academicJournals

Vol. 7(5), pp. 118-126, May, 2015
DOI: 10.5897/JHF2014.0381
Article Number: 097080453156
ISSN 2006-9782

http://www.academicjournals.org/JHF

Journal of Horticulture and Forestry

Full Length Research Paper

Determinants of deforestation in Western Oromia region of Ethiopia: The case of Komto Forest

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Received 11 December, 2014; Accepted 29 April, 2015

Deforestation and poverty are challenging problems in Ethiopia. The deforestation-poverty nexus is complicated by the institutional failures related to management of natural resources. This study was conducted to analyse the determinants of deforestation in Ethiopia, Western Oromia, the case of Komto Forest in East Wollega Zone, employing primary cross-sectional data on sampled households. Multistage sampling technique was used in selecting 150 household head respondents. Volume of woody biomass consumed and sold in cubic meter (M^3) was used to measure deforestation. The Heckman maximum likelihood model estimates showed that large landholding size explain lower level of deforestation. It was also found that forest product sale, and corruption behaviour of households and staff of institution aggravates deforestation. Probability of forest product use is negatively related to kerosene use and positively to road access, purpose of use, and corruption perception. The study showed that poverty and institutional failure related to the forest management are key factors determining deforestation and forest degradation in the study area. Thus solving poverty and institutional failures would help solve deforestation problem of the study area.

Key words: Deforestation, poverty, institutional failure, Heckman selection model.

INTRODUCTION

Poverty reduction and natural resources conservation are interrelated, and attempts to achieve one of the objectives adversely affect other objective. Rural people are striving to feed and survive their lives by using different natural resources, while conservation of them is alarming from government policy. Shively (2004) indicated acute trade-offs between forest protection and poverty alleviation. Particularly, this trade-offs is the case in least developed counties (LDCs), where majority of the rural people highly dependent on environment to obtain their daily livelihoods. For instance more than 70% of sub-Saharan Africa's population depends in large measure upon forests and woodlands for livelihoods and 60% of Africa's energy demand is met by forests (Stebek, 2008). Thus, to solve this two interrelated problems we need clear understanding of deforestation and poverty relationship at local level.

Theoretically deforestation-poverty relationship is related to vicious circle of poverty and resource degradation, tragedy of commons (Hardin, 1968), and the

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subsistence model (Kaimowitz and Angelsen 1998). The vicious cycle of land degradation and increasing poverty has been described as a downhill spiral into a poverty trap (Cleaver and Schreiber, 1994; Durning, 1989; Nyangena and Sterner, 2008). Poverty in rural areas is mainly linked to low and declining agricultural productivity arising from severe land degradation, land fragmentation, and low adoption of improved technologies (Nyangena and Sterner, 2008). High population growth combined with traditional farming practices has contributed to environ-mental degradation and further agricultural stag-nation. The poor are usually pushed to marginal lands raze plots in the rain forest, plough steep slopes, and overgraze fragile rangeland (Durning, 1989). Economic deprivation and environmental degradation have thus come to reinforce one another to form a maelstrom - a downward spiral that threatens to pull ever more into its grasp.

One of the commonly given reasons for the degrada-tion of natural resources, particularly common-pool ones, originate from the "Tragedy of the Commons" hypothesis initially stated or proposed by Garrett Hardin (1968). The tragedy of the commons hypothesis explains that indivi-duals tend to exploit natural resources on public lands without concern of cost for the society which arises from the self-interested nature of human beings. Thus, it leads to the conclusion that natural resources which are open to all will bring destruction to all. However, the tragedy of the commons hypothesis has been challenged by other scholars later on (Dolsak and Ostrom 2003; Ostrom, 1990; Steveson, 1991; Ostrom and Hess, 2007). Based on empirical evidences from different parts of the world, these scholars criticized the “tragedy” analysis, for mixing “open-access” systems with “common property” regime where the former implies the total absences of institutions to govern resource use. Rather, they emphasis on the role of institution to realize better conservation of natural resources. Empirical studies most of them are concen-trated on tropical forests and employed panel and time series data. Theoretical predictions of deforestation-po-verty relationship are ambiguous (Alexander et al., 2004) and lack a unique direction at local level (Wonder, 2001). In addition to the theoretical basis empirical studies on deforestation-poverty nexus also show ambiguous relation.

