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Determinants of market participation among smallholder farmers in Southwest Ethiopia: double-hurdle model approach

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Abstract

Background: Agricultural production by smallholder farm households is a means of livelihood for many rural households in developing economies, including Africa. Commercializing smallholder farmers in the agricultural sector is an indispensable path to boost economic growth and development of most developing countries, like Ethiopia. But, maize marketing has not been given due attention, which has potential production volume and marketability. Therefore, this study is designed to identify determinants of market participation decision and volume of supply among smallholder maize producer farmers in Southwest Ethiopia.

Methods: Data for this study were collected through cross-sectional survey from maize producer farm households. The primary data were generated by household survey using a pre-tested structured questionnaire. A both purposive and random sampling technique was used to draw an appropriate sample of 546 maize producer households for this cross-sectional survey study. The data were analyzed using descriptive statistics and double-hurdle econometric model.

Results: The result of the survey indicates that out of total 546 maize producers, 381 households are maize market participants and 165 households are non-participants. First hurdle model results show that nine variables—education level, farming experience, quantity of maize produced, cooperative membership, distance to nearest market, amount of credit received, off/non-farming income, number of oxen and perception about lagged price—significantly affect the market participation decision among maize producer farmers. The second hurdle result confirmed that seven variables—sex, family size, land allocated for maize, number of oxen, distance to nearest market, livestock holding and perception about lagged price—significantly affect the level of market participation by maize producer farmers.

Conclusion: The findings of this study revealed that understanding the factors and its extent is very important for policy-making to address the problem of market participation decision and level of participation among smallholder farm households. Therefore, the study suggests that important resource and socio-economic factors must take into consideration to enhance the productivity and strength supportive institutions or infrastructural facilities in the study area to improve market participation decision and level of participation of smallholders.

Keywords: Market participation, Level of participation, Double-hurdle, Maize, Southwest

Background

Economy of Ethiopia is predominantly agrarian, where 95% of the farm land is cultivated by smallholder farmers and 90% of the total agricultural output comes out of them [1]. The contribution of smallholder farmers is high to the overall agricultural growth in the country

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and the overall economy of Ethiopia depends on agricultural sector development. The movement of agriculture sector depends entirely on what is happening in smallholder sub-sector [2]. Studies indicated that, smallholder farmers are a key solution for economic growth, and for alleviation of poverty and food security problems in developing countries. Considering that issue, Ethiopian government has targeted smallholder farmers as the focal point for economic transformation and agricultural development, and for meeting the current growing food demand [3–5]. Commercial transformation of subsistence agriculture is an indispensable pathway towards economic growth and development for many agriculture-dependent famers in developing countries [6].

In Ethiopia, cereals are the major food crops both in terms of the area they are planted and volume of production obtained. Out of the total grain crop area, 79.83% (11,610,331 hectares) was under cereals and it contributed 87.08% (about 283,922,484 quintals) of the grain production [7]. Maize is one of the most commonly available cereals and source of high-calorie staple human foods, feed for animals and other industrial raw materials in different parts of the country. Also, maize crop is the lowest cost source of cereal calories and effective maize production sector development could push Ethiopia's food supply to quickly reduce the national food deficit and keep pace with a rapid population growth [8]. Southwest Ethiopia, particularly Kaffa, Sheka and Bench Sheko zones, have good potential for cereal crops production for which smallholder farming have diversified from staple food subsistence production into more market-oriented and higher value commodities. In southern Ethiopia, out of the total land allocated for cereal crops, maize accounts 322,714.36 hectares with production level of 10,857,255.50 quintal [9]. But, majority of Ethiopia's smallholder farmers grow maize mostly for subsistence-oriented production, and about three-fourths of the output is consumed at the household level [8]. Rural households' participation in agricultural markets is vital important strategy for poverty alleviation and food security in developing countries [10].

Currently, the government of Ethiopia has designed and implementing second growth and transformation plan (GTP II) as strategy to bring a dynamic change by focusing on productivity improvement and commercial transformation of smallholder subsistence agriculture. Despite these efforts made to commercialize and transform subsistence crop production to production of high-value crops, the current reality shows that commercialization of smallholder farming is much below the expectations and farmers are not yet out of the subsistence-oriented agriculture, low productivity, low income, and low degree of specialization [1, 11–17]. Thus, it is not possible for

the smallholder farmers to integrate with the market and enjoy the benefits of commercialization unless the already existing hurdles are removed and better environment is created. Specific study areas commercialization is affected by institutional factors, infrastructural and market-related factors, resource factors, and household-specific characteristics that influence production and marketing [18–20].

