Fuelwood collection: Does it matter for rural households' labourforce participation in the labour market?

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Abstract

The study explores the effect of time spent collecting fuelwood on rural labourforce participation in the labour market. We use the Uganda National Household Survey data (2019/20) and employe the instrumental variable probit model to address the potential selection bias associated with fuelwood collection and the joint decision making for fuelwood collection and labour market participation. We observe that rural labourforce participation rate in paid activities is 25.34%, and a minute increase in time spent gathering fuelwood for home use reduces the odds of rural labourforce participation in the labour market by 0.8%. However, fuelwood collection for market in Northern, Eastern and Western Uganda significantly increases the odds of labourforce participation in the labour market. In addition, household income, sickness from inhaling fumes, cooking technology and marital status significantly increases the odds of rural labourforce participation in the labour market. We recommend upscaling agro-forestry practices and improved cookstoves to facilitate rural livelihood sustenance in the short run. For the long- and medium-term employment sustainability, the government should plan for alternative income options for rural dwellers to augment their productivity and enroll them to the global sustainable supply chains.

Key words: Fuelwood collection, Participation in the labour market, Rural households, Labourforce, Time spent collecting fuel, cooking technology

1.0 Introduction

Participation in market activities is a prerequisite for sustainable household wellbeing through transformation from subsistence to monetary economy[1], [2], [3]. Nevertheless, in the developing countries, especially among the rural areas, subsistence production is predominant compared to labour market participation [1], [3], [4], [5], [6]. This is majorly attributed to the mismatch between skills and opportunities [7], [8]; discriminative recruitment practices [5], [9], [10]; and limited access to favourable labour markets [6]. In developing countries, majority labourforce is denied access to labour market due to fuelwood collection, which consumes a big proportion of their time[11], [12], [13], [14]. Moreover, the increasing scarcity of fuel wood has rendered some rural households to collecting and using dung, twigs and crop residues thus going lower to the energy ladder [15], [16], [17]. The use of dung and crop residues denies land of manure inhibiting soil fertility leading to low crop yields [18]. This further encourages subsistence production, and exacerbates disengagement in income generating activities. Per se, walking long distances in search for firewood and carrying heavy loads exposes collectors to physical health risks of snake

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bites[19], musculoskeletal discomfort (MSD) and disability[20], [21] and raping girls and women(UNHCR, 2017), which exacerbate alienation in the labour market. More still, households that cook using fuelwood contract respiratory infections from inhaling smoke. A total of 4.1 million people died globally in 2019 due to chronic respiratory diseases[23]. Moreover, the World Health Organisation report of 2021 reports household air pollution the second most health risk for women and children in sub-Saharan Africa (SSA) (WHO, 2021). Respiratory diseases reported to frequently affect traditional biomass energy dependent households include; Pneumonia, Stroke, Ischemic heart disease, Chronic Obstructive Pulmonary disease and lung cancer due to impediments in blood circulatory system, and burn risks (WHO, 2021). These health incumbrances limit households' participation in labour markets. Moreover, the healthy household members are forced to stay home to look after the sick(Ghosh & Chopra, 2019; Toff & Palmer, 2019) .

The global labourforce participation rate by the end of 2022 was estimated at 59.3% [27]. In Uganda, labourforce participation rate is estimated at 44% (UBOS, 2022). This is below the global average rate of 59.3% (ILO, 2022) and below the African average rate of 63% (ILO & ILO Regional Office for Africa., 2020). Low labour market participation in the rural communities has generated perpetual poverty further reinforcing non market participation due to low capital formation and absence of collateral to access credit [3], [28], [29]. Per se, traditional biomass dominates energy resources among the rural communities because it is either free or cheap but with costly socioeconomic outcomes on labourforce [19]. The reducing forest cover in Uganda has increased scarcity of solid biomass forcing rural dwellers to walking long distances and consuming immense time in its search [30], [31] limiting time for labour market participation. According to Uganda National Household Survey (UNHS) (2019/20), 94% of the households in Uganda rely on biomass energy for cooking where 73% depend on firewood [32]. Households that use firewood for cooking are predominantly rural dwellers amounting to 97% of the total households that use solid biomass. Firewood is majorly collected from forests, bushes and plantations and consume significant time of the collectors [33]. Therefore, time allotted to collection of fuel can limit time available for labour market participation since fuel is a basic input for food preparation[16], [34]. It's upon this background that the study seeks to examine the effect of fuelwood collection and use on rural households' labour market participation in Uganda, a study never conducted before. Specifically, the study addresses the following concerns;

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1. The contribution of time spent collecting fuel on rural households' labourforce participation in the labour market in Uganda.
2. Does time spent collecting fuelwood create regional disparities in labour market participation of the rural households in Uganda?

