did not own livestock.

The detailed review of above important studies highlights that there is unavailability of documented studies which covered effects of non-farm income on food security regarding Pakistan. For a bird's eye view, the findings of these studies are given in appendix.

Chapter 3

Data, Variables and Methodology

This chapter deals with the theoretical framework of the study and methodology. Model specification and construction of indices i.e. food security index and infrastructure index are discussed in the methodology. Further, this chapter also provides the definition of the variables, data description.

3.1 Theoretical Framework

Theoretically, this study is linked with Farm Household model (FHM) and it is simply a non-separable household model where market is assumed to be imperfect. Bicker (1965) was the first who presented a utility function of a household where the utility was the function of consumption and leisure but Singh *et. al.* (1986) included consumption of farm and market production and also he included the decision to the labor participation in farm and non-farm activities into a single framework. The formulation of that utility function can be given as:

$$U (Ya, Ym, Yl)$$

Where, U represents utility that is a quasi-concave, continuous and non-decreasing. Ya denotes the vector of the consumption of the home produced goods or agricultural commodities produced by a household. Ym and Yl stand for market produced goods and leisure respectively. This model provides a theoretical framework for the prediction of a household's off the farm and farm participation and hours of working decision. Let's consider a household who wants to maximize

his utility from above utility function (Singh *et al.*, 1986; Sadoulet and de Janvery, 1995; Donnellan and Hennesssy, 2012). It can be further written as below:

$$\text{Max } U = U(Ya, Ym, Yl) \quad (1)$$

A household faces optimization problem subject to constraints. These constraints are discussed below separately.

1) The production technology of the farm represents constraint on the rural household consumption possibilities and the production technology could be specified as:

$$Q = Q(L, X, A) \quad (2)$$

Q is total agricultural commodities produced by a household and X stands for a vector of purchasing inputs such as capital, labor, fertilizer, A is asset owned by individuals such as land while L stands for time allocation to on-farm activities. It is assumed that the production function is strictly concave.

2) The total time allocation could be specified as:

$$T = F + Yl \quad (3)$$

The above equation shows time constraint faced by household where T is the total time endowment and F is the availability of time for work after having leisure or some social activities. Now we are in a position to decompose total time into market work and farm work such as F-L is the time allocated to market work other than on-farm activities. Having formulated time constraint, cash constraint can be formulated as given below.

$$Pf.\ X - W(F-L) \leq R \quad (4)$$

Pf is the market price of the purchased inputs by farmers, W denotes the market wage rate and R is the cash-holding by a household. This equation can be interpreted as purchasing of the inputs such as fertilizer, hiring labor and capital is subject to cash-holding by a farmer.

3) A farm household is a producer as well as a consumer of market goods, his budget constraint can be specified in the following way.

$$Pm.Ym = Pa\,(Q - Ya) - Pf.X + W\,(F-L) + R \qquad (5)$$

In the above equation, Pm and Pa are the market price of commodities produced in the market and market value of agricultural commodities respectively. Q-Ya is that portion of agricultural commodities that are sold in the market after having kept for their domestic requirement.

4) To attain full budget constraint, equation (2), (3) and (4) should be combined to attain a single equation as follows.

$$Pm.Ym + Pa.Ya = Pa.Q\,(L, X, A) - Pf.X + W\,(T - Yl - L) + R \qquad (6)$$

We solve household utility maximizing problem subject to full budget constraints and cash constraint by setting the Langrange function.

$$Z = U(Ya, Ym, Yl) + \delta\,[Pa.Q\,(L, X, A) - Pf.X + WT - WL + R - Pm.Ym - Pa.Ya - W.Yl] + \lambda\,[R + W(T, Yl, L) - Pf.X] \qquad (7)$$

We differentiate this set Langrange function with respect L and setting it equal to zero and it gives us the first order condition of farm household.

$$\frac{\partial Z}{\partial L} = \delta\,(Pa.Q - W) - \lambda W = 0 \qquad (8)$$

$$Pa.Q = (\delta+\lambda)\,W / \delta \text{ or } MVPL = (\delta+\lambda)\,W / \delta \qquad (9)$$

If MVPL >1 => MVPL > W (10)

In the above equation, MVPL is the marginal value product of the labor and it is evident from equation (9) and (10) if there is a binding cash constraint, the household wage rate is deviating from the market wage rate (i.e. $\lambda>0$). As long as there is an existence of the cash binding, shadow wage rate (MVPL) would remain higher than that of market wage and it is not profitable for households to participate in labor market vice versa which is clear from the equation (10). This relationship suggests us that the shadow wage rate likes a stimulator for a household to decide whether he/she participate or not in other than farm sector.

From the aforementioned relationship between shadow wage and market wage rate, it can be perceived that decision of the participating in the off-farm sector by a farm household is dependent on the width of the price band. Some socioeconomic, demographic and market related factors are responsible to determine this relationship. These socioeconomic and demographic variables are such as education, inadequate access to formal credit markets, poor infrastructure, and gender of households, age, dependency ratio and family size. Therefore, this study would identify some factors which affect the decision to join the labor market because our main interest is to find the effects of off-farm income on the food security level of rural households in Pakistan.

3.2 Methodology

This section includes construction of some indices which are being used in this study such as infrastructure index and food security index. After that, econometric model is specified to identify the effects off-farm on food security.

3.2.1 Model Specification

Food security is our dependent variable and off-farm income and some other independent variables would be used. Firstly, a simple regression model is specified as follows:

$$y= B_1 OFI+ B_2 FI+ B_3 LS+B_4 SAV+B_5 AGE+B_6 GEND+B_7 LOW.DR+B_8 MED\ DR+B_9 CRM+ B_{10} PEDU+B_{11} MEDU+B_{12} AMEDU+B_{13} INF$$

Where y stands for the food security index, OFI=off farm income, FI=farm income, LS=livestock holdings, SAV=savings of households, AGE=age of household head, GEND= gender of household head, LOW DR= low dependency ratio, MED DR=medium dependency ratio, CRM= access to credit market, PEDU=primary education of household head, MEDU=middle education of household head, AMEDU=above middle education of household head, INF=infrastructure variables and β is the vector of co-efficient. A quick view of variables can be viewed from table 3.3.

3.2.2 Econometric Model

In literature, most of the researchers have used probit, logit model to deal with off-farm income and food security (Chaing *et a*l, 2009; Sultana and Kiyani, 2011; Arshad and Shafqat, 2012) and some have used the structural regression model as Babatunede and Qaim (2010) found the impact of off-farm income on food security in Nigeria and Fan (2012) has assessed the impact of commercialization of farming on food security in china by using the structural regression model. Some researchers (Chang and Mishra, 2008; Tafsey *et. al.,* 2008; Zearai and Gebreegziabher, 2011) used Heckman selection model.

It can be perceived from theoretical framework that decision to participate in off-farm activities is dependent on some constraints and off-farm labor participation is endogenously determined. Therefore first of all we need to observe those unobservable which determine the decision of a household. This study is using (Heckman) Treatment Effect Model to observe the impact of off-farm income on food security in Pakistan. Ouwsu *et. al.* (2009) have used Propensity Score Matching (PSM) in Ghana.

3.2.3 Treatment Effect Model (TEM)

Heckman (1979) developed an econometric model to handle the selection bias. It provides an econometric framework to deal with limited dependent variable. Madala (1983) extended this model to evaluate the treatment effectiveness. Heckman model provides the groundwork to understand Treatment effect model. It holds some common characteristics with Heckman selection model which are, (1) in the case of endogenous dummy variable, it is used (2) estimating the probability of participation in any activity, (3) treating the unobservable selection factors and (4) observing the treatment effect, is the major trait of the treatment effect model which segregates it from the original Heckman selection model (Madala, 1983).

Truncation and censoring are major traits of limited dependent variables. Truncation is an effect of the data collection instead of data generation. It comes across when sample data is taken from the subset of the larger population under consideration (Madala, 1983). For example, this study aims to analyze the effects of non-farm income on food security. Sample of non-farm income earning households is drawn from the farm households which are subset of rural households (e.g., only considering non-farm earning households). There comes the problem of truncation. While censoring deals entire population and it occurs when entire values in a certain range of

endogenous variable are transformed into a single value (e.g., if on the farm earning household is coded as zero). Having above conditions, a researcher may have to deal both truncation and censoring by using endogenous dependent dummy variables.

