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Preferences for REDD+ Contract Attributes in Low-Income Countries

A Choice Experiment in Ethiopia

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Abstract

This paper informs the national and international policy discussions related to the adoption of the United Nations Reducing Emissions from Deforestation and Forest Degradation Programme. Effective program instruments must carefully consider incentives, opportunity costs, and community interactions. A choice experiment survey was applied to rural Ethiopian communities to understand respondents' preferences toward the institutional structure of the program contracts. The results show that respondents have particular preferences about how Reducing Emissions from Deforestation and Forest Degradation programs are structured with regard to the manner in which the payments are divided between the households and the communities, the restrictions on using grazing land, and the level of payments received for the program. Surprisingly, restrictions on firewood collection do not significantly impact contract choice. The paper further analyzes the structure of the preferences by using attribute interaction terms and socio-demographic interaction terms. The analysis finds significant regional variation in preferences, indicating that Reducing Emissions from Deforestation and Forest Degradation should be tailored to specific regions. Finally, the marginal willingness to pay for attributes is calculated using the traditional preference space approach, as well as the more recent willingness-to-pay approach.

This paper is a product of the Environment and Energy Team, Development Research Group. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The lead author may be contacted at sdissan2@gmail.com

Preferences for REDD+ Contract Attributes in Low-Income Countries: A Choice Experiment in Ethiopia

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Preferences for REDD+ Contract Attributes in Low-Income Countries: A Choice Experiment in Ethiopia[1]

1. Introduction

According to Millennium Ecosystem Assessment (2005), approximately 30% of the global forest has been cut down in the last two centuries and 25 countries lost their forests completely, another 29 countries lost over 90% of their forests. Moreover, the total size of tropical forest is decreasing at a rate of over 10 million hectares per year. This rate of deforestation and the associated harm has not only created concerns for the local people who largely depend on the forests and forestry products for their livelihood, but also the world at large for the ecosystem services they provide. Worldwide, some 1 to 2 billion people depend primarily on forests for their livelihoods and deforestation and forest degradation accounts for 11%–20% of annual greenhouse gas emissions (Saatchi et al. 2011; van der Werfet al. 2009; Chao, 2012; UNEP 2012). Therefore preventing deforestation and forest degradation is necessary from both a climate stabilization and sustainable development point of view. It is difficult to envision reaching a climate stabilization goal without the inclusion of forests in an international carbon mitigation framework (Angelsen and Brockhaus, 2009).

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Reducing Emissions from Deforestation and Forest Degradation (REDD+) is a payment for ecosystem services (PES) system created under the Framework Convention on Climate Change (FCCC) tasked with creating markets for carbon sequestration services. Developing appropriate REDD+ carbon markets is a potentially important tool to give value to forest ecosystem services and create incentives for those who control forests to sequester carbon and for those who emit carbon into the atmosphere to pay for sequestration services (Bluffstone 2013).

From an economic point of view, carbon prices, payments to communities and the opportunity costs of carbon sequestration drive the decisions to adopt or not adopt REDD+. To achieve a welfare gain from the creation of the REDD+ carbon markets, the sellers (those sequestering carbon, typically in non-Annex 1 countries) must receive a price that is greater than the direct and indirect costs of participating in the carbon market by engaging in carbon sequestration. At the same time, the buyers in the carbon market (those paying for carbon sequestration services, typically in Annex-1 countries) will only engage in a REDD+ market if the price of carbon sequestration is competitive compared to the cost of alternate methods such as fuel switching and efficiency improvements (Bluffstone 2013). Therefore the costs borne by participants in non-Annex-1 countries, particularly the opportunity costs of participating in REDD+, will determine the success of a global REDD+ carbon market.

Despite the acknowledged importance of local level opportunity costs and preferences (e.g. McKinsey & Co, 2010; Gregorsen *et al.* 2011), the literature on opportunity costs of carbon sequestration in developing countries and preferences for programs to prevent deforestation like REDD+ is extremely limited. This paper attempts to partially close this critical research gap using choice experiment surveys conducted in three regional states in Ethiopia.[1] The main goal

of the analysis is to understand household preferences for REDD+ contracts and to estimate the cost to rural Ethiopian households of taking on fuelwood collection and grazing reduction obligations to sequester carbon. We also seek to shed light on respondents' preferences for REDD+ institutional arrangements, such as the portion of payments going to communities versus households and the terms of REDD+ contracts.

We focus on Ethiopia because it presents an ideal case study to answer the above questions. In Ethiopia population pressure has led to the expansion of agricultural activities, and unsustainable consumption of fuel wood and the country's forests are being lost at a rapid rate. Livestock grazing and to a lesser extent, illegal logging and forest fires also contribute to these problems. Though Ethiopia is not a major emitter of greenhouse gases, it has a significant potential for climate change mitigation. It is believed that the country's participation in REDD+ will generate many benefits to the sustainable management of forests and the rural people who depend on natural resources for their livelihood.

Ethiopia has committed to developing REDD+; the government submitted a REDD+ Program Idea Note (R-PIN) in 2008, a final REDD+ Preparation Proposal (R-PP), and Climate Resilient Green Economy (CRGE) strategy in 2011 with the objective of reaching carbon neutral economy by 2025 and established a REDD Secretariat in 2013 under the Ministry of Environment and Forest.

We use a choice experiment survey, which allows us to analyze preferences for individual attributes and to calculate part-worth utilities. In addition, we use an experimental design that includes attribute interaction terms to analyze the trade-offs between attributes. Finally, we analyze the robustness of the results by using the "WTP-Space" approach in addition to the standard "Utility-Space" approach to calculate the marginal values for attributes. The data

were collected from 504 randomly selected households in 36 randomly selected villages from the three largest regions in Ethiopia.

