DETERMINANTS OF FARMERS' WILLINGNESS TO PAY FOR SUBSIDIZED FARM INPUTS IN MALAWI

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I, the undersigned, hereby declare that this dissertation is my original work which has not been submitted to any other institution for similar purposes. Where other people's work has been used acknowledgements have been thoroughly made.

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CERTIFICATE OF APPROVAL

The undersigned certifies that he has read and hereby recommends for acceptance by the University of Malawi the dissertation entitled: "**DETERMINANTS OF FARMERS' WILLINGNESS TO PAY FOR SUBSIDIZED FARM INPUTS IN MALAWI**", submitted in partial fulfillment of the requirements for the award of a degree of Bachelors of Social Science by the University of Malawi.

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Mr. Gowokani Chijere Chirwa

(Supervisor)

Date:______________________________

To Malawi, the nation that is yet to achieve its full potential.

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ABSTRACT

Most recently, citing low price elasticity of demand for agricultural inputs in the agro-based Malawian economy, economists and non-economists have advocated for increasing prices charged in farm input subsidies. But elasticities alone are not enough since knowledge of whether higher prices are indeed acceptable by farmers is of special value in this field. This study uses a rigorous theoretical model of willingness to pay (WTP) for farm inputs and the standard Tobit model to calculate both the average household and aggregate WTP for subsidized fertilizers in Malawi at MK1, 000 and it traces the factors that influence farmers' WTP for the farm inputs. The results reveal that Malawian smallholder farmers are willing to pay for more inputs in the Farm Input Subsidy Programme (FISP) such that the mean WTP for each household at MK 1, 000 is 10.13 50kg fertilizer bags and the total WTP at the same price is 46, 891 bags per year. The study uses data from the Malawi 2011/12 Farm Input Subsidy Study (FISS4) and the Standard Tobit model shows ten potential explanatory variables that affect the WTP value. Age and sex of household head, farm size, education, food security and radio ownership have positive and significant effects on the WTP for farm inputs; whereas coupon receipt and farm incomes have negative and significant effects on WTP. Policy implications from the study suggest the exploration of new farmlands; intensification of free primary education; promotion of food security and an increase in access to information through easing the accessibility of farmers to radios or improving quality of network through adoption of digital transmission.

Key Words: Malawi, FISP, Willingness to Pay, FISS4, Tobit

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LIST OF ACRONYMS AND ABBREVIATIONS

ADMARC	Agricultural Development Marketing Corporation
AISP	Agricultural Input Subsidy Programme
CLRM	Classical Linear Regression Model
FISP	Farm Input Subsidy Programme
IMF	International Monetary Fund
JCE	Junior Certificate of Education
MSCE	Malawi School Certificate of Education
NASFAM	National Smallholder Farmers' Association of Malawi
NSO	National Statistics Office
PLSCE	Primary Leaving School Certificate of Education
SAPs	Structural Adjustment Programmes
SFFRFM	Smallholder Farmer Fertilizer Revolving Fund of Malawi
SP	Starter Pack
SSA	Sub-Saharan Africa
TIP	Targeted Input Programme
TWTP	Total Willingness to Pay
WTP	Willingness to Pay

CHAPTER ONE

1 INTRODUCTION

1.1 Background

One of the costs that may be incurred by farmers in farm production is the purchase of farm inputs. To make the purchase, a smallholder farmer must be willing to pay for the inputs [1]. It is well known that at any point in time different farmers purchase different quantities of inputs and as such it can be inferred that the farmers exhibit different levels of willingness to pay (WTP) for the inputs[2]. Such WTP is a function of many factors including education background, household income, input prices, farm size and household wealth, as shown by various studies (e.g. Mason & Ricker-Gilbert, 2012; Minot, Kherallah & Berry, 2000; Maganga et al, 2014), although they focused on either demand or use and not explicitly WTP. In Malawi, given that the majority of the population is poor, one of the clearest factors with a significant impact on the demand for the inputs is income (Maganga et al, 2014); whereby the Engel's Law auspicates a higher proportion of the people's food budget relative to the non-poor's. Evidence of this law implies that the farmers purchase less inputs and are therefore prone to self-fortifying poverty since in their poverty they still invest less funds on future revenue influxes thereby suppressing subsidy-driven poverty abatement efforts.

In order to improve farmers' equity in their access to farm inputs so as to alleviate poverty, many countries implement input subsidies. In Malawi, and indeed in many countries of the Sub-Saharan Africa (SSA), the principal inputs of the subsidy program are inorganic fertilizer and improved maize seeds. For example, in 2008 Malawi spent roughly 70% of the Ministry of Agriculture's budget or just over 16% of the government's total budget subsidizing fertilizer and seed (Mason & Ricker-Gilbert, 2012). The colossal focus on these inputs is basically due to the fact that they are used in production of the country's most cultivated food item, maize, which is the staple food. This item is so important in Malawi to the extent that Smale (1995) postulates that "maize is life". Critical consideration of the exorbitant direct and opportunity costs incurred in the subsidies vindicates the studies that have aimed at evaluating the benefits of the program relative to its costs.

1.1 History and Theory of Subsidies in Malawi

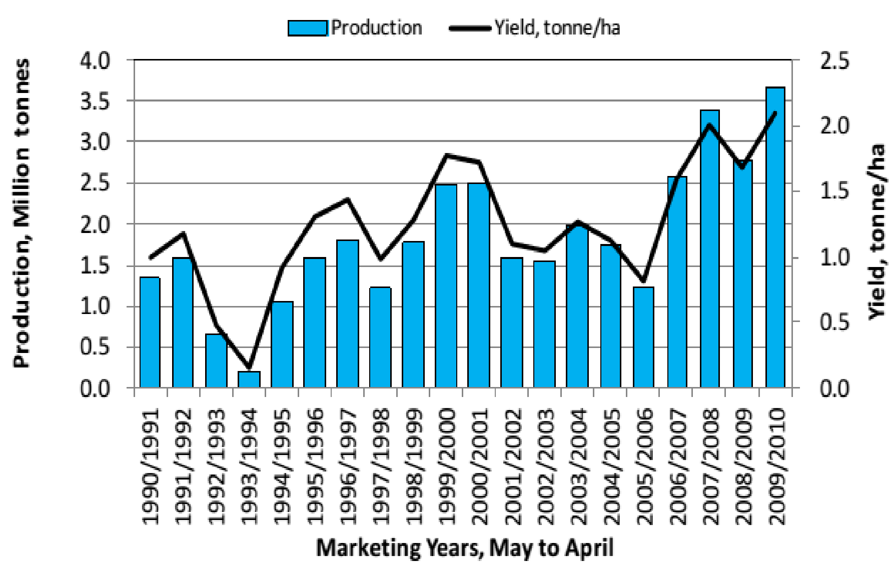
[1] "Smallholder" and "peasant" farmers are assumed to be equal and are thus used interchangeably in this study

[2] A farmer's willingness to pay for farm inputs is basically the farmer's amenableness to contribute a certain fee so as to obtain farm inputs for use on the farm.

The earliest forms of input subsidies in Malawi, known as Universal input subsidies, were implemented as agricultural development policies in poor rural areas from the year 1952 to the early 1980s to meliorate the availability of vital agricultural inputs at a low cost to even the most remote-located smallholder farmers so as to increase maize productivity and maintain soil fertility. However, Chirwa and Dorward (2013) assert that the subsidies were very expensive and placed a huge demand on public coffers as they stimulated increased fertilizer consumption and hence increased volumes of fertilizer subsidy. The high prices, coupled with deteriorating terms of trade, contributed to the ditching of this program in the early 1980s when the very first Structural Adjustment Programmes (SAPs)-by the World Bank and IMF-were introduced.

Between 1998 and 2000, the Starter Pack (SP) program was introduced with the intention of increasing maize yields and food security as well as countering soil nutrient depletion. In the program, starter packs of seed and fertilizer were provided to an estimated total of 2.86 million farming households to suffice for the cultivation of one-tenth of a hectare. The program was clearly necessary in raising maize output in Malawi but not sufficient as the country experienced poor harvests in the years 2001, 2002, 2004 and 2005 as illustrated by Figure 1 below.

Figure 1: Malawi Maize Production from 1990 to 2009



***Source**: Wiggins & Brooks, 2010*

The figure, depicting maize production from 1990 to 2009, shows a generally increasing pattern of maize production over the years with harvests exceeding the period’s estimated national requirement of 2.4 million metric tonnes. However, output from 2001 onwards was below the estimated minimum, leading to a review of the SP in favor of The Targeted Input Programme (TIP)[3].

In the 2004/5 Fiscal Year, Malawi was ranked as one of the poorest countries in the world, with 56% of its rural population classified as poor and 24% as ultra-poor (NSO, 2005a). Such perilous conditions, coupled with the hunger crises at the time, led to the initiation of the Agricultural Input Subsidy Programme (AISP) in the 2005/6 Fiscal Year targeting at least 50 percent of smallholder farmers to improve food security for the whole nation[4]. AISP involved the distribution of coupons for OPV maize and four types of fertilizers both of which were redeemed at the parastatal outlets ADMARC and SFFRFM (Dorward & Chirwa, 2009: 3). All fertilizers in this program were sold at about one-third of the normal price (maize fertilizers, for instance, were sold at MK950).

1.2 Problem Statement

More generally, it can be argued that farm inputs (including inorganic fertilizers and seeds) have a critical part in sustaining smallholder agricultural growth, not only in Malawi, but throughout the world, *ceteris paribus*. However, the fertilizer application rates in Africa, for instance, have been relatively low and insignificantly changing (Wiggins & Brooks, 2010). An example is in Malawi where the smallholder agriculture sector is characterized, *inter alia*, by low uptake of improved farm inputs thereby remaining unprofitable. To tackle this fall out, the state and various non-state actors (such as NASFAM) have taken many courses of action so as to intensify and commercialize smallholder agriculture. On the one hand, NASFAM promotes commercialization and change of mindset from mere subsistence farming to farming as business (Chirwa & Matita, 2012) and, on the other hand, the state through the FISP improves farmers' access to farm inputs.

