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RESEARCH PAPER

Market Participation of the Local People in Non-timber Forest Products (NTFPs) in Omo Forest Reserve, Nigeria

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Abstract Marketing systems for non-timber forest products (NTFPs) have evolved over centuries and are culturally rooted in the traditional practices of local people. Relative to timber marketing, marketing of NTFPs has received little attention. This study assessed the NTFPs market participation behavior of people living in Omo Forest Reserve, Ogun State, Nigeria. Primary data were collected from 192 respondents using a multistage sampling procedure and were analyzed using descriptive statistics and a Heckman model. The decision to participate in NTFPs marketing increases with being a female, larger households, greater number of males and females aged 15–64, higher dependency ratios, and being married. Conversely, it decreases with older collectors, higher educational attainment, engagement in farming activities, higher non-farm income, higher per capita land size and farther market distance. Level of market participation was found to be positively and significantly influenced by being married, income from NTFPs, membership of forest users' association and forest conservation. It is negatively and significantly influenced by being a male, age, household size, education level, livelihood diversification, non-farm income, transportation cost, per capita land size and average market distance.

Keywords Marketable surplus · Decision to participate · Level of market participation · Heckman model · Socio-economic characteristics

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Introduction

Forests are valued for the many products and benefits they provide. These include timber, food, fodder, fuel and medicine which generate substantial economic value to local people from harvesting, processing and trade in these items (Onuche 2011; Tewari 2012). Millions of households in developing countries, including Nigeria, depend on forest products other than timber, which have always constituted a large part of the local economy (Terry et al. 2004; Ahenkan and Boon 2011). Households extract and produce a variety of NTFPs from forests either for consumption or income generation and the sustained extraction and processing of these products by local people provide an alternative to deforestation whereby attention is shifted from timber (Arabomen and Ajewole 2012) to non-timber.

Extraction of NTFPs is a safety net for many poor people, providing a cheap alternative for food, medicines and building materials in times of economic hardship (Arnold 2002; Wiersum and Shackleton 2003). Marketing of NTFPs is being promoted as a potential solution to the current high rates of poverty in the rural areas of many developing countries (Angelsen et al. 2014; Ahenkan and Boon 2008). The relative scarcity of most NTFPs, which is attributable to deforestation (Nwoboshi 1986), has increased the prices the NTFPs and make them highly profitable. However, the indigenous people cannot sustainably add value to NTFPs because value-addition involves large capital investment. Although traditional markets for many NTFPs have been lost to competing synthetic materials, new markets are emerging in urban areas, especially with the growing interest in natural products (Aiyeloja and Ajewole 2006).

Marketing of NTFPs suggests marketing in all its possible variations since NTFPs comprise a variety of products that satisfy the needs and wants of all kinds of end-users. Some NTFPs are purchased by final consumers without any processing (e.g., kolanuts, mushrooms, chewstick, bamboo and sand), some are processed lightly for consumers (smoking of animals) while others are sold to customers who use them as raw materials in making either more refined products (e.g., conversion of essential oils to fragrances) or consumer products. Marketing of NTFPs is also a traditional source of household income and sustenance for local people and contributes significantly to their food security, income generation and livelihoods (Marshall et al. 2005; FAO 2006). Market participation is an important channel through which the global economy impacts these rural areas and can have a true impact on household welfare (Oduro and Osei-Akoto 2007). It is both a cause and a consequence of economic development because markets offer households the opportunity to specialize according to their comparative advantages and thereby enjoy welfare gains from trade (Boughton et al. 2007).

A review of market participation reveal that participation of households is influenced by age, marital status, household size, source of labour, farming experience, farm size, proximity to forests, proximity to markets, participation in forest conservation activities and whether the household uses the extracted forest products as a source of income (Mutie et al. 2006; Omiti et al. 2009; Asfaw et al. 2010; Gani and Adeoti 2011; Egbetokun and Omonona 2012; Zamasiya et al. 2014).

Ehui et al. (2003) also note that physical capital (ownership of different species of livestock and landholdings) and financial capital (crop and non-farm income) are factors influencing market participation and sales.

Relative to forest management for the production of timber, NTFPs and environmental services have received only scant attention by forest economists until recently (FAO 2011). There is a dearth of studies on market participation for NTFPs in Nigeria. Therefore, understanding the significance of market participation of the local people in NTFPs markets is important for any development policy to respond to the needs of people living in and near forests (Rajib 2009). Policies regarding the marketing of NTFPs will have impacts on marketing systems by affecting the quantity and quality of the products in developing countries. The objective of this study was to identify the correlates of market participation and level of market participation by rural households in Omo Forest Reserve, Ogun State. This study has implications for socio-economic policy change and sustainable management of forests in Ogun State—and potentially other developing countries. Half of the world's primary forests are located in the tropics (FAO 2016). Asia and Oceanic had the highest contribution ($67,408) to global income from NTFPs followed by Europe ($8026) and Africa ($5299) respectively in 2011(FAO 2014).

