Biomass energy dependency and implications for forest conservation policies in Malawi

A Research Concept Submitted to:

The STAAARS+ Fellows Program- USAID Feed the Future Innovation Lab for Food Security Policy Research, Capacity, and Influence (PRCI)

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1.0 Introduction

Forest degradation and deforestation are twin challenges affecting biodiversity conservation in developing countries, including those located in the sub-Saharan Africa region (SSA). Increasing demand for forest resources or forest dependence is one of the major drivers of forest degradation (Hosonuna et al 2012; Minde 2001; Skole 2021). There is mixed research evidence regarding the relationship between the existence of conservation regions and incidences of poverty which potentially fuels forest dependence (Wunder 2001; Verde Selva et al 2019). For many low-income countries, forests provide numerous goods and services which serve as 'intermediate' inputs into a household production processes (Bandyopadhyay et al 2011). This strand of literature indicates that forest incomes play an important role in reducing household poverty and inequality but also serve as natural insurance or safety nets during calamities (Wunder 2001; Jumbe 2011; Bandyopadhyay et al 2011; Fonta and Ayuk, 2013). On the other hand, emerging evidence suggests that poverty levels are high in the periphery of forests and biodiversity conservation zones (Verde Selva et al 2019). As a result, poverty fuels excessive and illegal resource extraction from proximate nature conservation areas (Verde Selva et al 2019; MacKenzie and Hartter 2013). Thus, there is a need to pursue off-forestry poverty-reduction interventions to simultaneously achieve livelihood improvement and sustainable nature conservation.

Biomass energy remains a very important source of cooking and heating energy in many developing countries. However, continued dependence on biomass for satisfying the growing demand for energy raises concerns about environmental degradation, biodiversity loss and energy security (Arabatzis 2012). In Africa, for example, biomass energy— particularly firewood and charcoal— is the main cooking energy source in rural and urban areas. We contend that unabated increased forest dependence could perpetuate poverty, and cause further resource degradation and ecosystem fragmentation. Arguably, biomass depletion or resource scarcity could increase the cost of energy and, consequently, push households into ultra-poverty. When fuelwood becomes scarce, households spend more time to collect these resources (ie actual resource collection time and frequency) or they collect low quality wood. Increased time allocation for fuelwood may affect other productive activities and a switch to low-quality resources may affect women and girls' welfare. For example, Nankhuni and Findeis (2004) reveal that Malawian children aged between 6 and 14 years spend 18 hours per week on domestic work, and consequently, the long hours spent in fuelwood and water collection negatively affects their school attendance. Additionally, use of low quality wood could exacerbate acute indoor pollution leading to respiratory infection (ARI) among children under five years, chronic obstructive pulmonary disease (COPD) and chronic obstructive lung disease for women. These health conditions are intensified by traditional cooking-energy technologies (Jagger et al 2017).

In this study, we explore the relationship between anti-poverty programs and forest degradation; specifically, examining whether targeted social cash transfer programs, with no direct connection to environmental goals, can incentivise forest conservation. Thus, the objective of the study is to assess whether income transfers can mitigate excessive forest-resource extraction and halt degradation in Malawi. It is hypothesized that social cash transfer improves household welfare and, in turn, reduces dependence on environmental resources. Understanding this question is vital for assessing the appropriateness of cash transfer schemes both as a poverty reduction strategy and nature conservation incentive, and thereby providing important insights into the design of future conditional social cash transfer programs. Current conditional or unconditional cash transfer schemes or social protection and crisis recovery packages do not couple nature conservation or environmental sustainability interests (Ferraro and Simorangkir, 2020). Yet, forest dependence is high among resource-poor households and incidences of illegal and unsustainable resource extraction are escalating. From a policy perspective, the findings are important in two ways. First, the findings highlight the potentiality of applying cash transfer programs as financial compensation or incentive for achieving nature conservation besides their cardinal objectives of alleviating poverty. Secondly, the income transfer as a form of conservation payment could help in the reconciliation of human-conservation conflicts by ensuring that the payment compensates local costs of conservation. This is important because regions of high biodiversity often coincide with regions of poverty and, thus, conservation can impose considerable opportunity costs among poor populations (Verde Selva et al 2019).

