Land Holders Willingness to Accept Compensation to Voluntarily Protect Natural Forest for Regeneration: Case of Kuyu Woreda

Addis Ababa University

School of Graduate Studies

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Addis Ababa University

School of Graduate Studies

We, the undersigned, certify that the thesis presented by Milkessa Seyum, "Land Holders Willingness to Accept Compensation to Voluntarily Protect Natural Forest for Regeneration: Case of Kuyu Woreda", is a result of his own work for the partial fulfillment of the requirement for the Degree of Master of Science (Resource and environmental economics), and that to the best of our knowledge, it has not been submitted for any academic qualification to the Addis Ababa University or elsewhere. The thesis is acceptable in form and content, and that satisfactory knowledge of the field covered by the thesis was demonstrated by the candidate through oral examination held on February 27/2015.

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Declaration

I, the undersigned, declare that this thesis is a result of my own original effort and work, and that to the best of my knowledge, the findings of this thesis have never been previously presented to Addis Ababa University or elsewhere for the award of any academic qualification. Where assistance was sought, it has been accordingly acknowledged.

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ABSTRACT

Land Holders Willingness to Accept Compensation to Voluntarily Protect Natural Forest for Regeneration: Case of Kuyu Woreda

Milkessa Seyoum

Adds Ababa University, 2015

The thesis assessed the compensation needed by small scale land holders to voluntarily protect degraded natural forests on the land they held in hypothetical protection program. Protection of the existing degraded natural forest brings cost to the holders as they lose benefits they have been getting if protected. Creating incentives (compensation) to the local people to voluntarily participate in the conservation and restoration of natural forests is important. This study developed a hypothetical market in which the 'Kuyu Woreda' small scale land holders are given compensation incentives to voluntarily stop the natural forest degrading activities and leave their lands for natural regeneration of indigenous forests and conservation of the remaining wild animals. The study used contingent valuation survey to identify factors affecting the WTA compensation of the small scale farmers and estimate their minimum WTA. It found that bid levels, livestock wealth, size of degraded forest land, sex of the household head, availability of substitutes, and the existence plan to change the land into farm land are significant factors affecting WTA. The mean minimum WTA is 1,170 birr per-hectare per year using single-bounded binary question and 3,073 birr per-hectare per-year using open-ended follow up questions. The ratio of open ended follow up mean to binary question mean is 2.63, which inflated the WTA. Totally, 168 households asked a compensation of 74,660.6 birr per year for about 63.8 hectares of degraded natural forest land using mean 1,170 birr per-year per-hectare.

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GLOSSARY OF LOCAL TERMS

Birr – is monetary unit in Ethiopia (Ethiopian Currency)

Hirta – traditional practice similar with contract in which peasants that have no enough land produce crops on others' land sharing the seed and fertilizer cost and output with the land holders

Guzm – local measure of land which is equivalent to 1/8 hectare

Kebele - Is the lowest administrative unit in Ethiopia

Kuta - is a traditional inheritance practice where parents give a plot of land to their children or other to use, but land holding right remain with the parents until their death.

Woreda – is an administrative unit higher than '*Kebele'* which is used synonymously with District

Zone – is an administrative unit above '*Woreda'* and below regional state.

ACRONYMS

CDM – Clean Development Mechanism

CV – Contingent Valuation

Cv – Compensation Variation

CSA - Central Statistic Agency

DA – Development Agents

DC – Dichotomous Choice

Defra - Department for Environment, Food and Rural Affairs

EPA - Environmental Protection Authority

Ev – Equivalent Variation

FAO - Food and Agriculture Organization

GDP – Gross Domestic Product

NAPA - National Adaptation Programme of Action

NGO – Nongovernmental Organizations

NOAA – National Oceanic Atmospheric Administration

OECD – Organization for Economic Cooperation and Development

OLS – Ordinary Least Square

TEEB - The Economics of Ecosystem and Biodiversity

UNCCD – United Nation Convention to Combat Desertification

UNFCCC – United Nation Framework Convention on Climate Change

WTA – Willingness To Accept

WTP – Willingness To Pay

CHAPTER I

Introduction

1.1. Background of the Study

Nowadays, climate change and environmental degradation is one of the global main problems. It adversely affects the current and sustainable future economic growth of all nations. Since most developing countries are economically depend on the primary economic activities (agriculture) that is highly vulnerable to climate change and environmental degradation they are severely affected (World Bank, 2008; Kissinger, Herold, and Desy, 2012; Guzman, 2013, and Global Forest Coalition, 2010).

Least developed countries are highly dependent on natural resources, particularly on forest ecosystems. Unfortunately forest ecosystems are currently under serious threat due to human economic activities (Guzman, 2013 and FAO, 2011). As forest ecosystems play very important role in regulating the climate, deforestation and forest degradation exacerbated the climate change problem and other environmental problems. Larger proportions of the forests are deforested and the remaining is severely degraded. The forests are left only at inaccessible areas of steep hills, on non-arable lands and securely protected areas. Even if the degraded forests have lost much of their ecological goods and services they once provided, many of the primary forest tree species and animals are still there and if protected a significant forest ecosystem can be recovered.

Countries need to take measures to reduce the environmental distraction and adapt to the climate change. Natural forests play a decisive role in solving most of the climate change problems; in creating climate resilient economic system to environmental shocks and regulate the

environment. Thus, significant investment in protecting and restoring degraded forest ecosystems has important potential for many policy sectors to adapt to climate change (TEEB, 2009; and Mansourian, Vallauri, and Dudley, 2005).

Protecting and restoring the degraded forest needs proper policy, programs and strategies. As shown in Hacket, (2006) early environmental regulation of direct command-and-control through putting directives and environmental standards lacks incentives for the local people and is inefficient and frequently met with little success. Payment (compensation) for ecosystem services policy is relatively new, direct approach, relatively efficient, cost effective and it is becoming popular environmental policy to regulate the environmental resources (Defra, 2011; and Lamb and Gilmour, 2003). It compensates land owners (managers) for ecosystem conservation, restoration and for other actions undertaken that increase the levels of desired ecosystem services (Kissinger, Patterson, and Neufeldt, 2013; and Defra, 2011).

Particularly, in developing countries critical forest ecosystem services are generated on rural lands owned (managed) by low income people. Since the livelihood of these people highly depends on the forests, voluntarily protection and restoration of natural forests need compensation (payment) for the people for lost benefits as they stop using the forest for restoration (TEEB, 2010; Bond *et al*., 2009; Holzman, 2008; and Chomitz, 2000). Such compensation needs the knowledge of the estimated value of the degraded forest to the local people to know their preference. In Ethiopia there are such degraded forests that can regenerate if protected. Thus this study tried to assess the preference of the local people on hypothetical protection program and estimate the compensation level *'Kuyu Woreda'* land holders need to voluntarily protect and restore the degraded forest on the land they held.

1.2. Statement of the Problem

Ethiopia is one of the developing countries which is severely affected by the climate change and environmental degradation. It is identified as one of the most vulnerable countries because of its low adaptive capacity to the adverse impacts of climate change (Edwards, 2010). To enhance the adaptive capacity the country has been taking measures. Environmental policy of Ethiopia, agriculture and rural development policy and strategy, the conservation strategy of Ethiopia, food security strategy, and the plan for accelerated and sustained development to end poverty which are based on improving the natural resources that raise agricultural productivity are some of the measures (EPA, 2010 and Edwards, 2010). The country also has signed most of the international environment conventions like UNFCCC, the Kyoto Protocol, UNCCD and NAPA (Edwards, 2010).

Currently, the country aims to achieve carbon-neutral middle-income status before 2025 by building a climate-resilient green economy with zero net emissions goal. To achieve the goal, environmental resource, particularly natural forest, protection plays crucial role. Protecting and re-establishing forests for their economic and ecosystem services is one of the pillars of green economy strategy to reduce emission and adapt to the climate changes while continuing economic growth (EPA, 2011).

According to the plan, protecting and preserving the existing forests, new afforestation and reforestation programs, supporting rehabilitation and regeneration of degraded forests, promoting agro-forestry and the green city approaches are strategies to reduce emission and adapt to climate change and environmental degradations. Restoration of natural forests is needed in many areas to sustain the ecosystem in the long term. For instance the ‘Humbo Regeneration Project’, which is the largest CDM in Africa, is being implemented on such lands (EPA, 2011).

Despite the government's efforts of increasing the forest cover of the country through conservation, restoration, afforestation, rehabilitation, awareness creation etc., the natural forests are being cleared and degraded, particularly forests on privately held lands. Since the land holders highly depend on the forest lands the remaining forest on such lands are highly fragmented and degraded. The left over indigenous natural trees that are capable and usually regenerate are being seasonally cut for different economic activities before they mature. Protection of such natural forest and its restoration is very important in adapting to the environmental problems. Literatures show that in poor and developing countries natural forest lands are owned by small scale farmers who need incentive to conserve it (Bond *et al*., 2009; and Dach, Höggel and Enz 2004). Thus, since protection of the degraded forest lands leads to loss of benefit and cost to the land holders, they are expected to be unwilling to tolerate the forest protection ideas unless they get incentives. Hence, they need compensation to cease economic activities on the land and conserve the remnant natural trees to restore natural forests either through natural self-regeneration or assisted restoration.

'*Kuyu Woreda'* is one of the areas where restoration of forest ecosystem is needed. Once in the past the '*Woreda'* was covered by dense forest and rich in biodiversity. Currently there is no significant dense forest. Most of the forest lands are deforested and changed to farm lands and the remaining forests severely degraded and have lost much of their productivity and biodiversity. It has been degraded for a long time to bush and shrubs but never become completely deforested and the remaining is potentially sound to regenerate itself. According to the office of agriculture, forest conservation and protection branch of the *'Woreda'*, even if there is no conducted research to identify the existing and disappeared species of flora and fauna, the areas are rich in indigenous plants species and considerable number of wild animals. In 2013, out

of the total area of the '*Woreda'* (97,400 hectares), about 9.53% is covered by forests (natural forests, manmade forests, bushes and shrubs).

Most of the degraded forest lands are held by small scale farmers of rural households who are highly depending on remaining degraded forest that make the conservation difficult. The inhabitants use it as grazing land, source of fuel-wood, to make charcoal for sale as source of income, to construct fence of their yard (compound) and farm land, build huts, etc. Even if they are highly depending on forest for many products the tendency to conserve it is very low since they are poor smallholder farmers that are driven by short term economic interests only. Population growth that caused farmland fragmentation has forced them to clear the forest land and change into farm land including the less arable land. Even if the environmental protection law through command and control prohibits the activities and practices that degrade the land like charcoal production it could not stop. High proportion of the '*Garbaguracha'* town dwellers still use charcoal for cooking that comes from the rural '*Kebeles'*.

Good protection, conservation, and management of forests needs voluntary participation of the local people (the land holders) compensating the lost benefit. This study tried to estimate the amount of compensation the degraded forest land holders need to voluntarily participate in a protection program. It used the WTA elicitation method. There are only few studies that used WTA elicitation methods of CV surveys to estimate the value of change in environmental goods and services in general and in estimating compensation to change in forest land use on privately held lands. Some of those who applied WTA are, Dupraz *et.al*. (2003), Smith *et.al* (1998), Sangkapitux *et.al*. (2009), Thoai, and Rañola, (2011), Bush et el, (2012), Zhai, and Suzuki, (2009), Gadaud, and Rambonilaza, (2010), and Lindhjem and Mitani, (2012).

There is no study (to the best of my knowledge) that used CV studies to assess the WTA compensation of small scale land holders that ask to voluntarily restore the degraded natural forests on the land they held in Ethiopia. The restoration of the natural forests is very important to adapt to climate change, biodiversity conservation, carbon sequestration, to provide water catchment services, beautification of the environment, source of income selling carbon credits etc. Hence the knowledge of the factors affecting WTA and mean minimum compensation level the farmers ask helps us to prioritize policy option. Thus the purpose of this study is to assess factors affecting the WTA and to estimate average compensation needed by degraded natural forest land holders to voluntarily restore natural forests in '*Kuyu Woreda'* through natural regeneration.

1.3. Objectives of the Study

1.3.1. General Objective

The main objective of the study is assessing preferences of small scale degraded natural forest land holders to voluntarily protect and restore the natural forest on the land they held through natural regeneration, taking compensation.

1.3.2. Specific Objectives

Specifically the objectives of the study are

- To identify factors affecting the land holders' WTA compensation that help in policy making,
- To estimate the land holders' mean minimum WTA compensation.
- Based on the findings of the study to give recommendation that help to restore the degraded forests

1.4. Significance of the Study

This study contributes something to policy making issues. It helps policy makers to make better decision to initiate restoration program through natural regeneration on privately held lands by compensating the land holders to participate voluntarily. It helps to compare and analyze alternative programs between restoration through natural regeneration and through afforesting or reforesting or other programs in forest management. It helps in identifying factors affecting the minimum WTA compensation which are important to take policy measures.

The study can provide information to those who want to fund the compensation of the degraded forest land holders to conserve and restore the degraded forest. The concerned bodies might include local, regional and federal government bodies, domestic and international NGOs,

international organizations established to conserve biodiversity and those who want to participate in carbon trade. Thus, the paper shows potential sellers of the forest ecosystem services. It provides them the information of the existence of such degraded forests that can regenerate, and the mean minimum compensation per hectare per year.

As there is no study (to the best of my knowledge) that used WTA compensation to estimate the economic value of land use change to its holders in Ethiopia, it is expected to be good initiative to further researches.

1.5. Scope of the Study

Geographically, the study covered '*Kuyu Woreda'* where the chain of steep hills covered by degraded forest exists and which are not totally cleared. It considers only privately held lands (excluding state and common forests) that are not ploughed yet and on which degraded natural forest that can regenerate if protection exist. Data were collected from 5 (five) selected Kebeles which are '*Dawicha Kerensa', 'Roge Kolati', 'Wuye Gose', 'Jila Kerensaa', and 'Halelu Chari'*.

The study focused on rural peoples that have been holding degraded forest land holders. However there are peoples who did not hold such lands but uses the others' by buying, getting permission from the holders, use hiddenly without permission. Thus this study does not show the value these other peoples attach to the degraded forests. Again the forests provide some environmental services for the local and global communities. But in this study only the use and non-use values of the forest to the land holders is estimated.

1.6. Description of the Study Area

'*Kuyu Woreda'* is one of the '*Woredas'* found in '*Salale'* (North Showa) '*Zone'* of Oromia Regional State. Its town is '*Garbaguracha'* and it is about 156km away from the capital city of

the country to the North. It is located at about 9^{o}36'34"-9^{o}56'56"N latitude and 38^{o}05'00"-38^{0}34'13"E longitude. The total area of the *'Woreda'* is 97,400 hectares. The '*Woreda'* accounts for about 8.3% of the '*zone'*. The altitude of the '*Woreda'* varies from 3,541m highest and 1,080m lowest.

According to the estimated data from '*Woreda's'* office of agriculture, about 529 square kilometers (54 percent) of the total area is arable land of which 457 square kilometers (86 percent) was cultivated. The rest non-arable land of the '*Woreda'* is occupied by several land use patterns such as forests (natural and manmade), bushes and shrubs, grasslands, bare land and urban areas. In 2013, about 9.53% is covered by forests. According to the revised 2007 Population and Housing Census of Ethiopia, the total population in '*Kuyu Woreda'* is 139,982, of which the rural population is 115,498 (82.51%). The rest 17.49% is urban dwellers who are living in the town (*Garbaguracha).* Of the total population, 49.8% was found male and the remaining 50.2% was female (CSA, 2008).