Materials and methods

The study was carried out in Omo Forest Reserve (OFR) in Ogun State, Nigeria, which has the largest area demarcated for protection (1300 km^2) and the largest forest area (381 km^2) still remaining natural in the State (Ogunsesan et al. 2011). The park is located in southwest Nigeria (6°90′N, 4°20′E) in Ijebu East and North Local Government Areas of the State. OFR is one of the few remaining large blocks of high forest in Nigeria and it is of great conservation value with 200 species of trees, 125 species of birds and many mammal species including forest elephants, chimpanzees and white-throated guenon monkeys, all of which are considered threatened. The reserve's vegetation is characterized by a mixed moist semi-evergreen rainforest. Collection and marketing of NTFPs for sale is a major occupation of households living in and around the reserve. The reserve is also a center for research and educational activities including the 460 ha Strict Nature Reserve (SNR), a part of the Man and Biosphere Project (MAB).

The study relied on primary data collected from face to face interviews using pre-tested, semi-structured questionnaires. For the purpose of equal representation, four villages were randomly selected from each of the four administrative areas (J1, J3, J4 and J6) with 200 respondents randomly sampled proportionate to the population sizes of the villages. One hundred and ninety-two respondents gave consistent responses and were included in the analyses. The survey included questions about household socioeconomic characteristics, livelihood activities, income from different sources and market participation in eleven types of NTFPs—arborea leaves, sponge, chewstick, kolanut, giant rat, grasscutter, snail, teak leaves, bamboo, antelope and sand—which are the most commonly extracted and traded NTFPs in the area. A major challenge to the data collection was the valuation of the NTFPs collected as the respondents depended on memory recall. Values were cross-checked with current, local market prices.

For the determination of the level of NTFPs market participation, a market participation index was calculated based on the quantities collected, harvested and sold by the respondents:

$$\text{Market participation index} = \frac{\text{Quantity sold}}{\text{Quantity collected or harvested}} \quad (1)$$

Heckman Model

The two-step econometric procedure used in the study was proposed by Heckman (1979). First, the factors that influence the decision to sell NTFPs were estimated. Second, the level of market participation (sales function) were identified, using results from the first stage. The decision to participate in the market (the selection equation) is specified in Eq. (2), where the selection variable Z^* (probably based on marginal profitability of participating) was not observed but rather a sign of whether they participated or not.

$$Z_i^* = \gamma_i w_i + U_i, \quad (2)$$

where γ_i is a vector of coefficients, w_i is a vector of factors influencing the decision to participate in the market, $U_i \sim N(0, 1)$ and $Z_i = 1$ if $Z_i^* > 0$; $Z_i = 0$ if $Z_i^* \leq 0$.

Equation (2) was estimated by the maximum likelihood method as a probit model from the entire sample of market participants and non-participants. The sample selection bias—what Heckman (1979) refered to as the inverse mill's ratio (λ), was computed from the parameter estimates of the selection equation for each observation in the selected sample (Greene 2003), and is represented by:

$$\lambda_i = \frac{\phi(\gamma_i w_i)}{\Phi(\gamma_i w_i)} \quad (3)$$

where ϕ and Φ are the density and distribution functions respectively. The level of sales, γ_i, specified in Eq. (4), was observed only if $\gamma_i w_i + U_i > 0$, and was estimated by ordinary least squares, where the vector of inverse mill's ratios was included as an additional regressor in the sales function regarding level of participation in order to correct for potential selection bias. This ratio is a summarized measure that reflects all the properties that cannot be measured.

$$\gamma_i = \beta_i X_i + \theta\lambda_i + \varepsilon_i \quad (4)$$

where $\varepsilon_i \sim N(0, \sigma)$.

The error terms of the market participation and the sales equation were correlated, as the Heckman procedure assumes that the decisions pertaining to market participation and the amount of sales were interdependent. The correlation coefficient for the error terms u_i and ε_i was represented by ρ, where u_i and ε_i were bivariate and assumed to be normally distributed (Greene 2003).

$$\mathrm{Corr}(u_i, \varepsilon_i) = \rho \tag{5}$$

If the inverse mill's ratio is significant, it suggests the presence of sample selection bias. Its inclusion as an explanatory variable in the second stage of the Heckman procedure corrected for the sample selection bias. Note that w_i and X_i were vectors of factors affecting participation and share of sales, respectively, and w was a subset of X_i (Holloway et al. 2000; Lapar et al. 2003). For the decision to participate model, the dependent variable was dichotomous assuming value 1 if the household sold some NTFPs and 0 if it did not. The OLS regression model estimated the level of market participation of a household (defined as the ratio of quantity of NTFPs sold by households to the quantity collected/harvested). The explanatory variables used were from published literature including gender, age, age squared, household size, number of adult male household members (aged 15–64), number of female household members (aged 15–64), education level, dependency ratio, marital status, livelihood diversification index, non-farm income, per capita land size and average market distance. The definitions of the variables and their a priori expectations were presented in supplemental materials.

To test for sample selection bias, we examined the relationship between the residuals for the decision to participate and level of participation equations. If the residuals in the decision model were correlated with the residuals in the level of participation equation, we would have biased estimates without correction (Fig. 1).

Results and Discussion

The Market Participation Index (MPI) shows that snails are the most traded NTFPs followed by bamboo and kolanut while sand, antelopes and giant rats have the lowest indices NTFPs (MPIs < 10 percent). Notably, none of the NTFPs attained an MPI of 50 percent suggesting that the households do not have adequate marketable surplus of NTFPs and as such a higher percentage of these NTFPs are consumed by the gatherers and their households.