Malawi is an interesting case for a number of reasons. First, the country has a vibrant social cash transfer scheme (SCTS) initiated in 2006 to reduce poverty and alleviate hunger while building the human capital of resource-poor and vulnerable households (Miller et al 2011; Brugh et al 2018). This cash transfer program has shown positive impacts in terms of agricultural productivity, food and nutrition security, health, and education (increased student enrolment and reduced absenteeism) (Miller et al 2012). Secondly, the country is experiencing rapid forest degradation and deforestation. Recent estimates show that between 2000 and 2015 the country experienced substantial forest degradation and deforestation rates within the ranges of 42,961-71,878 ha yr^{-1} and 22,410-38,937 ha yr^{-1}, respectively (Skole et al 2021). The major drivers of deforestation and forest degradation include charcoal production, firewood collection for subsistence use and tobacco curing, conversion of woodlands to cropland, and seasonal fires (Minde 2001; Skole 2021). Lastly, the country's dependence on biomass energy is overwhelmingly high since over 90% of the population use biomass as their primary cooking and lighting energy source (Openshaw, 2010; Zulu 2010; Adkins et al., 2010). The country's demand for biomass energy will remain high in the foreseeable future due to low accessibility of alternative energy sources such as electricity, liquefied petroleum gas (LPG) and solar. Interestingly, even households located within the national power grid still rely on biomass energy. Furthermore, transition to clean energy sources is slow for three reasons: 1) poor households cannot afford the cost of electricity connection and consumption, especially to meet cooking needs; 2) electricity supply is generally unreliable due to frequent and lengthy power outages; and 3) energy consumers prefer some biomass energy attributes (eg thermal energy yield of charcoal or fuel-wood derived from indigenous tree-species. In Malawi, the majority of charcoal is sourced from indigenous miombo woodlands (Brachystegia spp.) which leads to considerable loss of forest cover and biodiversity. Thus, excessive extraction of forest resources threatens the sustainability and integrity of forest ecosystems that underpin the very livelihood opportunities that support poverty alleviation and food security (Zulu and Richardson 2013).

1.2 Data and variable description

The study uses nationally representative data from four waves of the Malawi Integrated Household Survey (IHS) (2010, 2013, 2016, and 2019). This dataset is quite extensive as it tackles many livelihood aspects including information(variables) which can be used to explore the links between poverty and environmental degradation as well as to establish the impact of anti-poverty programs—namely, social cash transfer scheme—on forest conservation outcomes as a side-benefit.

The dependent variable depicting forest conservation outcomes are deduced from forest dependence using at least two variables: 1) participation in forest-based enterprises ie whether an individual sells forest-based products as part of non-agriculture business; and 2) biomass-energy dependence indicating the intensity of use of charcoal and fuelwood as part of the household energy mix/portfolio. In this analysis biomass-energy dependence is expressed as expenditure share of all the value of biomass energy resources or expenses incurred in a month relative to the total household energy expenditure. Data is available on household participation in social cash transfer programs (ie beneficiary household, value of cash transfer received, number of months in a year) which will be used as covariates together with other variables such as multidimensional poverty (ie subjectively assessed wellbeing, chronic food insecurity, housing, clothes and health); distance to forest resource (travel time); vulnerability to natural/social/economic shocks; and zone (rural or urban).

