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Welfare Impact of Moringa Market Participation in Southern Ethiopia

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Abstract

Increasing demand for Moringa stenopetala suggests that great opportunities exist for a supply-side response amongst rural smallholder farmers, especially in Southern Ethiopia. It needs evidence to understand whether or not smallholders farmers participate or if they benefit from participation in these new market opportunities. This study analyzes the welfare impact of smallholder farmers' participation in Moringa market (measured in terms of crop income, per-capita annual consumption expenditure and per capita daily calorie intake) in Segen area people zone of Southern Ethiopia. Cross-sectional data from 385 randomly selected smallholder farmers were used in the analysis. Endogenous Switching Regression(ESR) model that accounts for selection bias was used in impact assessment. This was further expanded with the generalized propensity score (GPS) approach to evaluate the effects of level of market participation on the response of the outcome variables. Results from ESR shows that demographic, institutional, socio-economic, and market factors affect participation decision and welfare of the farm households. Overall, Moringa market participation have a positive and significant impact on rural farmers welfare, with substantial differencial impacts between groups. Results from GPS, also shows the same as the welfare of the households has increased with the level of Moringa market participation. Policies aimed at reducing the transaction costs of accessing markets, promoting the tree via different medias, working on rural institution capacity building, encouraging and assisting Moringa associations, designing appropriate support from different stakeholders, encouraging market linkages among diverse market players, and providing farmers with the chance of attending basic education are critical to the improvement of household welfare.

Keywords: Moringa, market participation, welfare impact, self-selection, endogenous switching regression, generalized propensity score, treatment effects

1. Introduction

1.1 Background of the Study

Agriculture is central to the economic growth of Africa since it creates employment opportunities for 65–70 % of the labor force, supports the livelihoods of ninety percent of the population and accounts for about a quarter of the continent's gross domestic product (OECD and FAO, 2016; world bank, 2016). Integrating smallholders to markets are assumed to contribute towards agricultural growth and development in these countries (Wickramasinghe, 2015). Studies conducted in different countries found that market participation will increase households' financial gain as a result of farmers realized their comparative blessings in farming activities and specialization (World Bank, 2015; Wickramasinghe *et al.*, 2014). At the micro-level, it's additionally a positive impact on food security (Seng, 2016), household welfare and livelihoods (Asfaw *et al.*, 2012; Olwande *et al.*, 2015). Markets are observed as conditions for enhancing agriculture-based economic growth and increasing rural incomes within the medium term significantly for rural poor farming households (Oaegbetokun, *et al.*, 2017). In considering that, sub-Saharan African countries have recognized agricultural market participation as one of the key components of their agenda for development (NEPAD, 2010; Brian and Barret, 2014).

Ethiopia, one of the Sub-Saharan Africa countries, where 84 % of the population relies on agriculture for their livelihoods, and cultivate less than 1 ha in size per household, poor smallholder farmers can turn their surpluses into income only if they can access markets (CSA, 2015). Moreover, agricultural transformation through switching from semi-subsistence to a more productive and market-oriented system is a necessary pathway in Ethiopia to promote better living conditions in rural areas by raising income as well as households' welfare.

There are many underutilized plants in Ethiopia that have the potential to bring lots of prosperity in this regard. *Moringa stenopetala*, an edible plant, is at the top of the underutilized resources of Ethiopia (Kaleb *et al.,* 2014).

Moringa stenopetala was said to be domesticated in the east African lowlands and is indigenous to southern Ethiopia (Eyassu, 2012). It is a wonder tree that grows in all types of soil, and climate, especially in semiarid tropics (Yogesh *et al.,* 2017). The tree has economic, medicinal, social and cultural values for peoples of this region. It is a staple food for over 5 million people, consumed as a vegetable (UNIDO, 2015). Having a Moringa tree in a garden or home shows better wealth status and represents a stable food supply for the family, resulting in prestige for the head of the household. For inistance, in Konso area culturally the tree is taken as a dowery or measure of wealth as how many of those trees the bridge groom has within the garden or nearby farmland to feed his/her family (Liyew and Daniel, 2015; Abuye *et al.*, 2003). Apart from being consumed as a vegetable, *Moringa stenopetala* is also marketed as a source of income in a local market in southern Ethiopia (Endeshaw, 2003). With limited evidence, it is unclear the extent of smallholders' participation in the Moringa market and benefits from participation in these new market opportunities.

There are limited research carried out in the area so far, however focused only on the traditional uses of *Moringa stenopetala* based on information obtained from Moringa growers. The, survey results reported were even conducted only at or in the vicinity of the Konso district of southern Ethiopia even though Derashe is also one of the potential areas and are, as a result, far from complete. Furthermore, most of the impact studies related to modern agricultural technologies were conducted for staple crops like maize, wheat, and the likes. There is limited knowledge on the impact of *Moringa* market participation under smallholder agriculture. The claimed benefits of *Moringa stenopetala* need to be confirmed by impact analysis, and its potential uses should be exploited. Hence, analyzing the impact of market participation on rural farmers' welfare would be of policy relevance.

This study, therefore, aims at analyzing welfare impact of smallholder farmers' participation in Moringa market (measured in terms of crop income, per-capita annual consumption expenditure and per capita daily calorie intake) in Segen Area Peoples Zone (SAPZ) employing a diverse set of identification and estimation strategies that address selection and endogeneity problems. Further, the study contributes to the literature on the impacts of market participation in the following ways. First, this paper bridges the marketing and welfare literature by comprehensively estimating the impact of market participation on Moringa farmers' welfare. Second, the study uses three welfare indicators to capture the different dimensions of welfare. Third, recent methodological developments that are appropriate for impact evaluation in a cross-sectional data set were also employed.

2. Research Methodology

2.1 Description of the Study Area

The government of Ethiopia has autonomous regional states within the Federal Republic. Regional states are further subdivided into zones (provinces), Woredas (districts), and Kebeles (villages). A zone is a cluster of districts, and a district is a group of 20–50 villages. A Kebele is the lowest administrative structure. The study was carried out in SAPZ which comprises five districts which are Konso, Amaro, Derashe, Alle, and Burji out of which Konso and Derashe were purposively selected for the study based on the predominance of Moringa tree cultivation and marketing. The zone is one of the administrative Zones of Southern Nation Nationalities and Peoples Region of Ethiopia. Geographically, it is bordered with Gamo Gofa Zone at the North, Oromia Regional State at the South and East and South Omo Zone at the West. Its administrative capital is called Segen, 622 km far from Addis Ababa (capital of Ethiopia), 342 km from Hawasa (capital of the region) Segen Municipality (2014).