One critical element that has proven crucial to the effectiveness of the subsidy program and for achieving efficiency in resource use is targeting. In this regard, Chirwa, Matita & Dorward (2013) argue that the subsidized fertilizers should be targeted at households that could not have managed to purchase the same at the prevailing market prices so as to avoid displacing commercial sales of fertilizers. This implies that individual households' characteristics are necessary to the effectiveness of subsidy programs since they have an impact towards both WTP and access to farm

[3] The Targeted Input Programme (TIP) was a scaled down version of the SP with a smaller quantity of fertilizer (10kg) per beneficiary and targeted selection of beneficiaries (Dorward, 2009)
[4] AISP is still operational but now commonly referred to as the Farm Input Subsidy Programme (FISP)

inputs at the subsidy prices hence they should be taken into consideration in policy making. With subsidy prices fixed above the farmers' affordability level, the program cannot reach the rural poor households and, contrariwise, if prices are set below the average household's affordability level, the program is all but a waste of public funds and a displacement of commercial sales of fertilizer.

Given that household characteristics can influence subsidy programs, it is worth examining the factors that have this impact on WTP and the magnitudes of their effects. Not many studies have been conducted in this field. For example, Maganga et al (2014) looked at factors determining demand for purchased inputs in Lilongwe and Minot et al (2000) studied fertilizer market reform and the determinants of fertilizer use in Benin and Malawi. Maganga, however, did not consider the determinants for Malawi as a whole, whereas Minot focused on farmers' fertilizer use rather than WTP. With due recognition of the contribution made by the previous studies, this study empirically analyses research data for Malawi as a whole so as to assess the determinants of farmers' WTP thereby broadening literature in this field.

1.3 Objectives of the Study

1.3.1 General Objectives

The main objective of this study is to determine the factors that influence farmer's WTP for subsidized farm inputs in Malawi.

1.3.2 Specific Objectives

In pursuit of the main objective, the following specific objectives will be examined:

i. To determine the impact of sex on farmers' WTP for subsidized farm inputs in Malawi
ii. To examine the impact of radio ownership on farmers' WTP for subsidized farm inputs in Malawi
iii. To assess the impact of farm size on farmers' WTP for subsidized farm inputs in Malawi

1.3.3 Hypotheses

In order to scrutinize the above specific objectives, the following null hypotheses will be tested:

i. Sex has no impact on farmers' WTP for subsidized farm inputs in Malawi
ii. Radio ownership has no impact on farmers' WTP for subsidized farm inputs in Malawi
iii. Farm size has no impact on farmers' WTP for subsidized farm inputs in Malawi

1.4 Justification and Policy Relevance of the Study

Many studies (including Dorward, 2009) observe that subsidy programs are very costly and they present heavy burdens on government budgets. This presents the need to trim down the government allocation to subsidies to reduce government deficits. The best way to do this is to gauge the average maximum that farmers are willing to pay for the farm inputs and charge that. In Malawi, prices of subsidized inputs are typically pre-fixed by administrators based on the total budget allocation without employing quantitative methodologies. This may lead to economic inefficiency by causing a discrepancy between farmers' WTP and the charged prices.

To this end, a quantitative willingness-to-pay study is needed for pricing of farm inputs in order to ensure that the government can only contribute the minimum amount that people would wish the authorities to contribute. Such information will help the government, planners and policy makers to know the maximum amount to spend to subsidize the farm inputs while justifying the achievement of the intended objectives, that is, food self-sufficiency and poverty alleviation.

1.5 Organization of the Study

The study is organized in five chapters as follows. Having introduced the subject in Chapter one, Chapter two analyses both the theoretical and empirical literature surrounding WTP and input subsidies. Chapter three outlines the employed methodology in which an econometric model of WTP is estimated as specified by Abebe and Bogale (2014), but this is modified to fit the Malawian context and the available data. Chapter four gives an interpretation of empirical results from the econometric model and this is followed by Chapter five which provides policy implications, the conclusion as well as the limitations and further direction for research on the topic.

CHAPTER TWO

2 LITERATURE REVIEW

2.1 Introduction

The following is a coherent discussion of both theory and studies that have been conducted both in Malawi and elsewhere in the world on WTP and input subsidies, presented in three sections.

2.2 Theoretical Literature

2.2.1 Rational Choice Theory

No established theoretical basis in economics exists on WTP for inputs but considering the fact that WTP is a choice that can be considered as rational, the rational choice theory can be applied in this perspective. In the standard view, rational choice is defined as the process of considering the available options and then choosing the most preferred one according to some consistent criterion. Rational choice theory often presumes that the individual decision-making unit in question is "typical" or "representative" of some larger group such as consumers or producers in a particular market hence it examines how individual choices produce outcomes (Green, 2002). In this case, the consumer is said to face known alternative choices that are transitive and complete.

Applying the theory in this context, we can say that, producers are faced with alternative quantities of fertilizer which they are willing to buy at different levels of prices so as to maximize output (and consequently utility). Such WTP is expressed with respect to expected utilities at the different levels of price (which is basically the revealed demand). In the case of a farmer exhibiting WTP, the benefits are the farm outputs that accrue to each level of implied demand for inputs and the costs in this hypothetical transaction include the monetary payments and the transaction costs.

The most scrupulous analysis of rational choice was provided by Becker (1976) who made an important assumption about preferences for the underlying objects of choice that are produced by each household using market goods and services, own time and other inputs. He assumed that the preferences neither change substantially overtime nor differ between wealthy and poor persons or even between persons in different societies and cultures. This assumption of stable preferences provides a stable foundation for generating predictions about responses to various changes such that in this study it guides the prediction of WTP for inputs with varying levels of input prices.

Concisely, Becker's theory is extremely useful and powerful due to the frequent accuracy of its predictions as well as its guidance to the formulation of public policy. Nevertheless, the theory is mainly criticized, among others, for its assumption of stable preferences since preferences may be changed by factors such as advertising (Galbraith, 1984). Additionally, contrary to Becker's model, real-world choices often appear to be highly situational or context-dependent and in reality many choices are not considered; but rather, they are based on intuitive reasoning and instincts. However, the first criticism is flawed because as long as the observed phenomenon can be considered to be a logical conclusion from the argument containing the false assumption in question, the use of that assumption should be acceptable (Friedman, 1953).

2.2.2 The Neoclassical Theory of Farm Production

Another theory that is very relevant to this study is the neoclassical theory of farm production. This theory begins with the farmer as an individual decision maker concerned with questions such as how much labour to devote to the cultivation of each crop; whether or not to use purchased inputs; which crops to grow in which fields; and so on (Ellis, 1993). It proposes three relationships between inputs and outputs about the economic decision making capacity of the farmer, namely;

a) **Factor-product or input-output relationship**: This, also called the *production function,* is the physical relationship between inputs and output to which all other aspects of the production process are ultimately related. Here farmers have to decide how much of inputs, say nitrogen fertilizer, to purchase at different price levels, say MK 500, to produce some level of output.
b) **Substitution between inputs**: This is the physical interaction between inputs as depicted by *isoquants.* In this regard, a farmer has to choose the level of each input to use in production. This can be linked to farmers' WTP for farm inputs because each farmer is faced with the decision of how much of each input to mix in production, say between land and fertilizer.
c) **Enterprise choice**: This, called the *product-product relationship,* is the physical interaction between outputs whereby a farmer considers the combinations of alternative outputs which can be produced for a given set of resources such as between crop or livestock enterprises.

2.3 Empirical Literature

Voluminous empirical studies and reviews demonstrate a robust association between farm inputs and farmers' demand, use or WTP for them, some of which are reviewed below.

2.3.1 Empirical Results on WTP for Capital Goods Studies outside Malawi

A study by Sylivia (2014) in central Uganda investigated farmers' WTP for virus-free sweet potato vines due to the reported high incidence of the Sweet Potato Virus Disease (SPVD) in the area. Contingent valuation methods were used to estimate WTP and the Tobit model was used to analyze the factors affecting farmers' WTP for the vines. Employment of the Tobit model in the study was in line with the recommendation by Aydin et al (2009) in their study that assessed producers' WTP for quality water. The results in Sylivia's study revealed that older or male farmers and those farmers producing sweet potatoes for both home and commercial purposes (as opposed to home consumption only) were willing to pay more for the vines. Higher earnings from sweet potato sales as well as sweet potato production experience also had a positive influence on WTP. The Tobit model used in this study can be of great use in a WTP study for farm inputs in Malawi.

Using a Probit regression model, Oladele (2008) examined the factors determining farmers' WTP for extension services in Oyo State, Nigeria. Using a multi-stage technique to select 200 farmers, the study revealed that 30 percent of the respondents were willing to pay for extension services. Factors such as farmers' age, gender, educational level, farm size, farming experience, land tenure, income, and proportion of crops sold were found to be significant determinants of farmers' WTP for the extension services. The Probit model used in this study can be a bone-of-contention because as Basarir et al (2009) demonstrate; WTP studies that are more likely to have most respondents indicating zero imply that we have a censor problem and hence the Tobit gives better estimates.

Paudel et al (2009) presented a paper at the 83rd Annual Conference of the Agricultural Economics Society in Dublin about the socio-economic factors influencing the adoption of fertilizer for maize production in Chitwan district, Nepal. The study used the survey data collected from 117 farm households and employed the Tobit regression model and discovered that the major factors having positive influence on the use of fertilizer in maize production were family size, farm size, credit use, off-farm income and irrigation use. The study showed the need for adequate irrigation facility and assurance of easy credit availability from financial institutions to the farmers. Further, creation of off-farm activities in the study area to obtain additional income was necessary at the household level to fulfill the cash requirements for investing in the improved technologies. Apparently, the sole focus on socio-economic factors in this study is a flaw since various other factors are potent.