The results show that respondents have particular preferences about how REDD+ programs are structured with regard to the manner in which the payments are divided between the households and the communities, the restrictions on using grazing land and the level of payments received for the program. We also find that there are significant interaction effects between attributes that need to be accounted for when considering the preferences for the REDD+ contracts. Finally we find that regional indicators and respondents' beliefs influence preferences, in particular beliefs about institutional structure and governance influence respondents' preferences for the REDD+ contracts.

2. Key REDD+ Literature

Differential opportunity costs are at the heart of REDD+. To be economically viable as a climate change mitigation strategy, carbon sequestration must be low-cost compared to other approaches. Using simulation techniques Kindermann *et al.* (2008) estimate the cost of carbon sequestration by reducing deforestation at less than $20 per ton of CO2 for up to 4.3 Gt of CO2 per year. Similar values are identified in a study by McKinsey and Company (2010) that ranks costs to reduce carbon concentrations in the atmosphere per ton of carbon reduced and a study by Strassburg *et al.* (2009). These findings suggest that sequestration of carbon in forests can indeed effectively compete with other mitigation approaches such as renewable energy sources and alternate fuels. At the same time, as discussed by Bluffstone (2013), there is some controversy on whether all local opportunity costs of carbon sequestration were included in these studies (Dyer

and Counsel 2010; Gregorsen *et al.* 2011). By conducting in-person surveys with local communities we get at the heart of this question of what are the opportunity costs of carbon sequestration faced by households by directly calculating the costs faced by potential participants in a REDD+ program.

The potential for REDD+ to contribute to climate change mitigation appears significant, but to-date preferences of potential participants and related costs have not been fully explored. Costs associated with community negotiations, meetings, monitoring, risk aversion and high discount rates (Yesuf and Bluffstone, 2009; 2013) could turn out to be potentially significant and make communities unwilling to participate in REDD+ at prices carbon buyers would be willing to pay. A key overarching question therefore is how REDD+ benefits can effectively be transferred to the local level without disrupting the successful adoption of REDD+, especially at the community level (Bluffstone 2013). Further, understanding the preferences for the various attributes of REDD+ contracts allows planners to tailor the REDD+ contracts to better suit the preferences and local conditions. By using a choice experiment survey we are able to analyze the preferences for the various attributes of REDD+ contracts and the overall opportunity cost faced by the participants.

3. Study Site and Data

Ethiopia is a low-income REDD+ partner country of over 90 million people. With closed canopy forest cover of only about 4%, increasing forest cover is a critical policy goal. As a result, in 2000 forest sector reform was initiated and a variety of community-level devolution pilots, experiments and initiatives are underway around the country. CFM is a focus of the Ethiopia REDD Readiness Proposal, which was funded in August 2009 by the World Bank

Forest Carbon Partnership Facility (FCPF). The proposal was submitted in October 2010 and revised in 2011. The REDD+ Phase was launched in January 2013 with funding from the FCPF and the Royal Norwegian Government, and DFID (Moges and Tenkir 2014). The Proposal specifically notes that the key aspect of the enabling environment is to "reinforce and clarify the user rights of forest dependent people as this has been identified as a fundamental prerequisite for sustained protection of the forest."

Data were collected from 504 randomly selected households in 36 randomly selected villages in Amhara, Oromiya and Southern Nations, Nationalities and Peoples (SNNP) Regional States using in-person surveys. These regional states represent 80% of the population and over 70% of the land area of Ethiopia. The number of villages from each regional state included in the sample was stratified based on the forest cover of each state. As Oromia Regional State is the largest state and contains about half the forest area, 50% of respondents are from Oromia, with the remainder living in Amhara (22%) and SNNP (28%). Within each of the 36 surveyed communities 14 households participated in the survey, giving a total of 504 completed surveys. Data were collected in May and June 2013 by 20 enumerators and 5 supervisors who were trained on choice experiment surveys and had prior experience working with similar respondent groups.

Household Characteristics

In this section we briefly overview respondent and household characteristics. All three regional states are multi-ethnic and respondents report membership in a total of 9 ethnic groups (one group per household). The most important ethnic groups are Oromo (39%), Amhara (25%) and Wolayta (14%). Slightly over half of respondents follow the Ethiopian Orthodox religion, 29% are Muslim and the remainder (17%) are non-Orthodox Christians. All Muslims in the

sample live in Oromia Regional State and almost all non-Orthodox Christians live in SNNP.

Respondents in general are middle-aged (average age 42 years) males (90%). The average respondent is poorly educated, with 45% having a maximum of primary education and 38% being illiterate. Average household size in the sample is 4.9 adult equivalents, with a mean of 3 children under 15 years old. Households live at an average of 2,214 meters, but as low as 1,434 and as high as 3,150 meters. The sample can therefore reasonably be characterized as a highland sample.

Almost all respondents report being farmers (91%) and own an average of 1.8 hectares of land, with a maximum of 10.5 hectares. As is the case for the country as a whole, in the sample irrigation is unusual, only 8% of respondents have any irrigated land. Farmers both cultivate and raise animals, with virtually all households having animals, with an average of 5 tropical livestock units (TLU).[2] Only 7% of households had less than the equivalent of one cow and 10% had more than 9.5.