Factors Influencing Households' Decision to Participate NTFPs Marketing

The Wald test of independence rejects the null hypothesis of no correlation ($\rho = 0$) between the two error terms (i.e., decision to participate and level of participation equations) at the one percent level of significance for all of the equations. The negative sign of rho (σ) for arborea leaves, chewstick, kolanut, giant rat, grasscutter, snail and teak leaves shows that the unobservable factors that reduce the probability of participation in NTFPs markets increase the level of participation and vice versa. The positive sign of σ in bamboo, antelope, sand mining and sponge shows that the unobservable factors that are absorbed in these equations will generally affect the probability of participation and the level of participation in the same direction (Table 1).

The sigma is significantly different from zero, implying that the model is fit and that all the explanatory variables included in the Heckman model jointly explain the

Table 1 Market participation index of the respondents

Type of NTFPs	MPI (%)	Standard deviation
Snail	45.8	44.6
Sponge	18.8	39.1
Chewing stick	20.8	40.7
Kolanut	30.2	0.6
Sand	2.6	16.0
Grasscutter	22.4	41.2
Antelope	3.7	18.8
Giant rat	9.38	29.22
Teak leaves	16.15	36.89
Arborea leaves	22.92	42.14
Bamboo	33.33	47.26

level of household market participation in the selected NTFPs. The inverse mills ratio (λ) is significant for bamboo, antelope, giant rat, grasscutter, snail and sponge and sand suggesting the presence of sample selection bias, which the second stage of the Heckman model aims to correct. On the other hand, the coefficient on lambda (λ) for arborea leaves, chewstick, kolanut and teak leaves are not significantly different from zero, implying the absence of selection bias for these NTFPs.

Gender has a negative influence on the probability of market participation for all flora NTFPs except of bamboo (Table 2). Females are more likely to sell flora

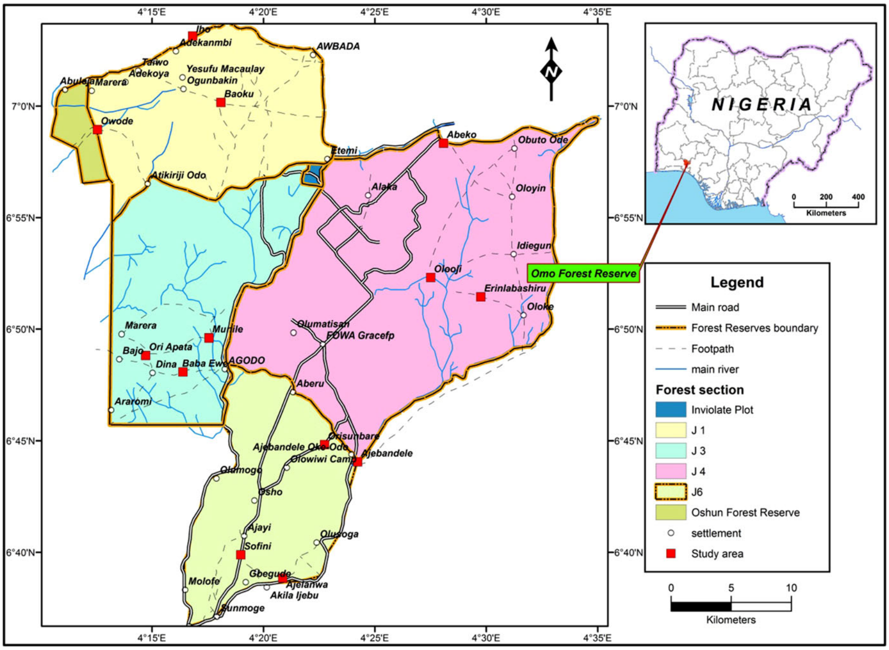

Fig. 1 Map of Nigeria showing the study area

Table 2 Factors influencing the decision to participate in flora NTFPs market

Variables	Arborea leaves	Bamboo	Chewstick	Sponge	Kolanut	Teak leaves
Gender	−1.2132*** (0.3293)	0.6898*** (0.2352)	−0.4397* (0.2592)	−0.5297* (0.2905)	−1.2511*** (0.2954)	−1.1827*** (0.4336)
Age	−0.1044 (0.1209)	0.2894** (0.1290)	−0.1952* (0.1184)	−0.0565 (0.1255)	0.2935** (0.1425)	−0.2901** (0.1316)
Age-squared	0.0008 (0.0013)	−0.0032** (0.0014)	0.0023* (0.0012)	0.0006 (0.0013)	0.1516 (0.1684)	0.0027* (0.0014)
Household size	0.1611** (0.0790)	−0.0151 (0.0731)	−0.0090 (0.0730)	0.0129 (0.0718)	−0.1169 (0.0718)	0.0119 (0.0771)
No of males aged 15-64	−0.4011** (0.1909)	0.1587 (0.1694)	−0.0264 (0.1599)	−0.0986 (0.1759)	0.1588 (0.1224)	−0.0190 (0.1988)
No of females aged 15-64	0.2384* (0.1389)	0.1075 (0.1282)	−0.0997 (0.1255)	−0.0025 (0.1293)	0.0031** (0.0014)	0.0745 (0.1359)
Education	0.0200 (0.0313)	0.0263 (0.0300)	0.0335 (0.0320)	−0.0261 (0.0308)	−0.0332 (0.0286)	−0.0589* (0.0344)
Dependency ratio	−0.0224 (0.1621)	0.0968 (0.1574)	0.3335** (0.1689)	−0.0233 (0.1671)	−0.0983 (0.1652)	0.1413 (0.1867)
Marital status	1.1365 (0.9199)	0.7684 (0.9135)	0.4898 (0.8012)	−0.3515 (0.8034)	5.2028 (3.3478)	0.4147 (0.9724)
Livelihood diversification index	0.4725 (0.3924)	0.0660 (0.3794)	−0.9838** (0.3917)	−0.0989 (0.3796)	−1.2228*** (0.4576)	0.9546* (0.5043)
Non-farm income	−0.0395*** (0.0150)	0.0224** (0.0090)	−0.0038*** (0.0013)	−0.0370** (0.0166)	−0.0015 (0.0011)	−0.0307 * (0.0182)
Per capita land size	−0.0145 (0.0614)	0.1188** (0.0517)	0.0835 (0.0551)	−0.0825 (0.0640)	0.1866*** (0.0628)	−0.0047 (0.0722)
Average market distance	0.0136 (0.0125)	−0.0220* (0.0114)	0.0064 (0.0123)	−0.0164 (0.0133)	0.0125 (0.0120)	−0.0063 (0.0143)
Constant	0.9348 (2.4123)	−7.6842*** (2.6678)	1.9114 (2.3491)	2.0030 (2.4775)	−12.8423** (5.9634)	5.7946 ** (2.6008)