According to Cho et al (2008), income and knowledge are positive and significant determinants of WTP for land conservation easements, while distance to poorer quality streams and duration of residency are negative and significant determinants. The study compared an ordered Probit model and a Tobit model with selection to take into account both true zero and protest zero bids while estimating the WTP for conservation easements in Macon County, NC. By comparing the two models, the ordered/unordered selection issue of the protest responses was analyzed to demonstrate how the treatment of protest responses can significantly influence WTP models. Similar results were obtained in a study conducted by Hagos, Mekonnen & Gebreegziabher (2012) where Mekelle City's residents' WTP for improved solid waste management was significantly related to income and awareness of environmental quality, among others. The analysis adopted Tobit and Probit models to assess the prevalent municipal sanitation fees and residents' WTP.

2.3.2 Empirical Results on WTP for Capital Goods Studies in Malawi

As already stated out; very few studies have been conducted on farmers' WTP for subsidized farm inputs in Malawi, where the most focus has been on determinants of either demand or actual use.

To begin with, Maganga et al (2014) did a study whose aim was to empirically determine the factors that affect smallholder farmers' demand for purchased fertilizer and seed using cross-section data from 160 farmers in Lilongwe district, Malawi. Model solutions, which were created by using Translog Cost Function, were carried out by the Seemingly Unrelated Regression (SUR). The study revealed that education, field size and household size have significant negative impacts on the share of fertilizer purchased and positive effects on the share of seed. On the contrary, price of output, seed, fertilizer and household income were found to be significant and positively related to the share of fertilizer and negatively related to share of purchased seed. However, the SUR used includes only exogenous regressors and may thus lose some important variables in the process. Related to this study by Maganga and others is Njiwa (2007) who found a positive relationship between price of fertilizer and intensity of its use. Price of output in this study was both significant and positively related to its use. Therefore, both prices of the output and fertilizer influence farmers' decision to use fertilizer. In the study, household size and share of fertilizer portrayed an inverse relationship whilst having a positive relationship with the share of seeds.

Another study by Maonga, Maganga and Kankwamba (2015) analyzed the critical and significant socioeconomic factors with high likelihood to determine smallholder farmers' decision and willingness to adopt jatropha into cropping systems in the country using cross-sectional data. A Probit model was used for the analysis which revealed that education, access to loan, bicycle ownership and farmers' expectation of raising socioeconomic status are major significant factors that would positively determine the probability of smallholder farmers' willingness to adopt jatropha as a biofuel crop on the farm. Furthermore, rearing of ruminant herds of livestock, long distance to market and fears of market unavailability were found to have a significant negative influence on farmers' decision and willingness to adopt jatropha. This study, however, had no data on the cost of jatropha production; hence the model only included the other observable variables. This implies that the model would not be useful to predict a price-demand relationship.

Last, in this paper, is Minot, Kherallah and Berry (2000) who did a study on fertilizer market reform and the determinants of fertilizer use in Benin and Malawi. The authors vehemently explored the factors behind widely different experiences with input market reform. A Heckman model was used to identify the determinants of fertilizer use and it was found that fertilizer use is closely related to crop mix and access to inputs on credit, but not to household income. In both countries, farmers growing cash crops were three times more likely to fertilize their maize fields than the other farmers. The results showed that cash and food crop production can be complementary through the residual effect of fertilizer on food crop production, through alleviation of cash constraints for the purchase of fertilizer and through the availability of inputs on credit. One point of strength of this study lies in its use of the Heckman model which allows it to predict both the decision to use fertilizer and the quantity used. However, the study does not tap into the revealed demand for subsidized farm inputs as is the aim of this paper.

2.4 Chapter Summary

According to the theoretical literature reviewed above; we may say that theory postulates that individual farmers' characteristics such as income, education, gender and household head age influence the farmer's consideration of WTP as rational or not. In this regard, these factors can be hypothesized as important determinants of a farmer's WTP. Other factors include credit use, fertilizer price and farm size. Empirically, most WTP studies for farm inputs have focused on farm inputs in general, rather than subsidized farm inputs. Some studies have also had relatively small sample sizes, less than 200.

CHAPTER THREE

3 METHODOLOGY

3.1 Introduction

This chapter is a presentation of the tools used in this study as motivated by both the theoretical and empirical review of literature provided in Chapter two. It explains all the variables, the econometric model, data and the diagnostic tests employed in this study.

3.2 Empirical Strategy

The dependent variable in this study is willingness to pay (WTP). WTP by various economic agents for either capital or non-capital goods has been widely researched in economics. For instance, Basarir (2009) analyses producers' WTP for high quality irrigation water and he defines WTP as the amount of money that a producer is willing to part ways with to access the water. Oladele (2008) defines WTP both as the services that farmers are willing to pay for and the sums of money they are willing to pay for such services. Based on these studies, this analysis proxies WTP as the number of 50kg fertilizer bags that a farmer would purchase given the various fixed subsidy prices. The questionnaire used to collect the data used in this study obtained the number of 50kg bags that farmers would buy in the 2012/13 season at five prices with no subsidies[5].

3.3 Theoretical Foundation

Based on expected utility theorem and an approach proposed by Stiglitz (1976), a farmer's preferences for income in any two states of nature, good or bad, can be functionally described. The expected income value can be defined as,

$$V(p, W_1, W_2) = (1 - p)U(W_1) + pU(W_2) \qquad (3.1)$$

where W_1 denotes the farmer's income in a good state of nature (say good rains); W_2 his income in a bad state of nature (say poor rains), with probability p; and $U(\ )$ the utility of money income.

Assuming that $\alpha = (\alpha_1, \alpha_2)$ represents the subsidy program; where α_1 is a farmer's payment for a 50kg fertilizer bag and α_2 is the output for each 50kg bag minus the payment per 50kg bag. Therefore, letting W be the initial income and d the income loss due to a bad state of nature, then the expected value of the subsidy is,

[5] The prices were MK1, 000; MK3, 000; MK5, 000; MK7, 000; and MK9, 000

$$V(p,\alpha) = V(p, W-\alpha_1, W-d+\alpha_2) = (1-p)U(W-\alpha_1) + pU(W-d+\alpha_2) \quad (3.2)$$

But a farmer always has the option of not buying the subsidized input. Hence he will utilize the subsidy α only if $V(p,\alpha) \geq V(p,0) = V(p,W,W-d) = (1-p)U(W) + pU(W-d)$.

Therefore farmers' WTP and the amount charged on each 50kg bag are related as follows;

when $\alpha_1 \leq WTP,\ V(p,\alpha) \geq V(p,0)$; and when $\alpha_1 > WTP,\ V(p,\alpha) < V(p,0)$

meaning that a farmer buys the input to get higher utility if subsidy price is less or equals WTP.

3.4 Analytic Modeling

This study makes use of the Tobit model to capture the determinants of farmers' WTP for subsidized farm inputs in Malawi. This is because the Ordinary Least Square (OLS) method cannot yield consistent and unbiased estimates given that information for the dependent variable (WTP) in this study is available only for some observations (Greene, 2007; Gujarati 2004)[6]. This far, the study would have employed the Logit or Probit models as is done in a number of similar studies. For instance, Tolera et al (2014) analyzed the factors affecting farmers' WTP for agricultural extension services in Ethiopia using the Logit model. Ahuja and Sen (2006) used the Probit analysis to assess the WTP for veterinary services in poor areas of Rural India and, similarly, Maonga et al (2015) used the Probit model to analyze socioeconomic determinants of smallholder farmers' willingness to adopt the biofuel crop (jatropha) in Malawi. However, use of the Logit or Probit model in this study would imply that WTP would be treated as dichotomous (Wooldridge, 2006) thereby not making full use of the comprehensive data used for this study[7].

An alternative model is the Heckman which involves, firstly, estimating the probability based on the Probit and then estimating the Tobit by adding to it a variable, called the inverse Mills ratio or the Hazard rate, that is derived from the Probit estimate. However, the Tobit is maintained because its Maximum Likelihood estimates are more efficient than those in the Heckman (Gujarati, 2004).

Another reason for selection of the Tobit is because the data being used shows some households that indicate zero WTP for the inputs but they still use the inputs on their farms, and more still, other households that have observable characteristics which reveal that they are willing to pay (that is, have a non-zero WTP) and yet they are not able to specify exactly how many fertilizer bags

[6] But if no observations were censored, then the Tobit estimates would be the same as the OLS estimates
[7] Malawi 2012/13 Farm Input Subsidy Study (FISS4)

they would purchase at the different prices. This means that we have some observations with information on the regressors only, but not the regressand and literally we have a limit or boundary on the regressand on which a good number of observations hit. In this regard we have excess zeros for WTP, as is shown by the Kernel density in Figure 4 from Appendix 1A. Gujarati (2004) argues that the Tobit in this regard is the best model to handle such a situation because of its use of censored data.

3.5 The Tobit Model

With some observations having information only on the regressors but not on the regressand, a sample is said to be censored[8]. Censoring basically means a loss of information; that is, we have missing observations on the regressand and hence the distribution that appropriately applies to the sample data is a mixture of discrete and conditional distribution, which is the Tobit. According to Greene (2003), the Tobit model, commonly known as the censored normal regression model or the corner solution model, assumes that many variables have a lower or upper limit, known as the threshold value, and a significant number of observations take on this limiting value. Since in this study we expect many zero (or non-negative) values for WTP, the Tobit is appropriate. The Tobit model censored from below is structured in the form of an index function as follows[9]:

$$y_i^* = \boldsymbol{x}_i'\beta + \varepsilon_i, \tag{3.3}$$

$$y_i = \begin{cases} y_i^* & \text{if } y_i^* > 0, \\ 0 & \text{if } y_i^* \leq 0 \end{cases}$$

Where, $y_i =$ the observed dependent variable, in this case the maximum WTP (measured as number of fertilizer bags) at various subsidy prices

$y_i^* =$ the latent variable which satisfies CLRM assumptions, and is not observable where $y_i^* \sim \mathcal{N}[\boldsymbol{x}_i'\beta, \sigma^2]$

$\boldsymbol{x}_i' =$ $k \times 1$ vector of factors affecting WTP (exogenous and fully observed regressors)

$\beta =$ $k \times 1$ vector of unknown parameters to be estimated (Tobit coefficients)

$\varepsilon_i =$ vector of independent and identically distributed normal random variables assumed to have mean zero and constant variance σ^2, that is, $\varepsilon \sim \mathcal{N}[0, \sigma^2]$

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[8] A censored sample where limit observations are included in the sample is different from a truncated sample in which limit observations are not included in the sample, and hence not a representative of the population.