2.0 Literature review

2.1 Time spent collecting fuel wood, its use and rural household labourforce participation in the labour market

Literature on rural household engagement in the labour market, influenced by fuel wood use and collection has mixed findings. Murphy et al., (2018) posits that majority of the rural low-income households spend much time collecting fuelwood hence less time for market activities. This observation conforms with findings by Waswa et al., (2020) in Kenya and [34] in Malawi. Contrariwise, Islam et al., (2018a) reveals that due to scarcity of fuel wood and its high shadow price, low-income households substitute it with lower energy forms such as dung, residues and twigs which worsens their status on the energy ladder, but consume less time to collect. Therefore, they can save time for other economic activities. Moreover, businesswise, some rural households collect fuel for commercial purposes [37].

Globally, forest resources raise income for over one billion poor people, especially in the rural communities of the developing countries [38]. Charcoal burning employs many men and income raised sustains their household wellbeing. Nevertheless, majority women spend time fetching fuel wood for domestic consumption with insignificant contribution to their incomes.

In Africa, some rural households have engaged in fuel wood production for commercial purposes. They spend time collecting fuel wood or growing trees for market purposes. Toth et al., (2019) postulates that trade in fuel wood in Malawi has engaged many households in the labour market. These households engage in agroforestry either on individual woodlots, mainly for male headed households, or communal woodlots mainly for female headed households.

Relatedly, Walle & Nayak, (2020) posits that rural households spend a lot of time on agriculture followed by non-timber fuel products. Using the Income accounting model, the study submits that agriculture contributes to 50.4% of rural income followed by non-timber forest products dominated by fuelwood that contribute 23.1% of the total households' income. These findings emphasise the

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role of forest products in engaging households' labourforce into paid labour. Amare et al., (2017), confirms these findings where findings report many people in Zege Peninsular attaining livelihoods from forest resources which are sold for economic sustenance and safety needs. Also Aabeyir et al., (2016) when assessing the impact of charcoal production from collected fuel in Ghana, credits the ability of fuel wood to engage many rural dwellers in paid labour, as confirmed by Fikir et al., (2016a) in Ethiopia, Bennett & Cronkleton, (2018) in Peru, Guild & Shackleton, (2018a) in South Africa and Nabukalu & Gier, (2019) in Uganda.

Furthermore, Murphy et al., (2018a), reports that, in Western Kenya, the shadow price for fuel wood collection for households is high and significant. This makes substitutability of fuelwood collection with other energy sources difficult, and instead, households are forced to supply more labour time to fuel wood collection. Using a two stage least squares (2SLS) estimation, the study posits that, a ten percent increase in the shadow price of fuelwood collection increases labour supply to fuel wood gathering by 3.6 percent. More still, a qualitative study in Kenya by Njenga et al., (2021) asserts that income earning abilities of some households are worse hit by fuelwood collection which reduces time for engagement in formal labour markets.

In Uganda, Tugume et al., (2019) assesses the relevance of non-timber forest products (NTFP) to rural communities around Mabira forest. The study reveals that, NTFPs have a high likelihood of hauling the rural households from poverty by enhancing the livelihoods. Using key informant interviews and questionnaires, the study reveals that, NTFP contribute $ 860,471 per annum in both cash and non-cash income to rural livelihoods around Mabira forest reserve through trading forest resources. This analysis postulates the relevance of time spent gathering fuelwood by rural households. Similar observations in Uganda are reported by Muwanika et al., (2023) in Alebtong and Gumoshabe et al., (2023) in Mpanga Community Forest Reserve in Central Uganda.

Contrariwise, [52] reveals that fuel wood use and poverty in Nigeria have a bi-directional causality. Households that invest time and other resources to use fuelwood are poorer as compared to households that use electricity, mainly for cooking. This arises from too much time required to collect fuelwood which inhibit labourforce from engaging in paid work. This study confirms the findings by Tagliapietra et al., (2020), in Nigeria, who posits that accessing electricity by a household increases its labour market participation by 8.1%. Furthermore, in Mexico Stabridis & Gameren, (2018) using Mexican Life Survey reveals that fuel wood use for cooking exposes

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households to indoor air pollution which damages their health limiting engagement in paid labour. In addition, Ghosh & Chopra, (2019a) reports that, fuel wood collection reduces households' paid work time, exposes women to harassment in the forests and are physically abused by forest officials when collecting fuelwood.

Relatedly, Langnel et al., (2021) posits that environmental degradation in SSA has worse affected women economic inclusion than men. Using 2SLS analysis and a panel of 22 countries, the study posits that, emissions affect women due to their engagement in climate sensitive activities such as farming, forestry and fisheries. Therefore, depletion of natural resources for economic or home use eliminates the women's economic base from which a livelihood is attained.