1.7. Organization of the Study

The study is organized as follows. Chapter I of this study introduced background of the study, statement of the problem, objectives, significance, scope and limitation of the study and description of the study area. In Chapter II the relevant literatures would be reviewed on the theoretically and empirically associated with the problem addressed in this study. Chapter III presents the methodology and procedures used for data collection and analysis. In Chapter IV the analysis of the data and presentation of the results would be presented. Lastly, in Chapter V summary of the researcher's findings and recommendations for future research would be presented.

CHAPTER II

Literatures Review

The damage and loss of environmental resources is severe and it is continuing. This severity necessitated its conservation to mitigate these negative trends that highlights a fundamental valuation question. In order to conserve natural resource and environment we have to know its value to the community. Economic valuation of natural resources is very important to make explicit the scarcity of the resources and its opportunity cost, to create market for the nonmarket resources, simplify decision for policy makers, to compensate the resource owners (managers) for lost benefits, to add natural resource accounting in GDP and others (TEEB, 2010; Defra, 2011; and Hacket, 2006).

Economic valuation of changes (proposed changes) in the quantity or quality of resources needs the proper method of measuring the values to the community. In this chapter relevant literatures would be reviewed. In the first section the theoretical literatures about economic models, and eliciting techniques of preferences would be assessed. Then the method of economic valuation is reviewed. Lastly the empirical related literatures would be discussed.

2.1. Theoretical Literatures Review

The central problem of scarcity raised the idea of efficient resource allocation that in turn raised the question of valuation. The valuation of resources needs the theoretical and empirical methods that show the extent to which the resources are being efficiently allocated. Particularly for public and quasi-public goods which have spreading externalities, or for which property rights are not clearly defined, valuation is very important since they have no market to efficiently allocate

them. The valuation method of such resources develops from the welfare economics. In this section the theoretical models and empirical methods of valuation are discussed.

2.1.1. The Theoretical Economic Model

Economic theories tried to model the preferences of individuals and developed theoretical models that help as to measure the welfare changes due to change in the environmental resources quality or quantity. Measures of individual welfare changes due to change in the resources are derived from utility model.

Assume an individual consumes a vector of market commodities $\boldsymbol{x}=(x_1, x_2, x_3 \ldots)$ and a vector of non-market environmental resources denoted by $\boldsymbol{q}= (q_1, q_2, q_3 \ldots)$. The individual's preferences for $\boldsymbol{x}$ and $\boldsymbol{q}$ are represented by ordinal utility function indifference curves derived from the consumption of the two types of goods $u(\boldsymbol{x},\boldsymbol{q})$. The utility function is assumed to be continuous, quasi-concave and non-decreasing as the consumption of both types of goods increases. Quasi-concavity assumption is for analytical convenience since it rules out corner solutions in which the individuals are concentrated on just a few market commodities and environmental goods and services. The market goods and services have a vector of prices $\boldsymbol{p}= (p1, p2, p3 \ldots)$ for respective goods or services. As assumed in Haab, and McConnell, (2002) the parametric prices may or may not be market determined. The environmental resources are assumed to be freely available as discussed in Bateman and Willis, (1999). Another assumption is the individual have a limited budget (income) which is *'y'*.

The individual chooses and set the amount (bundle) of the two goods that optimizes his/her utility, given the prices of the market goods and services, the fixed income and the environmental resources.

$\max_{x} u(\boldsymbol{x},\boldsymbol{q})$ subject to $\sum p_i x_i \le y$ where i=1, 2 … N ---------- (2.1)

From the utility maximization the ordinary demand (Marshallian) functions $x_i = g^i(p,q,y)$ and an indirect utility function, $v\ (p, q, y) \equiv u[h(p, q, y), q]$ are derived (Bateman and Willis, 1999). The indirect utility function is assumed to have the conventional properties (non increasing in ***p***, quasi-convex in ***p***, continuous at all ***p***, non decreasing in y, homogeneous of degree 0 in ***p*** and y, and it is non-decreasing in *q).*

The dual to the above utility maximization is an expenditure minimization, which is written as

$\min_{p} \sum p_i x_i$, subject to $u(\boldsymbol{x},\boldsymbol{q}) \ge u$ where i=1, 2 …. N ---------- (2.2)

The compensated (Hicksian) demand functions, $x_i = h^i(p, q, u)$, and an expenditure function,

$e(p, q, u) \equiv \Sigma\ p_i h^i(p, q, u)$, are derived from the minimization of the function with respect to ***p***. The expenditure functions are assumed to have the conventional properties (non- decreasing in *p* and *u*, homogeneous of degree *1* in *p*, concave in *p*, and continuous in *p*).

Here there is an identity between *u* and *v* and *y* and *e*. Note that $u \equiv v\ [p, q, e\ (p, q, u)]$ and $y \equiv e\ [p, q, v\ (p, q, y)]$, which reflect the fact that $y = e\ (p, q, u)$ is the inverse of $u = v\ (p, q, y)$, and vice versa (Bateman and Willis, 1999).

The indirect utility function and the expenditure function help us to develop theoretical structure to estimate the welfare changes due to change in environmental quality or quantity in monetary terms. Then what is the individual's welfare change due to change in environmental resources?

The models to estimate the welfare change are derived from the indirect utility function and the expenditure function. For the stated preference approaches in general and in the contingent valuation method in particular the changes in the indirect utility function or the expenditure functions estimates the welfare changes of the individual due to the change or proposed change.

For a change in price, quality or a change in some public good, there are two equally valid ways of describing money welfare measures (Haab, and McConnell, 2002; and Bateman and Willis, 1999). These are the compensating and equivalent variations which are derived from the indirect utility function and expenditure functions. Both ways of estimating the welfare changes considers the change in income of the individual that can compensate or equivalent to the change.

Hicks developed compensation and equivalent variation measures of welfare change due to change in price of market goods using indirect utility functions. By analogy with the Hicksian measures for price changes, the compensating (*Cv*) and equivalent (*Ev*) variations measures, for change in quantity (quality) of environmental resources are given in equations (3) and (4) as discussed in Haab, and McConnell, (2002) and Bateman and Willis, (1999). Suppose the environmental resources changed from q^0 to q^1 where the change is either an improvement ($\Delta u > 0$) or deterioration ($\Delta u < 0$). Then the compensation variation (*Cv*) and equivalent variation (*Ev*) are defined respectively as follows

$$v(p, q^1, y - Cv) = v(p, q^0, y) \quad \text{---------- (2.3)}$$

$$v(p, q^1, y) = v(p, q^0, y + Ev) \quad \text{---------- (2.4)}$$

Where '*y'* income of the individual, '***p***' is price of the marketable goods and services, *q* is the environmental quality or quantity, '*v'* is the indirect utility and the superscripts *0* and *1* represents the situations before the change and after the change.

For improvement in the environmental resources (increase in quantity or quality) that increase utility, the compensation variation measures the amount of money that should be taken away from income of the individual to tolerate the change. Thus it is the maximum amount of money that the individual is willing to pay (WTP), to tolerate the change and be as better as before the change. For deterioration (decline in the quantity or quality) it measures the amount of money that should be given to the individual to tolerate the change. Hence it is the minimum amount of money the individual is willing to accept (WTA) to tolerate the change and be as better off as before the change. Using the expenditure function *Cv* is the difference between the money expenditure (*e*) functions of the individual before the change and after the change that make the individual as better off as before, other things remaining constant.

$$Cv = e\,(p, q^0, u^0) - e\,(p, q^1, u^0) \quad \text{---------- (2.5)}$$

If the difference is positive *Cv= WTP (*in improvement case*)* and if it is negative *Cv= WTA (*in deterioration case*)*. Here note that, deterioration does not necessarily imply the decline in the quantity or quality of the environmental resources. Cases like government policies that prohibit some local community from using environmental resources like natural forest for public interest also decreases the quantity of the natural forests that the local community use for which they ask compensation. While the quantity and quality of the conserved natural forest increases the amount of forest products consumed by local community declines even if the forest ecosystem services consumed increases.

On the other hand, *equivalent variation* for improvement measures the amount of money that must be given to the individual to forgo the change and be as better of as if the proposed change has taken place. Thus it is the minimum amount of money the individual is willing to accept (WTA) to forgo the proposed change. For decline in the environmental resource it measures the maximum amount of money that the individual is willing to pay (WTP) to forgo the proposed change and be as better of as if the proposed change has taken place. In equivalent variation case, *EV* is the difference between money expenditure functions of the individual before the change and after the change that make the individual as better off as if the change has taken place, other things remaining constant.

$E_V = e\,(p, q^0, u^1) - e\,(p, q^1, u^1)$, ---------- (2.6)

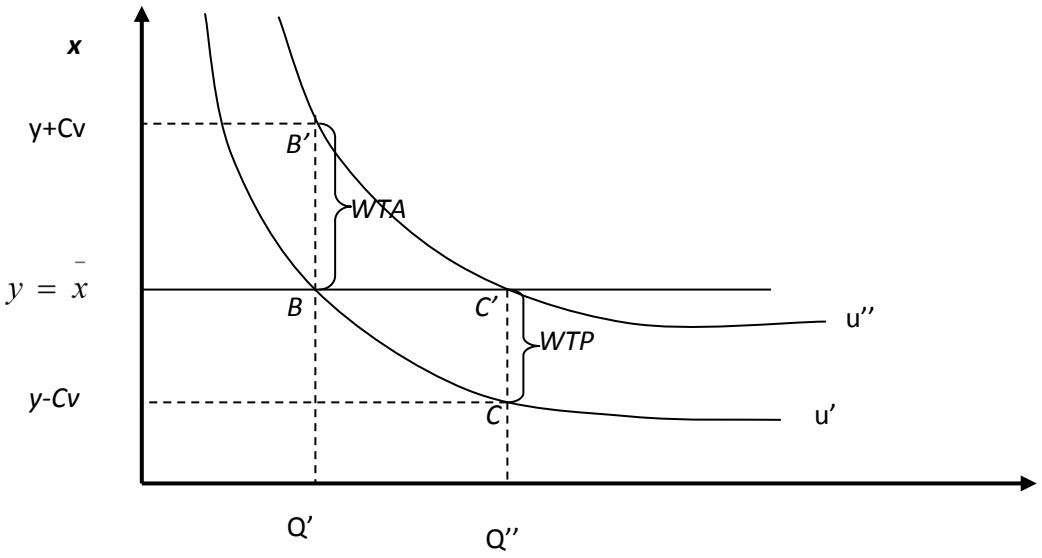
If the difference is positive $EV = WTA$ (in improvement case) and if is negative $EV = WTP$ (in deterioration case).

Hence, *Cv* and *Ev* measure the welfare of the individual for change in the environmental resources in terms of money. WTA and WTP are the elicitation methods used to estimate the monetary value of the welfare change due to the change. Thus, the WTA and WTP welfare measures are derived from the compensating variation (*Cv*) and the equivalent variation (*Ev*) welfare measures.

The *Cv* WTP for improvement in the environmental quality and the WTA compensation for environmental deterioration are shown below graphically. The graph is sketched in analogous of the graph shown in Bateman and Willis, (1999), to compare WTP/WTA disparity. Assume prices of the market goods ($\boldsymbol{p} = 1$) to easily express other goods in terms of money. Suppose we measure other market goods on the vertical line and environmental goods on the horizontal axis.

Since income of an individual is limited, the individual will have limited budget for consumption of market goods and consume a fixed amount of the goods $x=(\bar{x})$.

Figure 2.1. WTP for increase in Q and for decrease in Q



Source: The *graph is sketched in analogous of the graph sketched in Bateman and Willis, (1999), to compare WTP/WTA disparity*.

Assume the individual was initially consuming $(\bar{x})$ and *Q'* at point *B* with the limited budget that yield utility *u'*. If the environmental resource increased from *Q' to Q''*, the individual will consume more of the environmental resource *(Q'')* that yields higher utility on indifference curve *u''* at point *C'*. For the individual to be on the initial indifference curve, u', the budget of the individual should decline by *CC'* amount which is the *WTP*. *Cv=CC'=WTP*.

On the other hand assume that the individual was initially consuming at point *C'* on indifference curve *u''*. If the environmental resource declines from *Q'' to Q'*, the individual will drive lower utility (*u'*) on the lower indifference curve at point *B*. Hence to put the individual on the initial

higher indifference curve his budget should increase by *BB'* amount and consume at point *B'* which is the *WTA. Cv=BB'=WTA*.

Where theoretically the *WTA* and *WTP* measures of welfare are more or less equal for a change in environmental goods, empirically a large disparity found between the two. Hanemann (1991), as cited in (Bateman and Willis, 1999), mathematically shown that the size of the *WTA*-*WTP* disparity is affected by income and substitution effect, where substitution effect is stronger particularly in environmental resources. Ahlheima, and Buchholz, (2000) argue that where the welfare change is analysed within the framework of ordinal utility theory the difference between absolute values of *WTA* and *WTP*, are not important since only the sign of welfare change is needed. Comparing the absolute values of *WTP* and *WTA* is important in cost benefit analysis which is outside the ordinal utility theory.

2.1.2. Disparity between WTA and WTP Elicitation Methods

The well-known problem of stated preference method, (particularly *CV* surveys) is the disparities between *WTP* and *WTA*. Standard economic theory (utility theory) shows that the *WTP* to obtain a benefit and *WTA* compensation to tolerate a loss are approximately equal. However, empirical studies have shown that the *WTA* is often found to be higher than the corresponding *WTP* values in *CV* surveys (Haab, and McConnell, 2002; and Bateman and Willis, 1999). A variety of rational economic reasons, strategic misrepresentation and psychological factors contribute to the disparity of the *WTA*-*WTP* measures. Causes of the discrepancy includes: income effect, substitution effect, faulty questionnaire design or interviewing technique; strategic behavior by respondents and psychological effects such as loss-aversion and the endowment effect, and others (TEEB, 2010; and Brown and Gregory, 1999). The main factors are discussed below.

Income effect: income effect is one of the factors that create *WTP-WTA* disparity. It is due to differences in real income of the individuals which depends on income elasticity of demand for the good in question (Pearce, 2002). Income effect is the effect of additional income on the quantity purchased of a particular commodity through change in price (Hausman, 1993). Freeman, (1993) argued that the disparity between *WTA* and *WTP* is higher for goods that have higher income elasticity of demand. Thus the income effect of change in price depends on the nature of the good or service in question. If the good is normal good, income elasticity of demand is high and the respondents ask higher compensation, that widens the disparity between *WTA* and *WTP*. For a change in environmental quality or quantity, *WTA* > *WTP* if the environmental resource is normal and *WTA* < *WTP* if it is inferior (Bateman and Willis, 1999). The rationale of income effect is that *WTP* is constrained by the individual's budget and *WTA* is not. Thus, the difference between *WTP* and *WTA* should be small if income effects are small. Randall and Stoll (1980) analogously showed that the same argument in price change can be applied to quantity change. They argued that if the *WTP* is a small fraction of income of the individual, the income effect is less and disparity would be lower.

Substitution effect: Hanemann (1991) as discussed in (Bateman and Willis, 1999) showed that, even if there is only a small income effect, and the budget share of the environmental resource is small, there can still be a substantial disparity between WTP and WTA if the elasticity of substitution, between environmental good and marketable goods is sufficiently low. According to Hanemann, (1991) the substitution effect has strong influence than income effect in creating disparity between the two. Thus, if close substitutes are available for the change in resource being valued, the WTP-WTA disparity would be small (Brown and Gregory, 1999).