Observing selection bias and treatment effect are central tasks for Treatment effect model. Sample selection arises when the sample is not selected randomly or when individuals have to make a decision to participate in a project. This study aims to explore the effects of non-farm income on farm households on food security. There comes selection bias because of the decision to participate in non-farm activities or on farm activities. Nonrandom characteristics bring about selection bias. With the presence of the selection bias or non-randomness, Ordinary Least Square (OLS) estimator gives biased and inconsistent results. Therefore, it is inevitable to handle selection bias (Heckman, 1979). In Hecket models, those unobservable factors which affect the decision to participate are observed from selection equation.

Selection bias is tackled by estimating the Inverse Mills Ratio.[1] It is calculated from the selection factors and used as additional explanatory variables in outcome equation. If the Inverse Mills Ratio is found significant, it will confirm that there was selection bias in the model. Its specification is discussed in the specification of the treatment effect model.

The treatment effect is the major trait which discerns treatment effect model from the Heckman selection model. Term 'treatment effect' is commonly referred to observe the causal effect of binary variable on the policy interest (Green, 2003). The treatment effect score gives a counterfactual analysis of those who received treatment and not received treatment. For example, this study focuses on analyzing the effects of non-farm income of farm households on food

[1] Inverse Mills Ratio is defined as the ratio of probability density function to the cumulative distribution function. It is named after the John p. Mills and also known as selection hazard or Lambda (Heckman, 1979).

security. Treatment effect will show which households have higher level of food security whether treated (non-farm participants) or not treated households (only farm participants).

3.2.4 Rationale of using Treatment Effect Model (TEM)

The two major reasons of undertaking the Treatment Effect Model (TEM) are: 1) this study aims at analyzing the effects of non-farm income on food of farm households. There arises the problem of selection bias due to non-random nature of the sample[2] and 2) this study aims at having the counterfactual analysis of the both treated households (non-farm participants) and not treated households (only farm participants). Simply, analyzing the level of food security of treated farm households and not treated farm households. Due to the second reason, this study prefers Treatment Effect Model (TEM) to Heckman selection model.[3]

3.2.5 Specification of Treatment Effect Model (TEM)

Green (2011) suggests that Treatment Effect Model (TEM) holds two steps. In first step, selection or decision equation is estimated while outcome equation is estimated in second step. Contrary to the Heckman Selection model, it estimates direct inclusion of dummy variable which is indicating treatment effect in selection equation. Outcome equation is formulated same as in Heckman second stage does.

In selection or decision equation of TEM, the dependent variable is in dichotomous form that off-farm income participation=1 and otherwise farm income participation = 0. If Z=1 (participated in non-farm income) otherwise Z= 0 (for only participation in farming). Z* could

[2] Selection bias is explained in subsection 3.2.3 where it discussed in some detail.
[3] Heckman model deals the selection bias but it does not give the treatment effect score.

be estimated when Z=1 if Z*>0 and Z= 0 otherwise. It is evident from following selection equation

First stage: (selection equation) $Z^{*} = x_i^{'}\beta + \mu$ (2)

In the above selection equation, Z* has been defined and $x_i^{'}$ is a vector of explanatory variables β is a vector of coefficients. In this equation, ϖ is treatment score which is coefficient of y*, a directly adjusted dummy variable (if household is food secure=1 otherwise zero) in selection equation,[4] while u is a error term. This is the description of selection equation.

Specifically selection equation is written as:

$Z^{*}=B_1$ LAND+B_2FI+B_3LS+B_4SAV+B_5AGE+B_6GEND+B_7HHS+B_8CANI+B_9TUBWELL+

B_{10}PEDU+B_{11}MEDU+B_{12}AMEDU+B_{13}INF+ B_{14} ACM+ϖ y*+ u (3)

In above selection equation, z* is already defined in equation (2) and LAND=land size which is a continuous variable, HHS= household size, CANI=facility of canal irrigation, TUBEWELL=facility of tube wells. Rests of the variables are defined in equation (1). Land sizes, household size, age of households, farm income are used as continuous variables, while remaining variables in equation (3) are in dummy variable form. All explanatory variables other than y* in selection equation are employed to see their effects on the decision to participate in nonfarm activities or only farm activities by farm households. Coefficient of y* gives the treatment effect score or counterfactual analysis.

[4] Direct inclusion of dummy variable of food security in selection equation is major difference between the Heckman selection model and Treatment Effect Model. The interpretation of treatment effect score gives counterfactual analysis of treated and not treated households about their level of food security. Positive sign of treatment effect will show that treated households have higher food security as compare to not treated households, vice versa.

Now we move to discuss second stage that is also known as outcome equation.

Second stage: (outcome equation)

$$y_i^* = w_i^* \alpha + \varepsilon_i \qquad (4)$$

Equation (4) is observed only when Z >0 otherwise Z=0

y_i^* is a food security index[5] and it is a dichotomous variable if a household is food secure (above the threshold value)= 1 otherwise= 0 and w* stands for all independent variables like off-farm income, farm income, livestock, savings of household head, access to credit market, age of household head, sex of household head, normal dependency ratio (value of dependency ratio is below 0.5), medium dependency ratio (value of dependency ratio is between1and 0.5), education primary, education middle, education above middle and infrastructure are the independent variables to assess their effects on food security level of rural households. While, ε is standing for the error term of second equation and α is a vector of coefficients. Here, we assume that both error terms are following bivariate normal distributions with zero mean and constant variance respectively. Second equation would be like a probit model. It is based on the conditional observed expectation of an observed variable that is a food security index. From selection equation Inverse Mills Ratio is calculated and included as additional explanatory variable in equation (4). Equation (4) can be written as:

$$E(y_i^* / Z \geq 0) = w_i^{'} \alpha + \sigma \rho \lambda(-\beta X) + \varepsilon \qquad (5)$$

[5] Food Security Index is constructed by using Principal Component Analysis (PCA). See section (3.3.5.2) for detailed information.

Where, λ = the inverse Mills ratio and it is computed as $\lambda(-\beta x) = \phi(-\beta x)/1-\pi(-\beta x)$. Here, ϕ is a standard normal density function and π stands for the standard normal cumulative distribution function respectively and it is the ratio of probability density function to the cumulative distribution function. Specifically, outcome equation will be estimated using same variables in equation (1) along with Inverse Mills Ratio as an additional explanatory variable calculated from selection equation.

Significance of Inverse Mills Ratio will confirm the presence of selection bias in selection equation. It is assumed that both error terms are normally distributed (Moffit, 1999). Hence, above formulation would give us unbiased results on the nexus between off-farm income and food security. In Treatment Effect model, Maximum Likelihood (ML) approach is employed to estimate this model. The Wald chi^2 test is used to see the goodness of the model. To check the joint normality condition, it is hypothesized that there is a correlation between two error terms or Ho: rho is equal to zero and if the null hypothesis is rejected, there will be no correlation between error terms associated with equation (3) and (5)**.**

3.2.6 Infrastructure Index

This study calculates community infrastructure due to the unavailability of the information about the overall infrastructure of the society in our data set and eight variables are selected from PPHS (2010) to construct an index. These variables are availability of water, health facility, the distance of that facility, does household have electricity, gas and telephone, condition of washroom and its availability and last one is garbage or sanitation condition. Babatunde and Qaim (2010); Adoo *et.al*. (2013) have used water availability, condition of the washrooms, distance to the health facility, availability of gas and electricity as proxies for infrastructure.

Therefore these variables are considered as proxies for infrastructure and table 3.1 portraits these variables clearly.

Principal Component Analysis (PCA) has been used to construct index. PCA assigns weights according to the variance of the variables. The higher weights are assigned to higher variation. These weights are relative frequencies of their components and after construction of index. This constructed index is normalized at 1. It can be interpreted as above 1, represents a good infrastructure and below 1 is interpreted as poor infrastructure. The values of infrastructure index ranges from 0.274441 to 2.192059.

Table 3.1**:** List of Variables Which are Employed to Generate Infrastructure Index.