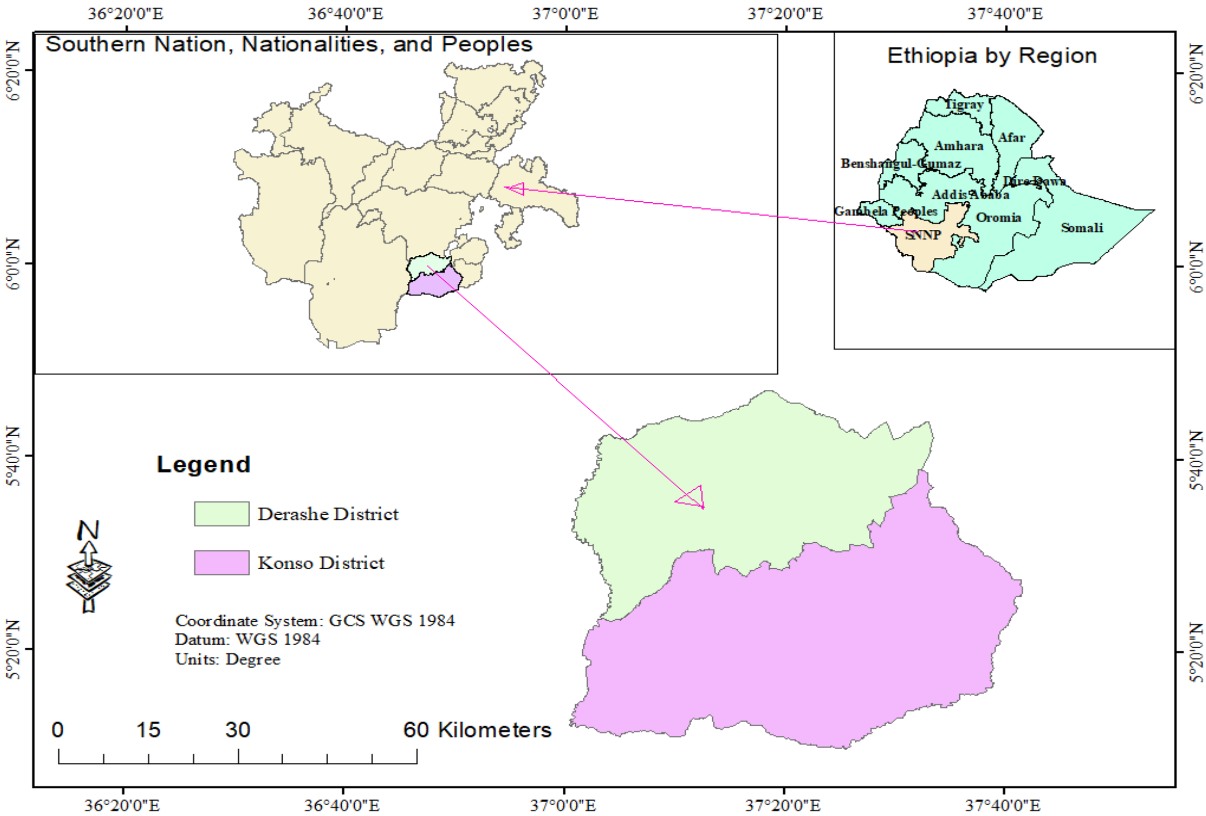

Figure 1. Map of the study sites

Konso district has a total of 43 Kebeles, 41 rural and 2 urban. For administrative porpose, the rural and urban Kebeles are structured under six clusters ('*Agelgelots'*). The cluster consists of some Kebeles based on the size of each cluster. Moreover, each Kebele is divided into small parts or sub-villages called *"Kantas"*. According to the population projection from 2014 to 2017 of the Central Statistical Agency (CSA, 2013), the population of Konso is estimated to be 265, 676. Derashe has 10 local administrative unit or sub-unit within the Woreda (kebeles) with different ethnic groups. The estimated total population of the District is 131,511, of whom 64,420 are male and 6,091 are female (*ibid*).

In both districts, mixed farming (crop production and animal rearing) is the major household economic activity in the area. *Moringa stenopetala* (*Shelaqta'a* in Konso) is the major cabbage tree and is part of the everyday meal where the fresh green leaves serve as a vegetable cooked and eaten as a staple food in household's regular meals and are used as a source of cash income in the local market.

2.2 Data Types, Sources, and Methods of Data Collection

In this study, the required data are generated from both primary and secondary sources. Primary data were collected using a structured questionnaire that was administered by trained enumerators. For qualitative data collection, focus group discussions, key informants interview, and personal observations were employed. In addition to primary data, secondary data were collected from various sources such as records, reports, and documents of the bureau of the district agriculture and other relevant institutions.Field trips were made before the actual survey to observe the overall features of selected *districts* and *kebeles*.

2.3 Sample Size and Sampling Technique

2.3.1 Sample Size Determination

To obtain a representative sample size for cross-sectional household survey, the study employed the sample size determination formula given by Kothari (2004):

$$n = \frac{Z^2pq}{e^2} = \frac{(1.96)^2(0.5)(0.5)}{(0.05)^2} = 385 \quad (1)$$

Where n is the required sample size, Z is the inverse of the standard cumulative distribution that corresponds to the level of confidence, e is the desired level of precision, q = 1-p, and p is the estimated proportion of an attribute that is present in the population. The value of Z is found from the statistical table which contains the area under the normal curve of 95% confidence level.

In the determination of sample size where there is a large population, but we do not know the variability in the proportion about the extent of market participation, and welfare impact of Moringa market participation, p = 0.5 is considered as suggested by Kothari (2004). Based on this, a total of 385 households were selected for the study from the two districts, assuming a 95 percent confidence level and ±5 percent precision.

2.3.2 Sampling Techniques

A three-stage sampling procedure with probability proportional to size was employed to draw districts, *Kebeles* and farm households. In the first stage, two districts namely Konso and Dersahe were purposively selected based on the intensity of Moringa tree production and participation in the Moringa market from SAPZ. These districts represent one of the major Moringa growing areas in the region as well as in the country where Moringa trees are said to be adopted for the first time.

In the second stage, eight kebeles were randomly selected from two purposively selected districts. Accordingly, five kebeles from Konso district and three kebeles from Derashe district were proportionally and randomly selected. Finally, a total of 385 households were randomly selected from the selected *kebeles* proportionate to the number of households in each kebele (Table 1).

Table 1. Total number of households by Kebeles and their respective sample size

Woreda	Kebele	Total number of households	Sampled households
	Mechelo	6180	42
Konso	Fasha	9885	68
	Gamole	4992	34
	Buso	8202	56
	Gocha	5982	41
	Total	**35241**	**241**
	Olte	7548	51
Derashe	Walessa	5940	41
	Onota	7553	52
	Total	**21041**	**144**
Grand Total		**56282**	**385**

Source: Own computation results (data obtained from WBoA, 2019).