Some studies contend that poor are responsible for deforestation (Kaimowitz and Angelsen, 1998; Swinton, 2003; Pandit and Thapa., 2003; Fisher, 2004; Shively, 2004; Sapkota and Oden, 2008; Aggrey et al., 2010; Onuche, 2010) while others blame the non-poor (Adhikari, 2003; Reetz et al., 2011). There are also cases where there is no relationship between deforestation and poverty (Alexander et al., 2004; Reetz et al., 2011). In addition to poverty some authors maintain that deforesta-tion is strongly related to institutional failures related to manage-ment and protection of forest (Kaimowitz and Angelsen 1998; Bluffstone, 1998; Gombya et al., 2001; Pandit and Thapa, 2003; Kuemmerle et al., 2007). failures and state[1] failures (Hasan, 2008). Institutional failure refers to some judgement about the potential im-provement in performance if institutions could be restructured (Khan, 1995). Khan used to explain state failures or government failures in two ways: structural failure which occurs if a particular formal institutional structure results in lower net benefits for society com-pared to an alternative structure, and transition/ process failure which occurs when the process for changing the structure of institutions attains a lower cumulative set of net benefits for society compared to an alternative pro--cess over a given period. The forest under consideration is under government management there-fore institutional failure in this case is related to government.

The importance of forest for the functioning of living things in general and particularly as a source of livelihood for the community dwelling nearby the forest is understandable. Rural farming households clear forests to get firewood, to get additional farmland, to construct home, to get safety nets etc. Examination characteristics of household associated with deforestation at local level are helpful in designing strategies to deal with these problems. Even though, it has been much said that de-forestation and poverty has a long history in Ethiopia, the generalization that poor is the both victims and agents of deforestation has to be proved at local level. Some lite-ratures have implied that non-poor are more responsible for deforestation as they are more capable to use forest products and invest more on cleared land than the poor. Mahiber (2008) explained direct causes of deforestation are those that are related to harvesting fuel wood and logging, clearing forests for agriculture and grazing, expansion of rural areas and villages into forest regions and forest fires. Indirect causes are population growth and development often encroach on forest land, creating demand for the areas they are contained in, as well as a overstretching the resource capacity of forests, adding to forest depletion. In this case Mahiber (2008) believes that both the poor and the wealthy contribute to deforestation. Particularly the poor often exploit forest resources for an absence of other choices. In addition to the poverty the problem of ill-defined property rights where there is lack of control over forest land; deforestation becomes a system of acquiring land. In Ethiopia some state forests have been devolved to the local communities dwelling near forest to be managed and protected from open access over exploitation and depletion while some forests are still protected by state (Mosissa, 2011). Among these protected forests Komto Forest is still not devolved to the local community there. It is located in East Wollega Zone, and is being deforested at speed rate currently by community dwelling nearby the forest (Dinkayehu, 2006; Mosissa, 2011; personal observation). There is also little quantitative empirical evidence related to the effect of institution (that is, state managed forests) on the

[1] State is the body responsible for the enforcement and protection of all formal property rights (Khan, 1995).

deforestation-poverty link in the study area.

Mosissa (2011) and Dinkayehu (2006) explained that Komto protected forest is one of the remnant forest priority areas (FPA) in Ethiopia, and that is affected by serious logging for charcoal and lumber production due to frequent logging, lack of follow up, tolerance of law and lack of fair enactment zone and Wereda[2] (Aanaa) level. To the extent they are not concerned with deforestation they did not consider explicitly the status of people and factors responsible for contributing to the deforestation. Mosissa is concerned with the natural composition of the forest while Dinkayehu is concerned with role of micro-finance program in improving the living standards of poor people.