No.	Proxies of infrastructure	Units
1	Does the household have the facility of health?	Dummy variable
2	How much farther it is from the house? If 3 km or below =1 otherwise zero	Dummy variable
3	Does the household have clean water to drink?	Dummy variable
4	Distance to fetch water if one kilometer or below=1 otherwise zero	Dummy variable
5	Does the household have the facility of electricity and gas?	Dummy variable
6	Does the household have the facility of the toilet?	Dummy variable
7	Does household has sanitation problem around his locality like garbage?	Dummy variable
8	Does the household have good sewerage system?	Dummy variable

Source of data: Pakistan Panel Household Survey (2010)

3.2.7 Food Security Index

Food security is measured on the basis of two components i.e., availability of food and accessibility of food. Absorption of food is not clearly included due to the data limitations.

Variables which affect these two components are related to agriculture variables. Food consumption, farm and domestic assets are employed to construct the food security index (Qureshi, 2007). However, absorption of food is covered somehow from the kilocalories of food commodities. Description of these variables is given in the table 3.2. Such proxies are very commonly used by the researchers [Qureshi(2007); Sulehri and Haq (2009);Matchaya and Chilonda (2012) and Rehman (2013)].

The rationale behind the usage of agricultural variables is to determine the food availability an important component of food security. These variables are characterized to determine increasing food production and getting self-sufficiency in food commodities, while consumption of food items such as milk, meat, wheat, pulses, fruit items etc. and their conversion in kilocalories is an indicator of physical and economic access of food. Information about food consumption is available in kilograms and they are multiplied with the calories of these items. Data of calories have been taken from the Planning Commission of Pakistan. Assets represent wealth that can be used to cope with adverse shocks and food shortage. An amalgamation of all these variables determines the persistent physical and economical provision of food.

Principal Component Analysis (PCA) has been applied to generate this index.[6] As it is discussed above in the infrastructure index that PCA gives weight to the variables according to their variance and these weights are relative frequency of their components. After constructing this index, it has been normalized by using the Z-Score and the median is used as an average. Zero was a cutoff point and values of the food security index ranges from -0.0633915 to 34.951309. Negative values stand for food insecurity while positive values suggest food security. The more

[6] STATA version 12 has been used to generate the indices of food security and infrastructure.

the value of food security is above to zero, the higher level of food security would be. It is found that about 57 percent households are food insecure in rural areas of Pakistan.

Table 3.2: List of Variables Which are Employed to Generate Food Security Index

No.	Agricultural variables	Units
1	Production of food commodities such as wheat, maize, rice, pulses and sugarcane	Mound (40 k.g.)
2	Availability of the inputs such as fertilizer, pesticides	Dummy variable
3	How much produced food commodities are stored for usage?	Mound (40 k.g.)
4	How much cultivated area owned by a household?	Kanal
5	Does the household have the facility of tube wells?	Dummy variable
6	Does the household have the facility of canal water?	Dummy variable
7	Does household hold flat land or sloped?	Dummy variable
8	Does the household have danger to lose his land by government or individuals?	Dummy variable
	Consumption Variable	
1	Food consumption by household (k.g.) and multiply them with their calories	Kilocalories
	Farm and Domestic Assets	
1	Does household hold farm assets such as tractor, thresher, Plough etc.	Dummy variable
2	Market value of these assets?	Rupees
3	Does a farmer hold domestic assets such as car, scooter, stove, washing machine etc.	Dummy variable

Source of data: Pakistan Panel Household Survey (2010)

3.3 Definitions of Variables

This section discusses the definitions of the variables which are used in this study are provided in table 3.3.

***Off-Farm Income*:** Off-farm income is income of a farm household earned other than from farm income which includes the income earned from public and private services, enterprises, remittances and transfer payments (Babatunde and Qaim*, 2010*; Owusu *et. al.*, 2011; Zearai and

Gebreegziabher, 2011). This study uses this variable both as continuous variable in outcome equation and Dummy variable in selection equation.

Table 3.3: List of the Description of Variables used in Treatment Effect Model

Names of variables	Description
Food security index	Dummy of food security index, if food security=1 otherwise food insecurity=0
Off-farm(dependent variable)	If off-farm income participation=1 otherwise (farm income) =0
Off-farm income	Monthly income, other than farm income in terms of rupees
Farm income	Monthly gross farm income in terms of rupees
Never attended school	Those with household heads who never attend school, dummy variable
Primary education	Primary education of head, dummy variable
Middle education	Middle education of household head in dummy variable form
Above middle education	Beyond middle education of head, in dummy variable
Normal dependency ratio	If the value of dependency ratio is below 0.5, dummy variable
Medium dependency ratio	If the value of dependency ratio is between 0.5 and 1, dummy variable
Severe dependency ratio	If the value of dependency ratio is above 1, dummy variable
Livestock holding	Does a household owns livestock or not
Access to credit market	Dummy variable, D=1 if access and D=0 otherwise
Savings of household	D=1 if HH head has savings, otherwise D=0
Age of head	A continuous variable, age of household head in years
Sex1	Gender of household head, D=1 if male otherwise zero
Infrastructure index	Infrastructure index, dichotomous variable
Sex2	D=1 female and otherwise zero (used in selection equation)
Tube well	D=1 for those who facility of water from tubewell, otherwise zero
Canal irrigation	D=1 for those who have canal water perennially, otherwise zero

Source of data: *Pakistan Panel Household Survey (2010)*

On-Farm Income: Income from farm activities and it comprises income from farm production, livestock dairy farming and fishing.

Land Size: This study treats this variable as total cultivated area operated by the farmer (Babatunde and Qaim, 2010; Tesfsye *et. al.*2008; Bjornsen and Mishra, 2012).

***Demographic Variables*:** Age of household head has been taken as a continuous variable. However, this variable is further classified into four groups to conduct cohort analysis. The first group includes household heads having age of 19 to 31 years. The second group includes household heads having age of 30 to 40 years. Thirdly, the group of age ranges from 41 to 50 years, while the fourth group includes household heads whose age is above 50 years. Sex of household head is taken as dichotomous variable.[7]

***Dependency Ratio**:* The dependency ratio is termed as the ratio of unemployed persons to working members in the farming. The dependency ratio is an indication of potential variations in population age structure to comprehend the social and economic development. It is classified into three categories that are normal dependency ratio (value of dependency ratio below 0.5), medium dependency ratio (when the values of dependency ratio are between 1 and .5) and the third one is a severe or higher dependency ratio (when values of dependency ratio are equal to or above 1). It is calculated as the number of households below age of 15 years plus the household members having age of above 64 years divided by the number of employed households which are between age of 18 and 64 years (Khatri-Chettri, 2006; Sultana and Kiyani, 2011; Matchaya and Chilonda, 2012; Rehman, 2013).

Education: Education of the household head has been categorized into four groups. These include never attended school, primary education, middle education and above middle.

Ownership of Livestock: Livestock ownership is used as the dummy variable and is defined as D=1 for ownership of livestock otherwise zero for non ownership (Khatri-Chettri, 2006; Tasfey, 2008).

[7] In selection equation female is coded, 1, and male is coded zero while in outcome equation, male is coded, 1, and female is equal to zero.

***Access to Credit*:** Formal institutions such as banks and informal institutions are loan from relatives, landlords etc. (see Table 4.7). This variable has also been used as dummy variable where D=1 if households received loan otherwise zero (Sultana and Kiyani, 2011; Matchaya and Chilonda, 2012).

***Savings of Households*:** This study uses a variety of savings of the households. This variable is used as dummy variable where D=1 if households having savings otherwise zero. Savings of a household consists of net cash, possessing gold, savings accounts and state life schemes etc.

***Land Danger*:** Land danger variable is defined as the risk of losing land to private party or government. This variable has also been used as dummy where D=1 if households have concern to lose land and zero otherwise.

***Irrigation Variables*:** Two variables are used for irrigation and these are defined as if farmers have access to perennial canal water and having the facility of irrigation through tube wells. Both variables are used as dummy variable.[8]

3.5 Data Source

Data for this study have been taken from the Pakistan Panel Household Survey (PPHS) conducted by Pakistan Institute of Development Economics (PIDE), Islamabad in 2010. PPHS (2010) comprises data collected from 16 districts of four provinces of Pakistan. There are six districts of Punjab (e.g., Faisalabad, Attock, Hafizabad, Vehari, Bahawalpur, Muzafargarh), four districts of Sindh (e.g., Larkana, Nawabshah, Mirpurkhas, Badin), three districts of Khaber

[8] Households having facility of canal water are assigned, 1 and otherwise zero. Similarly, those households which have the facility of tube well or any other source are coded, 1 and zero otherwise. These both variables are used in the generating food security index and as explanatory variables in selection equation to analyze their influence on the decision to participate in non-farm or farm activities.