Figures in parentheses are standard errors. *, ** and *** refer to statistical significance at 10, 5 and 1 %

NTFPs, except bamboo, while being a male collector enhances the decision to sell bamboo, sand and fauna NTFPs, except snail (Table 3). This result corroborates the findings of Mulenga et al. (2012) and Fonta et al. (2009), that gender influences the probability of market participation relative to the type the NTFPs.

The age of the NTFPs collectors is positively correlated with the probability of market participation for bamboo ($p < 0.05$) and kolanut ($p < 0.05$) but negatively correlated with chewstick ($p < 0.10$) and teak leaves ($p < 0.10$). Thus, older collectors of NTFPs tend to have more experience and greater contacts allowing for trade opportunities for bamboo and kolanut while younger collectors are more likely to participate in the marketing of chewstick and teak leaves.

The relationship between participation and age is parabolic indicating that as the collectors advance in age, they produce less and their participation in the market reduces (Goetz 1992). Age-squared has a positive influence on the decision to participate in marketing of chewstick and teak leaves but negative for the decision to market bamboo. This suggests that in the life cycle hypothesis, bamboo cutters in their youthful years are favourably disposed to marketing of bamboo, but will not likely participate in it as they advance in age. However, the older people are more likely to participate in the marketing of NTFPs that are not associated with laborious and rigorous activities, such as chewstick and teak leaves.

Household size has a positive relationship with the probability to participate in the marketing of arborea leaves ($p < 0.05$), antelope ($p < 0.05$) and snail gatherers ($p < 0.10$). This reveals that locals with larger household sizes are more likely to sell their collected NTFPs in order to meet the basic needs of their families. In addition, larger households have more labour to utilise for extraction activities. The positive relationship between number of adult female (15–64 years old) members of the household and the decision to participate in the marketing of arborea leaves and kolanut suggests that having more adult female members in a household increases the probability of market participation of extractors of these NTFPs while those with more adult males are not likely to participate in the marketing of arborea leaves. This reveals that marketing of arborea leaves and kolanut are dominantly female activities. Furthermore, dependency ratio and marital status of the household head are positively related to the decision to market chewsticks and antelope, suggesting that married respondents with many dependants enhance marketing of these NTFPs. This indicates that participation in marketing of NTFPs may be seen as a safety net, especially for larger rural households (Mulenga et al. 2012).

Per capita land-holding has a strong inverse relationship with the decision to market bamboos, kolanut, antelope, snails and sand. Increasing household land holdings has the potential to reduce household dependence on the extraction of NTFPs for income, and this, in turn, may help control extraction of NTFPs and improve resource sustainability. Education is a form of human capital which expands the possibilities for labour and employment, opens up alternative employment opportunities and diverts people from subsistence agriculture and extraction of NTFPs (Fonta et al. 2009). Therefore, increased access to formal education for the people living in the forest may reduce their likelihood to market antelope, giant rat, grasscutter and teak leaves.

Table 3 Factors influencing the decision to participate in fauna and non-biological NTFPs marketing