Although, even if the government of Ethiopia focused on commercialization of subsistence agriculture as priority policy decision, market participation by smallholder farmers in Ethiopia is limited and agricultural markets are fragmented and not well integrated into wider market systems which increases transaction costs and reduces farmers' incentive to produce for the market [6]. Thus, there is a dearth of information on the commercialization process and marketing behavior of small holders in Ethiopia.

Despite their undisputed importance, most of the studies conducted on the determinants of smallholders' market participation have methodological gaps of only capturing the revealed marketing decisions of households while they ignored the volume of supply [12, 13, 21–28]. In addition, their findings vary within and across countries due to heterogeneity of factors faced by smallholder farmers, maize market participation decision and factors hindering volume of supply in southwestern Ethiopia were not studied. There have been very limited studies regarding identifying status and determinants of market participation and implications of the challenges on decision-making of smallholder maize production. In this regard, the current study attempted to contribute to redressing this gap of knowledge for the market participation and its intensity in the study area. Therefore, the objective of the study was to identify the determinants of market participation and volume of supply by smallholder maize producers to figure out location-based analysis in Kaffa, Sheka and Bench Sheko Zones, Southwest Ethiopia.

Materials and methods

Description of the study area

The study was conducted in Kaffa, Sheka and Bench Sheko Zone of Southern Nations Nationalities and People's Regional State. Kaffa Zone lies within 07°00'–7°25'North latitude and 35°55'–36°37'East longitude (Fig. 1). The altitude of the study sites ranges from 1600 to 1900 meter above sea level. The topography is characterized by sloping and rugged areas with very little plain land [29]. According to Central Statistical Agency report on population projection the total population of the zone in the year 2017 was estimated to reach 1,102,278. Out of the total population 49.14% and 50.86% are male and

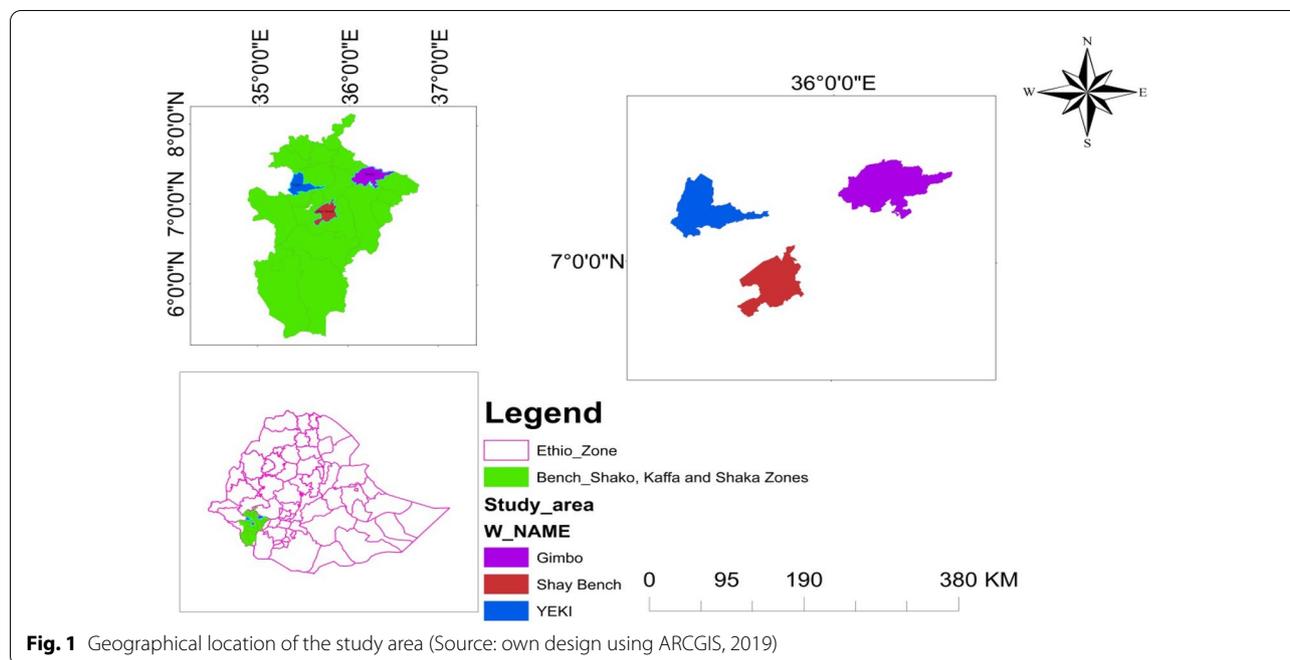


Fig. 1 Geographical location of the study area (Source: own design using ARCGIS, 2019)