Pakhtun Khah (KPK) (e.g., Mardan, Lakimarwat, Dir) and three districts of Balochistan (e.g., Loralai, Khuzdar,Gawadar) in PPHS (2010).

Pakistan Panel Household Survey (PPHS, 2010) comprises 4142 households. There are 2800 rural households in PPHS (2010) while remaining 1342 households belong to urban areas. This study aims to analyze the effects of non-farm income on food security. Therefore, data of 1740 farm households out of 2800 rural households are collected from PPHS (2010). 492 households out of 1740 farm households are involved in non-farm activities (See table 3.4 for detailed sample size).

Table 3.4: Households Covered in Pakistan Panel Household Survey (PPHS, 2010)

	Rural households	Urban households	Total households
Pakistan (overall)	2800	1342	4142
Punjab	1221	657	1878
Sindh	852	359	1211
KPK	435	166	601
Balouchistan	292	160	452

Arif (2012)

Table 3.4 gives complete description of the data collected from the four provinces of Pakistan. Data of 452 households is collected from Baluchistan and data of 601 households is collected from Khaiber Pakhtun Khah (KPK). Information about 1878 households are taken from Punjab and data of 1211 households are collected from Sindh.

Chapter 4

Results and Discussion

This chapter discusses the results obtained from both descriptive and econometric analysis. It is divided into three subsections. First section presents results derived from descriptive analysis. Section 2 explains findings obtained from econometric analysis. Third section is devoted to cohort analysis and its findings.

4.1 Descriptive Analysis

Descriptive analysis represented in table 4.1 shows that average yearly non-farm and farm income of rural households does not present satisfactory and encouraging figures which are almost 50000 and 58000 rupees respectively with larger deviation. Farm income is gross income without subtraction of input cost and it reflects the pitiable condition of rural households even off farm income also is not up to mark. Nonetheless, a household who participates in non-farm activities besides working on the farm gets higher total income. A rural household earns minimum amount Rs. 2500 and Rs. 2800 from both off-farm and on-farm activities respectively.

Youngest household head is 19 years old while the maximum age of household head is 92 years while the average age of the household head is approximately 48 years. Average family size is almost 7 members and maximum size is 43 members which is pretty high. The mean value of dependency ratio is 0.83, which is above 0.5 and below 1 with minimum of 0.74 and maximum of 4. It shows that on average, medium dependency ratio is prevailing among the households. Further it can be seen that average land size is 32 kanals with a maximum land holding of 384

kanals. Information about the savings and loan taken by households show that average savings of household is less than Rs. 10,000 with a huge variation ranging from Rs. 250 to Rs. 500000. Average credit received from all sources is little over 41000 rupees with a wide variation ranging from Rs. 1000 to Rs. 8, 00,000.

Table 4.1: Descriptive Statistics of Variables

Variable	Mean	S.D	Minimum value	Maximum value
Food security index	0.229	1.079	-0.0633	34.95
Off-farm income (Rs.)	50616.39	97163.33	2500	520000
Farm income (Rs.)	58050.89	22362.76	2800	2500000
Age of household head	47.97	15.38	19	92
Dependency ratio	0.82	0.738	0	4
Household size	6.76	3.78	2	43
Savings	9879.62	43836.35	250	500000
Land size	32.86	40.20	1	384
Credit received	41302.87	74301.34	1000	800000

Source of Data: Pakistan Panel Household Survey (PPHS), 2010

4.1.1 Food Security Analysis

As in the previous chapter,[9] this study has discussed that food security index is generated to calculate the food security in Pakistan. Our sample size is 1740 households and their food security level is 45.52 percent while food insecurity is 54.48% in rural areas of the Pakistan (see table 4.2).

Further counterfactual effects can be seen from table 4.2 and it can be assessed that those farm households which do not participate in non-farm activities are more than 57 percent food insecure. On the contrary, non-farm participants which are about 47 percent food insecure which is lower as compared to those did not participate in the off farm activities. However, it can be

[9] See section 3.2.6

concluded that level of food insecurity is alarmingly high irrespective of whether the household participate in off farm income or not.

Table 4.2: Food Security of Rural Households (Both Non-farm and Farm)

Food security level	Off-farm participants	On-farm participants	Overall level of Food security
Food secure	52.24 %	42.87 %	45.52 %
Food insecure	47.76 %	57.13 %	54.48 %
Frequency	**492**	**1248**	**1740**

4.1.2 Non-Farm Sector

Table 4.2 indicates that 492 households are engaged in off-farm activities and 1248 households remain in farming. The four components of non-farm income are remittances, business and enterprises, employment in private and public sectors and transfer payments. Average annual non-farm income is 50616 rupees and maximum income is 520000 rupees. This maximum income is one of that family which receives income from at least three major components such as remittances, private or public services and business activities.

Figure 4.3 indicates the descriptive statistics of the components of non-farm income. A services sector is the major contributor in off-farm income where 250 households out of 1740 farm households are earning incomes through private and public services. The mean contribution of services sector in non-farm income is Rs. 15000 with higher variation ranging from Rs. 2500 to 230000. The second major contributor in off farm income is remittances which are received by 176 households out of 1740 farm households. Its average annual share in household's income is Rs. 12000 with minimum of Rs. 15000 and maximum amount is Rs. 500000.

Net profit attained from business and enterprises are contributing on average almost Rs. 5000 in non-farm income. Share of transfer payments is the lowest amongst other components which is showing sorry figure and it reflects rural households are deprived of from receiving government and private charity or assistance[10] (see table 4.3).

Table 4.3: Descriptive Statistics of Non-Farm Sectors

Non-Farm Sectors	No. of households	Mean (Rs.)	S.D.	Minimum (Rs.)	Maximum (Rs.)
Services	250	15000	81155.86	2500	230000
Remittances	176	12000	42177.05	15000	500000
Net Profits	118	4800	28082.77	2000	600000
Transfer payments	23	300	2255.776	6000	54000

Source of Data: Pakistan Panel Household Survey (PPHS,2010)

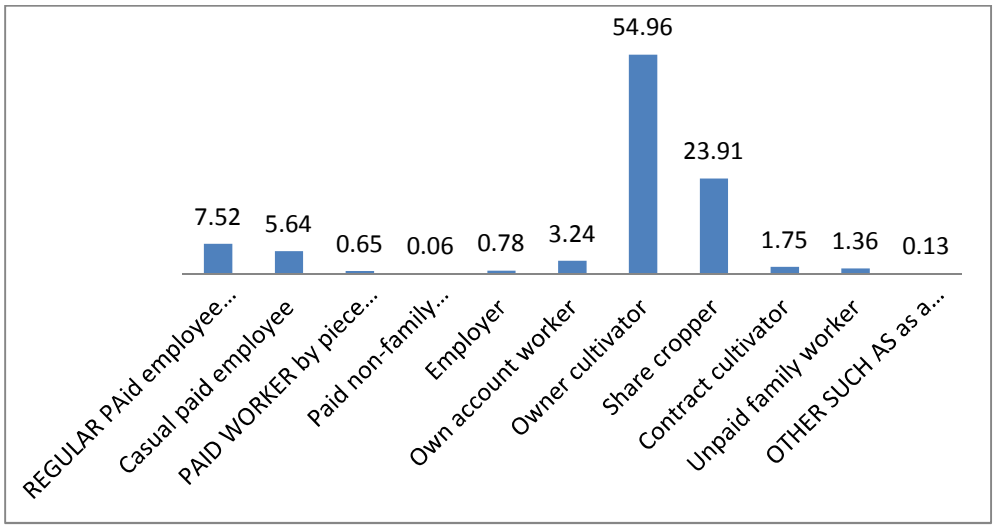
4.1.3 Overall Status of Rural Employment

Overall status of rural employment can be portrayed from figure 4.1 that virtually 55 percent rural households are own cultivated employee and share cropping contributes 23.91 percent in rural employment while contract cultivation is contributing 1.7 percent. This gives us a vivid spectrum of rural employment that the overall 80 percent source of livelihood is on-farm activities. Farm sector comprises own cultivating households, share croppers and contract cultivators. Off-farm income has just a meager contribution that is 20 percent in overall employment. On the whole, non-farm employment can be seen vividly from figure 4.1 which are paid worker, own account, employer, regular paid worker etc. These findings indicate that there

[10] There is a data limitation for transfer payments because only 23 rural farm households are reported among 1740 farm households. See Table 4.3

is a dire need of enhancing off-farm opportunities to enlarge the overall income of a farming family.