2.4 Methods of Data Analysis

Both descriptive and econometric analysis methods were employed to address the objectives of the study. In the descriptive part, mean, standard deviation, frequency, and percentages were used; and in the econometric analyses, endogenous switching regression (ESR) and generalized propensity score (GPS) were utilized to examine the impact of Moringa market participation decision and level of market participation on the welfare of smallholder farmers, respectively. The detailed econometric model specification for the analyses is given as follows:

An endogenous switching regression model that accounts for both endogeneity and sample selection was used following Maddala and Nelson (1975) and Di Falco *et al*. (2011). The model uses a probit model in the first stage to determine the relationship between market participation and some household and farm characteristics. In the second stage, separate regression equations are used to model the welfare outcome conditional on a specified criterion function. To clarify the method, consider a situation where a farmer could participate in the market or not. Let, a latent variable capturing the expected net benefits from market participation is D_i^*. The probit model of market participation can be specified as:

$$D_i^* = \alpha' Z_i + U_i \; with \; D_i = \begin{cases} 1 \; if \; D_i^* > 1 \\ 0 \; otherwise \end{cases} \tag{2}$$

Where D_i^* is the latent variable for market participation (unobservable); D_i is the dependent variable for market participation equals 1, if the farmer has sold any quantity of Moringa produced in the market, and 0 otherwise (observable counterpart); Z_i is a vector of observed explanatory variables determining market participation; the coefficient estimates is α, and a random disturbances associated with the market participation is U_i.

The two welfare regression equations where farmers face the regimes of participation or not to participate in the market are defined as follows:

$$Regime\ 1: Y_{1i} = \beta_1 X_{1i} + \varepsilon_{1i} if D_i = 1 \tag{3a}$$

$$Regime\ 2: Y_{2i} = \beta_2 X_{2i} + \varepsilon_{2i} if D_i = 0 \tag{3b}$$

Where Y_i is household welfare in regimes 1 and 2, X_i is a vector of exogenous variables of household i, expected to influence welfare; β is the coefficient vector; D is a dummy for market participation, and, ε_i the residuals.

For the ESR model to be identified, it is important to use exclusion restrictions, thus as selection instruments, not only those automatically generated by the nonlinearity of the selection model of participation (2) but also other variables that directly affect the selection variable but not the outcome variable (Di Falco *et al*., 2011). In this study, we used variables related to the source of information and distance from the nearest market following several other studies (Khonje *et al*., 2015; Shiferaw *et al*., 2014). Access to Moringa market information from different sources, contacts with government extension agents and distance to the nearest market are therefore included as selection instruments.

A simple falsification test following Di Falco *et al.* (2011) was used to test the validity of the instruments. The results in Appendix Table 3 shows that the instruments considered are jointly statistically significant ($\chi^2 = 68.85(P = 000)$) in the selection equation (2) but not in the outcome functions for non-participants [$F - stat = 0.63(P = 0.596); F - stat = 1.84(P = 0.241) \& F - stat = 1.63(P = 0.286)$] when crop income, per-capita annual consumption expenditure, and per-capita daily calorie intake are used as an outcome variable respectively.

The error terms are assumed to have a trivariate normal distribution with zero mean and non-singular covariance matrix specified as:

$$cov(\varepsilon_{1i}, \varepsilon_{2i}, U_i) = \begin{bmatrix} \sigma_{\varepsilon 2}^2 & . & \sigma_{\varepsilon 2U} \\ . & \sigma_{\varepsilon 1}^2 & \sigma_{\varepsilon 1U} \\ . & . & \sigma_U^2 \end{bmatrix} \tag{4}$$

Where, σ_U^2 is that the variance of the error term within the selection equation; $\sigma_{\varepsilon 1}^2$ and $\sigma_{\varepsilon 2}^2$ are the variances of the error terms within the welfare outcome functions; $\sigma_{\varepsilon 1U}$ is that the covariance of U_i and ε_{1i} and $\sigma_{\varepsilon 2U}$ is the covariance of U_i and ε_{2i}. Since Y_{1i} and Y_{2i} are not observed simultaneously, the covariance between ε_{1i} and ε_{2i} is not defined (Maddala, 1983). A crucial implication of the error structure is that as a result of the error term of the selection equation U_i is correlate with the error terms of the welfare outcome functions, ε_{1i} and ε_{2i}, the expected values of ε_{1i} and ε_{2i}, conditional on the sample selection are non-zero and are defined as:

$$E[\varepsilon_{1i}|D_i = 1] = \sigma_{\varepsilon 1U} \frac{\phi(\alpha Z_i)}{(\alpha Z_i)} = \sigma_{\varepsilon 1U}\lambda_{1U}\ and\ E[\varepsilon_{2i}|D_i = 0] = \sigma_{\varepsilon 2U} \frac{\phi(\alpha Z_i)}{1 - \Phi(\alpha Z_i)} = \sigma_{\varepsilon 2U}\lambda_{2U}$$

Where $\phi(.)$is that the standard normal probability density function, $\Phi(.)$ the standard normal cumulative density function, and $\lambda_{1i} = \frac{\phi(\alpha Z_i)}{\Phi(\alpha Z_i)}$ and $\lambda_{2i} = \frac{\phi(\alpha Z_i)}{1-\Phi(\alpha Z_i)}$. If the estimated covariance's $\sigma_{\varepsilon 1U}$ and $\sigma_{\varepsilon 2U}$ are statistically significant, then the decision to participate and the welfare outcome variables are correlated i.e, it's Associate in Nursing proof of the endogenous switch and that we reject the null hypothesis of absence of sample selectivity bias (Lokshin and Sajaia, 2004).

The full information maximum likelihood (FIML) method is a more efficient method of estimating endogenous switching regression model is. The FIML method simultaneously estimates binary and continuous parts of the model to yield consistent standard errors (ibid). The estimation of the model's parameters further grants us to compute conditional expectations:

Following Di Falco *et al.* (2011), the endogenous switching regression model can be used to compare the expected welfare outcome of households that participated (a) with respect to households that did not participate (b), and to investigate the expected welfare outcome in the counterfactual hypothetical cases (c) that the participated households did not participate, and (d) that the non-participant households participated. The conditional expectations for the outcome variables in the four cases are presented as follows:

$$E(Y_{1i}|D_i = 1) = \beta_1 X_{1i} + \sigma_{\varepsilon 1U}\lambda_{1i} \quad (participants\ with\ participation\ in\ Moringa\ market) \tag{6a}$$

$$E(Y_{2i}|D_i = 0) = \beta_2 X_{2i} + \sigma_{\varepsilon 2U}\lambda_{2i} \quad (Non-participants\ without\ participation) \tag{6b}$$

$$E(Y_{2i}|D_i = 1) = \beta_2 X_{1i} + \sigma_{\varepsilon 2U}\lambda_{1i} \quad (Non-participants\ as\ they\ decided\ participate) \tag{6c}$$

$$E(Y_{1i}|D_i = 0) = \beta_1 X_{2i} + \sigma_{\varepsilon 1U}\lambda_{2i} \quad (participants\ as\ they\ decided\ not\ to\ participate) \tag{6d}$$

The actual expectations observed in the sample were represented by cases (a) and (b), were as the counterfactual expected outcomes are cases (c) and (d). In addition, following Heckman *et al.* (2001), the effect of market participation on welfare outcome of the households that actually participated in the market is calculated as the difference between (a) and (c),

$$TT = E(Y_{1i}|D_i = 1) - E(Y_{2i}|D_i = 1) = X_{1i}(\beta_1 - \beta_2) + \lambda_{1i}(\sigma_{\varepsilon 1U} - \sigma_{\varepsilon 2U}) \tag{7}$$

Similarly, the impact of the treatment on the untreated (TU) for households that really failed to participate within the market is calculated because the difference between (d) and (b);

$$TU = E(Y_{1i}|D_i = 0) - E(Y_{2i}|D_i = 0) = X_{2i}(\beta_1 - \beta_2) + \lambda_{2i}(\sigma_{\varepsilon 1U} - \sigma_{\varepsilon 2U}) \tag{8}$$

In addition, the Generalized Propensity Score (GPS) was employed to address the welfare impacts of the level of market participation (percentage of Moringa sold) (Hirano and Imbens, 2004). Multicollinearity was checked employing a simple coefficient of correlation matrix and Variation Inflation factor (VIF), and found no proof of serious multicollinearity problem as correlation matrix and VIF results show less than 0.5 and less than ten, respectively.