Variables	Antelope	Giant rat	Grasscutter	Snail	Sand
Gender	0.5977* (0.3125)	1.1478*** (0.4076)	2.9968*** (0.5727)	−1.1800*** (0.2485)	0.5441* (0.3249)
Age	−0.0405 (0.3067)	0.0615 (0.1899)	0.1905 (0.1953)	0.0308 (0.1386)	−0.1804 (0.2347)
Age-Squared	0.0001 (0.0033)	−0.0534 (0.1896)	−0.0019 (0.0020)	−0.0012 (0.0015)	0.0020 (0.0026)
Household size	0.5304** (0.2537)	0.1300 (0.1265)	0.0725 (0.1264)	0.1148* (0.0606)	0.3561 (0.2506)
Number of males aged 15–64	0.5292*** (0.2007)	−0.3133 (0.2675)	0.1689 (0.2428)	0.1193 (0.1786)	0.2662 (0.3114)
Number of females aged 15–64	−0.3376 (0.7324)	−0.4328** (0.1942)	−0.1443 (0.2128)	0.3089** (0.1269)	−0.6806** (0.2914)
Education level of the household head	−0.1077** (0.0530)	−0.1039** (0.0522)	−0.1626*** (0.0622)	0.0063 (0.0292)	0.1079** (0.0465)
Dependency ratio	0.5633* (0.3421)	0.4227 (0.3071)	−0.3189 (0.2729)	−0.0699 (0.1707)	−0.0470 (0.2773)
Marital status	0.9040* (0.5049)	4.8622* (2.7824)	5.1076 (4.6890)	0.4598 (0.8013)	−0.3577 (1.0105)
Livelihood diversification index	−1.3914* (0.8195)	−1.1215** (0.5197)	−0.8543 (0.7034)	−0.1638 (0.3701)	−0.1369 (0.5746)
Non-farm income	0.0132 (0.0281)	0.0220 (0.0135)	0.0381*** (0.0146)	−0.1710* (0.0980)	0.0029 (0.0127)
Per capita land size	−1.1296** (0.5562)	0.0438 (0.0727)	0.0134 (0.0204)	−0.1076* (0.0554)	0.5587** (0.2301)
Average market distance	−0.0364** (0.0184)	−0.0021 (0.0177)	−0.3746*** (0.0949)	−0.0115 (0.0114)	−0.0325* (0.0172)
Constant	0.9498 (6.9975)	−7.2461 (4.6569)	−10.8197* (6.4482)	0.7751 (2.7804)	5.6621 (4.5499)

*, ** and *** refer to statistical significance at 10, 5 and 1 %

Scarcity of off-farm employment opportunities in remote areas compels households to engage in extraction and marketing of NTFPs as a source of income (Takasaki et al. 2004; Mulenga et al. 2012). Diversification of marketing of NTFPs with other livelihood activities has a negative relationship with the decision to market chewstick, antelope, kolanut and giant rat. The decision to market these NTFPs is in part due to scarcity of off-farm and non-farm employment opportunities, small landholdings and low levels of education, which compels households to engage in extraction and trade of NTFPs as a source of income. In addition, non-farm income has negative coefficients for arborea leaves, chewstick, sponge, teak leaves and snails. This suggests that collectors that are also engaged in non-farm employment (with higher returns) are usually casual or *ad hoc* market participants (those who participate in NTFPs harvest and sales as a safety net) while the landless, who are without access to non-farm income, are usually entrepreneurial participants (for example, women who pick and sell leaves, snails and chewstick regularly as a business) (Shackleton and Shackleton 2004).

Market distance lowers the probability of the local people to participate in bamboo, antelope, grasscutter and sand mining markets. This supports previous studies that have suggested that distance to the market negatively influences both the decision to participate in markets and the proportion of output sold (Key et al. 2000; Makhura et al. 2001).

Determinants of the Level of Market Participation

The second stage of the Heckman model to determine the level of market participation of NTFPs extractors is presented in Tables 4 and 5. The shares of marketable surplus for arborea leaves, kolanut, sponge and snails are higher among female[1] extractors but are higher for chewstick, giant rats and grasscutters among their male counterparts. Age is negative for chewstick, teak leaves and sand evacuation but positive for snails and kolanuts. Thus, a year increase in the ages of the extractors will lead to 0.53, 0.07 and 0.03 unit decreases in the share of marketable surplus for chewstick, teak and sand mining, respectively. A similar increase in age leads to 0.08 and 0.12 units in marketable surplus for kolanuts and snails, respectively. However, in the long-run, elderly locals have higher marketable surplus of chewstics, teak leaves and sand than younger ones.

An additional member to the family will lead to decrease in the marketable surplus by 0.0590, 0.5969, 0.2230, 0.1559 and 0.2618 units of arborea leaves, kolanuts, giant rat, and grasscutter and snails, respectively. This suggests that that a larger percentage of these NTFPs are consumed by the household. Conversely, household size has a positive relationship with snail marketing. This buttresses the findings of Alene et al. (2008) who reported that household size explains the family labour supply for production and household consumption levels. A unit increase in dependency ratio decreases the amount of marketable supply of chewstick, antelope, kolanut, giant rat, sand and snails by 0.84, 1.08, 6.92, 0.60, 0.35 and 6.07 %,

[1] Women from poor households generally rely more on NTFPs for domestic use and income (FAO 2014).