female, respectively [30]. Bench Sheko Zone is located 561 km southwest of the capital city, Addis Ababa. The altitude of the zone varies between 700 and 2500 m.a.s.l., and the mean annual rainfall and temperature varies between 400–2000 mm and 15–27 °C, respectively. The total population of Bench Sheko zone in the year 2017 was estimated to reach 847,168. Out of the total population 49.31% and 50.69% are male and female, respectively [30]. Also, Sheka zone lies between 7°24" to 7°52" N, 35°13" to 35°35" E and 900 to 2700 m.a.s.l. The area coverage of Sheka zone is 2175.25 km². It receives high amounts of rainfall, with an average between 1800 to 2200 mm per annum. The major crops grown in the zone are maize, sorghum, millet, beans, coffee, ginger, turmeric, "enset", wheat, barley and pea [31]. According to the report of Central Statistical Agency on these three zones, 852,433 quintal of maize produced from area allocated, 41,804 hectare with productivity of 20 qt/ha [32].

Types and sources of data

In order to generate the relevant data for this study, data were collected by a two-phase primary survey. First, preliminary survey was conducted to broadly understand the farming systems and the major types of crops grown in the study area. During this exploratory survey, formal and informal discussions were held with different stakeholders including crop producing farmers, DAs, agricultural marketing offices, non-governmental organizations (NGOs), and agricultural experts/officers. Purpose of this survey is to facilitate characterization of the existing

farming systems and livelihood strategies of the farm households in the context of their specific socio-economic and biophysical, settings and to refine the study objectives, sampling methods and the survey instrument. Once having the basic information using need assessment survey, main survey was carried out using structured survey instrument. A scheduled interview was made using questionnaire with farm households. The questionnaire was pre-tested and amended based on the feedback received during pre-test. The enumerators, who can speak the local languages and are familiar with the culture of the local people were selected and trained on data collection procedures and interview techniques to simplify the complexity of data collection. Thus, primary data analysis results were supported by secondary sources like; reports of offices, journal articles, books, and empirical findings of different relevant published and unpublished materials to generate relevant supportive data.

Sampling procedure and sample size determination

Smallholder maize producers are the target population for this study. To draw representative sample, a combination of both purposive and random sampling techniques was used. The data were collected from purposively selected three zones, Kaffa, Sheka and Bench Sheko. These three zones were among major maize growing zones in southwestern Ethiopia. From these three zones, according to information obtained from the zones agricultural office, Gimbo district (from Kaffa zone), Shay

Table 1 Zone, districts, *Kebeles*, and sample size proportion. Source: own sampling design

Zone	District	<i>Kebele</i>	Target population	Sample size proportion	Percentage
Kaffa	Gimbo	Kute	1240	37	6.78
		Yabkecha Keda	637	19	3.48
		Yabkecha Welega	1039	31	5.68
		Yertech	1441	43	7.88
		Kicho	670	20	3.66
		Gawo	1608	48	8.79
		Choba	704	21	3.85
Bench Sheko	Shay Bench	Cheda	1407	42	7.69
		Maze	1508	45	8.24
		Kulagecha	1273	38	6.96
		Kuka	1575	47	8.61
		Shapagud	804	24	4.40
Sheka	Yeki	Hibretfre	1876	56	10.26
		Adisbrhan	1374	41	7.51
		Shoshaa	1139	34	6.23
Total		15	18,295	546	100.00

Bench district (from Bench Sheko zone) and Yeki district (from Sheka zone) have a relatively higher potential in maize production than other districts in these zones. Thus, these districts were selected purposively. First, *Kebeles*¹ in the three districts was stratified into maize producers and non-producers. Then, among the maize producing *Kebeles*, 15 *Kebeles* (7 *Kebeles* from Gimbo district, 5 *Kebeles* from Shay Bench district and 3 *Kebeles* from Yeki district) were randomly taken in order to obtain representative sample household heads from the strata. Finally, from total list of maize producer farm households in the 15 *Kebeles*, 546 maize producer sample households were selected by using simple random sampling (SRS) technique based on probability proportional to size (PPS) as presented in Table 1.