2.5 Measurement of Outcome Variables

In this study, three different welfare indicators (i.e. crop income, per capita annual consumption expenditure, and per capita daily calorie intake) were used to capture the different dimensions of welfare. Other studies have also used the same indicators for welfare either a single indicator or a combination of two or more (e.g. Asfaw *et al.*, 2012; Khonje *et al.*, 2015; Mmbando *et al.*, 2015).

Crop income refers to the total annual income of the household generated from all crop production including *Moringa stenopetala*. This is a continuous variable that is measured in Birr**.** Total household expenditure per AE was included to capture all the household expenditure within a year measured in Birr. In this study, the consumption expenditure components include six major categories including food grains, livestock products (such as meat, egg, and milk), vegetables and other food items (such as sugar, salt), beverages (such as Borde, alcohol, coffee, Chaka, etc), clothing, energy and social activities (contribution to churches or local organization, education and medical expenditure on both their family and livestock) over the twelve months.

The final outcome variable is food security. Kilo calorie intake is used as a proxy measure of household food security. The households' food security status was measured by a direct survey of household consumption. The principal person responsible for preparing meals is asked how much food was prepared for consumption from purchase, stock and/or gift/loan/wage over a while. In this study, a seven days recall method was used since such a measure gives more reliable information than the household expenditure method (Bouis, 1993). Therefore, the consumption information collected on the premise of seven days recall methodology were converted into kilogram calorie using the food composition table manual adopted from Ethiopian Health and Nutrition research Institute (EHNRI, 1997). Then, to calculate the households' daily caloric intake, the entire households' caloric intake for the last seven days was divided by seven. The household's daily caloric intake per adult equivalent was calculated by dividing the household's daily caloric intake by the family size once adjusting for adults.

3. Results and Discussion

3.1 Descriptive Results

3.1.1 Characteristics of Sample Households

The description of general variations between Moringa market participant and nonparticipants in terms of each variable are given in Table 2. The results show that Moringa market participants are distinguishable in terms of demographic characteristics such as age, sex, family size, and dependency ratio. Participants are, on average, older, more likely to be male-headed, have a large family size and low dependency ratio. As indicated in Table 2, the average age of respondents for Moringa market participants was 44.40 years, whereas it is 40.21 years for the non-participants.

A closer look at the family size in the sampled households also showed that the treatment group of households (market participants) had relatively larger family size, accounting to about 6.74 persons than the control group of households which was found to be about 5.08 persons. This implies that, on average, Moringa market participants have relatively more family size than non-participants. However, the treatment group of households showed a slightly lower average dependency ratio (1.06) than households from the control group (1.27). This implies that market participants were supporting a fewer number of people who were either young or very old compared to non-participants. The t-test results in terms of age and family size were significant at a 1 % level of significance while the dependency ratio was insignificant. The χ^2-test result for differences in the sex of the household heads between the two groups is also significant at a 5% significance level.

Market participants are also distinct in terms of socio-economic factors. Market-oriented farmers (participants) seem to be relatively more endowed in terms of farm size and tropical livestock units, have more access to means of transportation, less participate in off/non-farm activities and have more formal years of school than non-participants (Table 2). The average farmland owned by the market participant household is 1.84ha which is significantly higher than the average farmland owned by the non-participants (1.07). This is because, farmers can only allocate more land to Moringa tree production if they have enough land, and therefore those who own more land are expected to have a comparative advantage when it comes to Moringa production and market participation.

Livestock holding, as a wealth variable, indicates the capacity of households to involve in income-generating activities from different sources. As shown in Table 2, the livestock holding in TLU was 4.97 for the treatment group and 3.45 for the control group. This implies that the livestock of market participants was significantly higher than that of non-participants. The education level of the household head is significantly higher for participants (3.72) than non-participants (3.05), and this makes them better able to understand the importance of market participation.

As a result in (Table 2) indicated, 77 percent of the participants and 64 percent of the non-participants have access to means of transportation services. This demonstrates that means of transportation to facilitate the link between farmers and the market would be one of the main factors contributing to promoting the market orientation of rural agriculture. Concerning off-farm activities, although there are no significant differences between the participants and non-participants, the percentage of non-participants engaging in the activities is higher than that of participants.

Market participants have more access to institutional services such as; extension services, training, NGO market linkage, and are members of rural cooperatives than non-participants. Those household heads participating in the Moringa market are relatively those who got trained in agroforestry practice (55 % *vs*. 34%), have access to NGO based market linkage (47% *vs*. 33%), have contacts with extension agents (63% *vs*. 37%) and more than half of them belong to rural cooperatives i.e. (59%), and belonged to either formal or informal institutions that work on agriculture-related activities than non-participants (41%). The mean difference between the two groups is statistically significant at 1% probability level for all variables.

Table 2. Characteristics of the sampled households by Moringa market participation

Variables	**Mean values by Market Participation**			
	Total	Market participants (43.38%)	Non-participants (56.62%)	t /χ^2-value
Sex of the household head (M = 1)	0.91	0.94	0.88	1.72**
Age of household head (years)	42.31	44.40	40.21	3.97***
Family size (AE)	5.91	6.74	5.08	4.25***
Dependency ratio (number)	-1.17	1.06	1.27	-2.02NS
Education of the household head (years)	3.38	3.72	3.05	2.60*
Training in any agro-forestry practice(yes=1)	0.43	0.55	0.34	4.24***
Farm size (ha)	1.39	1.84	1.06	8.52***
Livestock (TLU)	4.11	4.97	3.45	6.55***
Distance to the nearest output market (Km)	-6.29	5.40	6.97	-3.19***
Member of rural cooperative (Yes = 1)	0.49	0.59	0.41	3.64***
Contacts with extension agents (Yes=1)	0.48	0.63	0.37	5.29***
Had Moringa marketing information (Yes = 1)	0.58	0.75	0.45	6.20***
Contacts with NGO market linkage (Yes = 1)	0.39	0.47	0.33	2.89***
Participation in non/off farm activities(Yes=1)	-0.47	0.45	0.49	0.08NS
Access to means of transportation(Yes=1)	0.70	0.77	0.64	2.69**

Source: Own Computation result (2018/19) data

Note: Statistical significance at 10% (*), 5% (**) and 1% (***) probablity levels

Non-participants were located far from output markets (6.97 Km) compared to participants (5.40 Km). This is because distance imposes transaction costs to households and determines their decision to participate in the Moringa market. The results further indicate that about 75% of participants and 45 % of non-participants have access to Moringa market information from different sources. Therefore, farmers who have access to market information have more propensity of participating in the Moringa market than those without.