Time spent gathering fuelwood and its use has further created worrying scenarios in Uganda. Egeru et al., (2014) reveals that, the estimated opportunity cost per annum of weekly unpaid labour for fuel wood collection is US $ 232 and US $ 580 for daily fuel wood collectors. This study emphasizes the income loss due to time appropriated to fuelwood collection. More still, [57] in the analysis of biomass energy use in western Uganda, positulates that fuelwood collectors are prone to health risks such as physical injuries, respiratory infections and snake bites due to fuel wood collection, which deter participation in the labour market. Similar findings in Uganda have been reported by [58], [59], [60], [61].

In conclusion, time spent on fuelwood has mixed findings. Some studies report evidence of limited labourforce participation in paid labour, while others report otherwise. This study intends to examine the extent to which time spent gathering fuelwood and use influences rural labourforce participation in the labour market in Uganda.

3.0 Methods and Materials

3.1 Data and variable definition

The study analyses secondary data (UNHS data (2019/20)) collected by the Uganda Bureau of Statistics (UBOS). It encompasses all regions in Uganda i.e. Central, Western, Eastern and Northern and disaggregated into rural and urban households. The data has a sample of 13,732 households upon which data was collected.

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Labour market participation is the criterion variable of the study. The study entails all individuals of 15 years and above excluding full time students. Independent variables include; total time spent collecting fuel wood; Gender of the household head; Household income; Household size; nature of cooking stove; distance to fuel collecting areas; Kitchen type; Marital status; and sickness related to fuelwood collection and use; and Regions. The study has captured sickness cases of cough, severe headache and lower respiratory tract infections which literature reports to be directly linked to collection and use of solid biomass.

3.2 Methods

The study employs a binary instrumental variable (IV) probit model to estimate the likelihood of labourforce from rural labourforce that gathers fuelwood to participate in the labour market. We use the IV probit model because time spent collecting fuelwood is endogenous [62], [63], [64] to rural households. Endogeneity arises from the selection bias of considering only rural households that collect fuelwood and the joint decision making by households to either engage in labour market or gather fuel or both. The existence of endogeneity biases estimates and creates inconsistent coefficients which is corrected using the instrumental variable approach [65]. The structural equation for the binary IV probit model as a function of the study covariates is estimated below:

$$Y_1^* = X_i\beta_i + \varepsilon_{i1}, \quad (1)$$

$$y_1 = 1(Y_1{}^* > 0)$$

Where the indicator function $1(\cdot)$ for labour market participation takes on the value one if the event in brackets occurs and zero otherwise. The error term (ε_{i1}) in the labour market participation equation (1) follows a standard normal cumulative distribution (ε_{i1},ρ), independent and identically distributed. Covariates in equation (1) include time spent collecting fuel which is endogenous, the households' characteristics and regional dummies. We denote the reduced equation for the endogenous variable (time spent collecting fuel wood) as Y_2^*.

$$Y_2^* = X_i\partial_i + \varepsilon_{i2} \quad (2)$$

The individual observations from the structural equation (Y_1^*) and the reduced equation (Y_2^*)are described as y_1 and y_2 respectively.

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$$y_1 = x_i\beta_i + \varphi y_2 + \varepsilon_1 \quad (3)$$

$$y_2 = x_i\partial_i + \gamma z + \varepsilon_2 \quad (4)$$

Equations 3 and 4, are defined by x vector of covariates that explain variation in y_1 (structural equation for labour market participation) and y_2 (reduced equation for time spent gathering fuel wood), while z is the vector for the instrumental variable. We use the instrument to collect the endogeneity problem. The instrument (z) must be strongly correlated to the endogenous variable (y_2), with no correlation to the error term (ε_2) which proves its relevancy in defining the endogenous variable [65] .

$$Cov(z,x) \neq 0 \quad (5)$$

$$Cov(z,u) = 0 \quad (6)$$

We further estimate the instrument validity through using the ordinary least squares to estimate the reduced equation of time spent collecting fuel wood.

After the above tests, we estimate the structural binary IV probit model (equation 1) to determine the likelihood of labourforce from a rural household to participate in the labour market.