[9] The Tobit model is derived in Appendix 1B

More generally, Tobit models begin with equation (3.3) for the latent variable, but censoring from above; from both below and above (the two-limit tobit); and interval censored data, may be used.

3.6 Empirical Specification

This study adopts a similar specification to that by Abebe and Bogale (2014) in their study of the WTP for rainfall based insurance by smallholder farmers in Central Rift Valley of Ethiopia. However, this specification is modified selecting only those variables that may be appropriate for a study of WTP for farm inputs in Malawi, and adding completely new variables such as farm size, food security as well as on- and off-farm income based on the data set. WTP can be defined, more scrupulously, as the amount of money that must be taken away from a person's income while keeping his utility level constant computed by asking people how much they are willing to pay for non-market goods or for their quality improvement (Freeman, 2003). In this study we obtain the number of 50kg fertilizer bags that farmers would purchase at $MK\ 1000$. Choice of this price level is made because out of the five prices, it is $MK1,000$ which is the closest to $MK\ 950$, the usual price implemented in FISP (Dorward & Chirwa, 2009). Therefore;

$$WTP_{MK1,000}{}^{*} = \tau_0 + \tau_1 AGEHH + \tau_2 AGESQ + \tau_3 SEXH + \tau_4 FARMS + \tau_5 EDUHH + \\ + \tau_6 COUP + \tau_7 FINC + \tau_8 OFIN + \tau_9 ICOST + \tau_{10} FOOD + \tau_{11} RADIO + \tau_{12} LIVESTOCK + \mu_i$$

$$\text{where } \mu_i|X_i \sim \text{Normal}(0, \sigma^2) \text{ and } WTP_i = max(0, WTP_i{}^{*}) \quad (3.4)$$

3.6.1 Variable Definitions and Measurements

Age of Household Head: This is a continuous variable defining how old the head of each farm household is at the time of the interview. According to Maganga et al (2014), older farmers are likely to purchase more farm inputs than younger ones. This is due to the high experience and acquaintance with new technologies gained with aging, and hence older farmers have a higher ability to demand the new technologies more efficiently. Therefore, in this study it is hypothesized that the older the farmer the higher the WTP for subsidized farm inputs, and the converse is true.

Square of Age of Household Head: This is a continuous variable which is calculated as the square of the age of a household head. The older the farmer, the less the involvement in production hence the increments in WTP decline. Thus we hypothesize a negative relationship for this quadratic.

Sex of Household Head: This is a dummy variable taking a value of 1 for a male-headed household and 0 otherwise. In this study we hypothesize that sex is positively related to WTP, thus males are more likely to have a higher WTP than their counterparts.

Illness Costs: This is a continuous variable that measures the amount of money that was spent if a household member fell ill during the 2012/13 growing season. We expect this to have a negative effect on farmers' WTP for subsidized farm inputs. This is because the health insurance industry in Malawi is underdeveloped[10] hence the payment method for the illnesses is likely to be out-of-pocket (OOP) expenses which may lead to catastrophic health spending.

On-Farm Income: This is a continuous variable measuring the inflows that the household realized from sales of crops harvested in the 2011/12 season. Economic theory articulates that when income increases, consumers buy more of any normal good and the converse is true (Parkin, Powell & Matthews, 2008). Therefore we hypothesize a positive relationship for this regressor.

Off-Farm Income: This is the total of all received incomes from April 2012 to March 2013. For this variable we may also hypothesize a positive relationship with WTP. However, a farm household may be compelled to invest in those other revenue avenues if more returns are realized from them. In this case, off-farm income has a negative relationship with WTP.

Education of Household Head: This is a categorical variable defined in terms of the highest educational qualification acquired by the household head. In this study, we hypothesize a positive relationship between education and WTP. This is because educated farmers have a better chance to acquire more information leading to improved understanding of the importance of the farm inputs (Maonga, Maganga & Kankwamba, 2015).

Farm Size: This is a continuous variable measuring the amount of land in the area that the household currently has ownership or cultivation rights over. According to Maganga et al (2014), as land size increases, farmers use large seed quantities and relatively small amounts of fertilizer. Therefore, we hypothesize declining WTP with increases in farm size.

Livestock Holdings: This is a continuous variable representing the total number of animals held by the household. If sold, the animals increase income for the farm household thereby increasing WTP for farm inputs. However, WTP is inversely affected as animal holdings increase since funds may be shifted from crop production, hence this is a competing investment to crop production.

[10] See Makoka, Kaluwa & Kambewa (2007)

Radio Ownership of the Household: This is dummy variable defined as 1 if the household owns a radio and 0 otherwise. A radio is critical in information dissemination[11] hence with a radio one can quickly receive subsidy information and therefore more easily convinced to pay for the inputs.

Food Security: This is defined as a dummy taking a value of 1 if the household's farm output was just adequate or more than adequate to meet the household food needs over the past 12 months and 0 if output was less than adequate for household needs. The more food secure, the higher the WTP.

Coupon Receipt: This is a dummy variable taking 1 if any member of the household obtained fertilizer using coupons in the 2011/12 or 2012/13 agricultural seasons and 0 otherwise. We hypothesize a positive relationship between coupon receipt and WTP.

3.7 Data

This study makes use of data from the Malawi 2012/13 Farm Input Subsidy Study (FISS4) to determine the factors that affect farmers' WTP for subsidized farm inputs in Malawi. FISS4 is a national survey conducted by Wadonda Consult for the Malawi Ministry of Agriculture and Food Security to learn about the effects of various agricultural policies implemented by the Government, especially the input subsidy program, and to find out how to improve them to benefit farmers and the people of Malawi. Several households across the country were randomly selected and the survey collected detailed information on education, health, agriculture and many others.

3.8 Diagnostic Tests

3.8.1 Multicollinearity and Association

Multicollinearity exists if there exists a perfect or near-perfect linear relationship among some or all of the regressors in a model, contrary to the CLRM assumptions, leading to indeterminate regression coefficients, infinite standard errors and wider confidence intervals which reduce precision in estimation. Gujarati (2004) says it is a sample phenomenon hence we do not "test for multicollinearity" but simply measure its degree where a pair-wise correlation coefficient above 0.8 is worrisome[12]. Correlated variables can be dropped as a solution so long as new model is fit.

[11] Including extension service, credit service, use of new technologies, improved seed varieties, input price, output price and crop protection

[12] Of course although high zero-order coefficients may suggest collinearity, it is not necessary that they be high to have collinearity in any special case. See Gujarati (2004)

3.8.2 Heteroscedasticity

Apart from multicollinearity, heteroscedasticity is another problem in CLRMs which also assumes that the variance of each disturbance term conditional on the chosen values of the explanatory variables is constant. Heteroscedasticity means the error variances are non-constant hence OLS estimates are consistent but not efficient in a linear model. For limited dependent variable models, such as the Tobit, the estimates of the corresponding regression coefficients are upward biased with heteroscedasticity. In this regard, we can use the graphical method (plotting $\hat{\mu}_i^2$ against $\hat{Y}_i$) to see if there is a pattern that shows heteroscedasticity. More formally, we can also use the Breusch-Pagan-Godfrey (BPG) test to inspect the same. However, in this study, robust standard errors are used to control heteroscedasticity even without testing for it.

3.8.3 Model Specification and Overall Significance of the Model

This is a test about whether we are using the correct model for empirical analysis as is required in CLRM. According to Hendry and Richard, a model chosen for empirical analysis should be encompassing, data admissible, consistent with theory; it should exhibit parameter constancy, data coherency; and, lastly, it should have weakly exogenous regressors (Gujarati, 2004). In this study, the Link test is used to test for model specification. This test involves estimating the Tobit model and then running the STATA command *linktest, ll(0)* for the Tobit censored at zero. If the result shows that *_hat* is significant at 5% significance level while *_hatsq* is insignificant on the same level then the model is correctly specified. To test for overall significance, the pseudo-R^2 is used which gives the variation in the regressand that is explained by the independent variables.

3.8.4 Endogeneity

Endogeneity basically refers to the case where there is correlation between a variable and the error term. The causes of endogeneity include omitted variables and sample selection errors. Cameron and Trivedi (2005) argue that if any regressor is endogenous then in general OLS; estimates of all regression parameters are inconsistent unless the exogenous regressor is uncorrelated with the endogenous regressor. A quite general approach to control for endogeneity is the instrumental variables method. However, due to lack of instruments in this study, we do not test for endogeneity.

CHAPTER FOUR

4 PRESENTATION AND INTERPRETATION OF THE RESULTS

4.1 Introduction

The four sections in this chapter present and interpret the results obtained in this study.

4.2 Descriptive Analysis of the Data

This section uses descriptive statistics such as mean, standard deviation, minimum and maximum values to announce the major factors influencing farmers' WTP for subsidized farm inputs in Malawi. The statistics are displayed in Table 1*: Descriptive Statistics* below.