3.1.2 Mean Difference in Welfare Indicators between Market Participant and Non-participant Households

The difference in the mean of welfare indicators between farmers who participated in the Moringa markets and those who did not was tested using the t-test and the results are presented in Table 3. The analysis revealed that there were significant differences in all welfare indicators between farmers who participated in the Moringa markets and those who did not. Although causal relationships cannot be identified with descriptive statistics, smallholders who participated in Moringa markets earn more crop income, have higher per-capita annual consumption expenditure and per capita daily calorie intake than non-participants.

With an average per capita daily calorie intake of 2586.92 Kcal, farm households who participated in Moringa markets could enjoy significantly higher calorie intake than those who did not participate, with an average of 2081 Kcal. The mean per capita annual consumption expenditure of the total sample households is 3629 Birr (Note 1) per annum. The average expenditures for the market participant and non-participant households are 4069 Birr and 3293 Birr, respectively. The t-test result shows that there is a statistically significant difference among the two groups at a 1% probability level in terms of per capita consumption expenditure. The descriptive result further shows that there is a statistically significant difference between the two groups of households at a 1% probability level in mean crop incomes which are 7508 Birr and 5685 Birr, respectively.

Table 3. Mean Difference in some Welfare Indicators between Participants and Non-participants

Variables	**Total (385)**	**Market Participants (N = 167)**	**Non-Market Participants (N =218)**	**Difference**	**t-value**
Average crop income	6475.91	7507.89	5685.35	1822.54	5.43***
Average Per Capita consumption expenditure	3629.44	4068.86	3292.62	776.24	3.51***
Average calorie intake	2300.46	2586.92	2081.02	505.91	10.53***

Note: Statistical significance at 10% (*), 5% (**) and 1% (***) probability levels

3.2 Econometric Results

The descriptive analysis in the previous section indicates significant differences in household demographic, socio-economic, institutional, and marketing influence as well as the welfare of households between Moringa market participants and nonparticipants. However, to properly evaluate the impacts of market entrance and level of market participation on farm households' welfare, econometric models are used. This section discusses results obtained from endogenous switching regression and generalized propensity score approach.

3.2.1 Results from Endogenous Switching Regression Model

The welfare equations are jointly estimated with the selection equation explaining farm households' market participation. The first stage (probit) results of the endogenous switching regression which estimates the determinants of household's decision to participate in the Moringa market was depicted in Appendices Table 1. As was expected, out of fifteen variables entered into the model, three of them i.e. dependency ratio, distance to market and involvement in off/non-farm income have a negative significant effect on market participation, while the remaining have positive relationships. Except for a few variables (i.e. age, sex, dependency ratio, NGO market linkage, cooperative and off/non-farm income) the remaining variables significantly affected market participation of smallholder farmers. This indicates that demographic factors have little impact on Moringa market participation in this area. Further, institutional, socio-economic, and market issues should be of the main concern.

The Full Information Maximum Likelihood (FIML) estimates from the second stage of ESR for welfare are presented in (Table 4). The results of the estimation highlight that each type of welfare is affected by different factors and at different levels of significance by the same factor. The likelihood ratio test for joint independence of the three equations is reported in the last line of the output table. The significance of the coefficient of correlation between the participation equation and the farmers' welfare indicates that self-selection occurred in the Moringa market participation decision. This confirms that the endogenous switching model is an appropriate model for controlling for self-selection and inherent differences between the market participants and the non-participants. Moreover, the significant value for the Wald tests confirms the joint significance of the error correlation coefficients in the selection and outcome equations providing further evidence of endogeneity.

The estimated coefficient of correlation between the market participation equations and crop income equations ρ is positive for both groups of households. Since *ρ* is positive and significantly different from zero individuals who participate in the Moringa market would have higher crop income than a random individual from the sample. On the other hand, the non-significance of covariance estimates for the non-participants indicates that without participation in the Moringa market, there would be no evident difference in the average crop income between non-participants and a random household caused by unobserved factors.

In the participation and consumption expenditure equations, the error correlation coefficients alternate in signs indicating participation in the Moringa market is guided by comparative advantage. The coefficients are statistically significant for both market participants and non-participants. Farm households who choose to participate in the Moringa market would have a higher average per capita annual consumption expenditure in comparison to a random household in the sample. The significance of the coefficient of correlation between the participation equation and consumption expenditure of non-participants illustrates the presence of heterogeneity in the sample.

The covariance between the error terms of the participation equation and the calorie intake function (*ρ)* is negative and significantly different from zero indicating that the current participants had they not participated would have done worse than the current non-participants. In contrast, the negative sign of *ρ* for the participants indicates that the current non-participants had they participated would have done better than the current participants. However, the coefficient is insignificant meaning that, with participation in the market, there would be no significant difference in the average behavior of the two groups.

Table 4. ESR estimates for welfare of smallholder farmers

Variables	FIML Endogenous Switching Regression					
	Crop income		Per capita consumption expenditure		Calorie intake	
	With Participation	Without participation	With Participation	Without participation	With Participation	Without participation
Sex	485.10(983.9)	1441.73(747.84)**	134.09(546.86)	478.74(341.11)*	267.36(167.49)	40.17(145.10)
Age	10.85(18.58)	38.61(19.54)**	-12.63(10.13)	25.35(8.98)**	1.77(3.06)	0.92(3.81)
Family size	-361.91(126.9)***	-193.49(134.51)*	-398.97(70.09)***	-416.54(66.56)***	43.35(21.08)*	-16.72(24.92)
Depend ratio	-1.66(2.45)	-0.05(2.44)**	-1.46(1.33)	-1.64(1.16)	0.20(0.41)	-0.56(0.49)
Education	6.18(67.37)4	-39.84(80.47)	31.67(29.65)	-9.90(36.02)	13.67(9.04)**	13.29(14.58)
Training	94.97(513.67)**	391.64(528.53)	-187.32(297.94)	34.95(495.04)	183.51(89.10)**	312.16(175.01)*
Farm size	52.31(170.87)	967.47(489.08)**	202.96(93.18)**	544.04(245.89)**	30.26(27.83)*	108.40(85.50)**
Cooperative	101.96(538.50)	494.41(498.75)	56.57(314.06)	636.16(381.81)*	7.40(91.81)	509.36(139.19)***
NGO	533.74(561.83)*	-815.62(576.36)*	793.44(327.25)**	-1451.68(1145.46)	55.97(99.36)	101.14(103.30)***
Off/non-farm	-135.59(489.81)**	-983.02(478)**	31.11(262.34)	-253.37(224.98)	-36.69(80.36)	74.82(94.94)
Transport	206.79(593.95)*	1516.79(542.59)	205.49(335.04)	512.20(255.10)**	141.62(102.90)*	71.74(102.41)
Livestock	7.88(93.91)	179.45(169.48)***	30.61(50.76)*	115.11(73.94)***	3.93(15.49)	32.44(29.41)
Constant	9414.59(208.81)***	-755.54(1506.27)***	6642.34(1089.98)	2450.00(686.48)***	1652.17(310.53)**	2196.50(263.31)
σi	8.74 (0.05)***	8.86 (0.06)***	7.30(0.56)***	7.48(0.06)***	6.51(0.01)***	6.29(0.054)***
ρi	0.41 (0.18)**	0.25(0 .23)	0.38(0.23)*	-0.19(0.35)**	-0.32(0.1)	-0.85(0.086)***
Observation	385		385		385	
Log likelihood	-4061.05		-3518.47		-3110.84	
Wald test of independent equations χ2(2)	32.91***		56.70***		21.65**	