Table 4 Determinants of the level of market participation in flora NTFPs

Variable	Arborea leaves	Bamboo	Chewstick	Kolanut	Sponge	Teak leaves
Gender	−0.1951 ** (0.0810)	0.0739 (0.0604)	0.2071** (0.0896)	−0.4091*** (0.0803)	−0.1634** (0.0766)	−0.1065 (0.0724)
Age	−0.0311 (0.0349)	−0.0024 (0.0258)	−0.5287* (0.2903)	0.0809** (0.0344)	−0.0349 (0.0328)	−0.0673** (0.0310)
Age-Squared	0.0003 (0.0004)	−0.0183 (0.2720)	0.0669* (0.0401)	−0.0085** (0.0036)	0.3739 (0.3448)	0.6409** (0.3260)
Household size	−0.0590*** (0.0214)	0.0140 (0.0157)	−0.0196 (0.0241)	−0.5969*** (0.2093)	0.0006 (0.0200)	0.0298 (1.8929)
Number of males aged 15–64	0.1132** (0.1909)	0.0466* (0.0265)	−0.0018 (0.0525)	−0.9056** (0.4567)	−0.0247 (0.0436)	−0.7544** (0.3641)
Number of females aged 15–64	−0.1035*** (0.0361)	−0.0401 (0.0344)	−0.0047 (0.0406)	0.7604** (0.3532)	−0.0102 (0.0337)	−0.0289 (0.0319)
Education	0.0132 (0.0097)	−0.0137* (0.0072)	−0.0210* (0.0108)	−0.0512 (0.0953)	−0.0047 (0.0091)	−0.0127 (0.0086)
Dependency ratio	−0.0191 (0.0459)	−0.0467 (0.0338)	−0.0835* (0.0507)	−0.6921* (0.4053)	−0.4768 (4.2889)	0.2448 (0.4058)
Marital status	0.1698 (0.2824)	0.1436 (0.2136)	−0.1071 (0.3074)	−0.1555 (0.2839)	−0.2625 (0.2709)	−0.1159 (0.2552)
Livelihood diversification index	−0.0118 (0.1117)	0.4672 (0.8299)	−0.1995 (0.1244)	−0.3042*** (0.1102)	−0.0427 (0.1052)	0.1071 (0.0994)
NTFPS income	0.0244*** (0.0088)	0.0113* (0.0066)	0.0192** (0.0097)	0.0093 (0.0880)	0.0147* (0.0084)	0.9970 0.6579)
Non-farm income	−0.0443 (0.0290)	−0.0065 (0.0217)	−0.0799** (0.0320)	−0.0345 (0.0288)	−0.0262 (0.0275)	−0.0116 (0.0259)
Transport cost	−0.0002 (0.0006)	−0.1961*** (0.0460)	0.0028 (0.0668)	−0.1145* (0.0611)	−0.1329* (0.0583)	−0.0434 (0.0549)
Per capita land size	−0.0294* (0.0179)	1.0155** (0.4132)	−0.0115 (0.0200)	0.2508 (0.1758)	−0.0241 (0.0168)	−0.1147 (0.1586)
Average market distance	−0.0074** (0.0035)	−0.9927*** (0.2639)	−0.0158** (0.0069)	0.7082** (0.3505)	−0.3345*** (0.1137)	−0.7473** (0.3159)
Input cost	−0.0146 (0.0184)	−0.1344 (0.0947)	0.0014 (0.0009)	0.2358 (0.1860)	0.1374 (0.1009)	−0.0585 (0.0471)
Social group membership	0.1346 (0.0848)	0.0196 (0.6667)	0.0110 (0.0871)	0.1159 (1.1962)	0.0375 (0.0845)	0.7924 (0.4939)
Forest conservation participation	0.0313 (0.0146)	0.1321* (0.0796)	0.0177 (0.1129)	−0.4015*** (0.1059)	0.3058*** (0.0820)	0.2125** (0.0950)
Constant	0.9434 (0.6831)	−0.4861 (0.5055)	1.2536* (0.7648)	−1.5929** (0.6714)	1.3374** (0.6407)	1.8690*** (0.6059)
Mills Lambda	−0.2722 (0.1984)	0.3735** (0.1513)	−0.4484 (0.2136)	−0.0158 (0.2012)	0.0397* (0.0219)	−0.1009 (0.1806)
Rho	−0.6888	0.1292	−1.0000	−0.0411	0.1084	−0.2907
Sigma	0.3951	0.2890	0.4484	0.3837	0.3663	0.3469
Walds	82.76	327.84	56.14	111.63	68.28	69.40

*, ** and *** refer to statistical significance at 10, 5 and 1 %

Table 5 Determinants of the level of market participation in fauna and non-biological NTFPs

Variables	Antelope	Giant rat	Grasscutter	Snail	Sand
Gender	0.0439 (0.0364)	0.1009* (0.0564)	0.4558*** (0.0502)	−0.2329** (0.1155)	0.0135 (0.0281)
Age	−0.0014 (0.0157)	−0.0208 (0.0244)	0.0532 (0.2155)	0.1147** (0.0481)	−0.0276** (0.0121)
Age-squared	0.0459 (0.1656)	0.0269 (0.0257)	−0.0243 (0.2265)	−0.1239 (0.4575)	0.2953** (0.1275)
Household size	−0.0083 (0.0096)	−0.2230** (0.1101)	−0.1559* (0.0905)	0.2618* (0.1484)	−0.2171 (0.7439)
Number of males aged 15–64	0.4811** (0.2107)	0.4068* (0.2232)	0.0497* (0.0286)	0.0125 (0.0474)	0.0215** (0.0106)
Number of females aged 15–64	−0.0428*** (0.0162)	−0.6772*** (0.2529)	0.0041 (0.0221)	0.2536 (3.3764)	−0.0041 (0.0125)
Education	−0.0040 (0.0043)	−0.1086 (0.0678)	−0.1224** (0.0597)	−0.0056 (0.0068)	−0.0427 (0.0336)
Dependency ratio	−0.1082** (0.0507)	−0.0601* (0.0322)	0.0139 (0.0282)	−0.6065* (0.3541)	−0.0347** (0.0159)
Marital status	−0.0330 (0.1264)	0.1597 (0.1928)	−0.0999 (0.1772)	0.4388** (0.2182)	−0.0732 (0.0975)
Livelihood diversification index	−0.0827** (0.0502)	−0.1404* (0.0779)	−0.0358 (0.0690)	−0.1556* (0.0946)	0.0387** (0.0175)
NTFPs income	0.0987** (0.0395)	0.0920*** (0.0412)	0.0137** (0.0055)	0.0025*** (0.0008)	0.7020** (0.3050)
Non-farm income	0.0161 (0.0130)	0.0159 (0.0202)	−0.3970** (0.1800)	−0.0233 (0.0285)	−0.0306* (0.0182)
Transport cost	−0.1072*** (0.0273)	−0.1233*** (0.0424)	−0.1411*** (0.0381)	−0.0094* (0.0051)	−0.0377** (0.0189)
Per capita land size	−0.0184** (0.0080)	−0.2557 (1.2507)	−0.0493*** (0.0110)	−0.0306* (0.0174)	−0.0741 (0.0620)
Average market distance	0.1516** (0.0693)	0.0045 0.0247)	−0.1765*** (0.0535)	0.0184 (0.0739)	−0.4948** (0.2273)
Input cost	0.0178 (0.0373)	−0.0596 (0.0576)	0.1833 (2.1944)	−0.0514 (0.0394)	0.0377 (0.0289)
Social group Membership	0.0506* (0.0284)	0.2067*** (0.0577)	0.0427** (0.0215)	0.1619 (0.0996)	0.0039 (0.0290)
Forest conservation practices	0.1221*** (0.0467)	0.4002** (0.1722)	0.0755* (0.0406)	0.2466*** (0.0777)	0.0228 (0.0360)
Constant	−0.0416 (0.3079)	0.1987 (0.4779)	−0.5326 (0.4209)	−0.5362 (0.7261)	0.5650** (0.2370)
Mills Lambda	0.1404* (0.0785)	0.2254* (0.1369)	−0.7609* (0.4125)	−0.1816* (0.1045)	0.1032* (0.0614)
Rho	0.7854	−0.8116	−0.3155	−0.7411	0.7510
Sigma	0.1788	0.2777	0.2411	0.2450	0.1374
Walds	90.60	92.87	374.42	157.86	143.35