Table 1: Descriptive Statistics[13]

Variable	Obs	Mean	Std. Dev.	Min	Max
WTP_1000	4742	9.888	8.987	0	70
Age of H/H Head	1279	38.151	14.225	20	85
Square of Age	1279	1657.696	1316.364	400	7225
Male H/H Head	1279	0.782	0.413	0	1
Farm Size	4742	1.823	3.552	0	30.5
Education of H/H Head					
PSLC	4742	0.024	0.154	0	1
JCE	4742	0.012	0.110	0	1
MSCE	4742	0.000	0.021	0	1
Coupon Receipt	4742	0.988	0.107	0	1
Farm Income	4742	1418.67	8982.00	0	400000
Off-Farm Income	4742	21341.77	181210.00	0	2200000
Illness Costs	4742	558.08	2168.84	0	15500
Food Security	4742	0.682	0.466	0	1
Radio Ownership	4742	0.038	0.190	0	1
Livestock Ownership	4742	0.663	2.426	0	30

Source: Author's Tabulation from FISS4 data

The above table shows that the average age of the household head in the survey was 38.151 years with a minimum value of 20 and a maximum of 85. The variable has a standard deviation of about

[13] All figures are rounded off to 3 decimal places except for the monetary variables

14.225 which shows the range between the youngest and oldest farmers. For sex, where 1 indicates a male household head, the mean is 0.782 implying that about 78.2 percent of the 1279 responses that were non-missing in the data set were males and the rest were females. Deviation is small. In as far as farm size is concerned, the statistics show a mean of approximately 1.823 acres and a standard deviation of about 3.552 with the observations ranging from 0 to 30.5. This shows that there is a significant variation between the farmers who control the biggest pieces of land and those who control no piece at all. For education, about 2.4 percent of the surveyed household heads acquired a PLSCE as their highest qualification; 1.2 percent acquired a JCE; and 0.04 percent an MSCE with the remaining 96.36 percent of observations being with no education qualifications or giving missing values. These statistics show that education levels are very low among the farming households. The statistics also reveal that about 98.8 percent of the households under study had at least one household member obtaining fertilizer using coupons in either the 2011/12 or the 2012/13 agricultural seasons, compared to the 1.16 percent that did not obtain any fertilizers using coupons.

For the two income variables we have means of 1418.67 Kwacha and 21,341.77 Kwacha for on- and off-farm incomes respectively. For both incomes, we have very high deviations as shown by both the standard deviations (8982.00 and 181,210 respectively) and the ranges (400, 000 and 2,200,000 kwacha respectively). Another monetary variable is illness costs which has an average of 558.08 kwacha; minimum and maximum illness costs of 0 and 15,500 kwacha respectively and a standard deviation of 2168.84 which is the third highest, after the two income variables explained above.

In as far as food security is concerned, the statistics in the table show that about 68.2 percent of the households were food secure such that their food consumption over the past 12 months were either just adequate or more than adequate for household needs. From the table we also depict that radio ownership has a mean value of 0.038 showing that about 3.8 percent of the sample owns wireless radios and the remaining 96.2 percent do not own radios or have missing variables. This means that radio ownership is very scanty among the farming households in Malawi. The statistics also show that 66.3 percent of the households own livestock with a relatively small deviation ranging from 0 to 30. A quick look at the dependent variable shows 9.888 as the mean and 8.987 as the standard deviation with a minimum value of 0 and 70 as the maximum. The mean of 9.888 is the average number of 50kg fertilizer bags that households would purchase in the 2012/13 agricultural season at MK1, 000 if there were no subsidies and unsubsidized urea prices were different. The minimum value of 0 bags in this case is in line with the income levels which have 0 kwacha as the minimum.

4.3 Bivariate Analysis

Having explained the descriptive statistics for all the variables used in this study, a simple analysis of the relationship between the dependent variable and some dummy regressors is necessary, starting with the relationship between WTP and sex of the household head in Table 2 below.

Table 2: Relationship Between WTP_1000 and Sex

Willingness To Pay at MK1, 000 Against Sex					
SEXH	**N**	**Std. Dev.**	**Min**	**Max**	**Range**
Female	279	2.73078	0	12	12
Male	1000	5.21635	0	70	70
Total	**1279**	**5.17572**	**0**	**70**	**70**

Source: Author's Tabulation from FISS4 data

Just like in any other capital good, sex can influence WTP for farm inputs. In the above result out of 1279 non-missing values for WTP and sex, males are likely to demand more bags of fertilizer relative to females with the maximum value for females being 58 bags less than that of males. This may be because men are more likely to control large pieces of land demanding application of more fertilizers than for females. In Table 3: Relationship Between WTP_1000 and Food Security

below is the relationship between WTP and food security.

Table 3: Relationship Between WTP_1000 and Food Security

Willingness To Pay at MK1, 000 Against Food Security					
FOOD	**N**	**Std Dev.**	**Min**	**Max**	**Range**
Insecure	1510	4.70452	0	25	25
Secure	3232	10.1625	2	70	68
Total	**4742**	**8.98657**	**0**	**70**	**70**

Source: Author's Tabulation from FISS4 data

From the table above, we see that 1, 510 households were food insecure and they are willing to pay a maximum of only 25 bags of inorganic fertilizers relative to 70 bags for the 3, 232 households that were food secure. Such a discovery supports our positive *a priori* expectation between WTP and food security. Last is how WTP and education are related as illustrated in Table 4 below.

Table 4: Relationship Between WTP_1000 and Education

Willingness To Pay at MK1, 000 Against Education					
EDUHH	**N**	**Std. Dev.**	**Min**	**Max**	**Range**
None	4567	9.05794	0	70	70
PSLC	115	2.587743	2	30	28
JCE	58	2.405881	2	25	23
MSCE	2	42.42641	10	70	60
Total	**4742**	**8.986573**	**0**	**70**	**70**

Source: Author's Tabulation from FISS4 data

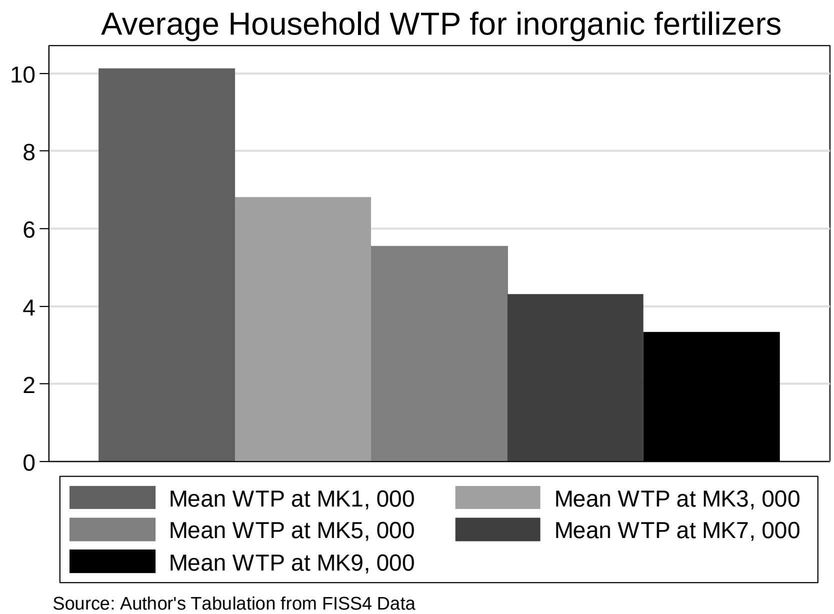
Education has a crucial role in enlightening people on the benefits of technology adoption. Maganga et al (2014) found that education has a negative impact on demand for purchased fertilizers. The above table shows that the minimum values of WTP increase with increasing levels of education and the maximum values decrease with increasing education levels. However, MSCE displays outlying statistics as it has a very high minimum and maximum WTP values. Disregarding the 70 as maximum WTP for the non-educated, we can say education increases WTP for inputs.

4.4 Derivation of Implied Average Household Demand and Aggregate Demand

Farm households in the FISS4 were asked to state the number of 50kg fertilizer bags they would be willing to buy at five different prices. In this respect, particular interest may be paid both to the average household's implied demand for the subsidized farm inputs as well as the aggregate demand for the whole population under study. The average household demand curve is derived by calculating the mean WTP for each of the five prices in FISS4 whereas the aggregate demand curve is found by summing all households' stated levels of demand for the five levels of prices. The bar graph for the average household WTP is plotted in

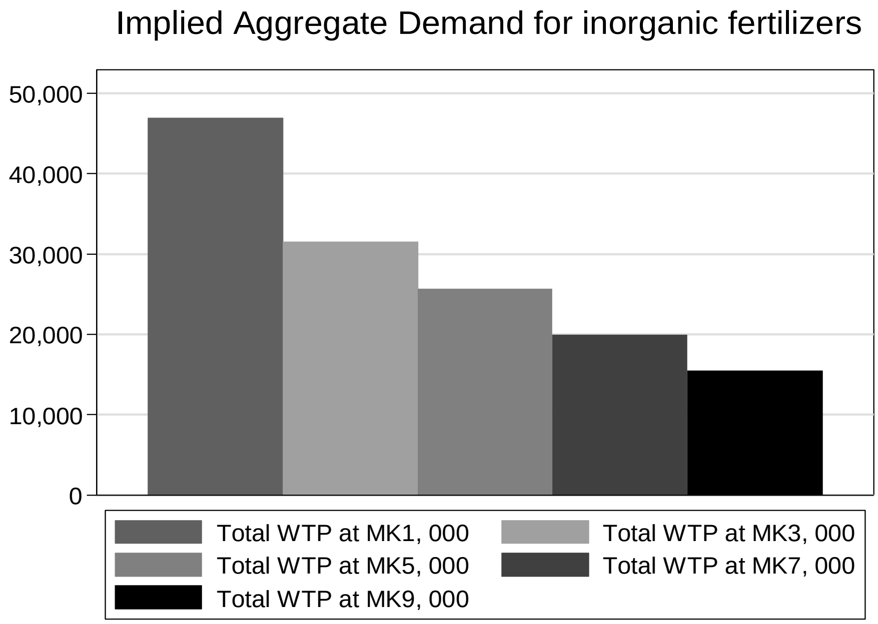
Figure *2* below.