4.0 Results and discussion of findings

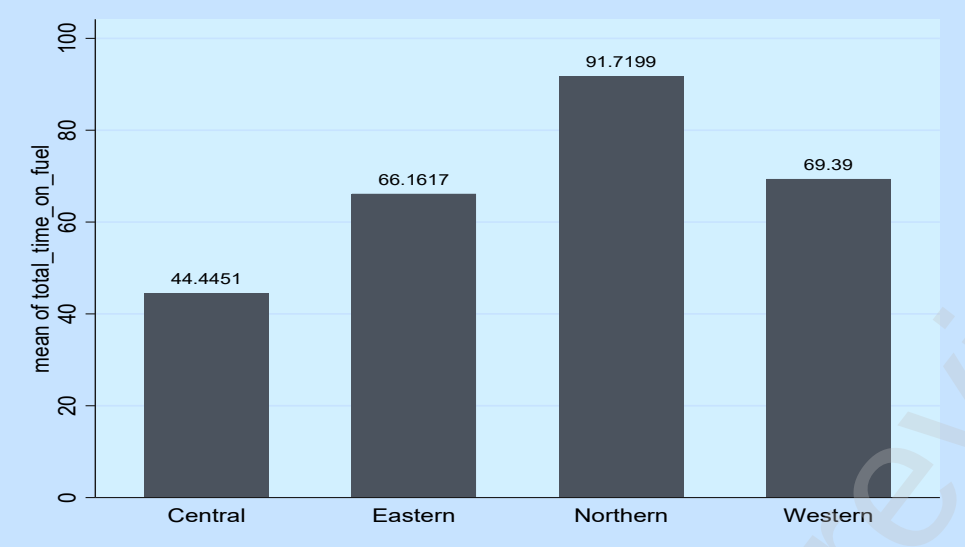
This section gives the descriptive statistics, confirmatory tests of the instrumental variable and the IV Probit estimates.

4.1 Descriptive statistics

Figure 1:Average time spent collecting fuelwood by the labourforce in rural regions of Uganda

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source: Author computation using UNHS 2019/20 data

From figure 1, labourforce from the Northern region engages most in fuelwood collection. They spend an average of 92 minutes per day, equivalent to 644 minutes (10.73 hours) weekly collecting fuel wood. The Western region rural household labourforce spend an average of 69.39 minutes every day collecting fuelwood, equivalent to 485.73 minutes (8.1 hours) weekly. The Eastern region rural household labourforce spend an average of 66.12 minutes collecting fuel every day, equivalent to 463.13 minutes (7.72 hours) weekly. The Central region rural households' labourforce spend least time on fuel wood collection equivalent to 44.5 minutes every day and 311.12 (5.12 hours) weekly). The Central region harbours the capital city hence higher access to modern energy, a factor that explains less time spent on fuel wood collection, unlike other regions.

4.1.2 Tabulated descriptive statistics for other study variables

Table 1: Descriptive statistics for the study variables

Categorical variables			
Rural Labour market participation (dependent variable)	**Frequency**	**Percent**	**Cumulative**
0 (Not Participate)	195171	74.66	71.29
1 (Participates)	66231	25.34	100
Kitchen type			
Inside, specific room	31075	9.94	9.94
Inside, no specific room	11776	3.77	13.7
Outside, built	206225	65.94	79.64

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Makeshift	21134	6.76	86.4
Open space	42542	13.6	100
Primary cooking stove			
3-Stone fire	273907	77.06	77.06
Traditional stove	41814	11.76	88.83
Improved stove	29438	8.28	97.11
Kerosene/paraffin stove	421	0.12	97.26
Sex of collectors			
1(Male)	137875	47.92	47.92
2(Female)	149853	52.08	100
Diseases related to solid biomass use			
0 (No related disease)	64753	17.45	17.45
1(related diseases)	306288	82.55	100
Sex Household head			
1 (Male)	24822	62.48	62.48
2(Female)	14909	37.52	100

Continuous variables

Variable	Observation	Mean	Std. Dev.	Min	Max
Household Income	356233	1798935	1.61E+08	0	9.25E+09
Household size	356305	5.139	2.669	1	28
Distance to fuel source	313676	1.193	0.561	1	4

From table 1, the study analyses 356,305 observations. 25.34% of the rural labourforce participate in market activities while 74.66% do not. This is below the Ugandan average of 44% labourforce participating rate (UBOS, 2022), implying that rural dwellers are worse alienated from labour market activities. Majority of the rural households cook from outside within built rooms (65.94%) while some cook from inside in specific rooms (9.94%), inside and no specific room (3.77%), make shift (6.76%) and open space (13.7%). Since majority cook from outside, the effects of inhaling biomass fumes should be more to those who prepare meals than those who do not [19]. In addition, many households use 3-stone fire to cook (77.06%), while some use traditional cook stoves (11.76%), improved cookstoves (8.26%) and kerosene cookstoves (0.12%). This implies that over 99% of the rural households rely on fuelwood and just a margin uses kerosene cookstoves. The study further reveals that more females (52.08%) collect fuel, than males (47.92%) among rural households' labourforce. Therefore, fuel wood collection is more likely to affect female labourforce participation rate. Further still, 82.55% of the sampled households had

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suffered from diseases associated with inhaling fumes (mostly cough, sickening eyes and headaches) in the past one year while 17.45% reported no related diseases. Majority of the household heads are male comprising 62.5% while female headed households are 37.5%. This is true of patrilinear communities common in Uganda. The average household size is 5 persons, while the average distance walked to collect fuel every day is 1.2 kilometres (KM).