1.3 Proposed empirical analysis methodology(ies)

Two analytical approaches are proposed to investigate the effect of cash transfer on forest dependence, which correlates with forest conservation outcomes. The first approach will employ fractional logit model. This modelling approach is suitable for fractions or ratio outcomes where zeros and ones are part of the pertinent data occurring through the same process as the rest of the proportions (Papke and Wooldridge, 1996; Baum, 2008; Cook *et al.*, 2008). We can characterize fractional data as bounded continuous variables which take values within a closed interval [0,1] or [0,100%]. In our study, the dependent variable is the biomass-energy dependence expressed as expenditure share of all the value of biomass energy resources or expenses incurred in a month relative to the total household energy expenditure. Fractional logit model is appropriate because it utilizes a complete set of observations by including both fractional outcomes and boundary observations (Papke and Wooldridge, 1996; Baum, 2008; Cook *et al.*, 2008). Thus, estimating a fractional logit model would yield efficient estimates rather than applying linear models or Tobit regression. Alternative application of the beta distribution such as the zero inflated beta regression (ZOIB) or its variants will be tried in case boundary observations would be in excess. The ZOIB regression is suitable if a substantial number of observations are clustered around the lower-limit (0) or upper-limit (1) of the closed interval.

The second approach will employ treatment effects methods (Abadie and Cattaneo 2018) to assess impact of cash transfer participation by comparing forest dependence outcomes between the treatment and the control groups. In particular, endogenous treatment effects model (Miranda and Rabe-Hesketh 2006; Lokshin and Sajaia 2011) would be applied because participation in a cash transfer program is potentially endogenous to the level of household vulnerability; that is, individuals who are more resource-constrained and vulnerable are also more likely to be selected as beneficiaries of the program based on the established selection criteria of social cash transfer scheme (SCTS).

1.4 Preliminary results (based on IHS 2019)

Table 1 presents descriptive statistics for the sample. On a self-assessed poverty scale of 1-6, where 1 depicts extreme poverty and 6 being very rich, 30% of the households considered themselves as very poor whereas only 1% perceived themselves as very rich. In the sample, only 9.3% reported to have received income transfer from state and non-state programs (NGO). Among those that participate in forest-based enterprises, only 9.1% had benefited from income transfers. On average, households spend MK17,084 (US$22) per month on cooking and lighting energy, where biomass energy accounts for the largest share (73%) of the total expenditure. Thus, the results show that biomass energy dependence is quite remarkable in Malawi. Twenty percent of the sample participate in forest-based businesses; this involves both rural and urban residents, however, it is evident that rural residents rely relatively more on biomass energy and forest products than do their urban counterparts.

Table 1: Descriptive statistics for the sample

Variable	Urban	Rural	All
Self-assessed poverty level	Mean	Mean	Mean
Very poor (%)	15.1	35.1	29.6
Somehow poor (%)	42.3	41.3	41.5
Poor (%)	29.1	18.8	21.7
Somehow rich (%)	10.3	3.5	5.4
Rich (%)	1.4	0.9	1.0
Very rich (%)	1.7	0.5	0.8
Distance to firewood source (walking time in hours)	0.54	0.53	0.54
Household energy consumption			
Electricity consumption cost (Malawi kwacha/month)	5,551	4,194	4570
Kerosene consumption cost (Malawi kwacha/month)		800	800
Candle consumption cost (Malawi kwacha/month)	1,630	1,116	1,520
Charcoal consumption cost (Malawi kwacha/month)	5,717	5,620	5,646
Fuelwood consumption cost (Malawi kwacha/month)	5,649	7,299	6,841
Biomass consumption cost (Malawi kwacha/month)	**11,365**	**12,918**	**12,487**
Total household energy consumption cost (Malawi kwacha/month)	**16,995**	**17,117**	**17,084**
Biomass energy dependence (%)	**0.70**	**0.74**	**0.73**
Participate (sell) forest-based products (1=Yes)	0.12	0.22	0.19
Forest-based enterprise survival period (years)	6.5	6.0	6.2
Urban resident (1=Yes)			0.3
Cash income transfer (1=Yes)	0.08	0.10	0.09
Value of income transfer (Malawi kwacha/month)	37,752	13,211	19,052
Experienced family break-up (1=Yes)	0.04	0.04	0.04
Household size	3.3	3.6	3.5

To examine the effect of cash transfer program on forest conservation outcomes we estimate fractional probit and probit regression models. Results are presented in Table 2. Preliminary evidence suggests that richer households are less likely to depend on biomass energy but also less likely to engage in forest-based businesses. Further the coefficient for cash transfer variable is negative and significant in both models suggesting that income transfers would likely reduce forest dependence, and therefore, can achieve positive conservation outcomes even without conditioning the payment on nature conservation or environmental sustainability goals.

