HYPOTHETICAL WILLINGNESS TO PAY FOR ENERGY ALTERNATIVES IN UGANDA: MARKET INCENTIVES AND POLICY TOOLS TOWARDS ZERO DEFORESTATION AND CLIMATE CHANGE

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Abstract
At the height of climate change, the world target of zero deforestation by 2030 seems like a dream in Africa's developing nations, where over 90% of household energy needs depend on wood fuels and charcoal. This is followed by time series increasing demand for round wood. This study conducts a Willingness to Pay for Energy Alternatives (WTPEA) in Uganda, where the populations depend on wood for almost all the energy needs at the household level. This research used a questionnaire to collect and analyze data collected between 2018 and 2019. A total of 1200 responses were collected, coded, and analyzed. The average willingness to pay an amount (WTPA) was 15 USD and the median 10 USD. Most of the respondents were observed to prefer gas and electricity for household cooking. Following a logistic regression, it was found that the socioeconomic characteristic did not impact the Willingness to Pay for Energy Alternatives (WTPEA). However, sex and age were found to have a very weak impact on the WTPEA. The respondents' Willingness to Pay for Forest Conservation (WTPFC) [0.0011] and Knowledge of Forest Functions and services (KFF) [0.0001] were found to have a positive and significant impact on the WTPEA. Ceteris paribus, the Government of Uganda, ought to employ policy tools to boost energy alternatives imports and production in Uganda. This would promote and improve the conservation of virgin Tropical rain forests.

Key words : Contingent Valuation Method, forest functions and services, energy mix, electricity, Zero Deforestation

Introduction

As the world sets to achieve zero deforestation by 2030, drivers of deforestation are yet to be attended to, especially in the deforestation hotspots. Deforestation in the Tropical African region has reduced forest cover and affected the provision and protection of forest functions and services, such as ecosystems and biodiversity loss (Bamwesigye et al. 2020a, CIFOR-ICRAF 2022). Wood fuels and Roundwood production and export form one of the biggest challenges (CIFOR-ICRAF 2022, Bamwesigye et al. 2020b). Biomass is the most significant energy source for the biggest percentage of Uganda's population (Bamwesigye et al. 2020b, Bamwesigye et al. 2017). Biomass accounts for about 90% of Uganda's total primary household energy consumption, i.e., charcoal, firewood, and crop residues (ERA 2012, ERA 2020). Electricity adds about 1.4% to the nationwide energy balance, whereas oil products for thermal power plants and vehicles cover approximately 9.7% (USEA 2019). The Ugandan Government has amplified electricity generation by installing 822MW, with around 692MW accounting for 84% hydropower (ERA 2020).

Charcoal offers the cooking requirements of the town population while firewood for the rural population (Du Can et al., 2018, Bamwesigye et al., 2020b). The high demand for uneconomically wood fuels is sought to result in the misuse and exhaustion of forests (Bamwesigye et al. 2020b, Bamwesigye et al. 2019, Bamwesigye et al. 2018, Bamwesigye et al. 2017)

Even though there are numerous drivers of deforestation, woodfuel and demand play a big role given the trend. Moreover, illegal logging increases amid the forest conservation laws coupled with weak implementation authorities (EnDev 2018, Bamwesigye et al., 2020b). Charcoal production is a mainly poor method with tremendously low efficiency (Cumbers 2016). The government of Uganda's efforts to employ market incentives to boost trade and demand for clean energy alternatives is also another problem (URA 2014,UIA, 2019). Even though Uganda seems to have the best conservation and sustainable energy policies, putting some of them to work is a different issue. There seems to be a lack of coordination on the uniformity and/or conflict between departments such as the energy ministry and the Uganda revenue authority that collects taxes (URA 2014).

Therefore, government policies such as reducing taxes on renewable energies equipment and the rural electrification schemes are bound to increase electricity accessibility and other energy products, thus the demand (Deichmann et al. 2011, du Can et al. 2018, Bamwesigye et al., 2020b). Therefore such direction would lead to less demand for wood fuels hence conservation of forests.

This study aimed to investigate the energy situation in Uganda and the willingness to pay for energy alternatives to reduce deforestation. The study used a contingent valuation questionnaire to analyze charcoal use, preference for energy alternatives, and hypothetical WTPEA. Logistic and ordinary least regression were used to understand the influences on WTPEA and the willingness to pay an amount (WTPA). The contingent valuation approach results have been presented. The regression results and policy recommendations are discussed and demonstrated for policy planning and decision-making on forest conservation to boost forest functions and services.