*, ** and *** refer to statistical significance at 10, 5 and 1 % levels respectively

respectively. The number of males between ages 15 and 64 is positive for arborea leaves, bamboo, antelope, giant rat, grasscutter and sand but it is negative for kolanut and teak leaves. However, the number of females between ages 15 and 64 is negative for arborea leaves, antelope and giant rat, suggesting that commercialisation of these NTFPs increases with prime-aged males in the households. Also, married snail gatherers sell a larger proportion of their collection than their single counterparts.

Being educated reduces the households' share of marketable surplus for bamboo, chewstick and grasscutter respectively. As expected, livelihood diversification has inverse relationships with the level of market participation for antelope, kolanut, giant rat and snail. Furthermore, the level of NTFPs market participation increases with income for arborea leaves, bamboo, chewstick, antelope, giant rat, grasscutter, sand mining, snail and sponge. This suggests that output price is an incentive for sellers to sell more in the market (Alene et al. 2008). On the other hand, non-farm income decreases with the level of household participation in NTFPs market for chewstick, grasscutters and sand. A unit increase in per capita land size may also lead to a less than proportionate reduction in the level of market participation in arborea leaves, antelopes, grasscutters and snails.

A naira[2] increase in the cost of transportation of NTFPs will lead to less than proportionate decrease in their share of marketable surplus of bamboo, antelopes, kolanuts, giant rats, grasscutters, sand, snail and sponge. Similarly, remote households face a lower opportunity cost of labour and may have less share of marketable surplus for arborea leaves, bamboo, chewstick, grasscutter, sand, sponge and teak leaves. This is consistent with previous studies (Pattanayak et al. 2004; Mulenga et al. 2012).

Participation in forest conservation practices (such as controlled and seasonal harvesting operations, soil conservation practices, conservation of biodiversity and watersheds) will increase the share of marketable surplus of bamboo, antelopes, giant rats, grasscutters, snails, sponge and teak leaves. Therefore, a great caution needs to be exercised with respect to un-regulated extraction of NTFPs, which threatens their sustainability.

Conclusions and Recommendations

The study has shown that marketing of NTFPs plays a pivotal role in the livelihood of the local people. Marketing of non-biological and fauna NTFPs (except snail gathering) and bamboo cutting are reserved exclusively for the men while the flora NTFPs are in the domain of women. Thus, market participation enhancement policies should target women for flora NTFPs while such policies should target men for non-biological, fauna NTFPs and bamboo cutting. The decision to trade in NTFPs market is related to scarcity of off-farm and non-farm employment opportunities, small landholdings and low levels of education in the reserve which is likely to compel households to engage in extraction and trade of NTFPs as a source

[2] Naira is the unit of currency in Nigeria.

of income. Years of formal education also has a negative influence on the proportion of marketable quantities of bamboo, chewstick and grasscutters. There is a need for the government authority in the reserve to focus more on the attainment of basic education and rural infrastructure, which have tendencies to increase chances of non-farm income and thus reduce the pressure on the forest for the supply of NTFPs.

Participation in forest conservation practices increases the proportion of marketable surplus of bamboo, antelope, giant rat, grasscutter, snail, sponge and teak leaves. Therefore, policies to regulate extraction of NTFPs and enhance forest resource conservation in rural communities should be enforced in order to increase the continued availability of these NTFPs, their marketable surplus and their sustainable harvest. Large households have less shares of marketable surplus of arborea leaves, kolanut, giant rats and grasscutters than smaller ones. The current birth control awareness campaigns will likely increase the present low level of marketable surplus. Education also enhances livelihood diversification by opening up more non-farm livelihood opportunities and thereby also reducing pressure on the extraction of NTFPs. Transportation costs and distance to markets have negative relationships with the shares of marketable surplus of the NTFPs. Provision of rural infrastructure like good quality road networks should reduce transaction costs and increase market participation. This study has implications for socio-economic policy change and sustainable management of Omo forests and potentially other tropical regions.