4. Methodology

Choice Experiment Surveys

CE surveys are based on Lancaster's (1966) consumer theory and are used to elicit preferences for environmental goods and policies (Boxall et al. 1996, Louviere et al. 2000). Lancaster (1966) proposed that consumers obtain utility from the characteristics of goods rather than the good itself. Therefore, CEs can be considered the analog of hedonic analysis for stated preference valuation methods and they allow the researcher to gain a detailed understanding of the respondents' preferences for the policy or scenario being analyzed. In a typical CE survey, the respondent repeatedly chooses the best bundle/choice from several hypothetical bundles/choices. The attribute values appearing in each bundle/choice are identified using

experimental design techniques to ensure a balanced representation of values across choices. Alpizar et al. (2003) Hanley et al. (2001), Hensher et al. (2005), and Hoyos (2010) provide reviews of the choice experiment methodology.

Survey Instruments

The survey for this particular study presents respondents with opportunities to express preferences over hypothetical REDD+ contracts that have the following attributes: Contract payment denominated per household, duration of the contract, percentage of the payment going to the household (as opposed to the community), required reduction in fuelwood and the required reduction in grazing. The exact list of attributes was refined after studying the REDD+ literature and analyzing results from 20 focus groups. The attribute levels and the descriptions for the attributes are provided in Table 1.

Once an initial list of attributes was developed, we conducted focus groups with potential survey respondents. The final survey instrument contains background information about the REDD+ program, a description of the attributes and the levels, seven sets of binary choice question sets, and a small demographic questionnaire. Appendix A provides an example of one of the choice questions and the actual background information document used. These documents were pretested in the field before launching full implementation. For each of the choice sets the respondents choose between the two given alternatives and the status quo option.

Empirical Design

We created an efficient experiment design that incorporates both main effects and interaction effects (Adamowicz et al. 1997, Adamowicz et al. 1998, Carlsson and Martinsson 2003, Louviere et al. 2000). The design for the choice experiment was generated following Kuhfeld (2010)[3] and achieved a 100% D-efficiency. The REDD+ survey design resulted in 84

unique choice profiles[4] (Kuhfeld, 2010; Vermeulen et al. 2008). Carlsson and Martinsson (2008) investigate the effect of the number of choice sets and the design of the first choice set as context dependence in a choice experiment, and they found no significant impact on estimated marginal willingness to pay. We created a block design where each of the surveys were separated into blocks of six choice profiles, giving fourteen unique REDD+ surveys with six questions each. Carlsson et al. (2010) test for learning and ordering effects in CE surveys and show that dropping the first choice question can decrease the error variance of estimates. We follow this suggestion and add an additional choice question before the six choice questions in each survey and drop the first choice question when conducting the analyses to account for possible learning effects. In order to account for possible ordering effects we reversed the order of the questions in half the surveys and obtained 28 unique versions of the REDD+ survey.

Model and Estimation

The standard conditional logit model (CL), which has been used for analyzing discrete choice models for many years, assumes that the respondents have homogeneous preferences (estimate a mean value for the sample for each attribute). To account for heterogeneity of preferences we also use a mixed multinomial logit model (MMNL)[5] that estimates both a mean and a standard deviation for each attribute (Carlsson *et al*. 2003; Hensher and Greene, 2003; Train, 2003, Hensher *et al*. 2005; Dissanayake 2014). Assuming a linear utility, the utility gained by person *q* from alternative *i* in choice situation *t* is given by

$$U_{qit} = \alpha_{qi} + \beta_q X_{qit} + \varepsilon_{qit} \qquad (1)$$

where X_{qit} is a vector of explanatory variables. Following standard practice for logit models we assume that ε_{qit} is independently and identically distributed extreme value type I. We assume the density of β_q is given by $f(\beta \mid \Omega)$ where the true parameter of the distribution is given by Ω.

In the choice experiment questions, option A and option B are REDD+ contracts that can be viewed as being closer substitutes with each other than with option C, the status quo option (Haaijer, *et al.* 2001; Blaeij et al. 2007). To account for this difference in substitution between options we use an econometric specification for the mixed multinomial logit model that contains an alternative specific constant (ASC), the parameter α_{qi} that differentiates between the status quo option and the choices that represent deviations from the status quo.

To better interpret the estimation results we calculate average marginal WTA for a change in each attribute *i* by dividing the coefficient estimate for each attribute with the coefficient estimate for the payment term, as given in (2).

$$MWTA_i = \frac{\beta_i}{\beta_{cost}} \qquad (2)$$

Though the above formulation has been the standard practice in the literature to calculate willingness to pay (or willingness to accept for this particular case), some recent work has shown that taking the ratio of two coefficients can be structurally incorrect when the coefficients are drawn from specific distributions. Specifically Train and Weeks (2005), Scarpa , Thiene and Train (2008), Daly, Hess and Train (2011) and Hole and Kolstad (2012) show that ratios of coefficients can have infinite variances and therefore an estimator compromising of a ratio of coefficients may not have finite moments. They propose a solution by reformulating the estimation equations from "preference space" to "WTP space". Specifically equations (1) can be expanded to separate out the cost/payment terms as

$$U_{qit} = \alpha_{qi} + \beta_q X_{qit} + \gamma_q C_{qit} + \varepsilon_{qit} \qquad (3)$$

where C is the cost or payment attribute and γ is the coefficient on the cost term. The RHS of the above equation can be reformulated by dividing by the coefficient on the cost term, γ to get

$$U_{qit} = \gamma_q[\alpha_{qi} / \gamma_q + \beta_q / \gamma_q X_{qit} + C_{qit}] + \varepsilon_{qit} \quad (4)$$

which can be presented as

$$U_{qit} = \gamma_q[\bar{\alpha}_{qi} + \bar{\beta}_q X_{qit} + C_{qit}] + \varepsilon_{qit} \quad (5)$$

Equation (5) represents a specification in "WTP Space" since the coefficient estimates are the ratios of the coefficients from specification (3), $\bar{\beta}_q = \beta_q / \gamma_q$. The specification is now nonlinear but can be estimated using both NLOGIT (Greene, 2013) and a new Stata module by Gu, Hole and Knox (2013).