Method of data analysis

A both descriptive and econometric statistical tool was used to analyze the data. Under descriptive analysis, mean, frequency, percentages, and standard deviations were used. Inferential statistical tests such as *T*-test and Chi-square test were used for the existence of any statistically verifiable differences among farmers participated and their counterfactuals. Under econometric analysis, double-hurdle model was used to estimate market participation decision and level of participation by smallholder maize producers.

Specification of the econometric model

Different limited dependent models such as double-hurdle model, Heckman two-stage models, and restrictive Tobit model have been used to study crop market participation and its intensity of participation. But, the model specification mainly depends on the purpose of the study and the type of data available. One of the most used methods for modeling market participation behavior is the censored regression model, also called the Tobit model. Tobit model assumes that a household not participating in marketing is making a rational decision and this leads to inconsistent parameter estimates [33].

Double-hurdle is the model introduced as a more flexible and alternative to Tobit model [34]. It assumes a two-step decision process: the first step involves the decision whether to participate in market or not and secondly the intensity of participation. The model estimation involves a Probit regression to identify factors affecting the decision to participate in marketing by using all sample households in the first-stage, and in the second-stage, the intensity of the participation was analyzed by truncated regression model.

Heckman two-stage model has been used extensively to correct for bias arising from sample selection [35]. In this model, the decision to participate is sequential two-stage decision-making process. One problem with the two-stage decision-making process is that the two-stage decision-making processes are not separable due to unmeasured variables determining both the discrete and continuous decision, thereby leading to the correlation between the errors of the equations. If the two errors are

¹ *Kebele* is the lowest administrative unit.

correlated, the estimated parameter values on the variables determining the intensity are biased [36]. Besides, there were many zeros in the dependent variable of second-stage, OLS estimation was biased because of duplications of many zeros which results no variability.

The double-hurdle procedure with Probit and truncation regressions was used separately to correct the above limitations. The model is a parametric generalization of the Tobit and Heckman model, in which two separate stochastic processes determine the decision to participate and the level of participation [33]. In addition, using double-hurdle model provides consistent and asymptotically efficient estimates for all the parameters. Thus, double-hurdle model was used to analyze decision to participate and intensity of participation. Selection model was not appropriate for this data set since the mills lambda (IMR=0.118) is insignificant. Thus, the Heckman is not appropriate for the data set of this study. Also, the most restrictive Tobit model and double-hurdle model were compared, and finally double-hurdle model found appropriate for the data set using model specification test (Tobittest (LR)=2 * (LL Probit + LL truncreg-LL Tobit)).

Specification of double-hurdle model

As specified below, the double-hurdle model involves two-step estimation procedure. In the first-stage, Probit regression was used to identify factors affecting adoption decision. The model takes a value 1 and 0 that are assigned to represent the choice whether a producer decides to adopt or not. The standard Probit model that assesses the household adoption decision was described in Eq. (1) as:

$$D_i = \alpha Z_i, k + \varepsilon_i \quad (1)$$

$$D_i = 1, \text{ if } D_i^* > 0,$$

$$D_i = 0, \text{ if } D_i^* \leq 0,$$

where D_i is a dummy variable that takes the value 1 if the producer participate in crop commercialization and 0 otherwise, Z_i is a vector of independent variables hypothesized to influence participation decision, k is the regressors, α is a vector of parameter to be estimated and ε_i error term. In the second-stage, truncated regression that excludes part of sampled observation based on the value of the dependent variable was used [36]. The regression considers the observations that take 1 for participation decision. Therefore, the second hurdle represents the actual level of participation, expressed by the volume of supply; the truncated regression model with the lower left truncation equal to 0 was used to determine factors affecting the intensity of participation.

The truncated regression model for intensity of participation was described in Eq. (2) as:

$$y_i = \beta_i \chi_i + \mu \lambda_i + \varepsilon_i$$

$$y_i^* = \beta_i \chi_i + v_i$$

$$y_i = \{y_i^* \text{ if } y_i^* > 0 \text{ and } D_i = 1; 0 \text{ otherwise}\} \quad (2)$$

where y_i^* and y_i are latent and the observed intensity of participation, respectively, χ_i is a vector of variables influencing intensity of participation and β is a vector of parameters to be estimated. The error terms are assumed to be independently and normally distributed as both decisions made by the individual producer independently which are as: $u_i \sim N(0, 1)$ and $v_i \sim N(0, \sigma^2)$.