4.2 Econometric results

4.2.1: Testing for instrument validity

We employ the OLS to test for validity of the instrument by running the reduced equation of time spent collecting fuelwood.

Table 2:OLS regression of time spent collecting fuelwood by the rural households' labourforce

Time spent collecting fuel	Coef.	St.Err.	t-value	Sig
Household size	3.59	0.094	38.33	***
Distance to collect fuel	69.54	0.553	125.71	***
Number of years of educ of the household head	-0.93	0.078	-11.96	***
Income (log)	-0.451	0.152	-2.97	***
Region: Base-Central				
Eastern	9.86	0.694	14.21	***
Northern	8.98	0.761	11.81	***
Western	19.54	0.72	27.15	***
Primary cookstove: Base-open fire				
Traditional stove	-3.61	0.812	-4.45	***
Improved stove	0.89	1.055	0.85	
Gender of household head: base Male				
Female	9.04	0.531	17.03	***
Sickness from inhaling fumes: Base-no sickness	0	.	.	
Sickness	1.75	0.602	2.91	***
Kitchen type: Base-inside, specific room	0	.	.	
Inside, no specific room	-5.81	1.333	-4.36	***
Outside, built	-9.43	0.779	-12.1	***
Makeshift	-6.35	1.133	-5.6	***
Open space	-4.43	0.968	-4.58	***
Constant	-22.41	1.35	-16.6	***
Adjusted R-squared	0.263			
F-test	1333.6	Prob> F		***

**** p<.01, ** p<.05, * p<.1; number of observations =58,599*

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Table 2 reports that keeping other factors constant, rural households' labourforce would not spend time on fuel wood collection given by the coefficient of the constant (-22.41), statistically significant at 1%. This is valid since fuel wood collection is derived from its use, and not an end in itself. The F-statistic is greater than 10 and its statistically significant at 1% which proves validity of the instrumental variable (distance). In addition, the T-statistic for distance moved to collect fuelwood is greater than 2 and statistically significant at 1% which proves that it is relevant in explaining variations in time spent collecting fuelwood.

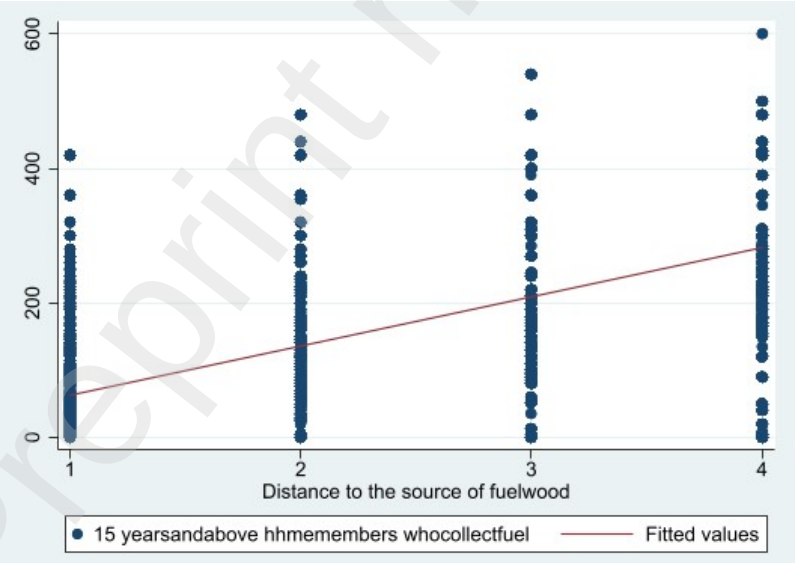
4.2.2 Testing for instrument relevance

Table 3:Pairwise correlation analysis between time spent collecting fuelwood and distance moved by the rural labourforce to collect it

Variables	Time collecting fuel	Distance to collect fuel
Time collecting fuel	1	
Distance to collect fuel	0.567	1
Sig	***	

Table 3 shows that time spent collecting fuel wood and distance moved to collect it are strongly positively correlated and significant at 1%. This proves the relevance of distance to estimating time spent collecting fuelwood by the labourforce of rural households.

Figure 2:Two-way scatter diagram for time spent collecting fuelwood and distance moved to collect it by the rural labourforce



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Figure 2 proves the strong positive correlation between time spent gathering fuel and the distance where fuel is collected.