Econometric Specification

We present a main effects (no interactions) specification and specifications with attribute interaction terms, regional interaction terms, and respondent belief interaction terms. The specifications are given in Equation 6 – Equation 9:

$$V_{ni} = ASC + \beta_{1n}X_{payment\_to\_community} + \beta_{3n}X_{duration} + \beta_{4n}X_{firewood} + \beta_{5n}X_{grazing} + \beta_{6n}X_{payment} + \varepsilon_{ni} \quad (6)$$

$$V_{ni} = (6) + \beta_{7n}X_{firewood} * X_{cost} + \beta_{8n}X_{grazing} * X_{cost} + \beta_{9n}X_{firewood} * X_{payment\_to\_community} + \beta_{8n}X_{grazing} * X_{payment\_to\_community} \quad (7)$$

$$V_{ni} = (6) + \beta_{7n}S_{regionAmhara} * X_{payment\_to\_community} + \beta_{8n}S_{regionSNNP} * X_{payment\_to\_community} + \beta_{9n}S_{regionAmhara} * X_{firewood} + \beta_{8n}S_{regionSNNP} * X_{firewood} + \beta_{9n}S_{regionAmhara} * X_{grazing} + \beta_{8n}S_{regionSNNP} * X_{grazing} \quad (8)$$

$$V_{ni} = (6) + \beta_{7n}X_{community\_follows\_rules} * X_{firewood} + \beta_{8n}X_{personal\ impact\ from\ climate\ change} * X_{cost} + \beta_{9n}X_{personal\ benefit\ from\ REDD} * X_{cost} \quad (9)$$

The data were analyzed using the clogit and mixlogit commands in STATA for the Conditional Logit and MMNL specifications. The WTP estimation was conducted in STATA

using the generalized mixed logit GMNL estimator created by Hole (2013).

5. Results and Discussion

Table 2 presents results for the main effects specifications analyzed using a conditional logit model (column 1), the main effects specification analyzed using an MMNL (column 2), the attribute interactions effects specification analyzed using an MMNL (column 3), the geographical interaction effects specification analyzed using an MMNL (column 4), and the respondent beliefs interaction effects analyzed using an MMNL (column 5). Table 3 identifies the presence of significant individual heterogeneity in the multinomial-logit setting (MMNL). As can be seen many of the variables exhibit individual heterogeneity and therefore it is necessary to account for this in the analysis by using an MMNL model.

The overall results from the five specifications indicate that the percentage of the payment going to the community, the duration of the contract, the required grazing reduction and the payment are all significant variables in determining the respondent s' willingness to adopt REDD+ contracts. The significant coefficient results are robust across the econometric specifications and have expected signs. The significant results indicate the following:

1. As the percentage of the payment going to the household increases, respondents are more likely to choose that option;
2. As the duration of the contract increases, respondents are more likely to choose that option;
3. As the required grazing reduction increases, respondents are less likely to choose that option;
4. As the payment values (amount) increase, respondents are more likely to choose that option

The results that include attribute interaction terms (column 3) indicate that the interaction term for the *firewood reduction* variable and the *payment to the community* is significant. Since

this variable is negative it indicates that at higher levels of required firewood reduction, the respondent would require more of the payment to be given to the household (as opposed to the community) compared to the low levels of firewood reduction. Implicitly the respondent is willing to trade-off between a higher firewood restriction and more of the payment going to the household.

The significant interaction term between *grazing restriction* and *payment* in the results from the attribute interaction specification (column 3) indicates that as the payment level increases respondents are willing to accept a higher grazing restriction (the marginal disutility of grazing decreases). Two of the regional interaction terms are significant implying that there is regional heterogeneity with regard to respondents' preferences for REDD+ contracts. Specifically the results state that

1. Compared to respondents from Oromia, respondents from Amhara require a higher payment when a larger portion of the payment is given to the community.
2. Compared to respondents from Oromia, respondents from SNNP require a higher payment to reduce the amount of grazing.

The significance of the regional interaction terms indicate that REDD+ programs should be designed at the regional level to account for differences in regional preferences.

We currently observe a result that is puzzling; we find that the required reduction in fuelwood collections is not a significant determinant of willingness to adopt REDD+ contracts in three of the first four specifications. This result is counter to what was suggested by focus groups and survey pretests and may be explained by the individual heterogeneity in the sample. Different respondent groups having varying preferences and access to firewood substitutes or beliefs about the enforcement of regulations may lead to this result. We include interactions

terms based on respondents' beliefs in an effort to understand the specific structure of respondents' preferences for the firewood reduction variable. Column 5 in Table 2 presents results from a specification that includes variables for the respondent's beliefs on if the community follows rules, if climate change will have an impact on the respondent, and if the REDD program will benefit the respondent. All the main attributes and two of the interactions terms are significant for this specification. Specifically if respondents believe the community members do not follow rules[6] they perceive firewood reduction as a cost. This gives weight to the idea that beliefs about enforcement and the likelihood of the community following rules has an impact on if the respondents consider firewood reduction as a legitimate cost. We also find that the respondents beliefs about the REDD program personal benefit have a significant impact on the contracts they choose.

Next we calculate the marginal WTA and include multiple specifications to test for the robustness of the results. Table 4 contains the results for the marginal WTA for the conditional logit model (column 1), MMNL with fixed price term (column 2), and MMNL with a normally distributed price term (column 3). Following the recent progress in the choice experiment literature we also estimate the Marginal WTA in "WTP Space", equation 8. The MWTA values are shown in (column 4) of Table 4 and the full estimation results are provided in Table 5. Figure 1 shows a comparison of the estimates from both preference space and WTP space and illustrates that for this data set there is no significant difference between the results obtained using the two methods.