The log-likelihood function for the double-hurdle model that nests Probit model and a truncated regression model is given following [37] as:

$$\begin{aligned} \text{LogL} = \sum \ln \left[1 - \Phi \left(Z_i' \alpha \right) \left(\frac{x_i' \beta}{\sigma} \right) \right] \\ + \sum \ln \left[\Phi \left(z_i' \alpha \right) \frac{1}{\sigma} \phi \left(\frac{y_i - x_i' \beta}{\sigma} \right) \right] \end{aligned} \quad (3)$$

where Φ and ϕ refer to the standard normal probability and density functions, respectively, Z_i and X_i represent independent variables for the Probit model and the Truncated model, respectively, α , σ , and β are parameters to be estimated for each model.

Hypothesis, variable descriptions and expected sign

Identifying factors determining market participation decision and level of participation of maize producers, exploring which factors significantly influence and how these factors are related with the dependent variables are required. Hence, the following dependent and independent variables were defined and hypothesized for this study as presented in Table 2.

Results and discussion

Descriptive statistics

The demographic, institutional, and resource ownership characteristics of sample households were addressed by different descriptive statistical measures such as frequency or mean and percentage values of variables used in the model briefly. As indicated in Tables 3 and 4, group comparisons of the market participants and non-participants were computed using t -test for continuous variables and χ^2 -test for dummy variables. The result of the survey indicates that out of total 546 maize producer farm households, 381 households were participated in maize market and 165 households are non-participants in 2018/19 production year.

Table 2 Summary of variable description and expected sign. Source: own design

Variables	Type	Descriptions and measures	Expected sign (hypothesis)	Theoretical suggestions and empirical literatures to support hypothesis
Dependent variable				
Market participation decision	Dummy	It is a binary dependent variable that represents the probability of market participation of the producers in the maize market. The variable takes the value of 1 for the household who participate in the market, where as it takes the value of 0 for the household who does not participate in the maize market		
Quantity of maize sold (Log)	Continuous	A continuous variable that indicating the amount of maize actually sold and measured in kilogram		
Independent variables				
Farming experience	Continuous	A continuous variable measured in years of farming	+	This is supported by empirical study conducted by [38, 39]
Sex of household head	Dummy	1 if the household head is male and 0 otherwise	±	Empirical studies conducted by [5, 22, 25, 28, 40, 41] found indeterminate results
Education level of HH	Continuous	Education level of household heads in number of years completed	±	Empirical studies conducted by [22, 42–44] found indeterminate results
Family size	Continuous	Total number family size in the household	+	A study conducted by [45–48] found positive result
Number of oxen owned	Continuous	Total number of oxen owned by the household head in terms of number	±	This is supported by empirical study by [49, 49–51] found indeterminate results
Land allotted for maize	Continuous	Total land size allotted for maize crop measured in hectare	+	Empirical studies conducted by [28, 51, 52] positive result
Participation in training	Continuous	It takes 1, if the household head participated training and 0 otherwise during survey period	+	Findings of [53] found positive effect
Livestock holding	Continuous	Total livestock holding in terms of Tropical Livestock Unit (TLU), excluding oxen	±	This is supported by findings of [54, 55] found indeterminate results
Amount of credit	Continuous	Amount of credit received by household in terms of Ethiopian Birr during survey period	+	This is supported by empirical study conducted by [14, 56, 57]
Quantity of maize produced	Continuous	Total quantity of maize produced by household in kilogram	+	It is supported by empirical study conducted by [21, 58] found positive effect
Cooperative membership	Dummy	1 if household is member and 0 otherwise	±	Empirical studies conducted by [59, 60] found indeterminate results
Distance to nearest market	Continuous	Distance to nearest market in walking minutes	–	Empirical findings of [14] found negative effect
Perception about lagged market price	Dummy	1 if the household head has high perception about market price and 0 otherwise	+	A study conducted by [44] found positive result
Non/off-farm income	Continuous	Amount of income obtained from non/off-farm activities (in Ethiopian Birr) annually	±	Empirical studies conducted by [39, 42, 61, 62] found indeterminate results
Distance to nearest road	Continuous	Distance to nearest all round road in terms of walking minutes	–	Empirical studies conducted by [19, 63] found negative effect