Empirical studies related to deforestation and poverty at local level in Ethiopia is scarce and the existing is either old or not directly related to the deforestation and poverty. For instance Cheng et al. (1998) indicates that population pressure, lack of awareness and weak management are major causes for the deforestation and degradation of natural resources in Ethiopia (the case of Belete-Gera forest), and did not consider status of the community responsible for the problem. Others are more or less concerned with the role of forest products in improving livelihoods of the poor rather than the problems. Poor are more reliant on forest product and forest income contributes larger shares to their income (Sultan, 2009; Yemiru et al., 2010). No empirical search for underlying social and economic factors contributing to deforestation by these authors, that is why and how this forest is being deforested by farm households that needs investigation. Thus, the general objective of the study is to examine the characteristics of farm households that contribute to deforestation. Specifically, to examine relationship between poverty and deforestation; and to examine how characteristics of forest management institutions are related to deforestation.

STUDY AREA

The study was carried out on Komto Protected Forest in the Oromia region of Ethiopia in East Wollega Zone. It is situated at 9° 05'10" – 9° 06' 35" N latitude and 036° 36' 47" – 036° 38' 10" E longitude with an elevation ranging from 2,135 to 2,482 m above sea level. This forest was proposed as one of the National Forest Priority Area (NFPAs) in 1976 and established as protected area in 1991 with an estimated total area of 9,100 ha including natural forests, plantations, disturbed and encroached areas (Mosissa, 2011; personal observation and communication with Oromia Forest and Wildlife Enterprise Wellega Branch Office). The settlers from the forest area were subjected to leave the forest when it was established as a protected area. However, a year later, following the fall of the Dergue regime in 1991, they returned to settle in and around the forest area. At present, because of encroachments, agricultural expansion and logging of trees for charcoal and timber production, the area of the forest has been reduced. The greatest portion of fuel wood and charcoal consumption of Nekemte town, which is about 12 km far, is obtained from this Komto[3] protected forest. Although, guards were employed, it is still seriously logged at night for timber and charcoal production (Mosissa, 2011) (Figure 1).

METHODOLOGY

Data

Primary cross-sectional data collected by structured survey schedule, focus group discussion and key informant interview were employed in this study. Information from focus group discussion and key informant interview were used to substantiate and complement the result of econometrics. The information collected includes the data related to deforestation, demographic characteristics, economic characteristics, social characteristics. Sample was drawn using multi-stage sampling method. At the first stage two[4] Weredas (Aanaas) were selected. This was because of the forest under consideration location between the two Weredas. In second stage, two Kebeles[5] surrounding the forest were selected purposively. In third stage, simple random sampling technique was used to draw household from selected sampled Kebeles. Household heads were randomly selected from two Kebeles to provide the total sample size (that is,150). This random selection was based on proportionate sampling technique to the respective population size of each Kebeles.

Household survey was conducted during February 2012, with a sample of 55 "Gaarii Kebele" households and 95 of "Daaloo Komto Kebele" households. The interviews were led by a team of four public office workers and one student. Four workers were first degree holder in social science and the other student was second degree student. English language was translated to "Afaan Oromoo"[6] to fill the questionnaires. The enumerators helped to clarify points before data entry and this has enhanced the accuracy of the information collected.

Model

To examine the determinants of deforestation in the study area, Heckman two step maximum likelihood model is used. Following Greene (2003) sample selection model was employed to analysis econometrics result. Deforestation was measured in cubic meter (M^3) of wood biomass and it is a continuous variable. The multiple linear regressions can be used for the parameter estimation for continues dependent variable. But, some of our respondents were not using forest product from Komto forest during the previous year so some dependent variable observations were missing or observed zero. For dependent variable with several zero observations, multiple linear regressions produce inconsistent and

[2] Wereda is equivalent to district.

[3] The forest is known as Komto-Wacha-Tsige forest. It has three parts which are known as"Komto","Wacha" and "Tsige. During the Dergue regime these three parts of the forest have been started to be merged.

[4] First we were supposed to conduct on six Kebeles that incorporate the three parts of forest. However, the two parts of this forest that are "Wacha" and "Tsige" forests are in good position.

[5] Kebele is the least administration unit.