We see from Table 4 that if the annual REDD+ payment per household increases by on average approximately 100 Ethiopian Birr (about $5.00) the proportion of payments to households can be decreased by 5%. We find that if under REDD+ households are required to

reduce their grazing by 10%, they would require an increased average payment of approximately 160 Birr (about $8.00). As already discussed, fuelwood collection reduction is not a significant determinant of REDD+ contract choice for this sample.

6. Conclusion

Reducing Emissions from Deforestation and Forest Degradation (REDD+) is a payment for ecosystem services (PES) system tasked with creating markets for carbon sequestration services (Bluffstone 2013). Despite the acknowledged importance of local level opportunity costs and preferences (e.g. McKinsey & Co, 2010; Gregorsen *et al.* 2011), the literature on costs and preferences for programs to prevent deforestation like REDD+ is extremely limited. In this paper we use choice experiment surveys conducted in in Ethiopia to understand household preferences for REDD+ contracts and to estimate the opportunity cost to rural Ethiopian households of reducing fuelwood collection and grazing. We also shed light on respondents' preferences for REDD+ institutional arrangements, such as the portion of payments going to communities versus households and the terms of REDD+ contracts.

The results show that respondents care how REDD+ programs are structured, particularly with regard to restrictions on grazing. A key REDD+ policy question is how to divide up REDD+ payments. Should they go to the community? To households? Or Part to households and part to communities? We find that respondents prefer that more of the payments go to households. This result may seem intuitive but similar ongoing work in Nepal finds that households prefer more of the payment to go to the community. It needs to be further investigated how the strength of the local institutions and the interactions between local, regional and government institutions may influence household preferences to how the payments are divided between households and the community.

We also find evidence that beliefs about enforcement and the likelihood of the community following rules has an impact on if the respondents consider firewood reduction as a legitimate cost. This result is implying that the strength of institutions and the enforcement of rules can change perceived opportunity costs of the contracts. It needs to be further investigated is these differences are caused by respondents acknowledging a potential for leakage or some other belief about the role of institutions. Further studies should be conducted that include different forms of enforcement as an attribute. This will allow a better understanding of how the form of enforcement will influence adoption decisions.

We also find that preferences for REDD+ contract attributes depend on the levels of other attributes. In particular we find that at higher payment levels respondents are willing to accept a higher grazing restriction (the marginal disutility of grazing decreases) and that at higher levels of required reduction of firewood collection respondents require more of the payment to be given to the household (as opposed to the community). These results show the importance of incorporating interaction terms when analyzing choice experiment data and in the context of REDD+ programs indicate that higher payments will not only increase the likelihood of contracts being adopted but also decrease the perceived opportunity cost of grazing restrictions.

We verify the robustness of the WTP estimates by analyzing the data using the "WTP-Space" approach and find that the results are robust to both estimation in "WTP-Space" and "Preference-Space". Perhaps the most intriguing finding is that Ethiopian households appear to value cash payments much more than losses in access to forest resources. These results suggest that the opportunity costs of carbon sequestration may indeed be low. The results also find that personal beliefs about the community, enforcement of contracts and the impact of the REDD+ program can significantly influence respondents' likelihood of adopting contracts.

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Table 1: Attributes and levels for the REDD+ survey instrument

Attributes		**Levels**
REDD + payments (birr per household per month, hh)	Annual total REDD+ payment to your community.	500 1000 1500 2000 2500 3000
Portion of the REDD+ payment going to the household.	The portion of REDD+ payments that go to communities for community projects and /or equally divided between households in your group.	100% community 50% community and 50% household 100% household
Term of REDD+ commitment	The duration of the REDD+ contract.	1-5 years 6-10 years 11-15 years
Reduction in amount of fuel wood collected	Required fuelwood reduction measured as a portion of your current use.	25% 50% 75%
Grazing land reduced	Required reduction of grazing measured as a portion of your current use.	25% 50% 75%

Table 2: Regression Results for the REDD+ CE Survey

	(1) CL Main Effects	(2) MMNL Main Effects	(3) MMNL Attribute Interaction	(4) MMNL Regional Interactions	(5) MMNL Respondent Beliefs
ASC	2.423***	10.07***	12.42***	10.67***	8.553***
	(0.135)	(1.356)	(2.290)	(1.437)	(1.067)
Payment % to Community	-0.0469***	-0.0693***	-0.00959	-0.0542***	-0.0702***
	(0.00546)	(0.00982)	(0.0308)	(0.0123)	(0.00996)
Duration	0.0143**	0.0154**	0.0271***	0.0156**	0.0157**
	(0.00557)	(0.00718)	(0.00870)	(0.00716)	(0.00723)
Firewood Reduction	-0.000415	0.00226	0.0966*	0.00938	-0.0675*
	(0.0150)	(0.0191)	(0.0554)	(0.0252)	(0.0356)
Grazing Reduction	-0.0430***	-0.0561***	0.00402	-0.00778	-0.0550**
	(0.0128)	(0.0218)	(0.0442)	(0.0283)	(0.0217)
Payment	0.246***	0.334***	0.556***	0.334***	-0.612**
	(0.0292)	(0.0417)	(0.143)	(0.0414)	(0.281)
FirewoodXPayment			-0.00592		
			(0.0247)		
GrazingXPayment			-0.0366*		
			(0.0216)		
FirewoodXPayToComm			-0.0164**		
			(0.00644)		
GrazingXPayToComm			-0.0000516		
			(0.00416)		
RegionAmharaXPayToComm				-0.00565**	
				(0.00272)	
RegionSNNPXPayToComm				-0.00149	
				(0.00216)	
RegionAmharaXFirewood				-0.0284	
				(0.0490)	
RegionSNNPXFirewood				-0.00914	
				(0.0462)	
RegionAmharaXGrazing				-0.0306	
				(0.0556)	
RegionSNNPXGrazing				-0.167***	
				(0.0489)	
FirewoodXCommFollowsRules					0.0962**
					(0.0421)
ClimateChangePersonalXPayment					0.0519
					(0.0809)
REDDbenefitsPersonalXPayment					0.942***
					(0.281)
Observations	9051	9051	9051	9051	9051
Log Likelihood	-2415.9	-2126.3	-2115.2	-2115.7	-2118.0
LR chi2	1797.2	579.3	589.5	532.3	362.0