The survey result indicated that, the average age of maize market participants was about 41.730 years while for non-participants was about 43.455 years as presented in Table 3. This shows that, aged household heads were less participated in maize market than younger

households. The average family size of the maize market participants was 5.719 and 5.812 for non-participants. This implies that large family could absorb a significant portion of the produce to home consumption. Study result shows that, the average education level of maize

Table 3 Demographic characteristics of sample households. Source: Survey data, 2018/2019

Variable description	Participant (n = 381) Mean (std. dev.)	Non-participant (n = 165) Mean (std. dev.)	Total (n = 546) Mean (std. dev.)	t-value/ λ^2 value
Age of household head	41.730 (10.897)	43.455 (11.925)	42.251 (11.234)	1.650
Family size	5.719 (2.284)	5.812 (2.866)	5.747 (2.472)	0.403
Education level of HH	3.302 (2.722)	4.212 (2.355)	3.577 (2.648)	3.732***
Farming Experience	19.472 (10.136)	21.660 (9.728)	20.134 (10.056)	2.345**
Sex of HH: male	302 (68.330)	140 (31.670)	442 (80.950)	2.328*
Female	79 (75.960)	25 (24.040)	104 (19.050)	

***, ** and * represent statistical significance of factors at 10, 5 and 1% levels, respectively

Table 4 Resource ownership and institutional characteristics of sample households. Source: Survey result of 2018/2019

Variable description	Participant (n = 381) Mean (std. dev.)	Non-participant (n = 165) Mean (std. dev.)	Total (n = 546) Mean (std. dev.)	t-value/ λ^2 value
Land allotted for maize (hectare)	0.970 (0.626)	0.849 (0.571)	0.933 (0.612)	2.117**
Quantity of maize produced (kilogram)	1512.800 (1408.420)	673.333 (486.320)	1259.115 (1266.152)	7.463***
Quantity of maize sold (kilogram)	963.614 (1162.838)	0.000 (0.000)	672.412 (1067.230)	10.639***
Number of oxen owned (count)	2.388 (1.338)	2.103 (1.328)	2.302 (1.340)	2.294**
Extension contact (frequency)	7.567 (9.208)	11.782 (11.479)	8.841 (10.125)	4.547***
Amount of credit (Ethiopian Birr)	4466.182 (17,222.540)	2252.150 (4206.060)	2921.230 (10,130.520)	2.355**
Off/non-farm income (Ethiopian Birr)	1292.650 (3139.996)	1201.697 (2318.710)	1265.165 (2914.480)	0.335
Distance nearest road (walking minutes)	31.430 (23.268)	36.218 (30.836)	32.877 (25.855)	1.993
Livestock holding (TLU)	5.141 (2.452)	4.952 (2.507)	5.084 (2.468)	0.823
Distance to nearest market (walking minutes)	63.472 (36.651)	74.495 (48.230)	66.803 (40.771)	2.921**
Lagged market price perception: good	236 (76.380)	73 (23.620)	309 (56.590)	14.684 ***
Otherwise	145 (61.180)	92 (38.820)	237 (43.410)	
Cooperative membership: members	180 (68.700)	82 (31.300)	262 (47.990)	0.2775
Non-members	201 (70.770)	83 (29.230)	284 (52.010)	
Participation in training: trained	249 (67.120)	122 (32.880)	371 (67.950)	3.8965**
Non-trained	132 (75.430)	43 (24.570)	175 (32.050)	

***, ** and * represent statistical significance of factors at 10, 5 and 1% levels, respectively

market participants was 3.302 while that for non-market participants was about 4.212. Thus, the level of education was statistically significant at 1%, signifying that the mean education level of market participants was less than that of non-market participants. As presented in Table 3, farming experience for maize market participants was 19.472 years while that for non-market participants was about 21.660 years. Also, 302 maize market participants and 140 non-participants were male-headed households. On the other hand, 79 participants, and 25 non-participants were female-headed households (Table 3).

As presented in Table 4, the average land allocated for maize crop by market participant households was 0.970 hectare while that of non-participants were 0.849 hectare. The result showed that land allocated for maize was statistically significant at 5%. Thus, shows that the mean land of market participants was greater than that of non-market participants. This may indicate land allocated for

maize could be seen as an incentive to produce surplus for market. The average annual maize production for market participants was 1512.800 kg while that of non-market participants was 673.333 kg. Thus, high quantity of harvest could lead households to higher level of market participation.