4.2.4 IV probit model for estimating the odds of rural labourforce participation in the labour market.

Table 4: Likelihood estimates of the rural labourforce participation in the labour market

Odds ratio				Marginal effects-Delta method		
labour market participation	**Coef.**	**t-value**	**Sig**	**dy/dx**	**Z**	**P>z**
Time spent collecting fuel	-0.061	-67.35	***	-0.008	-25.02	***
Household income (log)	0.371	3.77	***	0.371	3.77	***
Household size	-0.005	-0.45		-0.005	-0.45	
Gender of the household head; Base-Male						
Female	0.02	0.63		0.02	0.63	
Region: base Central						
Eastern	-2.771	-27.18	***	-2.8	-27.2	***
Northern	-2.752	-26.87	***	-2.8	-26.9	***
Western	-3.398	-37.66	***	-3.4	-37.7	***
Region#time collecting fuel: base Central						
Eastern	0.061	61.36	***			
Northern	0.063	62.05	***			
Western	0.063	58.62	***			
Sickness- Base: no sickness related to inhaling fumes						
Sickness related to inhaling fumes	0.295	5.43	***	0.224	6.98	***
Sickness#no. of days off when a household member is sick:						
oneself not sick	-0.012	-5.08	***			
Primary cookstove- Base: 3stone fire						
Traditional stove	-0.248	-5.35	***	-0.248	-5.35	***
Improved stove	0.155	1.59		0.155	1.59	
Kitchen type- base: inside with specific room	0	.				
Inside, no specific room	0.108	1.27		0.108	1.27	
Outside, built	-0.215	-5.41	***	-0.215	-5.41	***
Makeshift	-0.074	-0.97		-0.074	-0.97	
Open space	-0.059	-1.13		-0.059	-1.13	
Marital status- Base: Married Monogamous	0	.				
Married polygamous	-0.203	-3.29	***	-0.203	-3.29	***
Divorced/ Separated	0.069	0.83		0.069	0.83	
Widow/ Widower	0.055	0.77		0.055	0.77	
Never married	0.252	4.18	***	0.252	4.18	***

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Constant	63.63	32.02	***
Number of observations	12426		
Chi-square	6037.4	Prob > chi2	***
Wald test of exogeneity (corr = 0): chi2(1) = 48.25	Prob > chi2 = 0.0000		

*** p<.01, ** p<.05, * p<.1

From table 4, the study incorporates 12,526 observations. The structural model-chi square is statistically significant at 1% implying that the covariates significantly explain variations in labour market participation. The statistic for Wald test of exogeneity is 48.25, which is greater than 10, with a chi square probability that is statistically significant at 1%. Therefore, we reject the null hypothesis of no endogeneity, which qualifies the use of the IV probit model for the study estimates. The constant coefficient is 63.63 and statistically significant at 1% implying that on average, rural households labourforce is positive towards participation in the labour market, keeping other factors constant.

Interpretation of coefficients for the study covariates

Time spent collecting fuelwood

A minute increase in fuel wood collection by the rural households' labourforce reduces the odds of rural labourforce participation by 0.8%, statistically significant at 1%. This observation is critical where fuelwood collection is meant for domestic use [18], [66], [67]. The observation also relates to findings by Bakehe, (2022); Dinkelman & Ngai, (2022b) that posit fuel wood collection as a hindrance to time available for participation in paid activities, especially for women. More still, [12], [13], [70], [71], [72] agitate that fuel wood collection and use limits schooling which hinders human capital development, thus low employability. Nonetheless, empirical findings posit that households that collect fuel for trade purposes earn a livelihood from it, and join the labour market [40], [73], [74], [75]. This study therefore observes that time spent gathering fuel wood deters rural household labourforce participation in the labour market for the collectors.

Region

Compared to the rural households' labourforce in the Central region, there is less marginal effect of participating in the labour market by the labourforce in the rest of the regions (Eastern region (2.8), Northern region (2.8) and Western region (3.4)), statistically significant at 1%. This arises from locational differences. The Central region harbours the capital city, has more economic

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activities and is more civilised compared to any other region(UBOS, 2022). Therefore, the rural households in the central region exploit these advantages to participate more in paid labour.