***Loss aversion and the endowment effect*:** The 'reference-dependent preference theory' of Tversky and Kahneman (1991) explains the large *WTP-WTA* divergence is due to gain/loss disparity. According to the theory, preference is relative, and individuals evaluate a change in relative terms comparing to their current asset position and welfare as reference point not in absolute terms. Thus, a change is either an improvement (gain) or deterioration (loss) relative to reference point. For a symmetric change, where increase in the good is equals to the decrease in the same good, in environmental good or services, respondents usually require more compensation to give up a good than they are willing to pay to acquire the same good. According to the theory, it is due to psychological effect of loss aversion that makes the owners of the resources value more than the hypothetical owners (Alberini and Kahn, 2006; Bateman and Willis, 1999 and Kahneman, et.el., 1990). According to Casey, (1995), it is the owner who has good information about the resource than the hypothetical owners that is why they value more and the disparity increased.

Transaction costs: Transaction and search costs exaggerate the gain-loss disparity that in turn widens the *WTP-WTA* gap. When individuals own an item and lose it searching for replacement takes time and transaction costs that widen the gap between their maximum *WTP* to secure the gain and their minimum *WTA* compensation to tolerate the loss (Bateman and Willis, 1999).

Uncertainty: since the respondents have no enough time and opportunity to collect information about the change and how the change affects them respondents are usually uncertain about their responses. Particularly respondents are often uncertain in non-market resources valuation (Brown and Gregory, 1999; and TEEB, 2010). When respondents are uncertain about how the change affects them they understate their *WTP* and overstate their *WTA* to evade risk and be on

the safe side, because they see it as a bargaining situation and to avoid regret (Kolstad and Guzman, 1999; Brown and Gregory, 1999; and Bateman and Willis, 1999).

Despite the absence of consensus on the methods of measuring preference uncertainty, it can be estimated by one of the following three ways in stated preference method. One is to ask respondents to state how certain they are about their answer to the *WTP/WTA* question. Another one is to introduce uncertainty directly in the *WTP/WTA* question using polychotomous choice model. The other is to request respondents to report a range of values rather than a specific value for the change in the provision of an ecosystem service (Bateman and Willis, 1999; and TEEB, 2010).

Respondent satisficing: respondents' satisficing effect is questionnaire related argument. According to Hanemann, (1991), as discussed in (Bateman and Willis, 1999) it is difficult for respondents to answer an open-ended valuation questions than closed-ended. Since respondents may not be experienced in valuation of the change in the resources, it is hard for them to estimate its value. Open ended questions also encourage them to respond strategically. They usually reply to an open-ended *WTP/WTA* question by just 'saying'. They put *WTP* that they think enough for the change not their true maximum *WTP* and higher *WTA* that they think can accept not their minimum *WTA*. This systematically understates *WTP* and overstates *WTA*, and thus widens the disparity.

Payment vehicle: payment vehicle also contributes to the disparity of the two elicitation techniques. The gap between *WTP* and *WTA* is higher when the payments are in cash than other instruments (vehicles) of payments like tax increase or decrease, in kind payment etc. (Thaler, 1985; and Bateman and Willis, 1999).

Social norms: social norms contribute to the gap between *WTP* and *WTA* in open ended contingent survey. According to Hanemann, (1991), as cited in (Bateman and Willis, 1999), in a society, there is a norm that forbids overpayment for something than its actual cost that underestimates *WTP* and the norm of not selling something for less than a buyer will pay that over estimates *WTA*. Thus, social norms may elicit the truncated *WTP* (from above) and *WTA* (from below) distributions

Irreversibility and Uniqueness: If the respondents think the resource is unique and the change is irreversible, they deliberately exaggerate the *WTA* compensation for the change (Bateman and Willis, 1999).

Incentive-compatibility: Incentive compatibility is also related to questionnaire design. In a CV method binary discrete choice question is incentive-compatible and contributes in narrowing the gap between *WTP* and *WTA.* Other elicitation methods like double-bounded discrete choice questions, payment cards, and open-ended questions help to collect more information about a respondent's willingness to pay/accept. However, they increase the gap between the two (Bateman and Willis, 1999).

Generally, according to Hanemann, (1991), as explained in (Bateman and Willis, 1999), other effects other than income and substitution effects that are accounted for the disparity between *WTA* and *WTP* are severe in open ended *CV* survey in contrast to closed-ended. Thus, the open-ended format is generally less reliable since respondents respond to the open ended questions strategically in order to influence the outcome of the survey (Bateman and Willis, 1999).

2.1.3. The Choice between WTP and WTA Elicitation Methods

Due to the disparity between *WTA* and *WTP*, the choice between the two is controversial. Despite large number of studies (Hanemann and Kanninen 1999; Freeman, 1993; Randall and Stoll 1980; Tversky and Kahnemann 1991; and Bateman et al. 1997) that tried to find an evidence for the disparity between the *WTA* and *WTP*, literatures recommend using *WTP* (Mitchell and Carson 1989; NOAA, 1993; Brookshire and Coursey, 1987; and Haab and McConnell, 2002). According to the advocators of *WTP* the validity of *WTA* is questionable as individual tend to resist giving up something they already have especially for public goods (Mitchell and Carson, 1989). Brookshire and Coursey (1987) argue that the *WTP* is constrained by income budget of the consumers that make it more realistic. NOAA, (1993) panel's guidelines recommend the use of *WTP* than *WTA* as the former is more conservative. Haab and McConnell, (2002) focused on the *WTP* because of the absence of evidence for the disparity between the two in the behavioral approach and *WTA* is not incentive-compatible in the stated preference.

However the choice between the two elicitation methods is the unsettled state of research. According to Haab, and McConnell, (2002), the emphasis given to the *WTP* is a compromise. The choice may depend on different factors like property right, the type of the policy needed to take place, the kind of the changes that take place or proposed change.

The choice between the measures of welfare changes arising from changes in the environmental resources depends on the property rights to the resource and the right to a utility level (Haab, and McConnell, 2002; Pearce, 2002; and OECD, 2006). If the change (proposed change) in the environmental resource improves the wellbeing of the individuals we have to charge them for the additional gain they received and we estimate the maximum *WTP*. However, if the change deteriorates the situation and decreases the utility of the individuals they have to be compensated

to make them as better off as before the change. Rules of thumb for the choice between *WTP* and *WTA* are based on property rights. For improvement where the individuals do not have a property right to the post-change situation, but do have a property right to the pre-change situation we use *WTP*. For deterioration, where the individuals have a property right to the pre-change situation we use *WTA* (Pearce, 2002).

For public policies that improve the environment if the value of the change is underestimated the policy may not take place. According to Pearce (2002) if *WTP* is used in situation where policies improve the environment prohibiting those who have property right, the measure could understates the policy benefits. "Overall, policies that improve the status quo environment to some future state to which individuals can be deemed to have property rights would seem eligible for *WTA* valuations rather than *WTP* valuations." (Pearce, 2002, p: 35). Thus, he recommends the use of *WTA* if the change is improvement to the environment for the public interest, to estimate the compensation of the beneficiaries to forego the benefit for the public interest. Pearce argued that where the respondents have a right not to have their existing situation worsened, the relevant elicitation method is their willingness to accept compensation (Pearce, 2002).

According to Venkatachalam, (2004) the choice between *WTA* and *WTP* methods is contextual and the specific guidelines should emerge from the field and not from the texts. Even if most studies emphasize on the use of *WTP*, there are situation in which *WTA* should be applied. For instance, in many of the developing countries, the environmental impact assessment studies look at the negative impact of the developmental and environmental projects on the poorer section of the society who are indirectly paying in terms of damage cost. In this case, from the point of view of the losers, the *WTA* compensation rather than *WTP* is considered as an appropriate

measure (Venkatachalam, 2004). The use of *CV* is widely advocated with the WTP elicitation method. Hence, since in many natural resource and environmental situations, *WTA* is the correct welfare measure, it seems inconsistent to advocate the use of *CV* and without *WTA* elicitation method for CV (Pearce, 2002; Vatn and Bromley, 1994; Haab and McConnell, 2002; and Venkatachalam, 2004).

Provided that, the respondent has sufficient understanding of the mechanism, taking measures on factors that widens the disparity between the two and using proper guidelines make *WTA* and *WTP* comparable. Using the *WTA* in valuing goods for which income elasticity is low (Haab and McConnell, 2002; and OECD, 2006), resources which have substitutes and familiar resources to the respondent minimize the disparity (Kahneman, Ritov, and Schkade, 1999). Using hypothetical incentive compatible closed-ended questions minimize most of the survey related causes of the disparity (Haab and McConnell, 2002; and Bateman and Willis, 1999). If *CV* method practitioners use response compatible (choice tasks like closed ended questions) than response incompatible (valuation tasks like open ended questions) the disparity is lower by minimizing strategic responses (Alberini and Kahn, 2006). In incentive compatible designs respondents are available with a take-it-or-leave-it choice and providing the respondent with appropriate bid level.

Using well designed questionnaire that minimizes the respondents, uncertainty narrows the gap. Developing clear hypothetical scenario, providing enough information, including new information from pilot survey, clear resource description minimizes the problem of information asymmetry and uncertainty and minimizes the gap (Venkatachalam, 2004). Listing substitutes of the resource being evaluated as much as possible also narrows the disparity by solving the sense of irreversibility and uniqueness of the resources (OECD, 2006).

2.2. Methods of Economic Valuation

Different methods were devised to empirically estimate the value of change in natural and environmental resources. Thus, to reduce the uncertainties that lead to either overestimation or underestimation we need to select and use the appropriate valuation method.

Money measures of value indicate the rate at which an individual is willing to trade units of goods and services for money income or other goods. This tradeoff is elicited using the individuals' *WTP* to secure the gain or *WTA* compensating to tolerate loss that comes due to the change. For instance, in this study *WTA* is the willingness and minimum payment required to make the land holders indifferent to the situation before the hypothetical protection of the degraded forest land and after the expected protection.

Eliciting preferences of individual is not an easy task as there is no *single* unique technique that could be used effectively in all circumstances. There are different techniques of eliciting the *WTA*/*WTP*. The choice of the specific technique depends on the specific nature of the changed environmental resource and other circumstances (Hacket, 2006).

The preference- based total economic value estimation can be categorized into the direct market pricing approach, the revealed preference approach and the stated preference approach based on existence of market for the good or service (TEEB, 2010; and Alberini and Kahn, 2006). The direct market pricing approach is used if the change affects marketable goods and services. Revealed preference method is used if the change has related market goods (Hacket, 2006; and Bateman and Willis, 1999). The revealed preference method values only some parts of the use value and it is attribute specific. For instance hedonic pricing values location-related amenities,

the travel cost method values recreational amenities, and the averting behavior method can values health care and other services etc (Alberini and Khan, 2006).

The relatively new approach is the stated preference method which is used when there is no both direct and indirect market for the resource in question. It is the only method that measures both use and nonuse values, which is its main benefit (Hackett, 2006). Particularly it is very important in pure and quasi-public goods and resources (Alberini and Khan, 2006). In this approach, a hypothetical market that simulates a market for environmental goods and services may be created in order to elicit values from what individual state willingly. Recently stated preference techniques of measuring the value of public goods and services have become more accepted and popular (TEEB, 2010; and Haab and McConnell, 2002). Contingent valuation method, contingent choice (choice modeling) method, contingent ranking, and conjoint analysis are the main ones.

2.2.1. Contingent Valuation (CV) Method

Contingent valuation is a general empirical method to elicit individual preferences and estimate economic values through individuals' *WTP*/ *WTA* for changes in some environmental resource by developing hypothetical market (Hacket, 2006). It is a survey that uses questionnaires to ask individuals how much they would be willing to pay for a certain improvement in quality or quantity of environmental situation, or alternatively, how much they would be willing to accept for its deterioration (TEEB, 2010; Alberini and Kahn, 2006; and Hacket, 2006). The *WTP*/*WTA* depends on the individual preference.

Nowadays the *CV* method has become popular and an integral part of environmental assessment. Literatures show that the method is the most popular of the available methods for monetary

valuation of use and non-use values of change in the environmental goods or services (Alberini and Kahn, 2006). The wide spread use of the method is due its simplicity to apply, flexibility, unlimited in application, and measures the non-use and indirect use values (TEEB, 2010; Hacket, 2006; and Haab and McConnell, 2002). Substantial progress has been made in developing and implementing the CV methods to produce correct estimates as much as possible (Alberini and Kahn, 2006; and TEEB, 2010). In the working paper of environmental economics program for Southern and Eastern Asia, Whittington, (1996) argued that application of CV method is more appropriate to developing countries than developed countries given consideration of cultural values and practices in its implementation.

2.2.2. Contingent Valuation Method Criticisms

Despite popularity of the approach, the hypothetical nature of the market in stated preference approach in general and the *CV* method in particular has raised criticisms regarding the validity (accuracy) and reliability (consistency) of the estimates (TEEB, 2010; Hacket, 2006; Freeman, 1993; and NOAA, 1993). The main criticisms are the following

Disparities between WTP and WTA: The gap between the measure of *WTP* and *WTA* in stated preference valuations method is a well-known problem. According to standard economic (utilty) theory, in the measure of value of the identical change in public goods, there is no significant difference between *WTP* and *WTA.* According to the theory where income effect is small and the good has many substitutes, the disparity between the two (*WTP* and *WTA*) is insignificant and should be approximately equal (Alberini and Kahn, 2006). However, empirical literatures have shown that for identical and equal changes in environmental resources, where income effect is small and large substitutes are available, *WTA* is significantly larger than *WTP* (TEEB, 2010;

Bateman and Willis, 1999; Haab, and McConnell, 2002; Hanemann, 1993; and Alberini and Kahn, 2006). The following are the main criticism of the method.

Part-whole bias (***embedding effect):*** Since respondents usually put equal value for the whole system and for its components, preferences of people are often insensitive to scope of the resources (TEEB, 2010; Bateman and Willis, , 1999; and Hanemann, 1993).

Strategic bias: In the stated preference method, there is a potential for individual respondents to mislead the surveyor. Respondents of the survey would not reveal their true *WTP*/WTA and respond strategically to the questions to influence the outcome of the survey (Bateman and Willis, 1999 and Mitchell and Carson 1989). Strategic misrepresentation is mainly due to wrong study design and disappears in incentive-compatible designs (Kahneman, et.el, 1990).

Hypothetical bias: The hypothetical scenario influences the outcome of the survey. This bias occurs as the respondents' response to hypothetical scenario may not be the same if they are in real scenario. So the respondents may show higher *WTP* than their maximum *WTP* or less *WTA* than their minimum *WTA* in hypothetical scenario as they never pay or paid. Thus hypothetical *WTP* is greater than real *WTP* (TEEB, 2010; Hacket, 2006; and Alberini and Kahn, 2006). Hypothetical bias can be minimized and the hypothetical measurement can be compared with the real market measurements if incentive compatible (demand revealing) mechanisms are used to elicit values. This increases the validity of hypothetical measurements (Alberini and Kahn, 2006).

Information bias and lack of commodity description: The survey results are influenced by information provided to the respondents. What people are willing to pay for environmental assets depends on the quantity and quality of the information provided to them (Adamowicz et

al.,1993), including the questionnaire design or interviewing technique and the way questions are constructed like using *WTP* or *WTA* (Hackett, 2006; and TEEB, 2010). The *CV* surveys outcomes are also affected by changes in wording or order of survey questions. If the good or service is not well described, it becomes difficult for the respondent to value it. Eliciting the true *WTA*/*WTP* is difficult (Bateman and Willis, 1999).

Question forms (elicitation techniques): Using different elicitation questions (open ended, closed ended, bidding game etc) results in different *WTP*/*WTA*. In Hanemann and Kanninen (1999), it is argued that since different question forms have different merits and demerits, their answers are not equal. The appropriate elicitation technique should be selected contextually based on different factors such as the nature of the good investigated, cost of the survey, nature of the respondents targeted, nature of the statistical technique used, etc.