[6] Afaan Oromoo is language spoken in study area

biased parameter estimates. Censoring model that is, Tobit model can be used for dependent variable with several zero observations. Tobit model is however, not appropriate for missing data. It also assumes same factors determine both probability and intensity. Deforestation was observed for farmers using forest product during the survey. Therefore, Tobit fails to capture selection bias and produces inconsistent and biased estimates of parameters. In Heckman two step estimation model, there are two equations of interest that should be modelled. These are the selection equation, and the response (outcome) equation. In the selection equation, the probability of using forest product from Komto forest is modelled conditional on some relevant observable variables using a maximum likelihood of probit regression. Heckman two step estimation is used to model intensity of deforestation. Deforestation (outcome equation) is modelled as:

$$D_i = \beta X_i + e_i \quad (1)$$

Where D_i is the deforestation (cubic meter (M^3) of woody biomass), X_i's are observed variables related to households characteristics and e_i include all unobserved factors affecting deforestation.

The first step of the two-step approach runs a probit model of probability of using forest product using all the observations as follows:

$$p_i^* = \gamma Z_i + v_i \quad (2)$$

Where P_i* is a latent variable. Z_i is the vector of individual household characteristics that affect the probability of using forest product from Komto Forest. We observe only an indicator variable users, defined as P = 1(that is forest product user) if P_i* > 0 and, 0 otherwise.

The estimates of Υ from this probit model are then used to construct consistent estimates of the Inverse Mills Ratio (IMR[7]) term.

$$\lambda i\,(-Zi'\Upsilon) = \frac{f(Zi'\Upsilon)}{F\,(Zi'\Upsilon)} \quad (3)$$

Where *f* (.) is the probability density function of a standard normal variable, F (.) is the cumulative distribution function of a standard normal distribution and λi (.) is the Inverse Mills Ratio. In second stage, outcome equation (Di) is estimated by ordinary least squares where the outcome equation includes both the original variables (Xi) whose coefficients are the parameters of the population deforestation equation and the constructed value of the inverse Mills Ratio, which is:

$$Di = \beta Xi + \theta\lambda i\,(-Zi'\Upsilon) + ei \quad (4)$$

This step is carried out only for the uncensored observations and provides consistent and asymptotically normal estimators for β and θ. With the Inverse Mills Ratio (IMR) included, the coefficients on the X represent consistent estimates of the population deforestation equation. The coefficient on the Inverse Mills Ratio term estimates $\rho_{ev}\sigma_e$. Because σ_e is greater than 0 by definition, the sign of this coefficient is the same as the sign of ρ_{ev}. The sign of ρ_{ev} is often substantively useful information, as it indicates the correlation between the unobservable in the selection and outcome equations. The standard t-test of the null hypothesis that θ = 0 is a test of the null that there is no selection bias, conditional on the assumptions of model. For standard errors we must take into account the additional variance that results from the generated regressors - namely the Inverse Mills Ratio term; and if there is indeed selection, then there is heteroscedasticity. Thus Heckman (1979) includes a consistent variance estimator that deals with these problems and "STATA" software package produces the correct standard errors automatically.

[7] IMR is also called Lamda.

Definition of deforestation

Deforestation is explained as conversion of forested areas to non-forest land use, degradation that reduces forest quality, decreases in overall forest cover and clearing native forest land for different purposes (FAO, 2003, 2007; Amacher, 2008; UNRISD, 1994). Deforestation (VOLWOOD) was used as dependent variable in Heckman two-step estimation. It is a continuous variable defined as the volume of woody biomass consumed and sold by each household measured in cubic meter (M^3). Woody biomass used for charcoal production, firewood, lumber, and other timber products were considered. To come up with correct estimate of wood consumption, trees were categorized into three (large, medium and small tree) with the help of forestry experts working for Oromia Forest and Wildlife Enterprise Wellega branch office and local knowledgeable people. Those trees taller than 18 meters were considered as large trees whereas those less than 5 m were considered as small trees. Those trees which lie in between these two threshold figures in length were considered as medium. Thus volume of these trees categories were used for the purpose of measuring volume of wood used (deforestation). Following Mekuria (2007) the following formula was used to estimate wood biomass consumption for each tree categories consumed by each households.

$$V = \left(\frac{\Pi D^2}{4}\right) * H * f \quad (5)$$

Where: D = Diameter at Breast Height (DBH); H = total height; f = form factor = 0.45

Households were categorized as forest product user and non-user (FPU) from Komto Forest. It is used as dependent dummy variable that represents respondents who used forest product from Komto Forest that takes value of one whereas it takes the value of zero for the respondent who did not use forest product from Komto forest.