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Individual Heterogeneity in Regression Results for the REDD+ CE Survey

	(2) MMNL Main Effects	(3) MMNL Attribute Interaction	(4) MMNL Regional Interactions	(5) MMNL Respondent Beliefs
ASC	Yes	Yes	Yes	Yes
Payment % to Community	Yes	Yes	Yes	Yes
Duration			Yes	Yes
Firewood Reduction				
Grazing Reduction	Yes	Yes	Yes	Yes
Payment	Yes		Yes	
FirewoodXPayment		Yes		
GrazingXPayment		Yes		
FirewoodXPayToComm		Yes		
GrazingXPayToComm				
RegionAmharaXPayToComm			Yes	
RegionSNNPXPayToComm				
RegionAmharaXFirewood				
RegionSNNPXFirewood				
RegionAmharaXGrazing			Yes	
RegionSNNPXGrazing				
FirewoodXCommFollowsRules				
ClimateChangePersonalXPayment				
REDDbenefitsPersonalXPayment				

Table 4: Marginal Willingness to Accept for REDD+ Attributes

	MWTA - Main Effects			
	(1) CLOGIT Birr/unit	(2) MMNL Fixed Price Birr/unit	(3) MMNL Normal Price Birr/unit	(4) GMNL WTP-Space Birr/unit
Community percentage	-19.1***	-20.8***	-20.8***	-20.9***
Duration	5.8**	4.9**	4.6**	5.4**
Reduction in firewood	-0.2	0.9	0.7	-0.0402
Reduction in grazing	-17.5***	-17.3***	-16.8***	-17.8***

Table 5: MWTA Estimation in WTP Space

	GMNL WTP Space
Mean Estimates	
Payment	1
ASC	44.45***
	(8.550)
Community percentage	-0.209***
	(0.0336)
Duration	0.0544**
	(0.0220)
Reduction in firewood	-0.000402
	(0.0570)
Reduction in grazing	-0.178***
	(0.0637)
Het const	-0.844***
	(0.201)
SD Estimates	
ASC	-26.69***
	(4.809)
Community percentage	0.375***
	(0.0507)
Duration	-0.134**
	(0.0576)
Reduction in firewood	0.303**
	(0.130)
Reduction in grazing	0.747***
	(0.118)
tau	0.857***
	(0.240)
Observations	9051
Log Likelihood	-2127.8
LR chi2	54.03

t statistics in parentheses $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Figure 1: Comparison of WTA estimates from Preference Space and WTP-Space

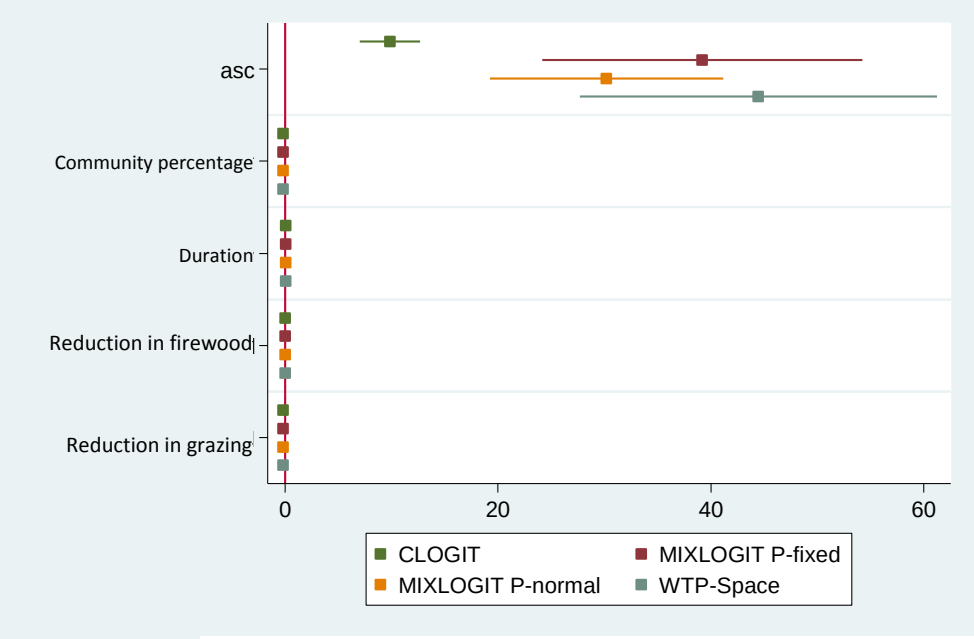


Figure 1A: Mean MWTA estimates and 95% confidence intervals for all attributes and ASC