Resource Familiarity: If the respondents have very limited or no direct knowledge of the good or service to be valued, they cannot give well-defined values. Thus, resource familiarity influences the estimated value of the resource particularly for those whose values are primarily passive-use values (Bateman and Willis, 1999).

2.2.3. Contingent Valuation Studies and Policy

Despite the limitations and weaknesses of preference based valuation in general and *CV* studies in particular, they provide valuable information for environmental policy making. *CV* is a promising method and it can be used to derive useful information if it is conducted properly and extremely carefully. Using *CV* surveys information in policy making is becoming popular (Alberini, and Kahn, 2006). Kontoleon and Pascual (2007) recommend policy-makers, to interpret and utilize the valuable information provided by these techniques while acknowledging

the limitations of this information. That is, when we use in line with the recommendations of the *CV* literature (Venkatachalam, 2004). According to Hanemann, (1991) as discussed in (Bateman and Willis, 1999) the *CV* methods of *WTP*/*WTA* estimates may be more personal judgment about socially acceptable estimates than the inherent economic value of the change in environmental resource in question. Thus since the value depends on how it is elicited and whose preference is it, we cannot say this is the accurately correct value or this is wrong value. It simply shows the preference of the respondents and we have to manipulate the important information in the outcome of the survey.

2.3. Empirical Literatures Review

There is limited number of published empirical studies that applied *WTA* elicitation techniques to value change in environmental resources. Some of the empirical studies applied to value the value of the services provided by forest and to estimate the payment of ecosystem services provision, (Dupraz, *et al*, 2003; Smith et al. 1998; Sangkapitux *et al*, 2009; Lindhjem and Mitani, 2012; and Thoai, and Rañola, 2011) and some to estimate benefit forgone from limited access to the coastal waterfront (Zhai, and Suzuki, 2009), and community forests (Bush et el, 2012), to see if the provision point mechanism solves the disparity between *WTP* and *WTA* problems, and *WTA* compensation to open access to private forest access (Gadaud, and Rambonilaza, 2010).

Dupraz, *et al* (2003) analyzed farmers' participation in environmental conservation schemes, through voluntary agreements that pay farmers for the provision of environmental services, using *CV* method. They used data collected for a survey of an agro-environmental scheme conducted to protect the nesting of some endangered bird species that was implemented in the Walloon region of Belgium since 1995. They defined the household's *WTA* compensation to participate in the scheme as the difference between the lost profit of participating in environmental services

provision and the willingness to pay to consume these services. Their study has shown that the *CV* is a reliable method to elicit the behaviours of farmers facing the invitation to participate in the scheme. They also confirm that farmer behaviour is also influenced by environmental preference (Dupraz, *et al*., 2003).

Smith et al. (1998) studied the possibility of the existence of trade in carbon sequestration services between utility companies and slash-and-burn farmers in the Peruvian Amazon. They used a *CV* survey to elicit the compensation required by farmers to supply carbon sequestration services, by switching from slash-and-burn agriculture to forest preservation and agroforestry. Their study that used an indirect WTP format showed that the farmers positively value the environmental services of forests. They found that creating market for forests is effective than traditional forest conservation efforts. The participatory market-based approaches benefit the resource-poor farmers who manage the forests.

A study was conducted by Sangkapitux and others in Thailand in 2009, to see potential of developing compensation schemes to upland farmers who are considered a threat to the natural resource. The case study was conducted in Mae Sa watershed, Chiang Mai province. In the study the downstream farmers were assumed to compensate the upstream farmers to shift from their conventional agricultural practices towards environment-friendly practices in which the water quantity and quality improved to the downstream farmers. The researcher used the choice experiment method to estimate the *WTA* compensation to the upstream ethnic minority farmers for the conservation measures and the *WTP* of the downstream communities of the watershed for water resource improvements. The study found that downstream resource managers would be willing to provide on average nearly 1% of their annual income. The estimated total *WTP* for the improvements from the downstream households is 6157 Euro per-year where as the total *WTA*

compensation asked by the upstream farmers is 131,006 EUR per year. Thus it shows that about 4.7% of the amount needed to compensate upstream resource managers could be collected from downstream resource managers in the watershed. The researcher recommended that the remainder would need to be contributed by other stakeholders like private businesses and local administration. Both *WTP* of downstream respondents and *WTA* compensation of upstream resource managers were positively correlated with age, education, participation in environmental conservation activities and previous experiences with droughts and/or erosion. The paper concluded that there is a potential for establishing compensation schemes for provision of watersheds environmental services if relevant stakeholders contribute a substantial share of the budget for compensation (Sangkapitux, *et al* 2009).

Thoai, and Rañola conducted a study to determine the level of *WTA* compensation of upland farmers to participate in forest management programs in the northwest mountainous region of Vietnam. The study estimated the amount of payment necessary to encourage upland farmers to willingly participate in the government's forest management programs. The results showed that the payment level that was existing before which was US$5.4 hectare-per-year for participating in the forest management programs was too low compared with the *WTA* estimated by their study which is US$15.5 / hectare-per-year. According to the study the important factors affecting the level of *WTA* include the opportunity cost of forest management, ethnic affiliation, access to the forest, total income of households and topography of the forest area (Thoai, and Rañola, 2011).

Bush et el, (2012), conducted a research using *CV* method to estimate the local benefits forgone from loss of access to a number of protected area types in Uganda. According to the researchers, restricting access to the forests would deprive the local communities of their benefits they obtain

from the forests which they consider themselves as having property rights. They argued that *WTA* compensation for those losses is a more appropriate measure than *WTP*. The researchers developed a hypothetical scenario in which the local communities completely loss the access to the forests and estimated the monetary compensation for the lost benefit. They estimated opportunity cost of the local communities adjacent to four protected areas in western and south western Uganda. They methodologically, implemented a 'provision point mechanism' to constrain *WTA* compensation of the households. Thus, their studies showed that the 'provision point mechanism 'reduced mean *WTA* by a significant degree. They also showed that the provision point mechanism significantly reduces outlier responses and the resulting estimate of average welfare loss (Bush *et el*, 2012).

Zhai, and Suzuki, (2009), measured the total economic value of a coastal waterfront (coastal zone) using *WTA*. They justified the use of *WTA* than WTP which is usually applied to estimate economic value of common goods as there is a trend that the landscapes of a coastal waterfront like viewing the sea should be regarded as one of the property rights of coastal residents in Japan. They estimated the *WTA* compensation for the loss of the accessibility to a coastal waterfront, because a number of empirical literatures show that *WTP* is usually substantially lower than *WTA*. They found that the *WTA* in Tokyo bay is 65.3 million yen per-household-per-year, more than ten times their annual household income and the total economic value of Tokyo bay is estimated to 539 trillion yen per-household-per-year, which they said can be taken into consideration in the coastal risk assessment process to evaluate the efficiency of coastal risk reduction measures.

Gadaud, and Rambonilaza, (2010), estimated the *WTA* compensation of private forest owners to maintain an open-access to forest for nature-based recreational activities. They estimated the

compensation level for the risks that occur due to open access. They used *CV* method subjective expected utility modeling approach.

Lindhjem and Mitani, (2012), investigated non-industrial private forest owners' preferences to voluntarily participate in forest conservation using *WTA* compensation using *CV* method in Norway. They found that *WTA* is negatively related to the size of the forest holding and absentee ownership, and positively related to the share of the forest classified as productive. The overall mean *WTA* is estimated to be *NOK* 1,800 per-year-per hectare. Costs of reaching conservation goals can be saved by targeting small and relatively less productive forests and absentee owners first, before considering increasingly expensive forest areas.

In Ethiopia there is no published study, (to the best of my knowledge) that valued forest use change using *WTA* elicitation method. However there are studies that used *WTP* elicitation technique. For instance, (Mokennen, 2000) conducted a study to estimate the value of community forestry to the rural households of Ethiopia using a *CV* method. He examined the determinants of the value of community forestry to the rural households to see its feasibility, when the plantations are established, managed, and used by the communities themselves. His study showed that household size, household income, distance of homestead to proposed place of plantation, number of trees owned and sex of household head and sites are significant variables that explain *WTP*.

2.4. Summary of the Literatures Review

Change in natural resources valuation is very important in policy making and awareness creation. The disparity between *WTP* and *WTA* elicitation techniques made the choice between the two, controversial. Studies recommend the use of *WTP* whereas other studies argue that the choice between the two is contextual. There are cases where *WTA* compensation is appropriate.

WTA is rarely applied in environmental resource valuation. Literature review shows that where the local communities have property rights on the resource and where the government policies are for the betterment of the public life the *WTA* is the appropriate one. The local farmers in Belgium (Dupraz, *el al.* 2003), the slash-and-burn farmers in Peruvian Amazon (Smith, *et al*., 1998), the upland farmers in Thailand (Sangkapitux, *et al*., 2009), upland farmers in Vietnam (Thoai, and Rañola, 2011), the local communities in Uganda (Bush *et al*,. 2012), the private forest owners (Gadaud and Rambonnilaza, 2010) and non-industrial private forest owners in Norway (Lindhjem and mitani, 2012) were all owner or managers of the forests and they protect the forests for the benefit of the society.

Some of the studies did not estimate *WTA* directly. Dupraz, *el al.* (2003) defined the *WTA* as the difference between profit loss from conserving the forest and the *WTP* to consume the provided services; which does not show the correct *WTA* of the forest managers. Smith, *et al*., (1998) used the indirect *WTP* to estimate the *WTA*. Since individuals tend to understate the *WTP* and overstate the *WTA*, using the indirect *WTP* for the Peruvian Amazon poor farmers who are constrained by income might widen the gap between the *WTP* and *WTA*. This shows the difficulty of using indirect *WTP* for *WTA*. Some of the studies focused on the specific services like watershed (Sangkapitux, *et al*., 2009) and carbon sequestration (Smith, *et al*., 1998) of the forest ecosystems that might be subjected to the whole part bias.

CHAPTER III

Methodology of the Study

Methodology of a study is an important part that determines the reliability and validity of results of the study. In this section the survey design, implementation of the survey, the economic and econometric models are discussed respectively. Under the survey design the *CV* method, choice of population and samples and mode of data collection would be discussed. Then in the implementation of the survey section the hypothetical program, the survey questionnaire, types of the valuation questions and the pilot survey would be discussed. Finally the economic, the rationale for using WTA elicitation method**,** econometric model and techniques of estimation, how mean is estimated and the definition of the econometric variables would be discussed in the last section.

3.1. Survey Design

3.1.1. Contingent Valuation Method

This study used the contingent valuation (CV) method of the stated preference approach which is common to estimate the value (use and nonuse value) of change in natural resources. Stated preference approach which includes the CV method is the only method to estimate the nonuse value (in addition to use value) of resources (TEEB, 2010; Hacket, 2006). CV is widely used in nonmarket resource valuation. It became popular as it is simple, flexible, and unlimited in its applications (Alberini and Kahn, 2006; Haab and McConnell, 2002; TEEB, 2010; Spash, 2008; and Hacket, 2006). It is a questionnaire survey which used practically to elicit individuals'

preferences of changes by revealing the individuals' WTP/WTA. CV method survey is selected in this study to easily collect needed data from the degraded forest land to the holders.

3.1.2. Choice of Population and Sample

A reliable, cost-efficient sampling design is very important in obtaining accurate estimates from a contingent valuation (CV) study. The study used stratified random sampling. Since in the developing countries a purely random sampling design based on a complete enumeration of the population is impossible as a complete list of sampling units is rarely available. A two-stage stratified sampling is important to minimize sampling error and make it representative in developing countries (Hussen, 2000). First the population frame was stratified into *'Kebeles'*. Then five '*Kebeles*' of a target population were purposefully selected from the 23 rural '*Kebeles'* of the '*Woreda*'. These *'Kebeles'* are among the 'Kebeles' where the fragmented and degraded natural forests are found. The selected '*Kebeles'* were '*Dawicha Kerensa', 'Jila Kerensa', 'Roge Kolati', 'Wuye Gose' and 'Halelu Chari'*. The samples were drawn from a sample frame of households that have been holding degraded forest land and have land holding-book for the land or given to them by '*kuta*'. With the help of the '*Kebele'* administrators those households that have been holding degraded natural forest land were identified. Then, from each '*Kebele*' 40 households, total of which are 200 households were sampled using simple random sampling considering the cost of the survey. The needed data were collected from heads of the households.

3.1.3. Mode of Data Collection

The in-person mode of data collection was applied. Although it is costly to use in person mode of data collection, using this mode is better and the only option. Stated preference practitioners generally recommend face-to-face surveys due to its merits (Alberini and Kahn, 2006; Haab and McConnell, 2002; and Bateman and Willis, 1999). In-person surveys can possibly be conducted

within a short period of time and allows an interviewer more control over respondents' responses despite it contains potential interviewer effect. Demerits of face to face survey mode are it is relatively expensive and possible interviewer bias. Four data collectors recruited from '*Garbaguracha'* Preparatory School. They were trained to minimize interviewer bias of face -to-face mode of data collection. They collected the data under the supervision of the researcher.

3.2. Implementation of the survey

3.2.1. The Hypothetical Program

The study developed a hypothetical program in which land holders voluntarily protect their degraded forest land for regeneration of natural forest accepting compensation for the lost benefit. According to the hypothetical scenario, only rural small scale land holders who have been holding land that is not ploughed before, on which there is degraded natural forests that are able to regenerate if protected. The hypothetical program would last for ten years. It is difficult to exactly show the boundaries of these degraded forests as it is fragmented and the degraded forests are not similar in all places. However, this study focused on farmers that held land on the chain of hills and hill sides in the '*Woreda'*. There are several chains of steep hills that are stretched through several '*Kebeles'*. These lands have been used as grazing land, sources of fuel-wood and construction materials for house, fence, storage facilities beehives, etc. They have been also used as source of income by selling forest products to '*Garbaguracha'* town.

According to the hypothetical program, the land holders would protect the lands and stop any activity that degrades the forest, except for grazing for ten continuous years. The hypothetical program is limited to last for only ten years for two reasons. One is to minimize the respondents'

uncertainty and fear of land holding alienation; and the other is, the forest is assumed to grow in to dense forests in ten years.

The scenario emphasized on restoring natural forests through natural regeneration than afforestation and reforestation through plantation of (usually, exotic, monoculture trees) for several reasons. Protecting existing degraded natural forest for natural regeneration and restoring forest is easy and cheap than afforestation and reforestation. This low cost of development will attract international support and fund as it will be attractive in carbon market and for other services that reduce capital problem. Carbon is stored in a more reliable stock in natural forests than in industrialized forests (Mackey *et al*., 2008). Indigenous natural forests are rich in biodiversity and provide multiple ecosystem services whereas plantations cannot provide all services that natural forest provides (Ehleringer, 2011; and Lamb and Gilmour, 2003). Conserving degraded forest helps in conserving indigenous plants and animals. The landscape aesthetic value of natural forest is also better than afforestation. Planting and maintaining trees can be a time-consuming, labor-intensive process for local communities and the probability of new planted trees to grow is less than the natural regeneration (Griscom, *et.el*., 2009). Natural forests are also, more resilient to adapt to climate change and easily recover after disturbance like fire, resistance to and from pests and diseases than plantations (Mackey *et al*., 2008).

3.2.2. The Survey Questionnaire

The survey questionnaires contained attitudinal, behavioral, demographic and socio economic sections, as recommended by empirical literatures (Alberini and Kahn, 2006). In the attitudinal section questions about climate change and other environmental problems like (deforestation; forest degradation land degradation etc.), services forest delivers; attitudes towards the protection and restoration of forests, and sources of information about the environment were asked. In the

behavioral section, questions related with the use and plan to use of the degraded natural forest land and questions related to the remaining forest were asked.