Source: Own survey result (2019)

Note: Statistical significance at 10% (*), 5% (**) and 1% (***) probablity levels. The number in parenthsis shows robust standard errors.

3.2.2 Endogenous Switching Regression-based Treatment Effects

The expected household welfare outcome under actual and counterfactual conditions for Moringa market participation was presented in Table 5. The result was obtained following conditional expectations that result from the estimation of the switching model presented above.

Table 5. ESR-based average treatment effects of Moringa market participation on welfare outcome variables

Mean of the outcome variable	Farm households type and treatment effects	Decision stage		Average treatment effects (ATE)
		To participate	Not to participate	
Crop income	Farm households that Participate (ATT)	7506.81	6044.15	1462.66***
	Farm households that did not participate(ATU)	6512.52	5684.79	827.73***
	Heterogeneous effects	**BH_1=994.29**	**BH_2= 359.36**	**TH=634.93**
Consumption expenditure	Farm households that Participate (ATT)	4068.86	3160.38	908.48***
	Farm households that did not participate(ATU)	3843.54	3292.62	550.92***
	Heterogeneous effects	**BH_1 = 225.32**	**BH_2 = -132.24**	**TH = 35.56**
Calorie intake	Farm households that Participate (ATT)	2586.94	1780.04	806.9***
	Farm households that did not participate(ATU)	2577.63	2079.95	497.68***
	Heterogeneous effects	**BH_1 = 9.31**	**BH_2 = -199.91**	**TH= 309.22**

Note: Statistical significance at 10% (*), 5% (**) and 1% (***) probablity levels.

Source: Own survey result (2019)

The treatment effects of market participation on crop income reveal that farm households who participated in the Moringa market would have an income loss of 1463 Birr had they not participated. On the other hand, non-participants would have achieved crop income of about 828 Birr had they participated in the Moringa market. The base heterogeneity (BH_1) for crop income is positive indicating that if the current non-market participants had participated, they would have gained less crop income (994 Birr) than farm households that participated. Similarly, the positive base heterogeneity (BH2) shows that participants would have gained more crop income (359 Birr) than actual non-participants even if they had not participated. Overall, the transitional heterogeneity (TH) effect is positive implying that the effect is greater for farm households that did participate compared to non-participants. This highlights that there are some important sources of heterogeneity that makes the participants “better-off” than the non-participants irrespective of market participation.

Results further showed that households who participated in Moringa markets would have per-capita consumption expenditure of 908 Birr less had they not participated (Table 6). On the contrary, non-participants would have increased consumption expenditure by 551 Birr had they participated in the Moringa market. Adjustments for the potential heterogeneity shows that the current Moringa market participants had they not participated would have an average annual per capita expenditure of 132 Birr less than what the current non-participants are observed to have. It can also be seen that the current non-participants had they participated would have 225 Birr less annual per capita expenditure than what the current participants are currently having.

The average calorie intake of a typical household who sold his Moringa output is 2586.94 kcal but would be lower (1780.04 kcal) if the household did not participate. On the other hand, for a typical household that does not participate in the Moringa market, participation would increase his/her calorie intake by 497.68 kcal (24%). The transitional heterogeneity effect is positive implying that the effect is greater for the farm households who did participate relative to those who did not participate. Overall, results show the role of Moringa market participation in improving the welfare of the rural households, whereby the resulting increase in crop income from market participation may facilitate the purchase of food and non-food items and improve food security, nutrition, and poverty reduction among smallholder farmers.

3.2.3 Continuous Treatment Effects Estimation Results

The endogenous switching regression method does not take into account the heterogeneity in the impacts of market participation. The Generalized propensity score (GPS) approach is therefore used to analyze the continuous treatment effects of Moringa market participation on the outcome variables.

The GPS model (dose-response function) estimated for Moringa market participation as a continuous dependent variable – which is the intensity of participation – takes only positive values. Therefore, non -participants were discarded from the analysis. The intensity of Moringa market participation (proportion of Moringa output sold), ranges from 0 to 1 that was captured by dividing the amount of Moringa output sold to the amount harvested by each household. Before estimating the generalized propensity score, it is, therefore, required to drop non-participants from the analysis and group the intensity of participation into three clusters at 30% and 70% following the procedure suggested by Kluve *et al.* (2007). Three groups of comparable size were formed based on the proportion of intensity of participation, i.e. group one (≤ 0.173); group two (> 0.173 and ≤ 0.293) and group three (>0.293 and ≤ 1). Group one presents the households with a relatively lower proportion of participations that consists of 57 households; the second group consists of households with a medium proportion of participation which contains 65 households and the third group indicates a relatively higher proportion of participants that consists of 46 samples households.

Figure 1 presents the dose-response and marginal treatment effects on the probability of farmers' welfare concerning the proportion of Moringa output sold. The results reveal that the average welfare of Moringa farmers increases as the proportion of Moringa output sold increases. The shapes of the expected crop income are initially flat indicating that a low level of Moringa market participation has no significant causal effect on household crop income up to about 20% supply doses (Figure 1a). However, as the graphs show, after this optimum supply, household crop income increases with the level of Moringa output sold. The marginal effect functions also show the same as the respective dose-response function (Figure 1b).

The results also reveal that household per capita annual consumption expenditure and the per capita daily calorie intakes slightly increase with the level of Moringa market participation (Figures 2a & 3a). Though the causal relationship is positive, the figure shows that consumption expenditure does not strongly respond to the level of participation. The marginal treatment effects results also tell a similar story for both (2b & 3b). Generally, the welfare of households increased with the level of Moringa market participation reflecting the importance of marketable surplus in market participation and welfare outcomes.

4. Conclusion and Policy Implications

This study evaluates the potential impact of Moringa market participation on household welfare in the Segen Area People zone of southern Ethiopia by utilizing cross-sectional farm household-level data collected from a randomly selected sample of 385 households using endogenous switching regression. This helps in estimating the true impact of market participation on welfare by controlling for the selectivity bias. Besides, the generalized propensity score (GPS) approach is used to evaluate the effects of continuous treatment on the outcome variables.