Table 2: Results of fractional probit and probit regression model

Variable	Fractional probit regression (Biomass energy dependence)				Probit regression (Participation in forest-based enterprises)			
	Coef.	Std. Err.	z-value	P>z	Coef.	Std. Err.	z-value	P>z
Residence								
Urban (reference)	0.00				0.00			
Rural	0.17	0.01	25.03	0.00	0.29	0.02	13.38	0.00
Poverty level								
Very poor (reference)								
Somehow poor	0.03	0.01	4.84	0.00	-0.32	0.02	-15.88	0.00
Poor	0.01	0.01	0.98	0.33	-0.47	0.03	-17.20	0.00
Somehow rich	-0.11	0.01	-7.48	0.00	-0.53	0.05	-10.77	0.00
Rich	-0.19	0.03	-6.52	0.00	-0.38	0.09	-4.01	0.00
Very rich	-0.68	0.03	-20.93	0.00	-0.17	0.10	-1.69	0.09
Food-insecurity	0.08	0.01	9.72	0.00	0.19	0.03	6.85	0.00
Family breakup	-0.01	0.01	-0.83	0.41	0.01	0.04	0.30	0.76
Cash and in-kind transfer	-0.05	0.01	-4.66	0.00	-0.04	0.03	-1.37	0.17
Distance to firewood source	0.01	0.01	1.38	0.17	-0.09	0.03	-3.20	0.00
Household size	0.00	0.00	0.40	0.69	0.01	0.00	2.60	0.01
Constant	0.80	0.01	69.41	0.00	-0.96	0.04	-26.34	0.00
Log likelihood					-13585			

1.5 Proposed division of labor among team members

Dr Robertson Khataza: Resource Economist, responsible for data analysis, economic interpretation and writing (rkhataza@luanar.ac.mw; rbkhatazam@yahoo.com)

Mr Jabulani Nyengere: Forester and geographer (GIS specialist), responsible for spatial mapping, data analysis and writing (jnyengere@luanar.ac,mw; jabulaninyenegre@yahoo.com)

1.6 Proposed study timeline (November 2021-April 2023)

Activity	Period
Building research collaboration (Matching mentors and mentees)	Nov-Dec 2021
Review and revise research concept based on mentors feedback	Nov 2021-Feb 2022
Explore and isolate related ideas for another manuscript development	Nov 2021-Feb 2022
Data management	
Collating, cleaning and variable identification/construction	Feb-April 2022
Skills enhancement on data analysis (mentor-mentee interaction)	April-June 2022
Preliminary analysis (testing of empirical models)	
Generate and submit draft table of results	*April-June 2022*
Preparation of manuscript (working paper): Can income transfers reduce biomass-energy dependence and excessive forest-resource extraction: research evidence from Malawi	
Review of relevant literature (update literature)	*April-August 2022*
Revise table of results	*August 2022*
Updating the concept into manuscript (working paper)	*June-Sept 2022*
Revise manuscript (after internal peer review)	*Sept-October 2022*
Submission of manuscript for external peer review (journal)	*Sept-October 2022*
Data organisation for a second manuscript	Nov 2022-Dec 2022
Draft second manuscript	Jan-April 2023
Draft policy brief	March-April 2023
Participating in professional and policy conference	Jan 2022-April 2023

1.7 References

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CVs of each individual team member

Attachment #3

Letter of support from each team member's home policy research institution(s)

Attachment #4