In the valuation scenario section, the hypothetical scenario developed was informed to the respondents by the language and expression they can understand. Possible losses and benefits were informed. Then, the value elicitation questions were asked using the single-bounded open–ended follow up questions.

The last section which is demographic section and socio-economic characteristics were collected. In the demographic section, age, sex and education level of head of the households and size were asked. In the socio economic characteristics: income of the 2013/14 year (income from crops production, animals sale, vegetables sale, forest product sale, honey, milk and eggs sale, and others income), wealth (total land size owned and animals wealth), and others collected.

3.2.3. Types of the Valuation Questions

The study used single-bounded dichotomous choice questions with open ended follow up questions. The dichotomous choice question has been the dominant and recommended form of CV questions in environmental resources valuation (Alberini and Kahn, 2006; Haab and McConnell, 2002). It is incentive compatible that reduces the strategic bias by encouraging truth telling and it is easy to answer since it facilitates the respondents' valuation tasks (Carson et al., 1996; and Hanemann, 1993). Using referendum form single-bounded dichotomous question is recommended by the NOAA, (1993), and open ended follow up question was suggested by Mitchell and Carson (1989). Mitchell and Carson, (1989) and Mekonnen, (2000) applied the single-bounded open-ended follow up question format. As cited in Mekonnen, (2000), Green et al. (1995) argued that more and valid information is collected using single bounded with open-

ended follow up question than alternatives such as the double referendum method. The open ended follow up question helps to identify whether the individual is protesting (reluctant to accept compensation) and to get the point estimates of minimum WTA compensation. According to Mekonnen (2000), the single-bounded open- ended follow up questions are widely used in practice (in market) in developing countries.

The demerits of single bounded dichotomous questions are researchers who use single bounded DC questions only learn whether each respondent's WTA/WTP is above or below bid not the actual amount. So it needs more sophisticated econometric methods to develop mean WTA/WTP. The variance on average WTA/WTP tends to be large. It relatively needs large samples for statistical purposes and hence it is costly (Alberini and Kahn, 2006 and Bateman et al., 1997).

3.2.4. *Pilot Survey*

A pilot survey was conducted to revise the questionnaires based on the lesson learnt. The bid levels (960, 1920, and 3840 birr per hectare per year) were selected. Open ended questions were used to determine the bids. Twenty-four (24) participants which held degraded forest land were asked to guess the minimum compensation needed to protect the land per '*guzm*' per year which is a local land measure and changed into hectare per year. Then, the minimum compensation was taken. Assuming that it is over estimated, half of the minimum was taken as the minimum bid, its double as maximum bid, and the minimum estimated as middle bid.

In the pilot survey, most of the land holders who have cattle protested the scenario and the remaining asked extremely large amount of compensation for the hypothetical program that prohibited them from using the land for grazing. Those who asked very large compensation (up

to Birr, 10,000 per '*guzm*' per year equivalently ≈Birr, 80,000 per hectare per year), justifying that they don't have substitute grazing land and would stop rearing animals and even, keeping oxen used for crop farming. Hence, grazing is allowed since its threat to the forest is not as serious as other factors like cutting trees and burning; and it is difficult to conduct the study where majority protest the scenario.

3.3. The Economic and Econometric Models

3.3.1. Economic Model

Economic theory (utility theory) recommends compensation when individual's welfare changes due to change in economic activities to make the individual's welfare constant. The compensation variation measures the amount of money to be added to or subtracted from the budget of the individual to make the individual as better off as before the change, other things remaining constant. As explained in Bateman and Willis, (1999) and Haab and McConnell (2002) the amount of money needed for compensation is determined by the difference in money expenditure before and after the change.

$$Cv = e\,(p, q^0, u^0) - e\,(p, q^1, u^0) \quad \text{---------- (3.1)}$$

Where *Cv* is compensation variation, *e* is expenditure, '*p'* is prices of market good, 'u^0' is utility before the change, and q^0 and q^1 are the change in the environmental resources from q^0 to q^1.

If the difference between the expenditure function is positive, *Cv* will measure *WTP* and if it is negative it measures *WTA*. In this study case Cv is expected to be negative and it measures the minimum WTA compensation of the land holders for lost benefit since the hypothetical program prohibits them from using the degraded natural forest.

WTA= $e\ (p, q^0, u^0) - e\ (p, q^1, u^0)$ ---------- *(3.2)*

In resource and environmental economics, compensation of affected individuals for loss of welfare is recommended either if the resources on which the individuals depend are damaged or the resources are protected for the public interest and the individuals are prohibited from extracting (exploiting) the resource (TEEB, 2010).

3.3.2. The Rationale for Using WTA Elicitation Method

Many literatures advice the use of WTP in estimating values of change in environmental resource due to the disparity between WTP and WTA problem (Mitchell and Carson 1989; Brookshire and Coursey, 1987; Haab and McConnell, 2002; and NOAA, 1993). NOAA (1993), panel's guidelines recommend using WTP than WTA as the former is more conservative. However what the NOAA panel guideline principle tried to explain is in measuring (assessment) in natural resource damage. In this study the resources (degraded natural forest) are going to be improved; not going to be damaged. Thus it is somewhat difficult to use this principle in environmental improvement which is good for public interest. The land holders ask compensation for the lost benefit from protection of the forest. However, in this study WTA is the appropriate measure of the respondents' preference revealing method for several reasons.

One is the choice between WTA and WTP valuation mainly depends on the respondents' property rights to the resources the right. A resource is private property if the individual have all access, withdrawal, management, exclusion and alienation rights (Mäler and Vincent, 2003). Land holders in Ethiopia have access, withdrawal, management and exclusion rights; and are restricted on alienation rights. Even if the land holders can transfer the land holding right willingly as heritance to others and can lease it for two years, they have no right to sell or

exchange. Given the land holding right, since the forests on the land would be protected and they stop using the land and the forest, they have the right to ask compensation for the lost benefit. According to the hypothetical program the land holders would protect the regenerating forest to provide ecosystem service for which they also need compensation for their labor.

Poverty and lack of commitment towards protecting the environment resources are other reasons that make *WTA* appropriate. The respondents would be poor small scale holders who may have low awareness about the environmental services. If we use *WTP* elicitation method to restore the forests to know how the respondents attach value to the forest, they would be expected to protest or *WTP* would be very small. Spash (2008) argued that using willingness-to-accept compensation (WTA) is important to avoid the respondents' protesting. Even if the respondents are well aware, they may not have demand for it despite the wish to have clean and comfortable environment. They would not be willing to pay and buy the service, as their income is low and give priorities to other subsistence socio-economic priorities.

Another reason is that using the WTP elicitation method in policies that improve the environment would understate the policy benefits even when poverty and lack of awareness are not reasons (Pearce, 2002). In conservation and restoration of natural resources using WTA elicitation method is better than WTP since people usually strategically understate or protest WTP that leads to the conclusion that the forests have no value to the people. This diverts policy makers from deciding to protect and leads to under provision of the ecosystem services. But in the WTA case land owners usually tend to overstate the value, which may increase the value of the resources and influence the policy makers and lead to high service provision.

Another justification is, what this study tried to estimate is the value the degraded forest has to the land holders. According to the hypothetical program, the forest is going to be regenerated. Thus asking maximum WTP to restore the forest cannot be compared with the minimum WTA for the currently lost benefit. The lost benefit is value the land holders put on the degraded forest, whereas restoration is what the respondents (land holder or non-land holder) put on forest.

Lastly, progress has been made in minimizing the difference between WTA and WTP, and applying WTA in valuation is improved. The disparity between WTP and WTA can be minimized by using suggested guidelines of contingent valuation method and developing a well-designed hypothetical scenario and questionnaire. Provided that, the respondent has sufficient understanding of the mechanism, taking measures on factors that widens the disparity between the two and using proper guidelines make WTA and WTP comparable.

Generally, for this study, due to the above listed reasons the use of WTA compensation for the lost benefit for the land holders was more appropriate one in the study.

3.3.3. Econometric Models and Estimation Techniques

From the economic model, the compensation (WTA) for the hypothetical protection of the degraded natural forest land is the difference between expenditure of the individual before the proposed change and after the proposed change, keeping the utility of the individual constant. However since the utility of the individual is influenced (affected) by different socio-economic demographic, and attitudinal factors it is difficult to keep it constant.

$$Cv = e\,(p, q^0, u^0) - e\,(p, q^1, u^0) \quad (3.3)$$

Thus the amount of the WTA of an individual depends on utility which in turn depends on the socio-economic and demographic factors.

WTA=f (socio-economic, demographic and attitudinal factors) ---------- *(3.4)*

The study tried to identify factors affecting the WTA compensation of the land holders and estimate the mean WTA compensation. The factors hypothesized to affect the WTA are included in the econometric model.

Two types of econometric models were used to see if the above expected factors were determinants of WTA compensation of the land holder, based on the types of survey questions used. The dependent variable (WTA) data were collected using two types of questions. The first type was, the single-bounded dichotomous questions in which the respondents were randomly assigned with amount of compensation (bid level). The other type is the open-ended follow-up question that asked the respondents to put the minimum WTA compensation after the single-bounded binary choice is chosen (answered).

The single-bounded binary answers were modeled using the Probit model which is one of the known models for binary dependent variables. Probit model is a widely applied model in empirical analysis in economics and other social sciences (Wooldridge, 2002). The Probit model is derived from an underlying latent variable that satisfies the classical linear regression model assumptions. As formulated in Wooldridge, (2002) and Maddala, (1992), assuming there is an underlying (latent variable) y* which is not observed, the model is given by,

$$y_i^* = \beta_0 + \sum \beta_j x_i + u_i$$ ---------- (3.5)

$$y = \begin{cases} 1 & if \quad y^* > 0 \\ 0 & otherwise \end{cases}$$

Where y is the observed variable, y^* is the latent variable and x_i are the explanatory variables, β_j are the parameters, and u_i is the disturbance term.

Then, given the explanatory variables the probability of success (y=1 or y*>0) is modeled as follows.

$$p(y = 1/x_i) = F(\beta_0 + \sum \beta_j x_i) \text{ ---------- (3.6)}$$

Where F is a function taking on values strictly between zero and one: $0 < F(z) < 1$, for all real numbers y* where, $z = y_i^* = \beta_0 + \sum \beta_j x_i + u_i$.

The disturbance term *(u)* is assumed to have the standard normal distribution with mean 0 and variance 1, and it is assumed to be independent of x_i.

Then the probit model is given by a nonlinear integral function

$$F(z) = \Phi(z) = \int_{-\infty}^{z} \frac{1}{\sqrt{2\pi}} \exp(-z^2/2) dx \text{ ---------- (3.7)}$$

Where $z = \beta_0 + \sum \beta_j x_i + u_i$

As explained in Wooldridge, (2002) and Maddala, (1992), the function *Φ(z)* is *a* standard normal cumulative density function for probit model. It is an increasing function and its value lies between 1 and 0. It increases most quickly at $z = 0$, *and* $\Phi(-\infty) = 0, \Phi(\infty) = 1$, *and* $\phi(z) = \frac{d\Phi(z)}{dz} > 0$

The nonlinear Probit model was estimated using the Maximum Likelihood (ML) estimation technique. To change the probit model to the maximum likelihood function, as given in Wooldridge, (2002), we need the probability density of the dependent (latent) variable y_i* *(*which is either *0 or 1)* given the explanatory variables $\boldsymbol{x}_i$. The probability density is given by

$$f(y/x_i;\beta) = [F(\beta_0 + x_i\beta)]^y [1 - F(\beta_0 + x_i\beta)]^{1-y}$$, where y=0, 1. ---------- (3.8)

Then, the log-likelihood function for observation *i* is a function of the parameters and the data ($\boldsymbol{x}_i$,y_i) and is obtained by taking the log of the above function (12) which is

$$l_i(\beta) = y_i \log[F(\beta_0 + x_i\beta)] + (1 - y_i)\log[1 - F(\beta_0 + x_i\beta)]$$ ---------- (3.9)

Since, for Probit, *F*(z) is strictly between zero and one (F(z)≠1and 0) the maximum log likelihood function of observation i ($l_i(\beta)$) is well-defined for all values of β.

For the total sample size *n*, the log-likelihood function is obtained by summing the individual loglikelihood function for all observation.

$$L(\beta) = \sum_{i=1}^{n} l_i(\beta)$$ ---------- (3.10)

The probability of success (yes) to the dichotomous question depends on the difference between the minimum payment they are willing to accept and the proposed bid level. If the minimum WTA they are thinking is less than the bid level, they would accept. Their minimum WTA in turn depends on the socio-economic, demographic and attitudinal factors.

The probit model is given in the following equations (3.11-3.13)

$$F(z) = \Phi(z) = \int_{-\infty}^{z} \frac{1}{\sqrt{2\pi}} \exp(-z^2/2) dz$$ ---------- (3.11)

$$z = \beta_0 + \sum \beta_j x_i + u_i$$ ---------- (3.12)

$$Wta1 = z = \beta_0 + \beta_1 bid + \beta_2 incom + \beta_3 livest + \beta_4 lanhld + \beta_5 sizdeg + \beta_6 hirta + \beta_7 age + \beta_8 sex + \beta_9 edulev + \beta_{10} famsiz + \beta_{11} sexfam + \beta_{12} certain + \beta_{13} arabil + \beta_{14} avasub + \beta_{15} chplan + \beta_{16} prplan + \beta_{17} protef + \beta_{18} distime + \beta_{19} regtime + ui$$ ---------- (3.13)

The open ended follow up questions were modeled using the Multiple Linear Regression models, in which the disturbance terms were assumed to be normally distributed. Since the minimum WTA compensation cannot be negative and there is no zero the open ended follow up is modeled using the log-linear model in which *'minwat', 'bid','income'* and the *'livest'* variables entered the model in logarithmic form. As Wooldridge (2002), explained taking logs of variables narrows the range of the variables, in some cases by a considerable amount and makes estimates less sensitive to outlying (or extreme) observations. Then the econometric model of minimum WTA compensation, to protect the degraded forest land, was given based on an additive functional form and was estimated using the Ordinary Least Square (OLS) method that minimizes the sum of the disturbance term. The model is shown in equation (3.14 and 3.15)

$$minwta = \beta_0 + \sum \beta_j xi + u_i$$ ---------- (3.14)

$$lnminwta = \beta_0 + \beta_{1ln} bid + \beta_2 \text{lnincom} + \beta_3 lnlivest + \beta_4 lanhld + \beta_5 sizdeg + \beta_6 hirta + \beta_7 age + \beta_8 sex + \beta_9 edulev + \beta_{10} famsiz + \beta_{11} sexfam + \beta_{12} certain + \beta_{13} arabil + \beta_{14} avasub + \beta_{15} chplan + \beta_{16} prplan + \beta_{17} protef + \beta_{18} distime + \beta_{19} regtime + u_i$$ ---------- (3.15)

Mean for the single-bounded dichotomous question data would be calculated using the Krinsky and Robb's method of finding mean for binary dependent variable as shown in Carson and Czajkowski, (2013). The formula is given in equation (3.16).

$$\text{Mean} = -\frac{\bar{X}\beta'}{\beta_0} \quad \text{---------- (3.16)}$$

Where $\bar{X}$ is row vector of sample mean including 1 for the constant term; β'_{k-1x1} is column vector of estimated coefficients and β'_0 coefficient on the bid variable.

3.3.4. The Variables

The definitions of the variables that are hypothesized to affect the dependent variable and how they are expected to affect WTA are discussed below.