The results indicate that agricultural factor endowments (farm size, labor, and livestock) and institutional services such as training are the key determinants of both smallholder farmers' market participation and their welfare whereas membership to rural cooperative and beneficiary of NGO market linkage program affects rural farmers welfare. Furthermore, farmers who have contacts with extension agents and access to Moringa market information are very likely to supply the produce to markets whereas the distance to market exerts a negative influence on market participation. The analysis further suggested that education and access to means of transportation are also the main factors facilitating market participation and farmers' welfare.

The result of the ATT reveals that Moringa market participants have a greater average value of crop income of 1463Birr (24%) than their counterfactuals. In the same vein, market participation increases per capita consumption expenditure and calorie intakes by 908Birr (29%) and 807Kcal (45%) respectively compared to non-participants. Similarly, households that did not participate in the Moringa market would have increased their crop income, per capita annual consumption expenditure and per capita daily calorie intake by 15%, 17%, and 24% respectively had they decided to participate in the market. Therefore, farm households who participated would have gained significantly higher welfare than farm households that did not participate had they decided to participate. The result highlights the heterogeneous effect of Moringa market participation between participants and non-participants.

The results from this study confirm the potential roles of enhancing Moringa market participation and level of participation in improving rural households' welfare, as income gains from crop sale would result in increasing consumption expenditure and improving household food security. However, smallholder farmers, tend to face constraints on offering the produce to markets, because of the limited market for their produce. Therefore, awareness campaigns on the importance of the tree trough leaflets, exhibitions, training, workshops, field day, mass media, etc should be intensively used in promoting the tree combined with improved local availability of production and marketing.

Improving information sources such as marketing extension services, training and making them more easily accessible to small-scale farmers could improve their access to market information and enhance their market participation. Further, more efforts should concentrate on rural institution capacity building, providing farmers with basic education, improving infrastructural facilities, value addition and market linkages among diverse market players.

Appropriate institutional support programs that could better link smallholder farmers to markets should be designed. Moreover, to produce Moringa as other cash crops and participate in the market, growers need an assured market for their products. Therefore, government and development agents should work on opening up new markets and also explore export opportunities for Moringa products.

Abbreviations

AE: Adult equivalent; BH: Base heterogeneity; CSA: Central Statistical Agency of Ethiopia; ESR: Endogenous switching regression model; FIML: Full Information Maximum Likelihood; GPS: Generalized propensity score; Kcal: Kilocalories; SAPZ: Segen Area Peoples Zone; TH: Transitional heterogeneity; TLU: Tropical livestock unit

Competing interests

The authors declare that they have no competing interests.

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Notes

Note 1. Birr is the Ethiopian currency (1 US$ = 29.28 Birr, at the time of the survey)

Appendix A

Table 1. Probit model estimates of Moringa market participation

Variables	**Coeff. (Std. Err.)**
Sex of the household head (M = 1)	0.171(0.288)
Age of household head (Years)	0.008(0.006)
Household size (AE)	0.135(0.039)***
Dependency ratio	-0.001(0.001)
Education of the household head (years)	0.062(0.023)**
Training in any agro-forestry practice (Yes = 1)	0.401(0.096)***
Farm size (ha)	0.191(0.158)
Member to rural cooperative (Yes = 1)	0.043(0.164)
Participation in non/off farm activities(Yes=1)	-0.308(0.162)
Access to any means of transportation(Yes=1)	0.445(0.174)***
Livestock owned (TLU)	0.070(0.034)**
Contacts with extension agents (Yes = 1)	0.228(0.158)*
Contacts with NGO market linkage (Yes = 1)	0.217(0.173)***
Had Moringa market information (Yes = 1)	0.426(0.157)**
Distance to main market (Km)	-0.042(0.016)**
Constant	-2.946(0.477)***

Note: Statistical significance at 10% (*), 5% (**) and 1% (***) probablity levels. The number in parenthsis shows robust standard errors..

Table 2. Test on the Validity of the Selected Instruments

Instrumental Variables	Model 1 (participation 1/0)	Model 2 (Welfare by Farm Households that did not participate)		
		Crop income	Consumption expenditure	Daily calorie intake
Extension contact	0.67***(0.140)	910.79 (512.3)	138.66(88.73)	18.67(81.32)
Access to market information	0.63***(0.143)	833.92(512.25)	288.11(489.68)	56.46(73.67)
Distance to market	-0.08***(0.031)	25.63(92.83)	826.67(540.52)	-26.67*(13.35)
Wald test	χ^2 =68.85***	F-stat. =0.63	F-stat. = 1.84	F-stat. =1.63
Sample size	385	218	218	218

Note: Model 1 Probit (For participation decision): model 2; ordinary least squares. (For outcome variable): Statistical significance at 10% (*), 5% (**) and 1% (***) probablity levels. The number in parenthsis shows robust standard errors.