Forest product use (FPU): Is the dummy variable that represents the forest product use from Komto Forest of the household that is regressed in the first step of two step estimation procedure. For the respondents who use forest product from Komto Forest takes value of one whereas it takes the value of zero for the respondent who did not use forest product from Komto.

RESULTS AND DISCUSSION

Descriptive results

Out of sampled households 62% of the respondents were Forest product users while 38%[8] were non-user from

[8] These 38% households did not use Komto forest to satisfy their forest product needs. They do have alternative sources. "Komto" is one part of "Komto, Wacha, Tsige" forest which is highly affected. In this case non-users of Komto forest they either used other forest (Wacha and Tsige), or used forest products from their own land.

Table 1. Descriptive statistic of continues variables included in estimation.

Variable	Minimum	Maximum	Mean	Standard Deviation
Volume of wood (VOLWOOD)	0	501.52	27.21	61.64
Dependency ratio(DEPRATIO)	0	6	0.92	0.84
Number of adult female (ADFEM)	0	5	1.88	1.17
Age of household head(AHHH)	17	92	42.61	15.57
Landholding size (LHSIZE)	0	12	1.5	1.71

Komto Forest during the 12 months before the survey. The average value of the dependency ratio is 0.92, which is very high. In the study area the average number of adult female in the household is almost 2 persons. Age of household heads ranges from 17 to 92 years. The average value of landholding size in the study area is equal to 1.5 ha.

There is significant mean difference of volume of wood used between households use for own consumption and sale purpose; and households use kerosene and do not use kerosene at less than one percent of level of significance. Again there is significant mean difference of volume of wood used between male headed households and female headed households at less than five percent of level of significance. There is also significant group mean difference in volume of wood used between who perceive Komto Forest is openly access and people who do not perceive it is not openly access; and literate and illiterate household head at less than ten percent of level of significance (Table 2).

Econometrics results

Factors affecting forest product use (FPU) in the study area

The result of the Heckman Maximum Likelihood Model (Table 3[9]) in first stage indicates Road Access (ROAD) positively and significantly related to the probability of using FPU. It implies that households that have a relatively better access to road are more likely to use forest products than their counterparts. This might be because household that have access to road have better opportunity either to take forest products to market by themselves or agents may easily collect forest products from household's home to market. The result is consonant with the results of other studies (Swinton, 2003; Shively, 2004).

Perception of corruption (CORRUPTION) and probability of using forest product from Komto Forest are positively and strongly related to each other. People who perceive that there is corruption to use forest product from Komto Forest are more likely to use forest product from Komto than those perceive no corruption. This may be due to the fact that households perceive there is corruption, if caught by guard or other concerned bodies (include staffs of the Forest and Wildlife Enterprise, local administrative (kebeles) officials), they believe they will be left by giving bribe. If that is the case the more the corruptors guards (may include other staffs of the institution) and households are the more likely to use from Komto Forest.

Kerosene use (KERUSE) negatively and significantly affected the probability of using forest product from Komto Forest. This might be due to the fact that kerosene is a good substitute of fuel wood, and hence households who use kerosene as a source of energy are less likely to use wood. This result particularly suggests that households who use kerosene for both lighting and cooking regularly are friendly of environment. The model estimates also indicated that deforestation and purpose of using forest (PURPOSE) products are positively and strongly related. Households that use forest products from Komto Forest for commercial purpose (sale) have higher probability of using forest product than those who use for own consumptions.

Estimation of deforestation

The Heckman two step maximum likelihood model estimates show that landholding size (LSIZE), purpose of forest use (PURPOSE) and Corruption perception (Corruption) are important factors determining deforestation (LVOLWOOD[10]) intensity in the study area (Table 3). Landholding is negatively related to the intensity of deforestation (as measured by the volume ofwoody biomass used by households within 12 months before the survey time). The result implies households cultivating small land are more dependent on forest products than households cultivating large farmland. This could be related to the argument of subsistence model; and the vicious circle of poverty and resources degradation, in which poor households tend to clear forest either to reach minimum subsistence level of food, or clear forest due to absence, fragile and scarce resources. In this case, households operating small

[9] "STATA 11" software is used to produce econometrics results.