However, when we interact region with time spent collecting fuel, the odds of rural labourforce participation in the labour market are higher for the Northern, Western and Eastern rural households compared to the rural households in the Central region. Rural households in the Central region have less forest cover due to urbanisation [77]. Consequently, rural households from the Central region have less access to forest resources for market purposes. However, rural households in the Northern, Eastern and Western regions of the country have higher odds of labour market participation due to spending time collecting fuel wood. This is attributed to the booming trade in firewood and charcoal among these communities in the country (FAO, 2023; Haysom et al., 2021), which mainly employes the youth. Muwanika et al., (2023) posits that the shea nut tree (Vitellaria paradoxa) which is very lucrative in rural Northern Uganda is vanishing due to cutting and collecting of fuel wood for charcoal production and sale. Unfortunately, the practice is unabated in the region despite existence of a bylaw to protect the Shea nut tree because of employing majority households[50]. Similar incidences are reported in other rural regions across Africa where forest protection laws are resisted because forest resources are a means of sustenance of households' basic requirements and income[80], [81], [82], [83], [84], [85]. In addition, Brobbey et al., (2019) reports that collection of fuelwoods to produce charcoal for sale is among the dominant strategies for coping with economic shocks among the rural households in Ghana. Henceforth, it employs both the low and high-income households whenever agricultural production and agricultural sales are not economically viable. Our observation therefore corroborates with the findings by [51], [80], [81], [82], [84], [85] which reveal that fuel wood collection in rural areas of the developing countries employ many rural households and includes them in the paid labour market. Upon these observations we ascertain that collecting fuelwood by the rural labourforce in the Northern, Eastern and Western regions increases the odds of households' labourforce participation in the labour market. However, it does not favour the central region where woodlots are minimal.

Despite employing many rural households, the high rate of forest degeneration within these communities is a big threat to the environment and the livelihood of the households. This implies

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that forest degeneration unless curbed, will in future worsen the unemployment rates in the country, where no immediate livelihood sources are seemingly feasible [66], [81], [87], [88], [89].

Sickness related to inhaling biomass fuels and labour market participation in the last 30 days.

The study analysed merged data on coughs, headache and difficulty in breathing which literature relate to inhaling fuelwood fumes[19], [70], [90]. Basing on the marginal effects, we observe that when labourforce in a rural household suffers from sickness related to fuel wood collection, it is more likely to supply paid labour than when not sick. The marginal effect to sickness related to inhaling fumes is 0.224 with 1% statistical significance. This suggests that sick labourforce is 22% more likely to supply paid labour compared to one who is not sick. This finding contradicted our initial expectations, where we had anticipated that more labour time is supplied when one is healthy. However, this observation can be attributed to poverty among many rural households which forces labourforce to work when sick in order to raise money for the medical bills[68], [90].

Furthermore, when we interact sickness from inhaling fumes with the number of days when a household member is sick in the last 30 days, we observe that the odds of labourforce participation in the labour market are negative, which is statistically significant at 1%. This is attributed to the required care taking responsibilities of adults, especially women in a household[26], [91]. This observation highlights the relevance of establishing nursing homes among the rural communities to give a leeway for labourforce participation in the labour market.

Primary cookstove

Compared to a rural household that cooks with 3-stonefire, labourforce in a household that uses traditional cookstoves is less likely to participate in the labour market. This is given by the marginal effect of -0.248 which is statistically significant at 1%. This arises due to heavy fuelwood requirement for traditional cookstoves which translate into a lot of time to collect fuel, which limits time for paid labour. On the other hand, 3-stone fire can use dung, twigs and crop residues for cooking which are usually nearby and require less time for collection. Similar observations are reported by Egeru, (2014), Jagger & Kittner, (2017) and Waswa et al., (2020)who agitate that the heavy fuel wood requirements constrain households by moving long distances for fuel wood search hence pay less attention to other economic activities. Furthermore, we observe that relative to a

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household that use 3-stone fire, households that use improved cookstoves are more likely to participate in the labour market, albeit, statistically insignificant. The statistical insignificance may be due to very few observations, because majority rural households rely on three-stone fire and traditional cookstoves [83], [92], [93], [94]. Nonetheless, improved cookstoves are energy efficient and use less feedstock compared to other cookstoves that rely on solid biomass [19], [95], [96] . Correspondingly, less time is required for fuelwood collection thus sparing time for market activities. Moreover, improved cookstoves are embraced by relatively high-income households with high value for paid labour supply(Das et al., 2019; Katutsi et al., 2020; Katutsi et al., 2023; Liu et al., 2020).

Kitchen type

Relative to a rural household that has a fixed kitchen inside the house, labourforce from a household that has a built kitchen outside the house is less likely to participate in the labour market given by 0.215 marginal effect, which is statistically significant at 1%. This arises from poor cooking technologies, usually, employed by rural households that cook from outside. Poor technologies consume a lot of fuelwoods which take a lot of time to collect, require long distance movements and emit fumes which lead to ill health and drudgery which deter participation in the labour market [100], [101], [102], [103]. In addition, households that have no permanent kitchens and those that cook from open space are less likely to participate in the labour market compared to the households with fixed kitchens in a house, but, statistically insignificant. Households that use temporary shelter for cooking are mostly the poor and subsistence who are alienated from the labour market[19].