Material and methods

The study was carried out in the capital of Uganda, Kampala Capital City, and its neighboring town of Wakiso. With the expansion of the capital city, the neighboring towns to Kampala grew very fast, and most of them are now districts of their own. Both the capital city and her neighboring towns have had an influx in population increase over the years.

The study employed face-to-face questionnaire interviews. The study was conducted between December 2018 and May 2019. A total of 1200 questionnaires were filled, checked for completeness, coded, and analyzed using statistical software.

The questions ranged from Willingness to pay for energy alternatives (WTPEA), willingness to pay for forest conservation (WTPFC), knowledge of forest functions and services (KFF), preference for energy alternatives (PEA), and the Willingness to pay an amount (WTPA).

The Contingent Valuation Method (CVM) has some drawbacks, such as bias. The study employed cheap talk to mitigate the bias associated with the method. The interview talked to the respondents before answering the questions and expounded on the importance of their responses. More so, a question on the maximum WTPEA amount.

The study conducted a logistic regression following a CVM approach to model the WTPEA regarding demographic characteristics and the KFF, WTPA, and WTPFC. Logistic regression helps to understand the influence of explanatory variables on the WTPEA. Logistic regression is the most appropriate to study the relationship between categorical predictor and binary categorical variables in a study.

The study assumed that the WTPEA is either 1or 0, thus the probability of WTPEA effort in the selected residential areas of Wakiso and Kampala. π_i = probability (WTP) =1, is related to the explanatory variable Z.

The logistic regression is presented herein (1).

$$Log\left(\frac{\pi i}{1-\pi i}\right) = C + yZ_i$$

Z is the vector of the explanatory variable that may impact the WTP, C is the intercept. y is the vector of coefficient and $\left(\frac{\pi i}{1-\pi i}\right)$ is the odd ratio for the WTP i.e., probability of willingness to pay and the probability of the unwillingness to pay. The study assumes the log of odds is a linear function of the explanatory variables, Z.

WTP Estimation using Contingent Valuation Method

Contingent Valuation Method (CVM) is the most used approach to estimate the value and or price of non-market resources and products. The study further employed an Ordinary Least Square (OLS) regression to estimate the WTPA amount and determine the factors that influence the value of the residents' WTPEA in the selected districts in Uganda (Table 1). The subsequent equation demonstrates the OLS model.

$$WTPAi = \beta 0 + \beta 1Si + \beta 2Ai + \beta 3MSi + \beta 4EAi + \beta 5Ei + \beta 6Ii + \beta 7PEAi + \beta 8KFFi + \beta 9WTPFCi + \beta 10CUi + \varepsilon i$$

Tab. 1: Description of the variables

Code	Definition of variables	Description of variables
S	Sex/gender	Male =1, and female =0
A	Age	Continuous
MS	Marital status	Married =1, and others =0
EA	Economic activity	Employed =1, and others =0
E	Education	Number of years spent in school. Continuous variable
I	Income	Continuous

PEA	Preference for energy alternatives	Gas =1, Hydroelectricity =2, Biogas =3, Others…… =4
WTPEA	Willingness to pay for energy alternatives	Yes =1, and No =0
KFF	Knowledge of Forest Functions	Very Good =1, Good =2, Neutral =3, Bad =4, Very bad =5, and Don't know =6
WTPA	Willingness to pay amount	Continuous
WTPFC	Willingness to pay for forest conservation	Yes =1, and No =0
CU	Charcoal use (wood fuel use)	Yes =1, and No =0

Results and Discussion

Data were collected from household residents using a survey face to face interviews which took place from December 2018 to May 22019. A sample of 1200 was interviewed; 772 (64%) were males while 428 (36%) were females. The majority of respondents were between the ages of 24 and 36 years, 54% (650), and 261 (22) were between 36 and 48 years. More so, 61% were employed, 54% were married, and 58% had at least 16 years of education. 67% had over 16 years of education equivalent to bachelor's education, assuming no repeated classes (Figure 1). The trend in all variables can be observed in (Figure 1).