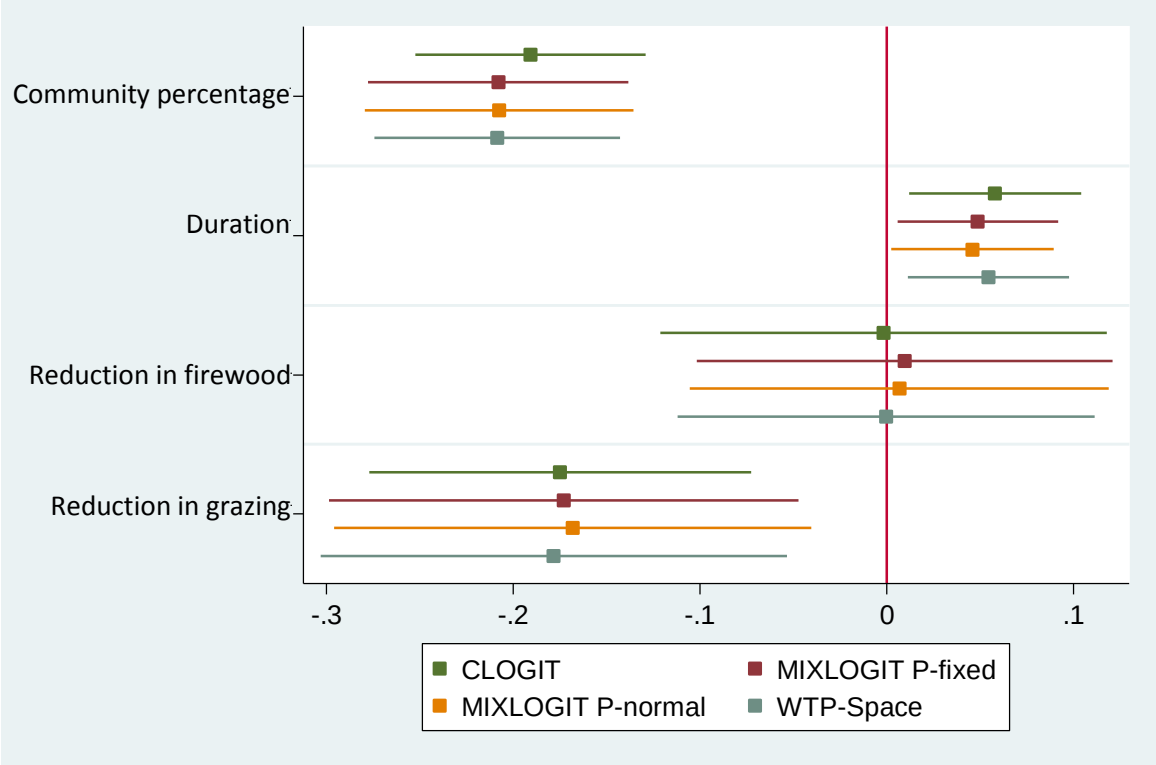
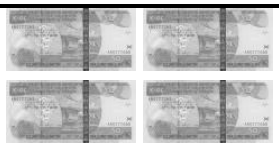
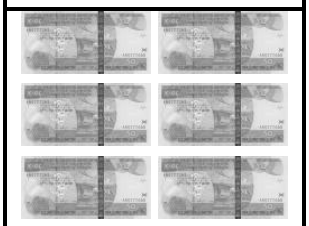
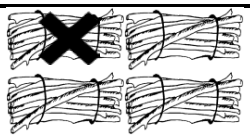
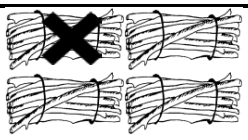
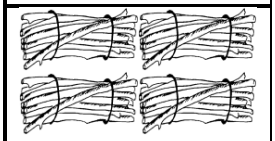
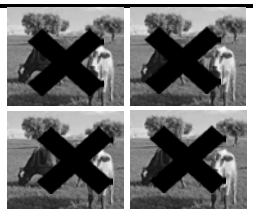
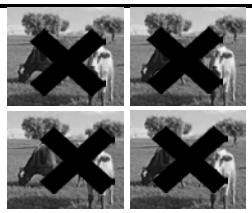
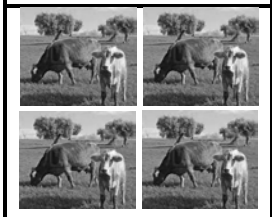


Figure 1B: Mean MWTA estimates and 95% confidence intervals for CE attributes

Appendix A: Sample REDD+ CE choice question

Choice experiment on REDD+

Ver No:_1__ QNo:_1_

Attributes	Alternative 1	Alternative 2	Status Quo
Monthly total REDD+ payment to your community (per household).	 **2000 birr**	 **3000 birr**	**0 birr** **No payment**
The portion of REDD+ payments that go to communities for community projects and /or equally divided between households in your group	 **100% to community**	 **100% to household**	**No payment**
REDD+ commitment period in years	**1-5 years**	**11-15 years**	**No commitment**
Required fuel wood reduction measured as a portion of your current use	 **25% fuel wood reduction**	 **25% fuel wood reduction**	 **No reduction**
Open grazing is prohibited	 **100% Reduction (No grazing)**	 **100% Reduction (No grazing)**	 **No grazing restrictions**
Please tick/mark (√) only one	❒	❒	❒

Appendix B Background Information for Choice Experiments Presented to Respondents and Follow-Up Questions

Introduction to Climate Change and REDD+

I would like to ask you to participate in a brief survey to understand what you like and dislike about a possible agreement between your community and international organizations. This agreement would focus on your community forest [*mention the name of the CFUG here*]. As you might know, the climate is changing. The climate of the earth on average is becoming warmer and weather patterns are changing. This climate change is caused by carbon pollution into the atmosphere from factories and vehicles mainly in the richer countries like Japan, United States of America and Europe. As a result of international agreements that were first made about 20 years ago, these rich countries and others are responsible to reduce their carbon emissions. These countries are finding it difficult to reduce their emissions and the world climate has therefore continued to change. This climate change is considered a serious problem.