Willingness to accept (wta1): The willingness to accept is a dependent variable that would come from the single bounded binary valuation questions. The respondent would be provided with randomly assigned proposed level of compensation (bid level), for the protection of the degraded forest and would say '*yes'* if he/she is willing to accept the compensation and '*no'* if not willing.

Minimum willingness to accept (minwta): The minimum willingness to accept is another dependent variable and it would come from the open ended follow up questions. After the single bounded dichotomous question is answered the respondent would be asked to put the minimum WTA compensation, for the lost benefit.

Bid: bid is the proposed amount of compensation randomly assigned to the respondents. Using the pilot survey three bid levels were identified. These were 120, 240 and 480 birr per '*guzm'* per year (equivalently 960, 1820, and 3840 birr per hectare per year, respectively). Higher bid levels were expected to induce the respondent to accept the proposed compensation and affect the minimum WTA positively.

Income (incom): The 2013/14 income is estimated by total income from crops cultivated, cash crops like vegetables and fruits, animal sales, sales of milk, honey, eggs, and other incomes. Respondents with higher income are expected to accept the proposed bid level compensation and ask lower minimum WTA than those with lower income.

Livestock ownership (livest): livestock ownership is the estimated total price of domestic animals. Their monetary value is estimated using the 2013/14 average price of each category of the livestock. The livestock include oxen, cows, calf, sheep, goat, horse, mule, donkey, and hens and cocks. Respondents who own higher livestoc wealth are expected to be more likely to accept the assigned bid level compensation and ask lower minimum WTA than those who own lower livestock wealth.

Total size of land holding (lanhld): land holding is another category of wealth. It is the total size of land hold by the respondents. Large total size land holders are expected to be more probable to accept the bid level compensation and ask lower minimum WTA compensation than those who held lower size of land. It is because they have other remaining land to use if the forest land is protected.

The size of degraded natural forest land (sizdeg): the size of degraded natural forest land is land on which degraded natural forest that can be regenerated if protected exist.

Hirta: '*Hirta*' is contract like practice in which farmers that have no enough land get into contract with land holders to cultivate crops sharing the cost of fertilizer and seeds and to share output with the land holder after harvest. Respondents that practice '*hirta'* are expected to be more probable to reject the proposed compensation and to ask higher WTA than those who do

not practice it. The rationale is that, they have no enough land and practicing '*hirta'* so that they would ask higher compensation to stop using the degraded natural forest land they held.

Age of the household head (age): Older head of households may know how the forest cover declined over time from their life experience and they have seen the impacts of the deforestation and forest degradation, and hence they may prefer protection of the existing forests. Thus, older age household heads are expected to accept the proposed bid level compensation and to ask lower minimum WTA compensation. On the other it is reasonable to argue that young household heads are more educated than older age household heads and thus, may better know the importance of forest. Thus, younger age heads may accept protection program at higher cost than older heads.

Sex of the head of households (sex): female heads of households know the uses of the degraded forest than male heads, as they are more close to the uses of forests like fuel wood, and sale of forest products. Thus female heads are more probable to reject the assigned bid amount compensation and to ask higher minimum WTA compensation level.

Education level of household head (edulev): Education helps to understand about our environment, environmental problems and how to minimize environmental problems. Thus, educated heads of households are expected to be more aware about climate change and other environmental problems, the impacts of deforestation and forest degradation and the important role of natural forest in solving environmental problems. So, more educated heads are expected to be more likely to accept the proposed compensation and to ask lower minimum WTA compensation than less educated heads.

Family size of the household (famsiz): living expenditure of households with higher family size is large. They expend on food, clothes, education materials and others. They also use more forest products like fuel wood in proportion of their family size. Those respondents with large family size are expected to reject the proposed compensation amount and ask higher minimum compensation than those with small family size.

Sex composition of family (sexfam): sex composition of family is the number of male members in the family. In rural areas male members usually go to town than female members. When they go to town may have expenditures to consume food and beverages. In addition rural students usually stay in the town to attend their high and preparatory school. Female students often prepare their food while male students consume from restaurants. Thus, families with higher number of male members are expected to have higher expenditure and ask higher compensation level. So, they are more probable to reject the proposed compensation.

Certainty (certain): When respondents are uncertain about how the change affects them they understate their WTP and overstate their WTA to evade risk and be on the safe side (Kolstad and Guzman, 1999; Brown and Gregory, 1999; and Bateman and Willis, 1999). Thus, uncertain respondents about their answer to the valuation question are more likely reject the bid level compensation and ask higher minimum WTA than the certain respondents.

Arability of the degraded natural forest land (arabil): accepting or rejecting the proposed amount compensation may depend on the thought of the respondents about the arability of the land. Those respondents who think that the land is arable may raise its value since in the future they may plough it.

Availability of substitute (avasub): Hanemann (1991) as discussed in (Bateman and Willis, 1999) showed that, the WTA is higher if the elasticity of substitution between environmental good and marketable goods is low. Hence respondents who think they can substitute the products of the degraded natural forest are expected to be more probable to accept the bid level compensation and ask lower minimum WTA than those who think they cannot substitute.

The existence of plan to change the land into farm land (chplan): respondents who have planned to change the land to farm land were expected to ask higher compensation for the protection of the forests. Thus, they are more probable to reject the proposed compensation than those who have no such plan, since changing the land may be more valuable.

The existence of plan to protect the forest (prplan): those respondents who have planned to protect the forests in the near future are more probable to accept the compensation since they have already planned to protect it without taking compensation. Hence they are expected to ask lower compensation than those who have no such plan.

The protection effort (protef): those respondents who have been exerting effort to protect (at least to exclude others) without compensation are expected to accept the proposed compensation and ask lower minimum WTA compensation.

Distance from homestead in time (distime): if the forest is far from homestead it is difficult to use it and the holders may lower its value. On the other hand it is difficult to protect forests far from homestead and the holder may ask higher compensation to protect.

Time the forests take to regenerate (regtime): Time the forests take to regenerate is period of time it takes for half of the forest to regenerate and reach height of 2 meters. It depends on the thought of the respondents. If the respondents think it regenerate and half of the forests reach

height of 2 meters quickly, they may ask higher compensation and more likely to reject the bid level compensation, as there might be already significant forest exist on the land that is useful for the holders.

Summary of all the definitions of the explanatory variables and how they were measured is given in **Table 3.1.**

Table 3.1. Variables Expected to Affect the WTA

Variable Name	Variable Definitions	How the variable is measured
wta	Willingness to accept the bid level compensation (the dependent variable)	1 if accept the bid 0 if not
minwta	Minimum willing to accept compensation (dependent variable)	Measured in birr in 1,000
bid	bid level	Measured in birr in 1,000
incom	income of 2013/14 from all sources	Estimated in birr in 1,000
livest	livestock wealth	Estimated in birr in 1,000
lanhld	total land holding wealth	In '*guzm'* and changed into hectare
Sizdeg	Size of degraded natural forest land holding	In '*guzm'* and changed to hectare
hirta	Produce crops on others' land sharing its output	1 if practice *hirta* 0 otherwise
age	age of the household head	Measured in years
sex	Sex of the household head	1 if male 0 otherwise
edulev	education level of the head of household,	1 if basic or elementary 0 if illiterate
famsiz	family size of the household	Measured in number of family members
sexfam	sex composition of family members	Number of male in the family
certain	certainty about their answer to the valuation question	1 if certain 0 otherwise
arabil	the arability of the degraded forest land	1 if arable 0 if not
avasub	availability of substitutes for the uses of degraded forest	1 if the respondent can substitute or to some extent substitute and 0 if not
chplan	Plan to change the land into farm land	1 if planned to change 0 otherwise
prplan	Plan to protect the forest	1 if planned to protect 0 otherwise
protef	current protection effort to exclude others	1 if protecting others from the land and 0 if not
distime	the distance between the land and homestead in time it takes	Measured in minutes
regtime	Length of time it takes for half of the forest to regenerate and reach height of 2 meters	rapidly regenerate and 1 if less than 2.5 years and 0 if longer than 2.5 years which is average

CHAPTER IV

Interpretation and Analysis

4.1. Summary of the Data

The data were collected from the households using questionnaires that helped to collect data on the attitudes, behavioral, valuation, demographic and other socio economic characters of the respondents. The data were collected from September 21 to November 5, 2014. Out of 200 distributed questionnaires, 168 (84%) valid questionnaires were collected. The remaining 32 questionnaires were left because of incomplete, inconsistent, and outlier's problems. Inconsistent answers include those questionnaire which shows that the size of degraded natural forest land held is greater than the total land held by the household; and those who thought the land is not arable but have plan to change it into farm land. Those respondents who did not hold degraded natural forest land and those who did not believe that the degraded forest will not naturally regenerate were invalid responses. All respondents of the 168 observation were those who believed that the degraded forest is capable to regenerate. Those respondents who asked minimum WTA compensation above 10,000 birr per-hectare-per-year were considered as outlier since only six of the respondents asked more than 10,000 birr which is very high compensation needed relative to other questionnaire and relative to their past year income.

The first section of the questionnaire evaluated the attitudes of the households' heads about climate change and other environmental problems (attcc); their awareness of the forest ecosystem services; their attitudes towards the protection of the left over degraded natural forest land and their source of information about the natural resources and environment. Fortunately,

the respondents were highly aware of the climate change and environmental problems, forest ecosystem services, and all of them believed that protecting the degraded natural forest land is important. Regarding the seriousness of climate change and environmental problems 157 (93.5%) of the respondents thought that the climate change and other environmental problems are serious problems. Only 4 (four) respondents considered the problems as 'not serious' and 7 (seven) respondents thought it is 'somewhat serious'.

The awareness about forest ecosystem services was evaluated by asking household heads if they know each of the forest ecosystem services listed that include: it absorbs smoke (CO_2); it moisturizes the air that leads to rain; it regulate temperature; it uses for biodiversity (different species of flora and fauna) conservation; helps to catch water in soil; reduce flood, soil erosion and land slide; beautifies the environment and use to attract tourists; and specify if other services exist, option also included. Surprisingly, all of the respondents showed that they know and aware of all of the services of forest ecosystem listed in the questionnaire. All of the respondents believed that protecting and restoring the local degraded forest land is important.

The main source of information about the natural resources and environment are development agents (DA), radio and students. All of the household heads get information from DA. About 53.2% get from radio in addition to DA and 5.3% from students in addition to DA. Such high degree of awareness about the natural resources, environment and environmental problems is very important for the protection of the environment and natural resources for the sustainable economic development.

The respondents were asked if they have been holding the degraded natural forest land, to be sure that they have the sort of the land. All of the 168 valid questionnaire respondents confirmed

that they have been holding degraded natural forest land and they all believed that the forest can regenerate if protected. According to the respondents guess about the length of the time it takes to regenerate, on average the forests will reach 2 meters height in two and half years (2.5 years). To include the 'time it takes to reach 2 meters height' in the regression model as dummy variable, period shorter than 2.5 years were considered as faster regenerating time and period longer than 2.5 years as slower regenerating time.

All of the respondents use the degraded natural forests for grazing, source of fuel wood and to get materials for construction of fences. Cutting trees for house construction and to make agricultural tools and materials like farm tools and equipment, beehive, rope, grain storage and others are also the purposes the degraded forests serve. None of the respondents admitted of making charcoal and selling forest products. However all of them know people who make charcoal and sell it to the town, which is paradoxical. Many '*Garbaguracha'* town dwellers use charcoal that comes from the rural areas. This might be due to either the DA's warning to punish those who destroy the forests or the rural people are well aware but have no other option to substitute the income received from sale of forest products. It seems those who tried to create awareness taught the people well to know the climate change and other environmental problems; the importance of forest in regulating the environment; and the need of protecting the forests. However it seems that they told the people that damaging forest is crime, and warned to punish those found damaging forest. Thus they might worry about the punishment to admit the sale of forest products. None of the respondents were convicted and fined (punished) and none of them knew those convicted for damaging the forests.

Payment in cash and freely provision of fertilizer were the dominant payment vehicle the respondents preferred. From the total sample (168 households), 45.2% preferred cash payment,

43.5% favored provision of fertilizer, 8.9% chose provision of wheat and the other 2.4% preferred reduction in land tax and provision of pesticide and herbicide. This is because they might think that since cash is liquid they can allocate the cash according to their interest and the expenditure on fertilizer might also be the largest farm expenditure.

Table 4.1 shows the summary, statistics of the data. There are 168 respondents (observation). In the dichotomous choice questions, about 40.5% of the respondents accepted the provided bid level compensation whereas the remaining (59.5%) refused to accept, where 'wta1' shows those accepted the proposed bid. In the open ended follow up questions, minimum of birr 640, maximum of birr 8,000 and on average birr, 3,075 compensation was asked by each respondent. The 2013/14 production year estimated income of the respondent households varied between birr, 6,200 minimum and birr, 25,900 maximum and on average each household earned about 14,928 birr. On average, the estimated livestock wealth of the households, changed into monetary terms, is about 30,972 birr and the minimum and the maximum are birr, 5,910 and birr 150,350, respectively. Each of the households held maximum of 3 hectares and minimum of 0.25 hectare land. On average each of them held about 1.31 hectares land. The degraded natural forest land holding of the households is 0.125 hectare minimum, 0.38 hectare average and 1.25 hectares maximum. About 35.7% of the households had no enough land to produce crops and practice *'hirta'* i.e. they produce crops on others' land by sharing the product. See the Table 4.1.

Table 4.1 Summary Statistics of the Data

Variable	Obs	Mean	Std. Dev.	Min	Max
Hhid*	168	84.5	48.64155	1	168
wta1	168	0.404762	0.492313	0	1
minwta	168	3075	1819.779	640	8000
bid	168	2302.857	1239.235	960	3840
incom	168	14927.86	4312.305	6200	25900
livest	168	30972.08	16198.46	5910	150350
lanhld	168	1.315104	0.722175	0.25	3
sizdeg	168	0.379836	0.248216	0.125	1.25
hirta	168	0.357143	0.48059	0	1
age	168	47.65476	12.72368	27	85
sex	168	0.928571	0.258309	0	1
edulev	168	0.428571	0.496351	0	1
famsiz	168	6.982143	2.128994	2	12
sexfam	168	3.410714	1.363908	0	7
certain	168	0.494048	0.501459	0	1
arabil	168	0.25	0.434307	0	1
avasub	168	0.559524	0.497928	0	1
chplan	168	0.190476	0.393851	0	1
prplan	168	0.315476	0.466095	0	1
protef	168	0.541667	0.49975	0	1
distime	168	10.35119	5.81876	2	30
regtime	168	0.52381	0.500926	0	1
attcc	168	0.935	0.0003	0	1

Source: Own Survey, 2014

*hhid is household identification number

Note: variables that were uniformly answered by all respondents were not shown in Table 4.1.

Ages of the household's heads were between the interval 27 and 85 years where the average is 47.7 years. Very large majority of the household heads were male which is about 92.9%. None of the household heads attended education level higher than elementary. Most of those who were educated were those who attended the basic literacy education. Those who attended basic literacy education and elementary level education were together, considered as educated and

others as uneducated. About 42.9% of them had attended either basic or elementary level education. On average, each household contained 7 family members and the largest and the smallest family size were 12 and 2, respectively. Regarding sex composition of the households, there were families where there was no male member to family where number of male member is 7. On average in each family there are about 3 male members.

The respondents were asked if they were certain about their answer to the valuation questions. There were three choices to select from, to indicate certainty. These were '*certain*', '*somewhat certain*' and '*not certain*'. Since in '*somewhat certain*', there is a sense of uncertainty it was considered as '*uncertain*' to simplify and add as dummy variable in the econometric regression. About 49.4% of the respondents were certain about their valuation answer. How certainty affects the WTA compensation would be shown in the econometric regression result.