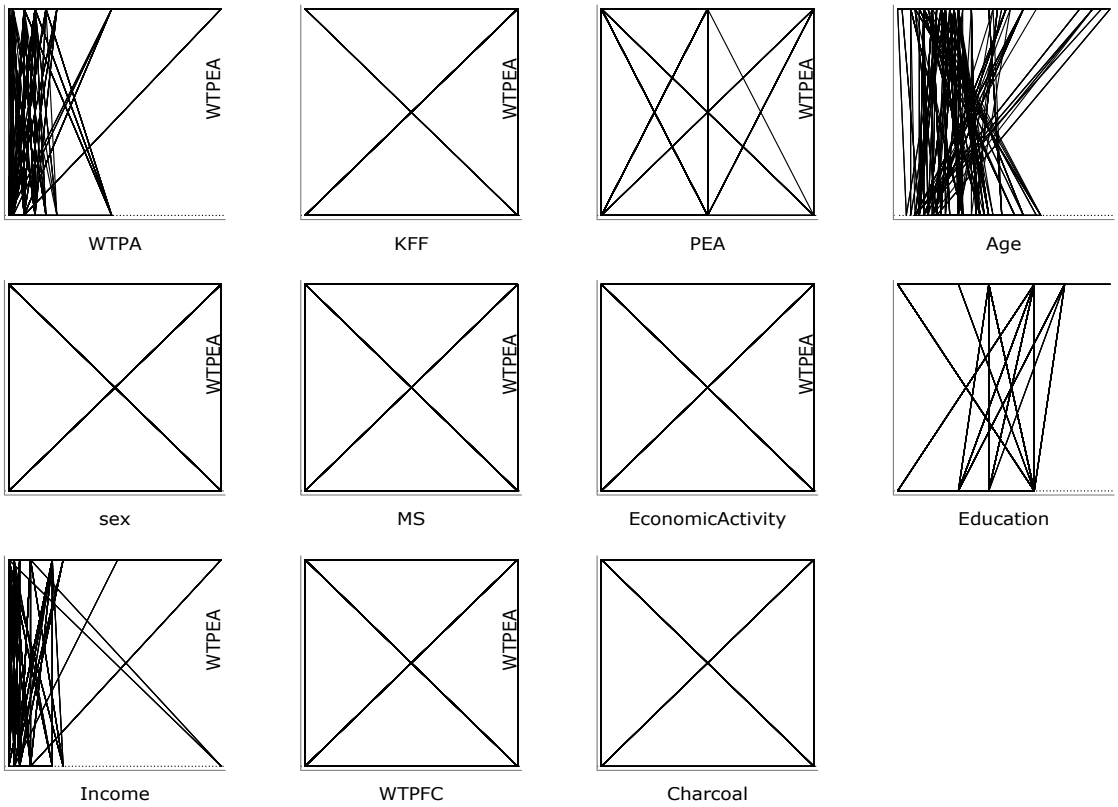

Fig. 6: Illustration of other factors against the WTPEA

Preference for energy alternatives (PEA) and willingness to pay (WTPEA)

The survey respondents' results demonstrated that 59% (702) prefer gas for their household cooking, 34% (408) preferred hydroelectricity and 8% (90) chose biogas (Figure 2). The hypothetical WTPEA results illustrated that 960 (80%) were willing to pay for the energy alternatives monthly, 236 (20%) were not willing to pay.