Figure 2: Implied Mean Household Demand Curve for subsidized farm inputs



This shows a negatively sloped implied demand curve with the highest being 10.13 bags. This validates the price-demand nexus. Figure 3 below presents the aggregate demand for farm inputs.

Figure 3: Implied Aggregate Household Demand Curve for subsidized farm inputs



Source: Author's Tabulation from FISS4 Data

The figure above shows the implied aggregate demand for subsidized farm inputs using the observations in the study. Just like the implied average household demand for farm inputs shown previously in figure 2, the implied aggregate demand in this curve exhibits a negative relationship. The maximum amount of fertilizer bags that people are willing to pay for is 46, 891 at MK1, 000 and the minimum is 15, 442 at the highest price of MK9, 000. The area under this demand (curve) represents the gross value of consumer surplus if the inputs are provided to producers for free[14]. Now a multivariate analysis can be conducted to control for other variables.

4.5 Econometric Results

To estimate the Tobit model, the study utilized the econometric software STATA version 13.1. In the Tobit model the main objective was to identify the factors affecting WTP for subsidized farm inputs in Malawi and its intensity in relation to demographic and socio-economic factors.

4.5.1 Econometric Tests and Results

Various diagnostic tests were conducted to ensure that the made statistical inferences are down-to-earth. First the model is estimated using robust standard errors to resolve any heteroscedasticity

[14] The producers are the demanders in this case

that may have been prevalent. Multicollinearity is also checked using pair-wise or zero-order correlation coefficients between any two regressors that are used. For this study, the result presented in Appendix 2A revealed that all values but one were less than 0.8, suggesting the absence of a serious multicollinearity problem among the regressors. The pair that shows a very high correlation is age and its square (about 0.9922), but this is not worrisome because collinearity between these two variables is inevitable looking at the fact that one is a function of the other.

Having successfully passed a bivariate analysis for the regressors, the model was tested to see if the specification is appropriate soon after running the Tobit model. To do this, the Link test was used taking into account the censoring at zero thereby employing the stata command *linktest, ll(0)*. Results of this test as depicted in Appendix 2B show that the model is correctly specified with a significant P-Value of *_hat* (0.000) and an insignificant one for *_hatsq* (0.607).

The econometric results of the Tobit model censored at zero are presented in Appendix 2C. With F(13, 1266) = 401.23 and Prob > F = 0.0000 the null hypothesis that all of the regression coefficients are simultaneously equal to zero is rejected. This small P-Value means that at least one of the regression coefficients in the model is not equal to zero. The Tobit regression coefficients are interpreted in the same way as the OLS regression coefficients, however, the linear effect is on the uncensored latent variable, not the observed outcome. Thus, for example, a 1-year increase in age leads to about a 0.79 increase in latent (desired unobservable) WTP for farm inputs, ceteris paribus. In this case, it is more economically sensible to interpret the marginal effects of the regressors on the actual expected observed WTP for farm inputs at MK1, 000. All these results are presented in Table 5 below where the first column is for the latent WTP and the other two columns depict marginal effects at means and the probabilities respectively.

Table 5: Marginal Effects of the Explanatory Variables on the Dependent Variable

VARIABLES		**Change in Latent Y** $\frac{\partial[E(y^*\|\boldsymbol{x})]}{\partial x_i}$	**Change At Means** $\frac{\partial[E(y\|\boldsymbol{x},y>0)]}{\partial x_i}$	**Change in Probability**[15] $\frac{\partial[P(y>0\|\boldsymbol{x})]}{\partial x_i}$
Age of H/H Head		0.7852636***	0.7671398***	0.0111327***
		(0.0845363)	(0.0821773)	(0.0018359)
Age Squared		-0.0082399***	-0.0080497***	-0.0001168***
		(0.000926)	(0.0009009)	(0.0000195)
Sex of H/H Head				
	Male	5.166269***	4.825429***	0.1609398***
		(0.3482826)	(0.3029703)	(0.0198197)
Farm Size		1.894079***	1.850364***	0.0268524***
		(0.1177463)	(0.1173106)	(0.0029406)
Education of H/H head				
	PLSCE	1.632459***	1.607898***	0.0159621***
		(0.2783333)	(0.2758209)	(0.0027581)
	JCE	(3.837266)	3.803761	0.0227373***
		(4.510688)	4.50314	(0.0070131)
Coupon Receipt				
	Yes	-5.188698***	-5.150964***	-0.0256047***
		(0.3799053)	(0.3788245)	(0.0039953)
On-Farm Income		-0.0000286**	-0.000028**	-0.000000406**
		(0.000014)	(0.0000136)	(0.000000201)
Off-Farm Income		-0.00000786***	-0.00000767***	-0.000000111***
		(0.00000259)	(0.00000254)	(0.0000000365)
Illness Costs		0.0000139	0.0000136	0.000000198
		(0.0003204)	(0.000313)	(0.00000454)
Food Security				
	Secure	1.921006***	1.863337***	0.0335869***
		(0.3283931)	(0.3131163)	(0.0086053)
Radio Ownership				
	Yes	2.238286***	2.209813***	0.0188215***
		(0.5219469)	(0.5185773)	(0.0035688)
Livestock Holdings		0.0328022	0.0320451	0.000465
		(0.0584307)	(0.057078)	(0.0008322)

Note: * denotes significance at 10% (i.e. $p < 0.10$); ** at 5% (i.e. $p < 0.05$); *** at 1% (i.e. $p < 0.01$)
In parentheses are Robust Standard errors

Source: Author's Tabulation from FISS4 data.

[15] This is also the same as $\frac{\partial E(y_i|x_i, y_i^*>0)]}{\partial x_i}$

4.5.2 Interpretation of the Results

Just as the usual R-squared for OLS is equal to the squared correlation between y_i and the OLS fitted values, the R-squared in the Tobit model is the square of the correlation coefficient between y_i and $\widehat{y_i}$, where $\widehat{y_i}$ is the estimate of $E(y|\boldsymbol{x} = \boldsymbol{x_i})$. It can be noted that the Tobit model (in Appendix 2C) with jointly significant regressors has a Pseudo R-squared of about 12.13%. This is, however, not substantially worrisome because the Tobit estimates are not chosen to maximize R-squared, but rather they maximize the log-likelihood function (Wooldridge…). Interest in this analysis centers on probabilities or expectations involving WTP. Below are results interpretations.

Farm Income (FINC): Farm income has a very small negative but statistically significant impact on WTP for 50kg fertilizer bags at 5 percent level of significance. Each additional Kwacha in the value of sales of crops such as maize, groundnuts and beans leads to a 0.0000286 decline in desired WTP for 50kg fertilizer bags, *ceteris paribus*. This shows that the variable is economically insignificant as the impact is very close to zero; a result contrary to our *a priori* expectation but similar to those by Minot, Kherallah and Berry (2000). The second column shows that conditional on WTP being positive, an additional Kwacha in the household crop sales (starting from mean values of all variables) is estimated to reduce expected WTP by a value very close to zero; that is, 0.000028. The results also show that the probability of crop sales affecting WTP is almost zero. Possible reasons behind these almost-zero values include farmers' underreporting due to inability to recall or failure to add sales together as well as the lack of control of sales for the respondents.

Off-Farm Income (OFIN): The result in this case is similar to that for farm income with almost negligible negative impacts, and the only difference being that here significance is at 1 percent level. The negative impact in this case shows that crop production and other enterprises such as fishing, making mats and tailoring are competing such that the high revenues from the other enterprises crowd-out investment in crop production thereby reducing investment in fertilizers.

Age of Household Head and Age Squared (AGEHH and AGESQ): The above results show that age of household head is an important factor that influences farmers' WTP positively and is statistically significant ($P<0.01$). A one-year increase in age of household head leads to about a 0.785 bags increase in desired WTP, a result depicting economic significance. There are however declining returns to age for WTP as can be seen in the negative coefficient of the square of age such that WTP increases with age at a declining rate. Conditional on WTP being positive and all variables being at their mean values, an additional year in the age of household head is estimated to increase WTP by about 0.767. Therefore older household heads are more likely to be willing to pay for the farm inputs compared to younger heads. This may be explained by the fact that older heads have more experience in farming and as such understand the big impact that the fertilizers have on yields so they are willing to pay for more. The result shows that for each additional year in age of the household head, the probability of WTP for subsidized farm inputs increases by 1.1 percent. This result is at par with our *a priori* expectations and a similar result was obtained by Maganga et al (2014) who were estimating determinants of jatropha adoption by peasants.

Radio Ownership of the Household (RADIO): This is another important variable which is positively and statistically significantly related to WTP at 1 percent level as expected. Information from the radio enhances the ability of farmer's access to improved technologies and management strategies. Farmers who own radios can easily access information about improved fertilizer varieties, input prices and output prices than farmers who do not have radios. *Ceteris paribus*, with "no radio" set as a benchmark category then holding all other variables constant, on average, farmers who hold radios are more likely to pay for about 2.24 50kg fertilizer bags more than their counterparts who own no radios. Conditional on WTP being positive, ownership of a radio at mean values of all variables is estimated to increase expected WTP by about 2.21 bags. This variable also shows that farmers that own radios have 1.88 percent more probability of paying for fertilizer than those farmers who do not possess. A similar economically significant result was established by Abebe and Bogale (2014) who found a positive relationship between radio and WTP.

Food Security (FOOD): As expected, food security is positively and statistically significantly related to WTP for farm inputs ($P<0.01$) with farmers who are were food secure in the past 12 months willing to pay for an average of about 1.92 bags of fertilizer more than non-food secure households can pay for, other things being equal. This result is economically significant and it satisfies the previously stated *a priori* expectation. It can be noted that with WTP being positive and all the variables being at their means, being food secure in the past growing season is estimated to increase WTP by about 1.86 bags and it increases WTP significantly by about 3.36 percent.