Appendix 1

See Table 6.

Table 6 Definition of model variables

Variables	Definitions
Dependent variable for level of participation (OLS)	
NTFPS	Market participation index of respondents
Covariates	
Gender	Gender of household head (male = 1, female = 0)
Age	Age of household head in years
Age-squared	Age of household head squared in years
Household size	Number of people living in the household
Number of males aged 15–64	The number of prime age male members in the household
Number of females aged 15–64	The number of prime age female members in the household
Education level	Number of years of schooling (0 = informal, 6 = primary, 12 = secondary and 16–21 = tertiary.
Dependency ratio	Dividing the proportion of household members less than 15 years plus those greater than 64 years of age by the number of individuals between 15 and 64

Table 6 continued

Variables	Definitions
Marital status	Marital status (1 = Married, 0 = unmarried)
Livelihood diversification index	Attempts by households to find new ways to raise incomes and reduce environmental risk (1 = Diversify, 0 if otherwise)
NTFPS income	Total income earned from forest activities in Naira
Non-farm income	Total income earned from off farm activities in Naira
Transport cost	Amount involved in conveying the proportion of the quantity of NTFPS meant for sale to the market in naira
Per capita land size	Ratio of land size exploited by the household for farming to household number in acre
Average market distance	Average distance to markets in the village in km
Input cost	Identify the inputs, determine the price per unit of each of the inputs and the quantity bought with their expected year of usage
Membership	Whether a household belongs to a forest management committee or NTFPS extractor or market association or not (1 if member and 0 otherwise)
Forest conservation practices	Land management practices implemented to control NTFPS extraction/harvesting (participate in forest conservation = 1, 0 if otherwise)
Decision to participate model (probit)	
NTFPS Participation	Whether household sold NTFPS or not (yes = 1, no = 0)

Appendix 2

See Table 7.

Table 7 A priori expectation of the exogenous variables influencing decision to participate (first stage)

Variables	Description	Expected Signs	Sources
Gender	Dummy	–	Adhikari (2004), Ehui et al. (2003)
Household head age	Continuous	–	Ehui et al. (2003)
		+	Cavendish (2000), Chilundika (2011), Gebremedhin and Jaleta (2010)
Household head age-squared	Dummy	–	Chilundika (2011)
Household size	Continuous	+	Alene et al. (2008)
		–	Gebremedhin and Jaleta (2010)
Number of males aged 15–64	Continuous	+	Chilundika (2011)
Number of females aged 15–64	Continuous	+	Chilundika (2011)
Education level of the household head	Continuous	–	Godoy and Contreras (2001), Gunatilake (1998), Shylajan and Mythili (2007)
		_	Ehui et al. (2003)

Table 7 continued

Variables	Description	Expected Signs	Sources
Dependency ratio	Continuous	–	Ehui et al. (2003)
		+	Adhikari et al. (2004)
Marital status	Dummy	+	Dyer et al. (2006)
Livelihood diversification	Continuous	–	Fonta et al. (2009)
		–	Ehui et al. (2003)
Non-farm income	Continuous	–	Shackleton and Shackleton (2004), Mulenga et al. (2012), Adhikari et al. (2004)
Per capita land size	Continuous	+	Strasberg (1999), Fonta et al. (2009)
Average market distance	Continuous	–	Godoy et al. (1997), Gebremedhin and Jaleta (2010)

Appendix 3

See Table 8.

Table 8 A priori expectation of the exogenous variables determining the level of participation (Second stage)

Variables	Description	Expected sign	References
Gender	Dummy	–	Cunningham et al. (2008)
Household head age (years)	Continuous	–	Ehui et al. (2003)
Household head age-squared	Dummy	–	Chilundika (2011)
Household size	Continuous	–	Alene et al. (2008)
Number of males aged 15–64	Continuous	+	Chilundika (2011)
Number of females aged 15–64	Continuous	+	Chilundika (2011)
Education level of the household head	Continuous	–	Adhikari et al. (2004)
		+	Makhura et al. (2001)
Dependency ratio	Continuous	+	Ehui et al. (2003)
Marital status	Dummy	+	Dyer et al. (2006)
Livelihood diversification	Continuous	–	Govereh et al. (1999), Fonta et al. (2009)
		–	Ehui et al. (2003)
NTFPS income	Continuous	+	Sadashivappa et al. (2006), Mutie et al. (2006)
Non-farm income	Continuous	–	Alene et al. (2008), Shackleton and Shackleton (2004), Ehui et al. (2003)
Transport cost	Continuous	–	Key et al. (2000), Makhura et al. (2001)
Per capita land size	Continuous	+	Straberg et al. (1999), Fonta et al. (2009)

Table 8 continued

Variables	Description	Expected sign	References
Average market distance	Continuous	−	Godoy et al. (1997), Gebremedhin and Jaleta (2010)
Input cost	Continuous	−	Vance and Geoghegan (2004), Dyer et al. (2006)
Membership	Dummy	+	Gebremedhin and Jaleta (2010)
Forest conservation practices	Dummy	+	Mutie et al. (2006)

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