Figure 4.1: Rural Employments Status (%)



4.1.4 Age Groups and Non-Farm Participation

Age of household is divided into four categories to see their frequency and their contribution in non-farm activities. Table 4.4 shows that younger age headed households (between 18 and 31 years) are participating more in non-farm activities as compared to older households. The households headed in the youngest person participated in off farm activities are about 36 percent while the households whose age are above 50 years are contributing 29 percent. Rest of the information can be seen from table 4.4.

Table 4.4: Age Groups of Households and Non-Farm Participation

Age Group	Frequency	Percentage	Off-Farm Participation
Age ≥19 & ≤30	248	14.25 %	35.89%
Age≥31 & ≤40	394	22.64 %	27.66%
Age≥41 & ≤50	383	22.01%	23.24%
Age>50	715	41.09%	28.67%
Total	**1740**	**100%**	**100%**

4.1.5 Sources of Savings

Sources of rural households are holding cash at home, gold/jewelry, deposits with banks, national savings schemes and prize bonds. Their shares can be viewed from following Table 4.5. Prize bonds appear to be the higher source of savings which is 22.36 percent and second major source is holding gold or jewelry. This implies that formal rural savings institutions are failed to motivate the rural people to deposits their savings in formal institutions, since almost the 50 percent of the rural households' savings are kept at home in one form or other.

One thing can be noticed that we did not include farm and domestic assets in this variable. Commonly rural households were used to sell these savings at the time adverse shock and marriages of their offspring. Therefore, it may have negative effects on food security.

Table 4.5: Sources of Savings

Sources of Savings	Frequency (%)
Cash at Home	13.91
Gold/Silver Jewelry	16.95
Deposit in Banks	16.09
National Savings Schemes	16.03
Prize Bond	22.36
Other	14.66

Source of Data: Pakistan Panel Household Survey

4.1.6 Access to Credit Market

Rural formal and informal credit markets play an important role to determine food security and the data shows that the informal market is more popular because of its easy access. Informal market comprises loan received from relatives, friends, neighbors, money lenders, Beoparies, shopkeepers, landlords and Arhties. Formal credit institutions like all sorts of banks and micro finance institutions are the sources of credit. Table 4.5 shows that informal institutions are working more than formal institutions as 25.24 percent rural households received loans from friends and relatives while 35.18 percent households obtained loan from landlords. Only 12.85 percent of households took loans from banks.

Table 4.6: Sources of Credit (Formal and Informal Market)

Sources of credit	Frequency	Percentage
Relatives / friends	155	25.24
Bank	76	12.38
MFI	2	0.33
Money Landers	7	1.14
Arhti/Beopari/shopkeeper	128	20.85
Landlords	216	35.18
Neighbors	11	1.79
Other	19	3.09
Total	**614**	**100**

4.1.7 Land structure and Food Security

Land structure has been classified into four categories and these are flat land, slightly sloped, moderately sloped and steeply sloped land. Table 4.7 shows that 89.37 percent of households own flat shaped land and 7.93 percent of households possess slightly sloped land. The other two

categories are minor that is 1.15 percent and 1.55 percent of households own steeper sloped and moderate sloped lands respectively.

Table 4.7:Structure of Land owned by Households

Land structure	Frequency	Percent
Flatland	1555	89.37
Slightly sloped	138	7.93
Moderate sloped	27	1.55
Steep sloped	20	1.15
Total	**1740**	**100**

Another variable which is called land danger' representing the risk of losing land can be observed from table 4.8 that there are 5 percent farm households who indicated risk of losing their land, while 95 percent households do not perceive any danger to lose their land.

Table 4.8: Households who have Risk of Losing Land

Land danger	Frequency	Food Insecurity
Yes	5 %	56 %
No	95 %	54%
Source of Data: PPHS (2010)		

The relationship between food security and land danger highlights that 56 percent of households are food insecure while 54 percent are food insecure among those households which do not feel the danger of losing land (see Table 4.8).

4.1.8 Livestock Ownership and Food Security

380 household heads own livestock out of 1740 and 125 households have large animals and 105 households have small animals and remaining has both small as well as large animals. The mean value of small animals is 1.768072. A rural household possesses maximum 100 animals and the minimum small animal holding is 1 (see table 4.9a and 4.9 b).

Table 4.9a: Food Insecurity and Livestock Ownership

No. of Households	Livestock Holding	Food Insecurity (%)
380	Yes	19.20
1360	No	80.80

Livestock is one of the major sources of livelihood for rural households. Milk of cows, buffaloes and goats works like a monthly pay of households and it also helps them to absorb micro nutrients. In Pakistan, livestock invigorates the level of food security. It can be observed from table 4.9a that those households who hold small and large animals are less food insecure. Their food insecurity level is almost 20 percent while 80 percent food insecurity is lying among those households which do not hold livestock.

Table 4.9 b: Descriptive Statistics of Small and Large Animals

Households	Animals	Mean	S.D	Minimum	Maximum
125	**Large**	2.134615	2.325096	1	30
105	**Small**	1.768072	5.773976	0	100

Source of Data: Pakistan Panel Household Survey (PPHS, 2010)

4.1.9 Education and Food Security

The relationship between food security and education shows that portion of food insecure people is higher that is 51 percent among households headed by uneducated persons as compared to educated household heads. Educated household heads are also 44 percent food insecure (see table 4.10). Table 4.10 also highlights that there are 55 percent families which are headed by uneducated persons while just 45 percent households are educated.

Table 4.10: Education and Food in Security

Education status	**Food insecurity**	**Frequency %**
No education	51.20 %	54.66%
Education	43.67%	45.34%
Source of Data: PPHS, 2010		

Four categories of the education have been used in empirical analysis which are households who never attended school, primary education, and middle education and above middle education. There are 17.36 percent households which have got primary education, 15 percent households have got middle education and only 12.24 percent households have attained above middle education.

4.3 Empirical Results and Discussion

This section deals with the results obtained from Treatment Effect Model. This section further subdivided into three subsections. First subsection presents the discussion the determinants of non-farm income and results obtained from outcome equation shall be discussed in second subsection where determinants of food security are estimated. At the end, third subsection discusses the cohort analysis.

Treatment effect model gives empirical results which are estimated from selection equation and outcome equation. Sample of 1740 farm households is used to estimate the treatment effect model. Selection equation[11] gives estimated determinants of non-farm income where dependent variable is in dichotomous[12] form. 492 households are involved in non-farm activities and 1248 households are participated in on farm activities. Selection bias has been observed from outcome equation because Inverse Mills Ratio[13] has been found highly significant (see table 4.11).

Second major finding from treatment effect model is direct estimation of treatment effect from selection equation (see equation 3.2). Value of treatment effect is found 2.11 which are interpreted as the counterfactual effects of non-farm participation and involvement in on farm activities. Treatment effect score indicates that other things remaining constant, households which are immersed in non-farm activities have higher treatment score (2.11) as compared to only farm income earning households. This treatment effect score shows positive effects of treatment (non-farm participation) on treated-households. This treatment effect also interpreted as counterfactual effects which indicate that treated farm households have higher food security as compared to non treated farm households. These results are matching with the studies of Owusu

[11] See equation 3.2

[12] Dummy variable is used as dependent variable where those households which involve in off-farm activities are coded 1 otherwise farm activities=0

[13] Inverse Mills Ratio is calculated from selection equation and is used as independent variable in outcome equation or second step. Significance of inverse Mills Ratio suggests the presence of selection bias (see specification of Treatment effect Model in chapter 3).

et. al. (2011). They found positive effects of treatment effect on treated households. Further, it has been observed that overall model is good fitted because Wald Chai^2 statistic is found 380 that is highly significant (see table 4.11).

To check the relationship between error terms of both selection and outcome equation, this study employed Likelihood Ratio (LR) test[14] and it has been found highly significant. Significance of LR statistic indicates that both error terms are normally distributed and have not correlated with each other[15]. Having discussed results about the model specification, we move to discuss the determinants of off farm income and food security.