Household Income

We observe that household income has a positive relationship with participation in the labour market by the rural households. A percentage increase in household income increases the likelihood of rural labourforce participation in the labour market by 37% given by the marginal effects, and statistically significant at 1%. This is attributed to uptake of modern energy as a household's income increases, hence limiting time spent collecting fuel, hence engagement in paid labour. This agrees with findings from Burke & Dundas, (2015a) which assert that increase in households' income encourages adoption of modern energy resources. Furthermore, Islam et al., (2018b) conforms that low-income levels are a strong determinant of solid biomass use among

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rural households. However, households that obtain a livelihood from sale of forest resources, such as fuelwood and charcoal get economically stable with more access to fuelwood. This is further proved by Jagger et al., (2018) who propounds that poor households in Rwenzori Mountain National Park are financially upscaled due to access to the forest non timber resources.

Household Size

The study observes that labourforce in a big household has negative odds of participation in the labour market. We observe from the marginal effects that a one person increase in the household is associated with reduced labour market participation of 0.5%. However, this is statistically insignificant. Nevertheless, this highlights the high domestic energy demands of big rural households which requires much time collecting fuelwood and jeorpadises participation in paid activities[68], [107].

Gender of the household head

Relative to the male headed household, labourforce in a female headed household is more likely to join the labour market by 2%, but statistically insignificant. Female household heads are associated with low incomes which forces their members to join the labour market to supplement the meagre income of the household head[108], [109]. The statistical insignificance may be attributed to very few female-headed households in the rural communities of Uganda due to cultural intolerance[110].

Marital status

Relative to labourforce from a married monogamous rural household, labourforce from a polygamous married household is 20% less likely to participate in the labour market, as explained by the marginal effect, and statistically significant at 1%. Polygamous households are characterised by conflicts among family members which collapse family businesses and cripple education attainment, which hamper labour market participation. [111] reports that majority polygamous family businesses cease to exist after the death of the family head due to rivalries among siblings, which creates poverty and unemployment within a household. In addition, most polygamous households encourage traditional cultural norms, where women and girl children are excluded from development practices and considered as household care takers, hence exclusion from the labour market[112], [113]. All these observations conquer with the study findings where

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polygamous household members are less likely to participate in the labour market. Contrary to our findings, [114] asserts that polygamy enhances labour market participation where women train their co-wives and daughters entrepreneur skills through family apprenticeships in the Adja community of Benin. More to that, compared to a married monogamous rural household member, a non-married household member is more likely to participate in the labour market, estimated at 25% marginal effects and significant at 1%. This is arising from absence of both unpaid care work at home and marital responsibilities, which consume time and discourage labour market participation[25], [26], [91], [112], [115]. The study finds related observation for widows and divorced individuals. A widow/ widower and a divorced/separated person from a rural household has more odds of participating in the labour market compared to a married monogamous person from a rural household. However, this is statistically insignificant in the study.

5.0 Conclusion and recommendations

The study explores the effect of time spent gathering fuelwood by rural households' labourforce on participation in the labour market. We employed the IV probit model for determination of study estimates. We controlled for household income, household size, gender of the household head and marital status which we assumed have an effect on labour market participation and could influence the findings. We observe that rural household labourforce that spends time gathering fuelwood for domestic purposes has less odds of participation in the labour market, while gathering fuelwood for sale includes many labourforce into the labour market in the Northern, Eastern and Western regions of the country. We further observe that households' income, sickness related to woodfuel collection, cooking technology and marital status have a significant effect on rural household labourforce participation in the labour market. However, household size, gender of the household head and the kitchen type used by the households have insignificant effects on rural household labourforce participation in the labour market.

We observe that many rural households spend time gathering fuelwood and is a considerable source of livelihood. However, caution has to be taken over environmental degradation which comes along through intensive deforestation which affects the ecosystem and influences climate change. Thus, in the short run, we recommend upscaling agro-forestry practices and farm tree planting for sustainable wood production to facilitate livelihood sustenance among the rural communities. In addition, the government and non-government organisations should campaign for

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uptake of improved cookstoves among the rural communities to minimise health defects that arise from inhaling biomass fumes which affect labour market participation of the rural labourforce. However, in the medium and long term, the government should plan for alternative income options for rural dwellers to enhance their productivity and enroll them to the global sustainable supply chains.

Data reference

The used secondary data (Uganda National Household Survey data, 2019/20) collected by Uganda Bureau of statistics accessed at https://www.ubos.org/explore-statistics/23/

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