Sex of Household Head (SEXH): Sex is another variable which is both economically and statistically significant at 1 percent level. The variable is positively related to WTP as expected such that, other things being constant, male-headed households are more likely to pay for an additional average of 5.17 50kg bags of fertilizer compared to female-headed households. This may be due to the fact that most males are more likely to be involved in large-scale agriculture requiring use of more inputs and also because males are generally assumed to take more risks in investment compared to females so they can invest in more fertilizer. The result shows that with WTP being positive and all variables at their average, being male is estimated to increase WTP by about 4.83 50kg fertilizer bags. Further, being male increases WTP by about 16.09 percent.

Farm Size (FARMS): The bigger the farm size that a household controls the more the fertilizers that the household needs to cultivate on the land. The result shows that farm size is statistically significantly related to desired WTP in a positive manner so that an increase in farm size by one acre leads on average to an increase in WTP of about 1.89 bags. This result is similar to that obtained by Tolera et al (2014) who found a significant positive relationship between WTP and farm size. The second column of the results shows that farm size is estimated to increase WTP by about 1.85 bags, given that WTP is positive and all regressors are at their means. Also, an acre increase in farm size increases the probability of WTP by about 2.69 percent.

Coupon Receipt (COUP): The receipt of coupons in the 2012 or previous season is another important variable which is both economically and statistically significant at 1 percent level. This variable is negatively related to WTP such that those households that obtained fertilizer using coupons are more likely to pay for 5.19 less bags of fertilizer compared to households that did not use coupons to obtain fertilizer. One possible explanation behind this may be because households that obtain fertilizer using coupons do so at a lower cost than they would in the market hence they produce more efficiently and are more likely to get satisfaction from their output. This may reduce their WTP for inputs in the next season especially due to the output they may still have in control. This should be taken advantage of by the authorities that desire for farmers to graduate from the program after some time. Such farmers can easily be left out of the program. Conditional on WTP being positive, the result shows that use of coupons is estimated to reduce WTP by about 5.15 bags, with all regressors at their means. The result also shows that farmers who use coupons have 2.56 percent less probability of paying for subsidized farm inputs than their counterparts.

Education of Household Head (EDUHH): For education, the "no education" variable was set as a benchmark category and so attainment of a PLSCE means an increase in desired WTP by about 1.63 bags compared to the farmers with no education, other things being equal. Primary education is not only economically significant but also statistically at the 1 percent level. At the means and with positive WTP, the attainment of a PLSCE is estimated to increase expected WTP by about 1.61 bags. Moreover, farmers with a PLSCE have a 1.6 percent more chance of paying for farm inputs that with no education. The results also show that in spite of economic significance for the JCE variable, the variable is statistically insignificant probably because farming for subsistence does not require much of education. The analysis aimed to test overall significance of the education variable to see if education in general is critical for WTP. The result, as shown in Appendix 2D, shows an F-Value of 17.57 and a $P<0.01$ meaning that the education level coefficients are not jointly equal to zero such that education generally has an impact on WTP.

The results in Table 4.5 show that variables illness costs and livestock holdings are highly statistically significant and hence not necessary for this discussion.

4.6 Conclusion

The results in this chapter show that WTP for subsidized farm inputs is a function of many factors in Malawi. Age of household head, sex, farm size, primary education, food security and radio ownership have been found to have positive and significant effects on WTP whereas farm incomes and coupon receipt have a negative impact on WTP. Based on these results, the next chapter summarizes policy implications, limitations and direction for further studies.

CHAPTER FIVE

5 SUMMARY AND CONCLUSION

5.1 Summary of Results

The main objective of this study was to identify the factors affecting farmers' WTP for subsidized farm inputs in Malawi. Focus was on demographic, socio-economic as well as other related factors in order to identify the influences of WTP. The study made use of data from the Malawi FISS4 and STATA version 13 was used in analysis of the Tobit model. Descriptive statistics were further employed to especially analyze differentials in WTP in terms of sex, food security and education. Significant differences were found among the different demographic categories such as sex and age with respect to their impact on WTP. Given all the characteristics that farmers may possess the descriptive statistics showed that the maximum number of bags that farmers would pay was 70 if fertilizer sold at MK1, 000. Cross-tabulations of the variables showed that all the variables used in this study can be analyzed with their Pearson Chi-Square variables significant at 1 percent level. For the entire sample studied, the total WTP at MK1, 000 is found to be 46, 891 50kg bags of fertilizer which sums up to MK46, 891, 000. This is the total amount that people are willing to pay for at MK1, 000 hence the public coffers will have to carter for the remaining amount.

The result from the employed Tobit model revealed that out of the twelve potential regressors ten were statistically significant at different levels, two of which had no economic significance. Among the significant variables, eight were significant at 1 percent level and the other two were found to be significant at 5 percent level. For the factors that are statistically significant at 1 percent level, the null hypotheses of no influence are rejected at that level. Such variables are age, age-squared, sex, farm size, primary education, coupon receipt, off-farm income, food security and radio ownership. Farm income is statistically significant at 5 percent level. In this regard, we reject all the null hypotheses in our specific objectives about sex, farm size and radio all at 1% level.

5.2 Policy Implications

An understanding of the determinants of smallholder farmers' WTP for subsidized farm inputs is necessary for the design of efficient and sustainable policy. Based on the research findings above, various points can be taken note of. Firstly, the positive impact by age and sex of household head means that given the options, farms should be headed by older males for higher demand of subsidy inputs. Of course this may be hard to practice especially in an economy like Malawi which is fighting for the involvement of many females and the youth in all sectors. Farm sizes should also be increased so as to ensure that farmers are willing to pay for more fertilizers. This may involve private or government clearing of idle land for use in production. The positive impact for primary education means that the authorities should increase access to the PLSCE. This may involve intensifying the free primary education that is provided in Malawi. Lastly, the public policy should improve the ownership of radios and other media outlets in households since these are positively related to WTP. This may involve cheapening radio prices and ensuring that radio stations work in all areas or encouraging digital migration in signal transmission.

5.3 Limitations of the Study

Assessment of WTP is not easy mainly because of the process involved. Such studies usually involve contingent valuation bidding games where the interviewer posits an initial bid (starting bid) to the respondent and the bid is revised upwards if the respondent is willing at the initial bid until a negative response is obtained or downwards if the response was negative (Boyle, Bishop & Welsh, 1985). This leads to the starting-point bias where the initial bid influences responses. Furthermore, the Tobit model used in this study relies on the assumptions of homoscedasticity and normality of the latent variable such that heteroscedasticity or nonnormality may entirely change the functional forms of the expected values of y given x. In this regard, the results of this study must be treated with caution. Recently there is also a development where the government has revised the target groups of the FISP from vulnerable orphans, widows, the elderly and other groups to active farmers to avert the problem where beneficiaries were selling the FISP inputs. The government has therefore raised the price from about MK 500 to MK3, 500. Therefore, more research is needed for this new price to see the latest results.

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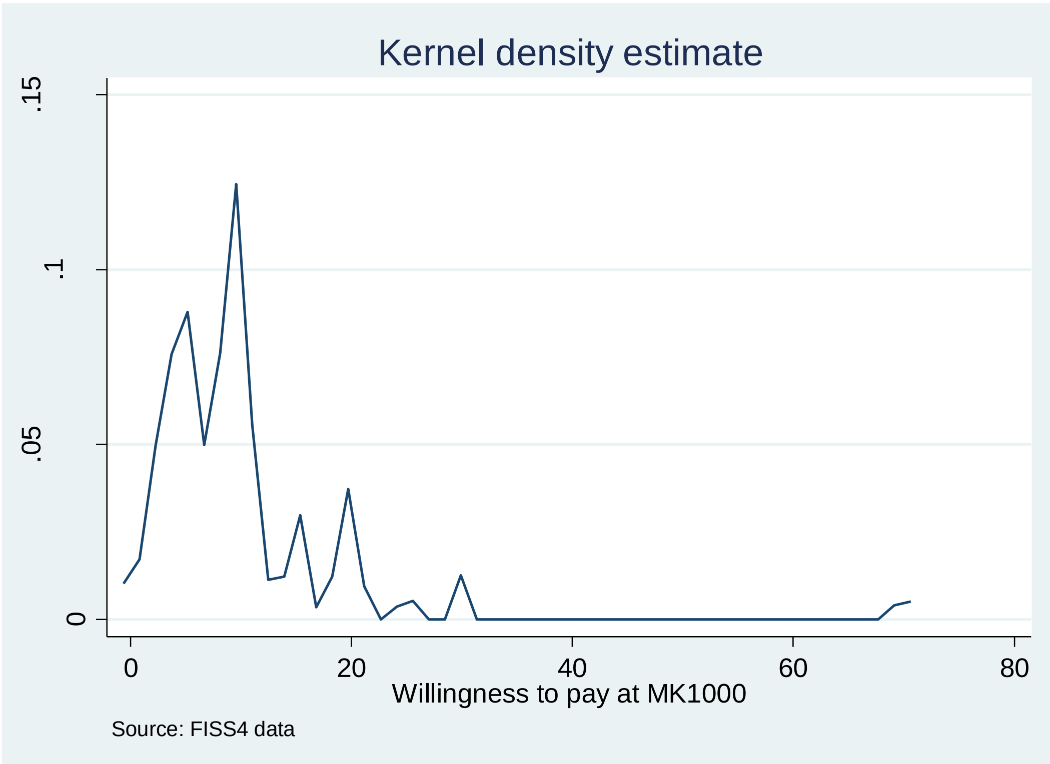
APPENDICES

Appendix 1A

Figure 4: The Kernel Density for Willingness to Pay at MK 1, 000



Appendix 1B: Derivation of the Tobit Model

Given that the conditional density when censoring from below can be depicted as[16];

$$f(y|\boldsymbol{x}) = f^*(y|\boldsymbol{x})^d F^*(L|\boldsymbol{x})^{1-d}, \qquad (3A.1)$$