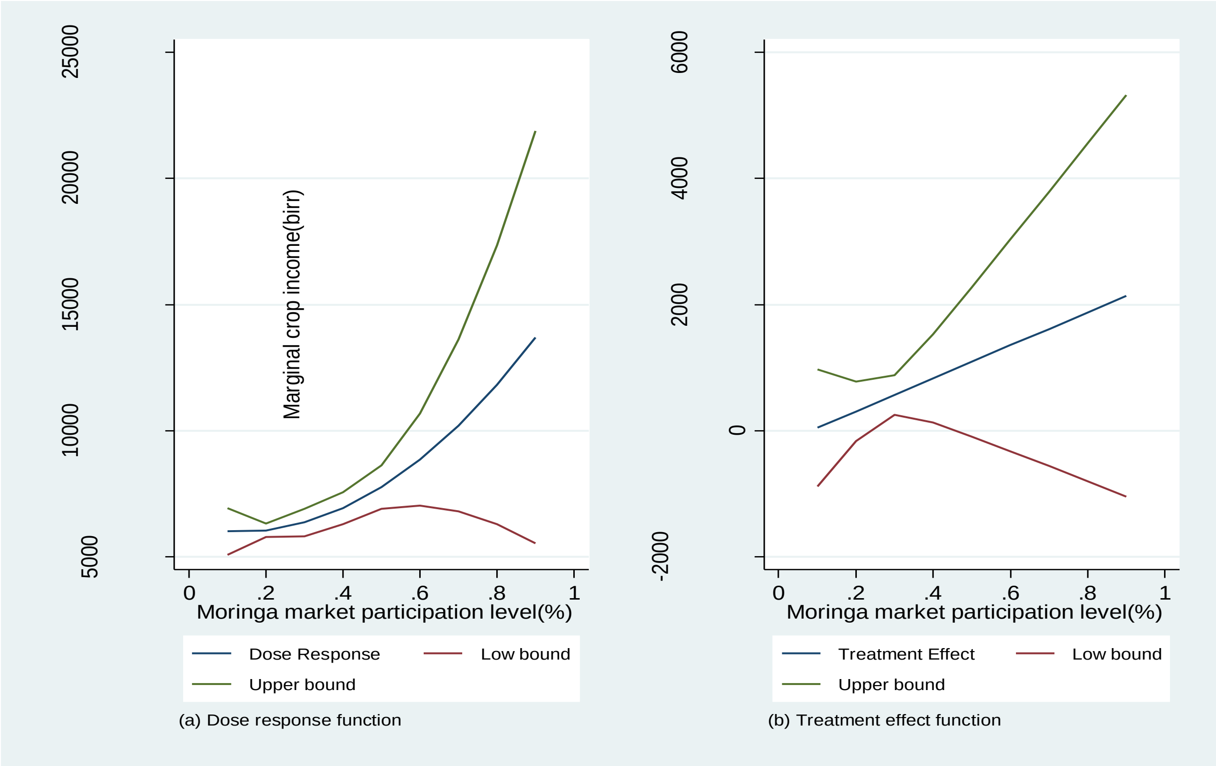

Figure 1. Dose response and marginal treatment effects on crop income

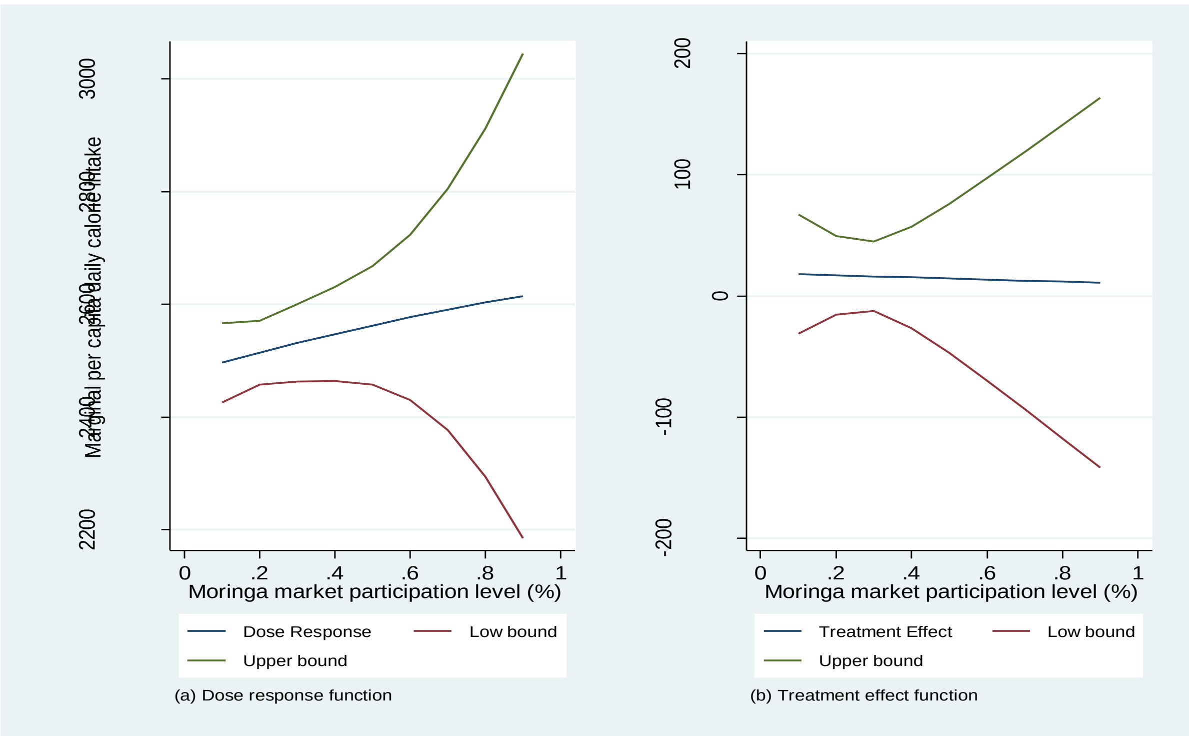

Figure 2. Dose response and marginal treatment effects on per capita consumption expenditure

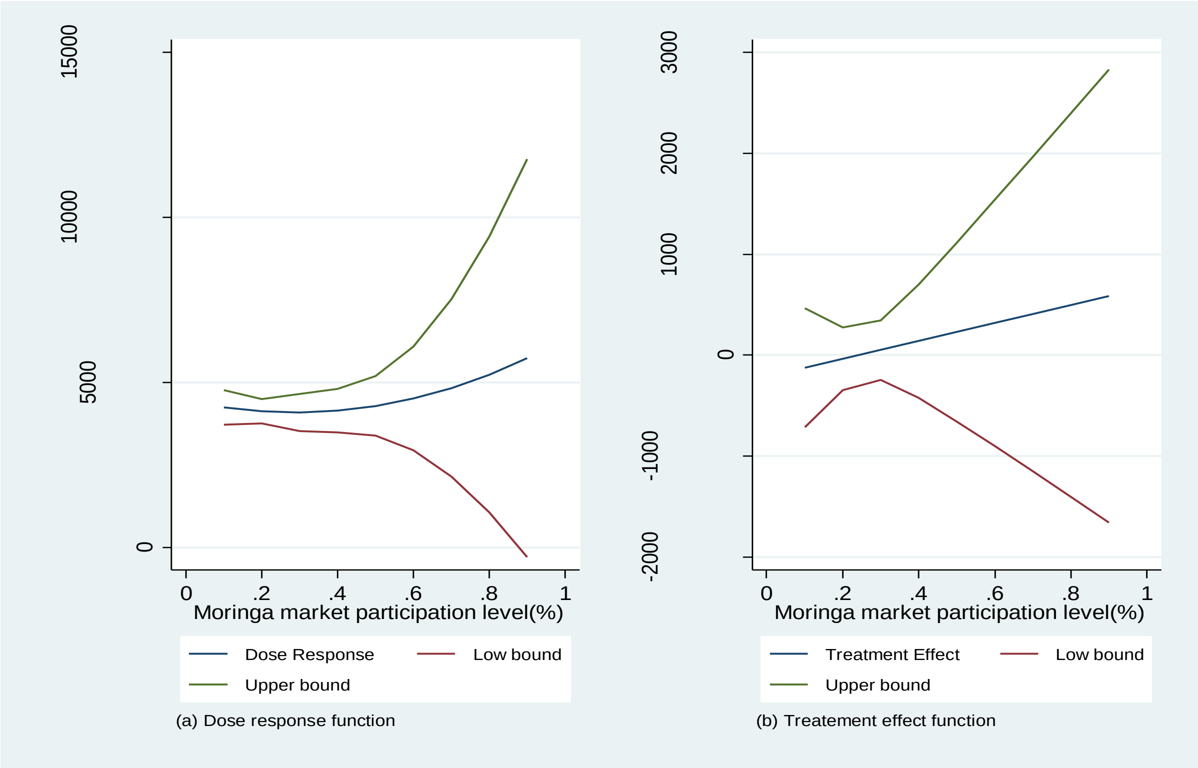

Figure 3. Dose response and marginal treatment effects on per capita daily calorie intake