To help with, or in addition to, the efforts to reduce the amount of carbon that the rich countries are emitting, an international program was created to use the abilities of forests to store carbon to help reduce climate change. As you may know, trees grow by combining sun light, water and carbon from the air. Healthy forests therefore actually remove carbon from the atmosphere, which helps the climate.

Money has been collected from richer countries for the purpose of reducing deforestation and forest degradation in low income countries like Ethiopia. Using these funds it is expected that international organizations will pay money to governments, individuals and communities like yours to reduce deforestation, improve forest quality and capture carbon. This program is called REDD+. The program is voluntary and no communities or individuals in Ethiopia will be forced to participate.

Do you have any questions about what I've just said? Do you agree to participate? *[Proceed if respondent agrees*]

Experiment Background

There has been no decision to implement REDD+ in your area and to my knowledge there is no plan to do so. It may, however, come to Ethiopia and it is therefore very important to understand what you and others in your community who use and protect forests would like to see in such agreements. That is why we want to ask you for your views. The choice of whether to participate will be made by you and your fellow forest users. Though you and your neighbors may decide to participate in REDD+, there will be no coercion.

If REDD+ were to come to Ethiopia, there will be an opportunity for Ethiopian communities to be paid money to capture carbon from the atmosphere in their forests. There would also be an

opportunity for communities to enjoy other benefits from higher quality forests, such as more animals and plants, non-timber forest products and simply the chance to help and protect the forest environment.

REDD+ agreements would be between international organizations interested in stopping climate change and the Government of Ethiopia. The Government would then make an agreement with your community, with active involvement of and some oversight by international organizations. The agreement will specify the responsibilities your community takes on, such as reductions in fuelwood collections and open grazing elimination (if appropriate). All these steps can improve forest quality and increase carbon sequestration. Progress will need to be monitored and verified every year. You may also need to make work and money contributions to your forest user group community in addition to what you are currently doing.

The agreement will also specify the payment in Birr that will be made each month and will detail how those resources can be used. For example, resources coming to the community may be used for community development projects like children's education, health and community recreation. They might also be used to fund household or individual projects administered by the community like support for income generation activities, installation of biogas digesters, purchase of tractors or use of improved seeds and fertilizers, health centers, schools, etc.

Alternatively, resources (or some part) could be divided equally among households in your group. Each household might therefore receive an equal share of the annual REDD+ payment and those funds could be used as each household prefers.

If you are part of a community forest user group (CFUG), this REDD+ agreement would be with the CFUG. If you have not established a CFUG, to participate in REDD+ and receive payments for increasing carbon in your forest you will need to establish a CFUG.

As of now, there are no specific activities related to forest management that focus on REDD+. To participate in REDD+, your CFUG would need to develop or revise its forest management plan to increase carbon sequestration. Monitoring and verification would also need to be included in such plans and as I mentioned, a formal agreement would be developed. The government, probably through the District Forestry Office, with financial resources from international organizations, would provide training and financial support to help you develop these plans. Because international organizations are providing the REDD+ funds, there will be good and open record-keeping, which will help control any potential mismanagement of community funds. The participation of such international organizations will also contribute to more equitable distributions of benefits among community members.

We emphasize that the main responsibility for organizing the CFUG and its members to meet REDD+ requirements and distribute rewards will be with you and your neighbors. If you and your community would like to participate in REDD+, any conflicts or controversies within your community that block the making and implementation of a REDD+ agreement will need to be

resolved. If you and your neighbors would like additional support, depending on the capacity, availability and goodwill in the District Forestry Office, help may be available with organizing your CFUG (if needed) or to improve its operation.

We will now ask you to make 7 choices among possible REDD+ contracts. Each choice will have three options, one of which is the current situation with no REDD+. These options are described by the following attributes:

Annual total REDD+ payment to your community. *These amounts are presented as Birr per household per month (to calculate the total payment, multiply the per household amount by the number of households in your community)*
The portion of REDD+ payments that go to communities for community projects, or equally divided between households in your group or half goes to community and half to households *The word after the word "community" is the portion going to communities and the word after the word "households" is the portion to households like yours.*
REDD+ commitment period in years
REDD+ required fuelwood reduction measured as a portion of your current use
Open grazing is prohibited (given as a percentage reduction)

Do you have any questions?

Endnotes

[1] Regional states are the main sub-federal jurisdiction in Ethiopia. Regional states covered in this paper include Amhara, Oromiya and Southern Nations Nationalities and Peoples, which include a majority of the forest biomass in the country.

[2] TLUs express standard farm animals based on their metabolic rates and weights compared with a 250 kilogram cow, which has the value of 1 TLU; households in the sample on average have the equivalent of 5 cows.

[3] The experiment design was conducted using the SAS experiment design macro (Kuhfeld 2010).

[4]D-efficiency is the most common criterion for evaluating linear designs. D-efficiency minimizes the generalized variance of the parameter estimates given by D = det [V(X,β)1/k] where V(X, β) is the variance-covariance matrix and k is the number of parameters . Huber and Zwerina (1996) identify four criteria (orthogonality, level balance, minimum overlap, and utility balance) which are required for a D-efficient experiment design.

[5]This approach is also referred to as the mixed logit, hybrid logit, random parameter logit, and random coefficient logit model.

[6] The respondents answered the following question "2.33.7. In your observation, do individuals in the community follow the rules and regulations for accessing and harvesting products from the forest or using the forest for non-consumptive purposes?
(1) Rarely or never (2) Sometimes (3) About half the time (4) Most of the time (5) Yes, almost always and the variable *CommFollowsRules* is dummy coded with 1 for choice (4) or (5) above.