4.3.1 Determinants of Non-Farm Income Obtained from Empirical Model

Results regarding the determinants or factors that influence the rural farming households to participate in non-farm activities are discussed in this subsection. Table 4.11 presents the results obtained from selection equation estimated using probit estimated technique since the dependent variable is dichotomous assuming the value of 1 if households are participating in non-farm activities and otherwise zero for only participating in farming. Maximum Likelihood estimator has been used to estimate the factors which affect off-farm income. Coefficients of decision equation are difficult to estimate directly. From this equation, Inverse Mills Ratio is calculated to observe selection bias and is used as independent variable in outcome equation.

[14] Likelihood Ratio (LR) test has been used to check the joint normality condition where null hypothesis, H0: rho is equal to zero ($\rho = 0$) and Ha: rho is not equal to zero. Significance of LR test shows the rejection of null hypotheses that there is no correlation between both error terms.

[15] Likelihood Ratio statistic= 320 and p-value=0.000 by using SATATA version 12.

Table 4.11: Estimated Treatment Effect Model for N=140

Independent variables	**Coefficient for off-farm income (Selection equation)**	**Coefficient for food security (Outcome equation)**
Age of household	-0.0061***	0.0053**
	(0.001)	(0.002)
Gender of household	-0.4081*	0.4007
	(0.21)	(0.27)
Household Size	0.0164***	
	(0.004)	
Off-farm income		0.0000124***
		(4.03e-07)
Normal dependency ratio		-0.1616**
		(0.07)
Medium dependency ratio		-0.2174**
		(0.08)
higher dependency ratio		Reference category
Cultivated Area	-0.0016***	
	(0.0005)	
Access to credit	0.1356	-0.1934
	(0.18)	(0.21)
Livestock ownership	-0.1554**	0.1902**
	(0.71)	(0.07)
Savings of household	0.1793**	-0.1589**
	(0.07)	(0.08)
Farm income	-5.54e-06***	0.000104***
	(1.34e-06)	(2.24e-06)
Tube well	0.1475***	
	(0.03)	
Canal irrigation	-0.0752**	
	(0.03)	
Primary education	-0.279***	0.2573***
	(0.087)	(0.08)
Middle education	0.0168	0.0911
	(0.84)	(0.09)
Above middle Education	-0.2634***	0.2955***
	(0.09)	(0.10)
Never attended school	Reference category	Reference category
Infrastructure	0.0093***	0.3468***
	(0.11)	(0.115)
Treatment E. Score	2.1165***	
	(0.405)	
Inverse mills ratio		-1.306***
		(0.25)

Wald Chai^2 statistic =380 and P-value=0.000, * P<0.1, ** P<0.05, *** P<0.01, ( )=Standard Error

Results of the decision equation show that age and gender of the household heads negatively and significantly influence the decision of the farming households to participate in off farm income activities. This result implies that younger farmers have more likelihood to participate in nonfarm activates while older farmers concentrate on farming. It is more likely to that higher off farm wages attract the younger households to work in non-farm sector. This result is consistent with the findings of Mishra and Chang (2008), Babatunde and Qaim (2010), Huffman (1980), Mishra *et. al.,* (2002) and Rehman (2013).

The negative sign of gender variable indicates that the probability of male farmers' participation in non-farm work is more than female in the off-farm sector which is quite logical in the case of Pakistan. However, the female members' participation farm work is common particularly during the period of harvesting and sowing of crops. Due to lack of education and complex social structure, most of the females have to attach with home-made commodities. This result is matching with Babtunde and Qaim (2010), Zhu and Luo (2006) and Rehman (2013).

Household size has positive and statistically significant effects on the likelihood to participate in off-farm. This relationship is justified in a sense that large family size may have more productive members because increase in household size implies that more individuals to nourish and feed. They need to earn more income to meet their mounting requirements. There is a higher probability to adopt non-farm business or jobs by younger individuals instead of sticking on farming. These results are matched with the findings of Babtunde and Qaim (2010), and Joo and Mishra (2013) in Nigeria and South Korea respectively. These studies have also found positive and significant co-efficient of household size. Rehman (2013) figured out that the growing burden of family size tempts individuals to seek off-farm business or household head looks other ways to maintain this burgeoning pressure of family size.

Land size variable is found with a negative sign and is highly significant. It suggests that those farmers having more cultivated land have a higher likelihood to participate in the farm sector and has less probability to participate in the off-farm sector. These evidences are implying that higher farm size or cultivated area causes an increase in farm production and it may give a household incentive to stick on farming. These findings are compatible with Tafsey (2008); Babatunde and Qaim (2010); Fatima (2012); Joo and Mishra, 2013).

Farm income variable also comes with negative sign and statistically significant. It can be interpreted as holding other things constant, those households which have higher farm income would like to stay in the farming and they have less likelihood to involve in off-farm income. Babtunde and Qaim (2010) have found the positive signs contrary to our study. But Joo and Mishra (2013); Adoo *et. al*. (2013) has found negative signs of farm income which supports our findings.

Access to credit market seems to be not playing any role in determining the decision to participate in off-farm activities. It is justifiable in the case of Pakistan because here formal and informal institutions of credit are malfunctioned. As it is apparent from our data analysis (see table 4.6) that informal market is contributing more than a formal one. The social structure of the country is embedded with informal institutions and due to governance related issues the formal credit institutions are not functioning well in the country. Therefore it may affect insignificantly the off-farm participation.

This has used some agriculture related variables like irrigation through tube wells and canal water. Both canal irrigation and access to tube wells have been found significant variables. It indicates that Farmers who have access to canal water are less likely to participate in off-farm

activities while those rural households which have the facility of tube wells are more likely to participle in non-farm sector. The reason could be the energy crises and it may force them to move out from farming. These results are consistent with Tasfey *et. al*. (2008).

The coefficient of livestock variable has been found statistically significant and negative. This implies that farmers/households which own livestock have lower probability to participate in the off-farm sector. In Pakistan, it can be observed that most of small farmers hold livestock to meet their dietary needs as well as are a source of additional income. Farm income earning households prefer to hold livestock along with growing crops because it is an economical and profitable business for them. Therefore, it is negatively affecting the decision to participate in non-farm sector (see table 4.11). This relationship is supported by the studies of Tasfey *et. al.* (2008); Ali and Khan (2013).

The coefficient of savings variable of households is found statistically significant and positive. This implies that other things remain constant; the households which have possession of savings e.g. Gold and other sources (see table 4.5) are positively affecting the decision to participate in non-farm sector. This result is difficult to interpret in a sense that these savings could be the outcome of nonfarm income that motivates farm households to work in off farm activities additional to their farm work. These findings are commensurate with Alderman and Gracia (1996); Carter *et. al.* (2010); Shaw and Pomero (2011) these study.

Infrastructure variable is used in continuous form to assess its effects on non-farm income and empirical results show that it has positive effects on the likelihood to participate in non-farm business. Expansion and improvements in infrastructure are the stimulator to spread out the opportunities for non-farm income livelihoods. The findings of this study are congruent with the

studies of Faiz (2012) and Osei et al (2013) where they found the positive relationship between non-farm income and infrastructure developments.

The last variable is the level of education of the head of the household. It has been characterized into four categories which never attended school, primary education, and middle education and above middle education. Never attended school was considered as the reference category and primary education negatively affects the decision to participate in off farm work significantly. Middle education is found insignificant while above middle education has been significant and is inversely related to the likelihood to participate in non-farm sector. These results show negative effects of education on non-farm income participation which are fairly surprising due to various reasons: 1) only the small portions of heads are educated, 2) they have got general education not technical, 3) educated workers are less likely to participate in physical work, 4) sample size consists of rural farm household heads. Therefore, the effects of education on decision to participate in non-farm income are negative. These results are matched with the study of Babatunde and Qaim (2010).

4.3.2 Estimated effects of Non-Farm Income on Food Security in Pakistan

Having discussed selection equation where factors which influence on decision to participate in non-farm income, this subsection presents the results regarding the effects of non-farm income on food security as well as other determinants of food security using the treatment effect model by using Maximum Likelihood estimator. It is palpably evident that there is positive relationship between off farm income and level of food security because its coefficient is associated with positive sign and is statistically significant. These evidences are consistent with the studies of Babatunde and Qaim (2010 ; Owusu *et al.* (2011); Joo and Mishra (2013); Adoo *et. al.* (2013).