[10] LVOLWOOD is natural logarithm of volume of woody biomass.

Table 2. Descriptive statistics of Volume of wood used in relation to dummy variables.

Variable	Mean	Standard deviation	t-value
Purpose of use (PURPOSE)			-11.74*
Volume of wood sold	40.89	57.36	
Volume of wood consumed	9.68	62.83	
Perception toward Guard (PERGUARD)			0.42
Committed	29.06	54.3	
Not committed	24.74	71.8	
Open access perception (OPENACESS)			-1.72***
Perceive not openly access	13.32	25.12	
Perceive openly access	32.64	69.96	
State management perception (STATEMGT)			-0.94
Not better than other	23.96	65.28	
Better than other	33.97	53.65	
Corruption Perception (CORRUPTION)			-0.35
Perceive no corruption	26.18	62.56	
Perceive there is corruption	30.03	59.89	
Gender of Household head (GENHHH)			2.31**
Male headed	24.5	175.37	
Female headed	75.47	48.47	
Education of Household head (EDUHHH)			1.51***
Literate	21.8	46.47	
Illiterate	37.73	83.19	
Kerosene use (KERUSE)			3.54*
Users	24.38	48.32	
Non-users	130.82	247.34	
Road Access (ROAD)			-1.06
Access	30.16	67	
No access	17.55	38.45	
Non-farm-non-forest income activities (NFNFINCOME)			0.66
Participates	24.85	46.89	
No participation	31.95	84.14	
Total	27.22	61.64	

*, ** and ***, are level of significance at less 1, 5 and 10% respectively.

farmland may not produce agricultural products sufficient to sustain their household members throughout a year and hence, as an alternative, may depend on forest products to fill their food gap. This result is in agreement with the finding of Pandit and Thapa (2003) that shows local people with small landholdings collect more non-timber forest products (NTFPs) than those with relatively large landholdings. Swinton (2003) and Fisher (2004) also reported that land-poor households are more reliant on forest activities.

The intensity of deforestation is influenced by whether households use timber products for home consumption or for sale. The results indicate that households who use timber products for sale harvest more volume of timber products from Komto Forest than those who use the products for home consumption. This implies that households' commercial motives are more responsible for the degradation of the natural forest in the area.

Pattern of forest product consumption in rural can be related to amount of forest product used in rural areas. In study area, Own fuel (charcoal and fuel wood) consumptions may not require significant amount of woody biomass and own construction material consumptions may not be frequently. Charcoal is produced mostly for commercial purpose than for own consumption. In the study area using charcoal as source of energy is not popular as technologies (e.g. stoves) help households use charcoal are lacking; cooking meals using charcoal may be time consuming than using fuel wood; and using charcoal as source of heat in the house may be specific to a given place and person that all members of the household cannot get access of it. E ven though, fuel

Table 3. Econometrics result of deforestation regression.

Variable	Coefficient	Robust Standard Error	Z-value	P-Value
LVOLWOOD				
LDEPRATIO	0.43	0.38	1.13	0.26
GENDHHH	0.37	1.15	0.32	0.75
ADFEM	0.24	0.19	1.26	0.21
ROAD	0.07	0.54	0.13	0.90
LHSIZE	-0.20	0.07	-2.86	0.01
KERUSE	-0.58	1.33	-0.44	0.66
PURPOSE	2.28	0.46	4.96	0.00
CORRUPTION	0.73	0.42	1.74	0.08
OPENACCESS	0.67	0.52	1.29	0.19
NFNFINCOME	0.00	0.00	0.00	0.97
COSTANT	0.17	1.82	0.09	0.93
FPU				
LDEPRATIO	0.174	0.19	0.92	0.37
ROAD	1.13	0.32	3.53	0.00
AHHH	-0.01	0.01	-1.00	0.10
EDUHHH	-0.36	0.27	-1.33	0.17
KERUSE	-1.08	0.61	-1.77	0.08
PERGUARD	-0.03	0.29	-0.10	0.93
OPENACCESS	0.16	0.27	0.59	0.56
STATEMGMT	0.26	0.30	0.87	0.38
CORRUPTION	0.93	0.27	3.44	0.00
PURPOSE	8.80	0.99	8.89	0.00
NFNFINCOME	0.00	0.00	0.00	0.58
CONSTANT	0.55	0.78	0.71	0.48
/antro	0.81	0.28	2.89	
/lnsigma	0.68	0.08	8.50	
Rho	0.67	0.16		
Sigma	1.97	0.15		
Lahmda	1.31	0.39		
Wald test of independency equations (rho=0):chi2(1)=8.21 prob>ch2=0.00				
	Number of observations=			150
Heckman selection model	Censored observations=			57
(regression model with sample selection)	Uncensored observations=			93
	wald ch2(10)=			43.07
Log pseudo likelihood= -252.05	prob>ch2=			0.00