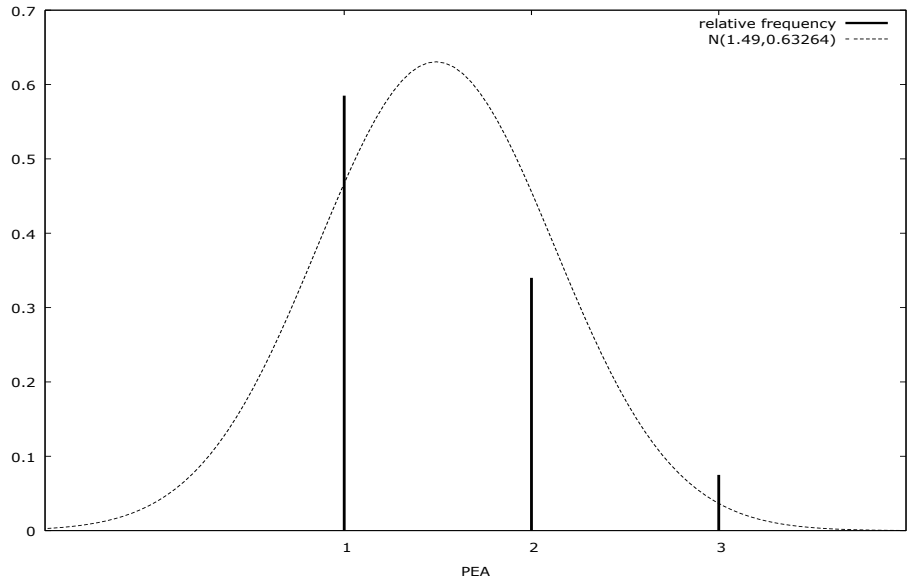

Fig. 7: Preference for energy alternatives; i is gas, 2 is electricity, and 3 is biogas

There is a potential for bias regarding WTP. The study mitigated this problem through a cheap talk where the interviewer conversed with the respondents before asking the WTP question. The talk included why using alternative energy sources is important in efforts to conserve forests and fight deforestation.

The majority of the respondents expressed their disappointment with the government in the management of forests and no effort to subsidize energy alternatives to incentivize them market forces. The majority were willing to pay and use the energy alternatives. The majority (581 or 48%) respondents were willing to pay up to 20 USD, while 26% (300) respondents and about 7% were willing to pay more than 50 USD for energy alternatives monthly. The summary statistics showed that an average of more than 80% were willing to pay the mean amount of 15 USD and the median payment 10 USD. This corresponded with an average response of more than 87% with good knowledge of forest functions and services. The average age illustrated 33 years, and the median is 31, which shows that most respondents are young. Moreover, 94 % of the respondents used charcoal/wood fuel. This justifies why most of them were willing to pay for alternative energy sources to save the forests (Figure 3).

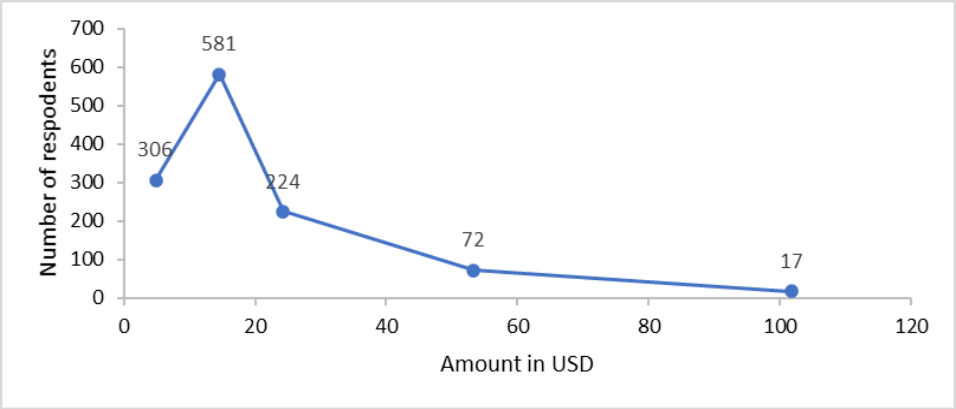

Fig. 8: Willingness to Pay Amount (WTPA)

The logit regression results showed that socioeconomic factors do not influence the hypothetical WTPEA. However, gender was found to negatively influence the willingness to pay for energy alternatives at 10% in model 1 and 2. This influence is very weak, as indicated by the result. WTPEA was observed to be significantly influenced by the knowledge of forest functions and services (KFF) [p<00.0001] and the willingness to pay for forest conservation (WTPFC) [model 1 and 3= p<0.0006, and model 2= p<0.0011] at 1%. This demonstrated very strong evidence against the null hypothesis. Preference for energy alternatives and charcoal use was found not significantly influence the WTP.

More so, the willingness to pay amount was found to have a very weak positive but significant influence on the WTPEA [model 1 and 2] (Table 2).