Intuitively, this relationship makes sense because off-farm income encompasses overall income of farm household and makes him able to counter the risk involving the farm income. Erudite discussion held in descriptive analysis reveals four components of non-farm income which is the employment in private and public services, business, remittances and transfer payments are helpful to improve the food security level of off-farm earning households. Moreover, it enables a household to diversify his income by doing job in different non-farm sectors such as micro rural entrepreneurship, daily labor and employee in public as well as private sectors Rehman (2013). Consequently, ceteris paribus, non-farm income has positive effects on the food security.

Farm income has a positive impact on food security and which is also statistically significant. These positive effects are minor but amassing farm and off-farm income both increases the magnitude of the total income of farming families and enables them to cope with risk involving in farm production and food security level. This finding is consistent with the studies of Babtunde and Qaim (2010); Owusu *et. al.* (2009) Matchaya and Chilonda (2012) and Adoo *et. al*. (2013).

Credit markets are showing insignificant effects on food security which are not consistent with Mongid and Tahir (2008); Matchaya and Chilonda (2012); Joo and Mishra (2013); Adoo *et. al.* (2013). It demands some justification, formal rural credit markets is not performing efficiently in Pakistan which has been discussed already in explanation of selection equation. Sultana and Kiyani (2011) found insignificant effects of the credit market in Pakistan.

Effects of ownership of livestock are found positive and significant. Table 4.11shows that those farmers which possess livestock such as sheep, goats, buffalo etc. are more food secure than those which not owned. Its coefficient is attached with positive sign and highly significant. This

variable has been specified in dichotomous form and non-holding of livestock by households has been set as base category. Therefore, positive sign can be interpreted as other things remaining same, the livestock holding households have higher levels of food security as compared to non-holding households. The findings of this study are commensurate with the findings of Joo and Mishra (2013); Ali and Khan (2013) and their studies indicated the positive effects of the livestock ownerships South Korea and Pakistan respectively.

It has been found that savings of rural households affect the food security negatively where co-efficient of savings is attached with a negative sign and found significant. These are not consistent with the results of Carter *et. al.* (2010); Shaw and Pomero (2011). They segregated formal and informal sources of savings. Formal savings comprise banks, national savings schemes while informal sources of savings are holding livestock, farm and domestic assets. Negative effects are justifiable because this used livestock ownership, farm assets and these formal sources of savings are separately in this study. Effects of holding livestock have been discussed above and its positive effects are also weaved up while farm and domestic assets have been used in constructing the food security index. Second justification may be same as defined in interpreting the effects of credit markets that our formal institution are not working efficiently, especially in rural areas where individuals use these savings during bad time or construction of houses, diseases and ceremonious obligations.

Education plays its positive role in determining the level of food security. Those households which never go to school have been considered as base category. It has been found that primary and beyond middle class has a positive and significant impact on the food security level. Primary educated households are more likely to attach with farming and beyond middle education may enable a household to have advance knowledge of farming. Hence, overall positive effects of

education on food security are found. These results are consistant with the studies of Sultana and Kiyani (2011); Babatunde and Qaim (2010); Zhu and Luo (2006); Tafsey *et. al.* (2008).

Age of household heads has been found positive and statistically significant. Age of the household head is taken as a continuous variable. Other things remaining constant, older household heads are more food secure. Intuitively, it could be due to having more farming experience and skills which may cause to increase his agriculture output. This result is matched with the studies of Carter *et. al*. (2010); Babatunde and Qaim (2010). While the sex of household heads has been found insignificant and have no impact on food security. Hence gender discrimination at the household head level may have an insignificant role to determine the food security. This finding is consistent with the studies of Adoo *et. al*. (2013).

The dependency ratio is the ratio of productive and non-productive family members. It has negative and statistically significant impacts on food security because the more dependent people, the more food is required to feed dependent individuals. To capture the effects of dependency ratio, it has been classified into three categories and these are low dependency when the value of dependency ratio is below 0.05, medium dependency (value of dependency ratio is below 1 while above 0.5 and a higher dependency ratio (value of dependency ratio is above 1). This study kept higher dependency ratio as base category and the rest of the categories have been found with negative signs. Evidences indicate that dependency ratio is inversely related to food security. This finding is matched with Sultana and Kiyani (2011) found a similar type of results in Pakistan while Matchaya and Chilonda (2012) assessed in Malawi.

At the end, this study used variable of rural community infrastructure. To analyze the values of infrastructure, an index has been constructed on the basis of eight variables[16]. Econometric results show that rural infrastructure has positive and statistically significant effects on level of food security. This result is consistent with the studies of Babatunde and Qaim (2010); Chang and Mishra (2008); Matchaya and Chilonda (2012).

In sum, empirical results obtained from the treatment effect model and descriptive insights are conversed in this chapter. Factors which determine off-farm income and food security have been discussed. The paramount concern of this study is to identify the effects of off farm income on food security and pragmatic evidence recommends positive impact of non-farm income on food security in rural areas of Pakistan. Moreover, presence of selection bias has been observed and counterfactual effects of non-farm and farm income also seen through the interpretation of the positive sign of the treatment effect score which shows household which are involved in non-farm participation are more food secure.

4.4 Cohort Analysis

In the previous sections, the results were reported from Treatment Effect Model where the age of the head of household was used as a continuous variable to identify its effects on decision to participate in non-farm activities and food security. The age found inversely related to the decision to involve in off-farm employment and found positive association with the food security. But this study further inspects its effects assuming different categories of age on both participation in off-farm activities and households' food security. Four categories of age are younger households aged between 19 to 30 years, middle aged ranging from 31 to 40, slightly

[16] See Table 3.2 where detailed information of these variables is given.

older aged households ranging between 40 to 50; and households have age of above 50 years. The treatment effect model is estimated on the basis of sample size that in aforementioned categories.[17]

Table 4.12 presents the cohort analysis where effect of non-farm income is investigated separately for each age group. The results show that non-farm income positively influences food security has been found positive but it is statistically significant only in two age groups which are 31-40 years and 41-50 years. Our results remained consistent even after dividing the data into four different age groups.

The treatment effect score is lower than that was obtained using full sample of 1740 households. Interestingly, sign of treatment score is negative of the model for age group of 19-30 years. This implies that the households which are headed by relatively younger persons and are not involved in off farm activities are more food secure as compared to those which earn off farm income. It could be due to the reason that younger farmers are more motivate and manage their farms more efficiently. Overall results however implies that the households which are able to earn income from non-farm income are more food secure as indicated by the sign of the coefficient of treatment effect in table 4.12.

The effects of education on food security are found statistically but their signs in different regressions differ. These signs are negative for the younger age group and older age group (above 50 years). They have found negative effects of education for school children to assess their food security and nutritious level but found positive effects of education by using overall sample. The coefficients of education variables have shown mixed results having inference on

[17] Selection equation is used to estimate determinants of off farm income and outcome equation is employed for having the effects of non farm income on food security.

likelihood of participation in non-farm activity second age group (31-40 years) and third age group (41-50 years), education variables have positive coefficients implied that educated persons have greater probability to participate in non-farm sector.

Livestock has been found positive and significant in determining the food security. In the case of age group ranges from 31 to 40 years, livestock has been found insignificant which shows it has no role to determine food security level. Coefficient of the livestock is higher in the age group of younger households but it lowers in higher age groups. The coefficient of household size variable is found positive and showing greater likelihood to involve in the off farm business. The dependency ratio is associated with negative consistently all age groups to determine the food security (See table 4.12).

In summary, the cohort analysis generally implies that off-farm and farm income positively influence food security in all age groups. However, treatment effect score is different for different age of households. It is found that those households which are involved in non-farm income earning activities are more food secured as compared to those which stay in on farm income activities only. However, the results from first age group (19 to 30 years) model indicate farm income earning households are more food secured than that of the non-farm income earning households. It could be due to the reason that young educated generation is more innovative and practice agriculture as business activity.