Availability of substitute was elicited based on the respondent thoughts about the availability of substitute for the forest products if the forest protected. To measure the availability of substitute for the degraded forest products, there were also three choices, which were '*yes I can substitute*', '*I can substitute to some extent*' and '*no I cannot substitute'.* Since perfect substitutes rarely exist in practice, those who answered 'I *can substitute to some extent*' and '*yes I can substitute*' show availability of substitute and the other show absence of substitutability. Thus, 55.95 % of the respondents showed the availability of substitute for the direct use of degraded natural forest products.

Length of time the degraded natural forest takes to regenerate and reach 2 meter height was estimated. The respondents were asked to guess and choose time it takes to reach the specified height from the choices 1, 2, 3, 4, 5, and more than 5 years. Then the average of the years (2.5

years) calculated and it is rapidly regenerating if the respondents think that it will grow to 2 meter in period shorter than 2.5 years and slowly regenerate if it takes longer period (more than 2.5years). Based on this classification, on average, 52.38% thought that the forests will grow rapidly (in less than 2.5 years). About 54.17% of the respondents protect the degraded natural forests land they have been holding from other users (they use themselves). About 31.55% had a plan to protect the degraded natural forest in the future. On average it takes about 10.4 minutes walking time to reach the forest land from homestead and maximum half an hour.

Regarding arability of the land 25% of the respondents thought that the degraded natural forest land is arable, where as 19.05% of the total respondents had a plan to change the land to farm land. The remaining respondents (49.4%) which are other than those who had a plan to change into farmland (19.05%), and plan to protect (31.55%), had no new plan for the land.

4.2. Results of Econometric Regressions and Interpretations

The main aim of this study was to find relationships that have some policy relevance and estimate mean minimum compensation needed. That is to find factors affecting the amount of compensation land holders need to voluntarily protect the degraded natural forest existing on the land they held. Two types of regression (estimation techniques) were used to find such relationships. One is the Probit estimation technique that found the relationship between the probability of accepting the proposed compensation amount (bid level) and other explanatory variables. In the Probit model the answers to the single-bounded valuation questions were regressed on the other covariates. The other one is the multiple log-linear regression model that is estimated using the Ordinary Least Square (OLS) technique. In this model, the answers to open-ended follow up questions were regressed on the other independent variables. In this

subsection first we see the result of Probit regression model. Next the result of the log-linear model is discussed and compared with the result of the Probit model.

4.2.1. Results of the Probit Regression Model

Table 4.2 shows the estimates of the Probit model, where the probability of success (wta=1), in single-bounded the binary question is regressed on the covariates. The probit model is regressed using the maximum likelihood estimation technique. Three variables which are *'lanhld', 'sexfam'* and *'arabil'* were excluded from the regression to minimize the multicollinearity problem. The variance inflation factor multicollinearity test (see appendix II) showed that *'famsize', 'age', 'lanhld', 'sexfam', 'sex', 'income',* and *'livest'* have the variance inflation factor greater than 10, which is evidences for the existence of multicollinearity problem. Then using correlation coefficients (see appendix III), total size of land holding (*lanhld*) was found highly correlated with '*livest'*, '*sizdeg'* and '*hirta'*. Sex compositions of the family (*sexfam*), i.e. number of male in the household and family size (*famsiz*) were highly correlated. Arability of the degraded forest land (*arabil*) was also highly correlated with the existence of plan to change the land to farm land (*chplan*). The correlation coefficient of these variables are those variables that have correlation coefficient greater than 0.5.

Result of the regression given in **Table 4.2** shows the bid level (*bid*), livestock ownership (*livest*), size of degraded natural forest land holding (*sizdeg*), sex of head of household (*sex*), family size (*famsiz*), certainty (*certain*), availability of substitute (*avasub*), and the existence of plan to change the land to farm land in the near future (*chplan*) were found to be significant at either 1%, 5%, or 10%. Among the significant variables *bid, livest, sizdeg, certain, and avasub* affect the probability of accepting the proposed bid level compensation positively; whereas *sex, famsiz* and *chplan* negatively.

Table 4.2 The Probit Model Regression Result

wta1(dependent)	Coefficients	Standard errors
bid	0.4309**	(0.1845)
incom	0.0360	(0.0521)
livest	0.1399***	(0.0330)
sizdeg	6.5231***	(1.5603)
hirta	-0.3951	(0.4692)
age	0.0292	(0.0196)
sex	-1.5702**	(0.7203)
edulev	0.5070	(0.4854)
famsiz	-0.2903**	(0.1324)
certain	0.9610**	(0.3928)
avasub	2.0755***	(0.5740)
chplan	-2.1349***	(0.6738)
prplan	0.8182	(0.5593)
protef	0.2974	(0.4915)
distime	-0.0275	(0.0443)
regtime	0.0035	(0.4439)
_cons	-8.0228***	(2.1055)
	Number of obs. =168 LR $chi^2(16)$ = 159.09 Prob > chi^2 = 0.0000 Log likelihood = -33.837638 Pseudo R^2 = 0.7016	

*Note: * Statistically significant at 10% significance level*

*** Statistically significant at 5% significance level*

**** Statistically significant at 1% significance level*

The bid level (bid): The regression outcome showed that higher bid level increases the probability of accepting the bid level. It got the expected sign as people usually want to sale their products at higher price than to lower price.

Livestock ownership (livest): livestock wealth affected the probability of accepting the proposed compensation positively as expected. Rich people may think that they have relatively

higher wealth and feel secured even if they leave the forest land for protection. Thus they are more likely to accept the provided compensation than relatively poor peoples. As long as they are not prohibited from using the land for grazing in the hypothetical program, they do not relate their livestock wealth to grazing land problem.

Size of the degraded forest land (sizdeg): the degraded forest land size is statistically significant and positively affects the probability of accepting the compensation. It got the expected sign. Those who have larger area of degraded forest land may think that, they would get higher compensation than those who held small size and they are more likely to accept the bid.

Sex: the regression outcome showed that sex of the head of the household is statistically significant and the probability of accepting the bid level compensation of men is less than women. The coefficient got unexpected sign. This may be because women are more curious about environment or since forest product are domestically largely used by women, and they know the declining trend of availability of the forest products used domestically, they may think that conservation is important for the future source of forest products.

Family size (famsiz): is statistically significant and negatively affect the probability of accepting the bid. Perhaps, large family size use more of forest products than small family size and protection of the forests may cause shortage of fuel-wood and other forest products that would be severe problem for large family size.

Certainty (certain): Respondents those who were certain about their answer to the valuation questions were more likely to accept the bid than the uncertain ones. Respondents are usually uncertain about their responses (Brown and Gregory, 1999; and TEEB, 2010). When respondents are uncertain about how the change affects them they overstate their WTA to evade risk and be

on the safe side, (Kolstad and Guzman, 1999; Brown and Gregory, 1999; and Bateman and Willis, 1999). About 49.4% of the respondents thought they were certain about their valuation answer. The regression showed that those who were relatively uncertain were unlikely to accept the bid level compensation which shows they need higher compensation to minimize risk.

Availability of substitute (avasub): the availability of substitute was found statistically significant. Those respondents who thought that they can substitute the use of the degraded forest product were more likely to accept the proposed compensation. Hanemann (1991) as discussed in (Bateman and Willis, 1999) showed that, the WTA is large if the elasticity of substitution, between environmental good and marketable goods is sufficiently low. The respondents that can substitute the forest products may not bother what they will consume if the forests are protected and more probable to accept the proposed compensation.

Land use changing plan (chplan): Respondents who have planned to change the land to farm land in the near future were more probable to reject the bid level compensation. If the land was arable, since the outcome of crop production might be higher than the use of the forest land for the holder, if they had such plan they ask higher WTA compensation. Hence, the probability of accepting the bid would be less for those who have changing plan.

4.2.2. Effect of Excluding Highly Correlated Variables

Excluding the highly correlated variables (*lanhld, sexfam and arabil*) makes some difference. The highly correlated variables affected some of the significance level and the sign of coefficients of the variables. Livestock ownership (*livest*) was significant at 5% before, and now it is improved and significant at 1% significance level. Significance of sex of head of households is also improved from 10% to 5% significance level. The sign of coefficient of '*hirta'* changed

from the unexpected positive sign to the expected negative sign, even if it is not statistically significantly. Using common sense (intuition) we can say people with no enough resource inflates the value of the small resources they have. '*Hirta'* is practiced by those who have no enough land so that respondents who practice '*hirta'* are more likely to reject the proposed compensation. Degree of significance level of the family size and changing plan were worsening. Family size was significant at 1% and changing plan at 5% before the highly correlated variables were excluded and now family size and changing plan are significant at 5% and 10% significance levels respectively. The significance and sign of coefficients of the remaining variables did not change due to the exclusion. See **Table 4.3** which compared the result of the regression before and after the highly correlated variables were excluded.

Table 4.3 Effect of Excluding Highly Correlated Variables

	Not excluded		**Excluded**	
Variables	**Coefficients**	**Standard errors**	**Coefficients**	**Standard errors**
bid	0.4968**	(0.1981)	0.4309**	(0.1845)
incom	0.0168	(0.0540)	0.0360	(0.0521)
livest	0.0987**	(0.0412)	0.1399***	(0.0330)
lanhld	1.7223**	(0.7278)	-	-
sizdeg	5.6235***	(1.7372)	6.5231***	(1.5603)
hirta	0.0608	(0.5444)	-0.3951	(0.4692)
age	0.021	(0.0224)	0.0292	(0.0196)
sex	-1.5485 *	(0.8047)	-1.5702**	(0.7203)
edulev	0.4183	(0.5428)	0.5070	(0.4854)
famsiz	-0.5256***	(0.1973)	-0.2903**	(0.1324)
sexfam	0.2579	(0.2177)	-	-
certain	1.0348**	(0.4195)	0.9610**	(0.3928)
arabil	-0.0416	(0.7541)	-	-
avasub	2.0947***	(0.6327)	2.0755***	(0.5740)
chplan	-2.148**	(0.9344)	-2.1349***	(0.6738)
prplan	0.8262	(0.5964)	0.8182	(0.5593)
protef	0.4958	(0.5529)	0.2974	(0.4915)
distime	-0.0165	(0.0506)	-0.0275	(0.0443)
regtime	0.3007	(0.5229)	0.0035	(0.4439)
_cons	-8.0545***	(2.3837)	-8.0228***	(2.1055)
	Number of obs. =168 LR $chi^2(19)$ = 167.58 Prob > chi^2 = 0.0000 Log likelihood=-29.594282 Pseudo R^2 = 0.7390		Number of obs. =168 LR $chi^2(16)$ = 159.09 Prob > chi^2 = 0.0000 Log likelihood = -33.837638 Pseudo R^2 = 0.7016	

*Note: * Statistically significant at 10% significance level*

*** Statistically significant at 5% significance level*

**** Statistically significant at 1% significance level*

From the excluded variables only total size of land hold by the households is significant (at 5%) and the other two are not significant at 10%.

4.2.3. The Multiple Log-linear Regression Model Result

The open ended follow up valuation question responses were modeled using the multiple log-linear regression models. Since there is no protest zeros and only six respondents asked most unreasonably high minimum WTA (outlier), the exclusion of the six respondents have no significant effect on the sample selection. The OLS estimate of the multiple log-linear regression model is shown **Table 4.4**. The regression is robust to minimize heteroskedasticity problem. The model was regressed the '*minwta'* dependent variable on the covariates. The result of the regression shows *lnbid, lnincom, lnlivest, sizdeg, hirta, sex, avasub, chplan and prplan* were found to be significant at 1%, 5% or 10% significance level.

Table 4.4 Log-linear Model Regression Result

Lnminwta (dependent)	**Coefficient**	**Std. Err. (Robust)**
lnbid	0.7467***	(0.0489)
lnincom	-0.1692*	(0.0936)
lnlivest	-0.2158**	(0.0892)
sizdeg	-0.5186***	(0.1319)
hirta	0.1423*	(0.0728)
age	-0.0031	(0.0024)
sex	0.3186***	(0.0781)
edulev	0.0315	(0.0683)
famsiz	0.0173	(0.0157)
certain	-0.0890	(0.0550)
avasub	-0.1093*	(0.0626)
chplan	0.2072**	(0.0838)
prplan	-0.1887***	(0.0688)
protef	-0.0008	(0.0794)
distime	0.0018	(0.0056)
regtime	-0.0733	(0.0565)
_cons	6.0237***	(1.0835)
	Number of obs. = 168 F(16,151) = 49.08 Prob > F = 0.0000 R^2 = 0.7439	

*Note: * Statistically significant at 10% significance level*

*** Statistically significant at 5% significance level*

**** Statistically significant at 1% significance level*

lnbid: The bid level is significant in both the Probit and the log-linear models at 5% and 1%, respectively. Effect of bid is in the similar direction in both regression models. Higher bid level induces the respondents to accept the proposed bid level compensation in the Probit model. In the log-linear model a 1% increase in the bid level increases the minimum WTA compensation by about 0.75%, ceteris paribus.

lnincom: The estimated income of the last year (2013/14) is found to be statistically significant at 10% significance level in the log-linear model and insignificant in the Probit model, at 10% significance level. Its parameter in the log-linear model shows a 1% rise in the income of the household decreases the minimum WTA compensation by 0.17%, other things remaining constant. Even if the coefficient of '*incom*' is statistically insignificant in the Probit model it has the tendency to affect the WTA in the same direction as in the linear regression model which makes the two model consistent on the direction of effect. The probit model shows those households who earned higher income in the 2013/14 production year were more probable to accept the proposed compensation. Perhaps this difference between the two models is due to difficulty of estimating income of households.

lnlivest: The estimated monetary value of livestock wealth is statistically significant at 1% and 0.5% significance level in the Probit and the log-linear models, respectively. The probit coefficient showed that those respondents with higher wealth of livestock were more probably to accept the bid level compensation than poor respondents. In the log-linear model the negative

coefficient suggests that a 1% equivalent increase in the wealth of livestock of respondents decreases the minimum WTA compensation of the respondent by about 21.6%, ceteris paribus. The direction of the effect of livestock wealth on the WTA is consistent in the two models.

sizdeg: The size of degraded natural forest land held by the respondent is another significant variable that affects minimum WTA compensation negatively. It is significant in both the Probit and the linear models at 1% significance level and has similar effects on the WTA compensation. The probit parameter suggests high probability of accepting the bid level with large size of degraded size. From the log-linear coefficient we see that a 1 hectare increase in the '*sizdeg'* decreases the minimum WTA accepts compensation by about 51.9%, other things remaining constant.

'***hirta***': is not statistically significant in the probit model and significant in the log-linear model at 10% significance level. The negative coefficient in the probit model suggests that those households that have no enough land to produce crop are more likely to reject the proposed bid level compensation for the degraded forest land they have been holding. In the linear model, ceteris paribus, the minimum WTA compensation of respondents who practice '*hirta'* is about 14.2% higher than those who do not practice it.