Tab. 2: Determinants of the hypothetical willingness to pay for energy alternatives (WTPEA)

Variables	**Model 1**		**Model 2**		**Model 3**	
	Coefficient	*p-value*	*Coefficient*	*p-value*	*Coefficient*	*p-value*
Constant	0.408645	0.5268	0.361451	0.3841	−0.01840	0.9321
WTPA	0.0138663	0.0835*	0.0143127	0.0700*	0.0119226	0.1274
KFF	1.27678	<0.0001***	1.20880	<0.0001***	1.15842	<0.0001***
PEA	0.122627	0.3139	0.125713	0.3009		
A	0.0061200	0.5159				
S	−0.278353	0.0881*	−0.270276	0.0916*	−0.232822	0.1428
MS	0.004546	0.9781				
EA	−0.157035	0.3749	−0.228006	0.1591		
E	−0.02649	0.4515				
I	5.56182e-05	0.1372	5.55152e-05	0.1093	4.89414e-05	0.1525
WTPFC	0.543033	0.0006***	0.505553	0.0011***	0.524976	0.0006***
CU	−0.431000	0.1549	−0.451874	0.1350		
***p<0.01, **p<0.05, *p<0.1						

The influencing factors of the WTPA presented very interesting results. Economic activity was found to have the highest Coefficient 4.2, followed by charcoal use with 4.0, willingness to pay for forest conservation 3.9, gender 2.3, the knowledge of forest functions and services 1.8, and willingness to pay for energy alternative 1.4. However, the knowledge of forest functions and services was not significant throughout. This indicates the strength of the impact of the factors behind the WTPA. On the other hand, other socioeconomic factors such as age, marital status, education, and incomes have weak but positive and significant influences on the WPTA. Age, economic activity, gender, incomes, WTPFC, and charcoal were found to have very significant at 1% and positive, respectively. The preference (PEA) and willingness to pay for energy alternatives were significant at 10%, respectively, and education at 5%.

Conclusion

The study conducted a hypothetical and real willingness to pay study using the CVM approach. Questionnaire survey results showed an average willingness to pay of 80% of the respondents. The average willingness to pay an amount (WTPA) was 15 USD, and the median WTPA 10 USD. Most of the respondents were observed to prefer gas and electricity for household cooking. The study recommends that ceteris paribus, the government of Uganda, and development partners consider policy tools and market incentives such as subsidies for cleaner energy production and consumption tax reliefs local producers, traders, and importers. The availability of energy alternatives and mix will guarantee energy security and food security since some poor families cook once due to energy poverty characterized by high prices for charcoal and firewood. Moreover, this will also translate into relief to the current pressure on forests to meet increasing energy demand in the country. This would promote and improve the conservation of virgin Tropical rain forests, which are at the blink of extinction given the already dare climatic conditions in the East African nation and the region (Cumbers 2016, Bamwesigye et al. 2020a).

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Souhrn
V době vrcholících klimatických změn se celosvětový cíl nulového odlesňování do roku 2030 zdá být v afrických rozvojových zemích, kde více než 90 % energetických potřeb domácností závisí na dřevěných palivech a dřevěném uhlí, jen snem. Na to navazuje časová řada zvyšující se poptávky po kulatině. Tato studie provádí průzkum ochoty platit za energetické alternativy (Willingness to Pay for Energy Alternatives, WTPEA) v Ugandě, kde je obyvatelstvo závislé na dřevě pro téměř všechny energetické potřeby v domácnosti Tento výzkum použil dotazník ke sběru a analýze dat shromážděných v letech 2018 až 2019. Celkem bylo shromážděno, kódováno a analyzováno 1 200 odpovědí. Průměrná ochota platit částku (WTPA) byla 15 USD a medián 10 USD. Bylo zjištěno, že většina respondentů preferuje pro vaření v domácnosti plyn a elektřinu. Po provedení logistické regrese bylo zjištěno, že socioekonomická charakteristika nemá vliv na ochotu platit za energetické alternativy (WTPEA). Bylo však zjištěno, že pohlaví a věk mají na WTPEA velmi slabý vliv. Bylo zjištěno, že ochota respondentů platit za ochranu lesa (WTPFC) [0,0011] a znalost funkcí a služeb lesa (KFF) [0,0001] mají pozitivní a významný vliv na WTPEA. Ceteris paribus, ugandská vláda by měla použít politické nástroje ke zvýšení dovozu a výroby alternativních zdrojů energie v Ugandě. To by podpořilo a zlepšilo ochranu panenských tropických deštných lesů.

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