Table 4.12: Cohort Analysis of the Effects of Non-Farm Income on Food Security by Dividing Sample into Four Age Groups

Age groups	Age≥19&≤30, N=248		Age≥31&≤40, N=394		Age≥41&≤50, N=383		Age≥51, N=715	
Variables	**Selection Equation**	**Outcome Equation**	**Selection Equation**	**Outcome Equation**	**Selection equation**	**Outcome equation**	**Selection equation**	**Outcome Equation**
Off farm income		-7.00e-06		1.69e-06**		3.74e-06***		3.63e-07
Farm income	8.20e-06**	0.0000114*	2.05e-06	-6.82e-06	-9.91e-06***	0.000104**	-2.65e-06***	0.0000124**
Household size	.0073227		.0328889***		.0205304**		.0173708***	
Low depend Ratio		.1622831		-.8938829***		-.5360938***		.0968286
Average depend Ratio		-1.501449***		-.1698608		.0273872		-.478796***
Higher depend ratio	Reference category	Reference category	Reference category	Reference category	Reference category	Reference category	Reference category	Reference category
Land size	-.0072421***		-.0034954***		.0010492		-.001657***	
Savings	.2453983***	-.3598582	.0684881	-.443671**	.2293438*	-.4697005 **	-.018347	.0867674
Livestock	-0.01352**	.8237983**	-.0344446	.1504851	-.0709637	.2941226*	-.0570307	.25602**
Can. irigation	.0003178		-.1888184***		-.0601303		-.0915327**	
Primary Education	-.2333662**	.3430974	.1907853***	.5418235***	-.5573373***	1.468059***	-.0485103	-.3143253**
Middle education	-.4802316***	-2.101246***	.2126***	.9564146***	-.3770019***	.5249433**	.0319001	.0822366
Above middle education	-.5956806***	-1.711812***	.1615317	1.720569***	-.7704278***	1.661415***	-.0027663	-.3268716
Never attend School	Reference category	Reference category	Reference category	Reference category	Reference category	Reference category	Reference category	Reference category
Infrastructure	.613828***	1.2866**	.1801234	-.7492197**	.2882538*	-.1439994	-.0923731	.9383799***
Treatment effect Score	-.7457222***		.2876385*		1.369389***		1.090554***	
Lambda		.4869036***		-.1348764		-.8487061***		-.6945053***

*** P<0.01, ** P<0.05, * P<0.1 ; Selection Equation for off farm income determinants, Outcome Equation for food security determinants

Chapter 5

Conclusion and Policy Implication

This chapter summarizes and concludes the findings of the study along with provision of some policy implications based on the results and evidences.

5.1 Concluding Remarks

The paramount concern of this thesis is to identify the influence of off-farm income on food security in Pakistan and also provides counterfactual analysis. This study is an endeavor to bridge the gap on the nexus between off-farm income and food security in Pakistan by using Treatment Effect Model. The data used in this study pertains to 1740 rural farm households from the Pakistan Panel Household Survey (PPHS, 2010). Out of 1740 farm households 492 households are involved in off-farm income earning activities. Food security index has been constructed by using Principal Component Analysis.

This study made empirical as well as descriptive analyses. The results show that about 55 % of sampled households were found food insecure in rural areas of Pakistan. Those households which were involved in off farm income activities have higher food security level than those who did not participate in off farm sector. The results have however indicated that income earned from services sector is contributing more to food security than that of the contribution made by any other component of the non-farm income activities. About 48 percent of the households were food insecure among those who received off-farm earning in addition to farm income while about 58 percent of the households found food insecure which relied only

on farming. Descriptive analysis further revealed that off-farm income is only contributing about 20 percent of overall rural employment[18].

The results obtained from econometric analysis have also shown positive and significant effects of off farm income on food security in rural Pakistan. The treatment effect score suggests that farmers which are involved in off farm income have 2.11 higher average score than those which do not participate in off farm activities. It implies that non-farm participants have higher food security as compared only farm participants. However, the problem of the selection bias is observed from the significance of the Inverse Mills ratio.

This study shows factors instead of non-farm income like credit market, ownership of livestock, demographic variables and savings of a household have found significant which affect the food security level in Pakistan. These factors demonstrate that access to credit market has been found insignificant to determine food security because of the inefficiency of formal credit markets while informal markets have been found well-functioned but due to the social structure and behavior of people net gain of well functioning of informal credit markets doesn't favor to improve the food security.

In addition, to the role of non-farm in improving food security, this study analyzed the contribution of factors like credit market, ownership of livestock, farm income, irrigation variables education, demographic variables and savings of households. The results show that access to credit market was. It may be due to the inefficiency of formal credit markets and higher cost of credit in informal markets.

The treatment effect model also takes account of the determinants of off farm income and fourteen variables have been considered to identify the factors which are influencing on the decision making of the households to participate in non-farm activities. The significant

[18] See figure 4.1

factors are age and gender of the household head, household size, cultivated area, livestock holding, farm income, irrigation variables and education while remaining four variables are found insignificant such as credit market, land structure and primary education.

Further results indicated that the likelihood of female participation in off-farm activities is very low as compared to male. Agricultural variables like irrigation, farm size and farm income affect negatively to the likelihood to participate in the off-farm income activities. Infrastructure variable has been used to check its effects and it is found positive and significant variable to determine the food security. The livestock ownership has been found statistically significant and positive to determine food security. The effects of education have been found significant and positive on both off-farm income and food security level in Pakistan (see Table 4.11).

The cohort analysis also analyzed by dividing the sample into four age groups to explore the effects of off-farm income on food security. These categories are: 19-30 years; 31-40 years; 41-50 years and above 50 years. Effects of non-farm income are found positive for food security at every age group of households. Moreover, remaining variables change their sign and significance for different age groups of households (see table 4.12).

5.2 Policy Implication

Based on the results obtained from the analysis, this study provides recommendations to ensure food security. The most important one is expansion of off farm related opportunities in rural areas to bring diversification in the income sources of the farm households as agriculture is becoming more exposed to extreme weather events with changing climates. The specific policies and recommendations can be drawn from the preceding discussion.

- First and foremost, building rural infrastructure may be given priority as this study shows that basic rural infrastructure positively influences both off farm participation and food security.
- The property inheritance for rural women is also another obstacle in ensuring better level of food security. There is a dire need to implement the laws related to inheritance particularly for women.
- It also recommended that undistributed government land may be distributed to non-land owners.
- Easy access to credit from formal sector should be provided to landless and small farmers. If credit market works efficiently, it will increase the off-farm activities and improve the food security. Private and public banks and some other rural institutions should be encouraged to establish it in the rural areas with prime objective supporting small business in rural areas.
- Education must be a top priority in rural areas to address food security and enhancing the non-farm income opportunities.

5.3 Limitations of the Study

We want to explore the effects of non-farm income on food security provincially but due to data limitations, this study has been confined to overall sample. 492 rural farm households are found participating in non-form activities where sample size for the province Khaiber Pakhtun Khah (KPK) and Baluchistan was not enough to analyze the effect of non-farm income. 492 rural non-farm participants are not truly representing whole rural market due to aforementioned data limitations.

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Appendix

Table 1 Literature Review on Off Farm Income and Food Security

Citation	Model / Data	Results
Blank and Erickson (2007) "Impact of off-farm income and risk In farm Income in USA"	Simple portfolio model **Data:** ARMS (1996-2004)	Positive
Tesfaye *et al* (2008) "Impact of irrigation on food security In Ethopia"	Heckman two step model **Data** : Primary data	Positive
Owusu and Abdulai (2009) "Impact of off-farm income on Food security in Ghana"	Propensity Score Matchi (PSM) **Data**: Primary data	Positive
Babatunede and Qaim (2010) "Impact of off-farm income on Food security and nutrition in Nigeria."	Structural regressions **Data**: primary data	Positive
Babatunde *et al.* (2010) "The impact of remittances on Food security and nutrition in Nigeria."	Linear regression model **Data:** primary data	Positive
Zearai and Gebreegziabher (2011) "Impact of off-farm income on food Security in Ethopia"	Heckman Selection moc **Data:** Primary data	Positive

Briggman (2011) "Impact of off-farm income and Servicing farm Debt"	Semi-log model **Data**: ARMS (1960-2008)	Positive
Fatima (2012) "Exploring the linkage between Rural incomes and non-farm Activities in Pakistan."	Heckman Two Step model **Data**: PSLM- HIES (2006-07)	Positive
Fan (2012) "Impact of market commercialization On the off-farm income and food Security in China"	Simultaneous (equation) model **Data**: Primary data	Positive
Ali and khan (2013) "Impact of livestock on food security in Pakistan"	Propensity Score Matching (PSM) **Data:** Primary data	Positive
Joo and Mishra (2013) "Impacts of off-farm income on food Consumption in South Korea : A farm household analysis"	Heckman selection model Data: primary data	Positive