Then seeing that y_i^* is normally distributed, it implies that the density of y_i given $\boldsymbol{x}$ is the same as the density of y_i^* given $\boldsymbol{x}$ for positive values. Further,

$$F^*(0) = Pr[y^* \leq 0|\boldsymbol{x}]$$

$$= Pr[\boldsymbol{x}_i'\beta + \varepsilon \leq 0]$$

$$= \Phi(-\boldsymbol{x}_i' \beta/\sigma)$$

[16] See Maddala (1983)

$$= 1 - \Phi(\boldsymbol{x}_i' \ \beta/\sigma), \text{ symmetry of the standard normal distribution} \quad (3A.2)$$

where $\Phi(\cdot) =$ the standard normal cdf. In this case, if $(\boldsymbol{x_i}, y_i)$ is a random draw from the population, then the censored density of y_i given $\boldsymbol{x_i}$ can be expressed either as:

$$f(y_i|\boldsymbol{x}) = \left[\frac{1}{\sqrt{2\pi\sigma^2}} exp\left\{-\frac{1}{2\sigma^2}(y - \boldsymbol{x}_i'\beta)^2\right\}\right]^d \left[1 - \Phi\left(\frac{x_i'\beta}{\sigma}\right)\right]^{1-d}, \quad (3A.3)$$

or more specifically,

$$f(y_i|\boldsymbol{x}) = \left[\frac{1}{\sqrt{2\pi\sigma^2}} exp\left\{-\frac{1}{2\sigma^2}(y - \boldsymbol{x}_i'\beta)^2\right\}\right] = \left(\frac{1}{\sigma}\right)\phi[y - \boldsymbol{x}_i'\beta/\sigma], y > 0$$

$$= 1 - \Phi\left(\frac{x_i'\beta}{\sigma}\right) \quad (3A.4)$$

in which case the binary indicator d is defined with $L = 0$, is the lower bound. Our aim in this model is to estimate β and σ^2 and Tobin (1958) proposed ML estimation[17] of the Tobit model and asserted that the usual ML theory applies. Maddala (1973) argues that the censored log-likelihood function is defined as;

$$lnL_N(\boldsymbol{\theta}) = \sum_{i=1}^{N}\{d_i \, lnf^*(y_i|\boldsymbol{x_i}, \boldsymbol{\theta}) + (1 - d_i)lnF^*(L_i|\boldsymbol{x_i}, \boldsymbol{\theta})\}, \quad (3A.5)$$

where $\boldsymbol{\theta}$ are parameters of the distribution of y_i^*. For the case with $L = 0$ we have[18],

$$\ln(\boldsymbol{\beta}, \boldsymbol{\sigma}) = 1(y_i = 0)ln\left[1 - \Phi\left(\frac{x_i'\beta}{\sigma}\right)\right] + 1(y_i > 0)ln\left\{\left(\frac{1}{\sigma}\right)\phi\left[\frac{y_i - x_i'\beta}{\sigma}\right]\right\} \quad (3A.6)$$

Therefore, using the censored density expressed in equation (3.10), the Tobit MLE $\hat{\theta} = (\hat{\beta}', \hat{\sigma}^2)'$ maximizes the censored log-likelihood function given by equation (3.12) to give the following result;

$$lnL_N(\beta, \sigma^2) = \sum_{i=1}^{N}\left\{d_i\left(-\frac{1}{2}ln2\pi - \frac{1}{2}ln\sigma^2 - \frac{1}{2\sigma^2}(y_i - \boldsymbol{x}_i'\beta)^2\right) + (1 - d_i)ln\left(1 - \Phi\left(\frac{x_i'\beta}{\sigma}\right)\right)\right\}, \quad (3A.7)$$

a mixture of continuous and discrete densities. Therefore, the first order conditions are;

---

[17] Maximum Likelihood estimation

[18] See Wooldridge (2002)

$$\frac{\partial lnL_N}{\partial \beta} = \sum_{i=1}^{N} \frac{1}{\sigma^2}\left(d_i(y_i - \boldsymbol{x}_i'\beta) - (1-d_i)\frac{\sigma\phi_i}{(1-\Phi_i)}\right)\boldsymbol{x_i} = 0 \quad \text{and,} \tag{3A.8}$$

$$\frac{\partial lnL_N}{\partial \sigma^2} = \sum_{i=1}^{N}\left\{d_i\left(-\frac{1}{2\sigma^2} + \frac{\left(y_i - x_i'\beta\right)^2}{2\sigma^4}\right) + (1-d_i)\frac{\phi_i x_i'\beta}{(1-\Phi_i)}\frac{1}{2\sigma^3}\right\} = 0 \tag{3A.9}$$

using $\partial\Phi(\mathrm{z})/\partial\mathrm{z} = \phi(\mathrm{z})$ where $\phi(\cdot)$ is the standard normal pdf, using the definitions $\phi_i = \phi(\boldsymbol{x_i'\beta}/\sigma)$ and $\Phi_i = \Phi(\boldsymbol{x_i'\beta}/\sigma)$.

In order to decompose the effects of regressors into the willingness to pay and intensity effects, Maddala (1997) proposes techniques that show that any regressor has two effects. Firstly, it affects the conditional mean of y_i^* to the right of our limit value, $L = 0$, and it affects the probability that the observation will fall in that part of the distribution.

APPENDIX 2A: Pair-Wise Correlations Among Regressors

	AGEHH	AGESQ	SEXH	FARMS	EDUHH	COUP	FINC	OFIN	ICOST	FOOD	RADIO	LIVEST~K
AGEHH	1.0000											
AGESQ	0.9922	1.0000										
SEXH	-0.4911	-0.5373	1.0000									
FARMS	0.0847	0.0649	-0.0395	1.0000								
EDUHH	0.3492	0.3737	-0.3223	-0.0307	1.0000							
COUP	0.1885	0.1538	-0.0968	0.1663	0.0423	1.0000						
FINC	0.1259	0.1151	0.1131	0.1584	-0.0208	0.0434	1.0000					
OFIN	-0.1477	-0.1254	0.0966	-0.0162	-0.0326	0.0418	-0.0465	1.0000				
ICOST	-0.0921	-0.0826	0.0046	-0.0728	-0.0352	0.0466	-0.0514	-0.0341	1.0000			
FOOD	0.2948	0.2830	-0.1178	0.2032	0.0816	-0.1356	0.1535	0.0795	-0.1115	1.0000		
RADIO	-0.0559	-0.0670	0.0961	-0.0316	-0.0187	0.0367	-0.0336	-0.0305	0.0688	-0.2036	1.0000	
LIVESTOCK	0.1301	0.1320	-0.0866	0.1482	0.0923	0.0171	-0.0106	-0.0390	-0.0441	0.1673	-0.0565	1.0000

APPENDIX 2B: Link Test for Model Specification

Tobit regression	Number of obs	=	1279
	LR chi2(2)	=	923.74
	Prob > chi2	=	0.0000
Log likelihood = -3344.0632	Pseudo R2	=	0.1213

WTP_1000	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
_hat	0.9837500	0.0422757	23.27	0.000	0.9008125	1.0666880
_hatsq	0.0006192	0.0012059	0.51	0.608	-0.0017466	0.0029851
_cons	0.0802584	0.2916998	0.28	0.783	-0.4920051	0.6525220
/sigma	3.8525140	0.0806749			3.6942440	4.0107830

Obs. summary: 107 left-censored observations at WTP_1000<=0 1172 uncensored observations 0 right-censored observations

APPENDIX 2C: Maximum Likelihood Estimates of the Censored Tobit Model

Tobit regression

Number of obs	=	1279
F(13, 1266)	=	401.23
Prob > F	=	0.0000
Pseudo R2	=	0.1213

Log pseudolikelihood = -3344.1646

WTP_1000	Coef.	Robust Std. Err.	t	P>t	[95% Conf.	Interval]
AGEHH	0.7852636	0.0845363	9.29	0.000	0.6194169	0.9511103
AGESQ	-0.0082399	0.0009260	-8.90	0.000	-0.0100566	-0.0064231
SEXH						
Male	5.1662690	0.3482826	14.83	0.000	4.4829940	5.8495430
FARMS	1.8940790	0.1177463	16.09	0.000	1.6630800	2.1250780
EDUHH						
PLSCE	1.6324590	0.2783333	5.87	0.000	1.0864130	2.1785040
JCE	3.8372660	4.5106880	0.85	0.395	-5.0119800	12.686510
COUP						
Yes	-5.1886980	0.3799053	-13.66	0.000	-5.9340120	-4.4433850
FINC	-0.0000286	0.0000140	-2.05	0.041	-0.0000560	-0.0000012
OFIN	-0.0000079	0.0000026	-3.03	0.002	-0.0000129	-0.0000028
ICOST	0.0000139	0.0003204	0.04	0.965	-0.0006146	0.0006425
FOOD						
Secure	1.9210060	0.3283931	5.85	0.000	1.2767510	2.5652600
RADIO						
Yes	2.2382860	0.5219469	4.29	0.000	1.2143090	3.2622620
LIVESTOCK	0.0328022	0.0584307	0.56	0.575	-0.0818295	0.1474338
_cons	-11.583950	1.4474410	-8.00	0.000	-14.423600	-8.7443050
/sigma	3.85478	0.1246231			3.6102890	4.099271

Obs. summary: 107 left-censored observations at WTP_1000<=0

1172 uncensored observations

0 right-censored observations

Appendix 2D: Overall Significance of the Education Variable

. test 1.EDUHH 2.EDUHH 3.EDUHH

(1) [model]1b.EDUHH = 0

(2) [model]2.EDUHH = 0

(3) [model]3.EDUHH = 0

F(2, 1266) = 17.57 Prob > F = 0.0000