woods may be consumed more in rural as there are limited alternatives, fuel wood used for commercial purpose may outweigh. For own consumption household may simply go the forest and collect fuel woods without cutting live trees. These fuel woods may be leftovers: scraps of tree cut for different purposes. Since fuel woods serve immediate service for cooking meals, rural households may not cut live trees for immediate service than simply collecting fuel woods. Fuel woods can also be easily accessed from the household's compound without going the forest. Fuel woods and lumber produced for commercial purpose however may differ from fuel woods and lumber produced for own consumptions in terms of quality and quantity. In terms of quality customers demand quality fuel woods and lumber as a result of which households that sale these forest products may cut live trees that they think is quality. Quality of fuel wood may be related with large tree. In terms of quantity households may cut large live trees to get huge amount of money than those use for own consumption. This result may confirm the argument that the higher lumber price and presence of trade the more they exacerbate deforestation (Kaimowitz and Angelsen 1998).

Trade-offs between charcoal and lumber production and other economic production may be other factors. Charcoal and lumber production is laborious and potentially reduces the labour time farmer household has for agricultural production. As farmer household tends to spend more of his/her time producing these forest products for own consumption the less labour time left for other activities. Technical knowhow of producing them may also be related to lower own woody biomass consumption of households in the study area.

Institution related variable significantly and positively related to deforestation is corruption perception (CORRUPTION). Positive and significant relationship between deforestation and corruption perception of household indicates that improper forest management and protection are sources of the forest degradation/ deforestation problem in the study area. This may be because some staff of the institutions (Forest and Wildlife Enterprise Wellega branch office, local administrative (Kebeles) officials, guards hired to protect the forest) related to forest management and forest product users are favouring each other in using forest products. It is possibly related to institutional ineffectiveness to enforce and enact rules and regulation in which those corrupt households and staffs would be discouraged. This result is in line with findings of Pandit and Thapa (2003) that indicates forest products depletion is due to unsustainable harvesting practices and lack of proper management activities.

CONCLUSION AND POLICY IMPLICATIONS

In this study, Heckman two step maximum likelihood model is used to show the determinants of deforestation. From the study deforestation is strongly related to poverty (measured in landholding size), institutional failures. Road access, corruption perception, kerosene use, and purpose of use were found important factors determining forest product use from Komto Forest. While landholdings size, purpose, and corruption perception were found important factors determining the intensity of deforestation. Possible policy implications of the study:

(i) Only access to road may not solve multifaceted rural problems related to their livelihoods, but creating alternative activities that help generate income may reduce probability of reliance of rural households on forest resources.
(ii) Changing attitude of local community and staff of the institution with regard to corruption behaviours by strengthening and establishing management system in which transparency in using and managing forest resources prevails (like Participatory Forest Management (PFM) or Community Based Forest Management (CBFM)) could be helpful in lessening probability as well as deforestation.
(iii) Mechanisms in which problem of land could be solved probably by increasing land productivity either by utilization of improved agricultural inputs or by introduction of land augmented technologies, or both helps solve both poverty and deforestation problem. Other policy implication related to deforestation reduction is promotion of alternative energy source use as kerosene use in the study area is related to lower probability of deforestation.
(iv) Provision of either alternative income generating activities that are profitable than forest product sell or facilitating mechanisms which help both generate income and conserve forest resources sustainably is recommendable.

Conflict of Interest

The authors have not declared any conflict of interest.

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