Sex: is statistically significant at 5% in the Probit and 1% in the log-linear regression models. In the Probit model it showed that male household heads are more likely to reject the proposed compensation than female heads. In the linear model its parameter suggests that the minimum WTA compensation of male household head is about 31.9% higher than that of female heads, other things remaining constant which shows the result from both models are consistent.

famsiz: In the Probit model the size of family is statistically significant at 5% significance level and large family households are more likely to reject the bid level compensation. In the log-linear regression model similar effect exist even if it is not statistically significant at 10%. Its coefficient in the log-linear model shows the minimum WTA compensation tends to increase as number of family members increases.

certain: Certainty is statistically significant at 5% significance level in the probit model and it is not statistically significant at 10% in the log-linear model. Certain respondents about the valuation question were more likely to accept the proposed compensation and tend ask lower minimum WTA compensation than uncertain respondents in the probit model.

avasub: Parameter of availability of substitute is significant at 1% and 10% in the Probit and log-linear models, respectively. Respondents that think they can substitute the forest products if the degraded natural forest is protected are more probable to accept the proposed bid level compensation. The log-linear coefficient shows the minimum WTA of those households that think they can substitute the forest products if the degraded natural forest is protected is about 10.9% lower than others, keeping other factors constant.

chplan: The existence of plan to change the land to farm land in the near future is the other factor that affects WTA. It is significant variable at 1% and 5% significant level in the probit and log-linear models respectively. Its coefficient in the Probit model shows that those who have planned to change the land to farm land in the near future were less likely to accept the proposed compensation. The linear model coefficient shows that other things remaining constant, the minimum WTA of those respondents that have intention to change the land into farm in the near future is about 20.7% higher than others.

prplan: the existence of plan to protect the forest in the near future is not statistically significant in the Probit at 10% and significant at1% in the linear model. Those who have planned to protect the forest are more likely to accept the proposed compensation and they ask about 18.9% lower minimum WTA compensation than those who do not have planned to protect, other things remaining constant.

Generally, the bid level, livestock wealth, size of the degraded natural forest land, sex of the household head, availability of substitute and the existence of changing plan are significant variables in both the two models and important determinants of the WTA of the land holders. Family size and certainty of the respondents are variables that significantly affect the WTA of the land holders in the probit model and last year income (income of 3013/14), hirta and existence of plan to protect the forest are statistically important variables in the log-linear model. Even though the dependent variables are different in both models and measured differently the WTA compensation of the '*Kuyu Woreda*' rural small scale land holders are affected by bid levels, income of the last year, livestock wealth, size of degraded forest land, '*hirta'*, sex of the household head, family size, certainty, availability of substitutes, the existence of changing the land into farm land and the existence of plan to protect the forest.

3.2.4. Mean of WTA Compensation

On average the households asked 1,170 birr compensation per hectare per year. This mean calculated from the binary responses with lower bound 620 and upper bound 3840 birr, with 95% confidence interval. The mean of the minimum WTA compensation the respondents stated in the open ended follow-up questions is simply the mean of *minwta* which is 3,075 birr per-hectare per-year, with minimum 640 and maximum 8000 birr per-year-per hectare. The mean compensation calculated using the response to the open ended follow up question is about 2.63

times the mean estimated by response to single-bounded the binary questions. Totally the 168 sample households asked a compensation of 74,660.6 birr-per-year for a total of 63.8 hectares protection, on average, using the single-bounded binary question data mean. Using the open-ended follow up data mean, about 196,223.4 birr compensation per-year, is needed for the same amount of degraded forest land protection. Thus, the open ended follow up questions inflated the minimum WTA compensation by about 2.63 times.

CHAPTER V

Conclusion and Recommendation

5.1. Conclusion

This study used contingent valuation method to analyze the determinants of WTA and estimate mean WTA compensation of '*Kuyu Woreda'* rural small scale land holders who have been holding degraded natural forest land. The study developed a hypothetical program in which the degraded forest holders are compensated for lost benefit and voluntarily protect the left over natural forest on their land. The study used WTA elicitation method. Single-bounded with open-ended follow up questions were used to elicit WTA of the sample households.

Many literatures recommend the use of WTP than WTA due to the disparities between the two. The main factors that create discrepancy between the two are income effect, substitution effect, faulty questionnaire design or interviewing technique; strategic behavior by respondents and psychological effects such as loss-aversion and the endowment effect, etc. However others argue that the choice between the two is contextual in which specific guidelines emerge from the field and not from the texts. Thus the choice between the two is unsettled state of research. According to literatures the choice between the two depends on the kind of the change in environmental resources, property right to the resources, the type of policy needed and other factors.

Generally the outcome of the study showed that, bid levels, livestock wealth, size of degraded forest land, sex of the household head, availability of substitutes and the existence plan to change the land into farm land were found to be important variables to explain WTA compensation for the protection of the degraded forest land. The mean minimum WTA per hectare per year is

estimated to be 1,170 birr. The average calculated using the open ended follow up question is 2.63 times higher than the average calculated in the single bounded binary question. Totally the 168 samples need about 74,660.6 birr compensation for 63.8 hectares per-year.

5.2. Recommendation

The study showed that if the remaining degraded natural forests found on the privately held small scale lands are protected can naturally regenerate. It shows the existence of potential sellers of the natural forest ecosystem services which are biodiversity conservation, carbon sequestration services, water catchment and aesthetic services. Several important policy implications are drowning from the study.

- The study shows that if enough funds are available this voluntary protection program is good in forest management. It recommends compensating the land holders based on the calculated average minimum WTA compensation. This needs to compare the cost of this hypothetical protection program with other alternative programs and with other compliment studies that compare cost and benefit of other forest protection and conservation programs. If the average minimum WTA compensation is cost effective than other programs, implementing this program to restore the natural forest through natural regeneration is worthwhile. The payment vehicle the land holders mainly preferred for compensation is cash payment and free provision of fertilizer.
- On the other hand if compensating the land holders and implementing the compensation program is difficult, the study recommends the need to consider the important variables that are responsible for the WTA compensation in the protection and conservation of remaining natural forests. The study recommends helping the land holders by increasing the availability of substitute, increase the productivity of the farm land, and accumulate

wealth. The availability of substitute may be increased by helping them plant exotic fast growing trees on eroded land, boundaries and around homestead for fuel wood, construction and source of income; plant living trees fence and providing fuel efficient stoves. Helping the land holders increase productivity of already changed farm lands may also minimize the probability of changing the degraded forest land into forest land. Increasing the wealth of the land holder also helps in the protection of the forests as wealthier respondents were more probable to accept the proposed compensation.

- Lastly, the study showed that respondents have good awareness about climate change and other environmental problems. Most of the respondents see the climate change and other environmental problems as very serious problems. They are highly aware of the services of forest ecosystem and showed good attitude towards the protection of remaining degraded natural forest. However the degradation of the remaining forests continued which is paradox. The study recommends interested bodies to conduct research to identify the causes of inconsistency between high awareness about the environment and role of forests in regulating the environment on one hand and continued degradation of the natural forest in the '*Woreda'* on the other hand.

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APPENDIX (I) Questionnaire

Attitudinal questions

1) What do you think the extent of climate change and other environmental problems like deforestation; forest degradation land degradation etc are?

Very serious problem ☐ somewhat serious problem ☐ Not serious problem ☐

2) From the following list which services of forest do you know?

- It absorb smoke (CO_2) ☐
- It moisturizes the air and leads to rain ☐
- It regulate temperature ☐
- It uses for biodiversity (different species of flora and fauna) conservation ☐
- Helps to catch water in soil ☐
- Reduce flood, soil erosion and land slide ☐
- Beautifies the environment and use to attract tourist ☐
- If other specify_____

3) Do you believe that protecting and restoring the local degraded forest land is important?

Yes ☐ No ☐

4) Where do you get information about natural resources and environment?

- From development agents ☐
- From radio ☐
- TV ☐
- From gazette and magazines ☐
- If other specify _____

Behavioral questions

5) Do you have degraded natural forest land that is never ploughed before, for which you have land holding right book or you are given by your family ('Kuta')? Yes ☐ No ☐

6) Do you think that the left over degraded trees on your land can regenerate and grow into forest? Yes ☐ No ☐

7) On average, how long it takes do you think, for at least half of the trees to reach height of 2 meters?

1year ☐ 2 years ☐ 3years ☐ 4 years ☐ 5 years ☐ More than 5 years ☐

8) What is the size of the degraded forest land you own in 'guzm'? _____

9) Do you think the degraded forest land is arable? Yes ☐ No ☐

10) From the following list of forest purposes for which purpose or purposes do you use the degraded forest land?

- Grazing ☐
- Source of firewood ☐
- To make fences ☐
- To construct houses ☐
- To make charcoal ☐
- Other wood products for sell ☐
- Other (if any) _____

11) Do you think that you can substitute the degraded forest purposes by other products like animal dung, crop residuals, stones, fast-growing trees like eucalyptus etc?

Yes I can substitute ☐ I can substitute to some extent ☐ No I cannot substitute ☐

12) What do you planned to use the land in the future?

- To protect the forests ☐
- To change into farm land ☐
- No new plan ☐
- Other (if any), _____

13) Do you exclude others from using it? (Not environmental services) Yes ☐ No ☐

14) How long it takes to reach the land from your home in minutes? _____

15) Are you convicted before for destroying natural forest? Yes ☐ No ☐

16) Do you know others who convicted before for destroying natural forest, from you '*Kebele*'?

Yes ☐ No ☐

17) Do you know people that sell charcoal in your village? Yes ☐ No ☐

18) Do you practice ('Hirta')? (Produce crops on others' land sharing its output) Yes ☐ No ☐

Valuation section

19) Assume a program wants to protect privately hold degraded forest lands in your '*Kebele*' and compensate the land holders for the loss of benefits. Suppose according to the program the land holders (you) will use your land only for grazing. You will not be allowed to cut trees, burn trees and hunt animals. You will stop any activities that degrade the land and the degraded forest on the land for ten continuous years. The program will not take away your land holding right and you continue to pay land taxes.

The possible benefits you will get are you will own a forest in the future and paid ecosystem serves payment, it will minimize the soil erosion and land degradation, it improves the water catchment of the land, moisturizes the environment and regulate local temperature, helps to preserve biodiversity, beautifies the environment, etc. The disadvantages that might happen includes, the loss of benefit for which you will be compensated by equivalent money amount for the ten years and you will find substitutes for the forest products, the number of

wild animals will increase in the forest. These wild animals that includes hyena, fox (‘*kebero*’), monkeys, apes, rats, birds and other animals that may harm your crops and domestic animals.

Taking the advantages and disadvantages of protection into consideration, answer the following questions. Assume the program have limited amount of capital to compensate all of the land owners. So the program protects only degraded forest lands hold by those who accept the proposed compensation. If the program wants to include the degraded forest land that you hold, to the protected forest, would you participate in the program if the compensation is birr, _____per ‘guzm’ per year?

Yes ☐ No ☐

20) How much are you certain about your answer to questions?

Certain ☐ Somewhat certain ☐ Not certain ☐

21) What is the minimum WTA compensation for the lost benefit, if you participate in the program? _____

21) If your answer to Q (20) is ‘Yes’, how do you want to be paid?

- In cash ☐
- Reduction in land tax ☐
- Provision of fertilizer ☐
- Provision of wheat ☐
- Provision of pesticide and herbicide ☐
- Others _____

Economic and demographic questions

22) Demographic questions

- Age _____

- Sex _____
- Education level _____
- Family size _____ Male _____ Female _____

Income

22) What is your last year (2006 E.C. or 2013/2014) production of crop? [in quintal]

- 'Teff' _____[in quintal]
- Wheat _____[in quintal]
- Sorghum _____[in quintal]
- Maize_____[in quintal]
- Bean/pea _____[in quintal]
- Barley _____ [in quintal]
- 'Nuge' _____ [in quintal]
- Cash crops like vegetables, fruits, etc _____ in birr (estimated)
- Other crops if exist _____in birr (estimated)
- Sale of animals in the last year _____ in birr (estimated)
- Sales of honey, milk and eggs _____ in birr (estimated)
- Other income (if any)_____ in birr (estimated)
- Income from the sale of forest products _____ in birr (estimated)

Wealth

23) Land Wealth – What is the total size of land you hold _____(in 'guzm')

24) livestock wealth – What are the number of animals do you own?

- Cattle:- Number of oxen _____number of cows _____number of calves _____
- Number of Sheep _____ Number of goats _____

- Number of horses _____ Number of donkeys _____ number of mules_____
- Poultry:- number of cocks _____Number of hens _____

APPENDIX (II) Variance inflation factors test for Probit (uncentered)

Variable	VIF	1/VIF
famsiz	27.79	0.035979
age	21.91	0.04564
lanhld	17.64	0.056699
sexfam	15.28	0.06546
sex	15.02	0.066556
incom	13.4	0.074638
livest	10.36	0.096565
sizdeg	6.92	0.144428
distime	5.22	0.191698
bid	5.05	0.198006
chplan	4.37	0.228652
arabil	4.05	0.246734
protef	3.98	0.251246
avasub	3.37	0.296604
hirta	2.65	0.37689
prplan	2.58	0.387067
regtime	2.55	0.392712
edulev	2.23	0.447463
certain	2.12	0.471436
Mean VIF	8.76	

Appendex (III) Correlation of variables

	bid	incom	animw	lanhld	sizdeg	hirta	age
bid	1						
incom	-0.0717	1					
livest	0.0255	0.1555	1				
lanhld	-0.018	0.2157	0.7277	1			
sizdeg	0.043	0.1473	0.4852	0.6571	1		
hirta	-0.0669	0.0094	-0.44	-0.6249	-0.4099	1	
age	0.1455	0.1065	0.1243	0.2524	0.179	-0.1217	1
sex	0.0141	0.0995	0.0585	0.0411	0.0346	0.0138	-0.0057
edulev	-0.0908	-0.0462	-0.109	-0.07	-0.0595	0.0072	-0.4657
famsiz	0.1551	0.0592	-0.0699	-0.0229	-0.1287	0.0941	0.414
sexfam	0.1615	0.0251	-0.1514	-0.174	-0.2535	0.1677	0.3029
certain	0.0268	0.0068	0.0239	0.0243	0.0047	-0.0408	0.0006
arabil	0.1949	-0.1466	-0.0039	-0.0629	-0.0668	0	-0.0222
avasub	0.0141	0.0335	-0.0256	-0.0603	-0.0796	0.0357	0.1242
chplan	0.1913	-0.1116	0.01	-0.0925	-0.0784	0.0497	-0.0023
prplan	0.0185	0.0688	0.1484	0.1854	0.2099	-0.0783	-0.0593
protef	-0.0584	0.0159	0.0878	0.1195	0.1507	-0.0125	-0.1286
distime	-0.1359	-0.0063	-0.1327	-0.0672	0.0732	-0.0087	0.0783
regtime	0.1288	0.0066	-0.0361	0.0241	0.0999	-0.0853	-0.0072

	sex	edulev	famsiz	sexfam	certain	arabil	avasub
sex	1						
edulev	0.1001	1					
famsiz	0.2263	-0.3384	1				
sexfam	0.1518	-0.2262	0.6769	1			
certain	-0.0033	-0.0137	0.0924	0.1043	1		
arabil	-0.1068	0	0.0696	0.048	0.0069	1	
avasub	-0.0133	-0.1523	0.0603	-0.0054	0.0854	0.3184	1
chplan	-0.042	-0.0831	0.0898	0.0876	0.0058	0.8052	0.3999
prplan	0.0391	0.1627	-0.0124	0.021	0.1234	-0.2145	-0.4039
protef	0.0232	0.0966	0.0317	-0.0121	0.1444	-0.2414	-0.383
distime	-0.0669	-0.0815	-0.1237	-0.1322	-0.1152	-0.0515	0.2645
regtime	0.1058	0.1755	-0.1091	-0.0013	-0.0114	-0.1101	-0.0777

	chplan	prplan	protef	distime	regtime
chplan	1				
prplan	-0.3293	1			
protef	-0.3752	0.5731	1		
distime	-0.0163	-0.3679	-0.4241	1	
regtime	-0.1749	0.16	0.2233	-0.0594	1