A study result depicts that, the average extension contact by smallholder farmers was 7.567 for maize market participants and 11.782 for non-participants. This might be smallholder maize producers who have frequent contact with development agent could not get practical information on new technologies and agronomic practices which might boost their maize production. Instead development agents out of their profession, might spend their time with farmers talking about other issues which are not directly relevant to enhance farmers' production and productivity. In the study area, the average amount of credit obtained by sample households during the

survey period was 4466.182 Ethiopian Birr/year for maize market participants and 2252.150 Ethiopian Birr/year for non-participants. This shows that farm households who obtained high amount of credit participated in maize market more than non-participants. The survey result in Table 4 depicts that average distance to the nearest market for the maize market participants was 63.472 while of non-participants was 74.495 walking minutes. Thus, there was statistically significant difference in distance to the nearest market across the maize market participants and non-participant households at $P < 0.05$.

As presented in Table 4, 236 market participant households had good perception about lagged market price while 145 maize market participants had less perception about lagged market price. On other hand, about 73 of non-market participants had good perception about lagged market price while 92 non-market participants had less perception about lagged market price. The result shows significant difference between the groups in terms of perception about lagged market price at 1% significant level. Regarding cooperative membership, out of the total sample households 180 were member of the multi-purpose cooperative and participated in maize market while 201 were non-members and participated in maize market. On the other hand, about 82 of non-market participants were member of cooperative and the remaining 83 non-participants were not members of cooperatives. Additionally, 249 market participant households got training while 132 market participants did not participate in training. On other hand, about 122 of non-market participants participated in training and the remaining 43 non-market participants did not participate in training. The result shows significant difference between the groups in terms of participation in training for maize market at 5%.

Econometrics analysis

Determinants of market participation decision by smallholder maize producers

The analysis of factors affecting smallholder farmers' participation decision and its intensity in maize market was analyzed by using double-hurdle model regression. However, before running the final regression analysis all preliminary tests were made. Results for the determinants of maize market participation have a binary nature and estimated using the Probit model (the first-stage or tier one) as presented in Table 5. The likelihood ratio test indicates that, the overall goodness of fit of the double-hurdle model is statistically significant at $P < 0.01$ significance level. This indicates that explanatory variables jointly explained the probability of participating in the maize market.

The double-hurdle model was fitted with 15 explanatory variables as presented in Table 5. The first-stage model results show that nine variables—education level, farming experience, quantity of maize produced, cooperative membership, distance to nearest market, amount of credit received, off/non-farming income, number of oxen and perception about lagged price—significantly affect the market participation of smallholder maize producer farmers. While the second-stage result confirmed that seven variables—sex, family size, land allocated for maize, number of oxen owned, distance to nearest market, livestock holding and perception about lagged price—significantly affect the volume of supply to market by smallholder maize producer. The significant variables are described as follows.

Education level had negative and significant influences on the farmers' participation decision in maize market at 1% significance level. This indicates that attending education may create other job opportunities to participate in non-agricultural activities as employee. Marginal effect shows for each additional year of education, the farmers' participation decision in maize market decreases by 2.74%, holding all other factors constant. This result is in line with [42] who found a negative and significant relationship between education level and maize producer market participation decision.

Farming experience is found to be significantly and negatively influencing market participation at 5% significance level. An increase in the farming experience of household head by 1 year decreases the probability of participating in the maize market by 0.42%, all other factors held constant. This implies that older farmers (more experienced household heads) might be more concerned about being food secured and would not want to take the risk of demanding their crop banks. On contrary, younger household heads would engage in the markets probably they are more dynamic to adopt new technologies that enhance productivity. This result is consistent with the finding of [38] who found that that farming experience has negative effect in market participation decision.

Numbers of oxen owned have significant and positive effect on the probability of household participation in maize market at 5% level of significance. Ox is a production asset used in the study area. This implies that on average the probability of farmers' decision to participate in maize market increased by 4.04% as one additional ox to the maize producers. Thus, farmers owning higher number of ox can produce more maize output which increases marketable surplus. This finding is in agreement with finding of [64] who found that ownership of oxen increases output market participation due to its effect on production. Evidence from the study area reflected that farmers who had more number of oxen

Table 5 Estimates of double-hurdle model for determinants of market participation. Source: own computation from survey result, 2018/19

Description of variables	First-stage (Tier 1)			Second-stage (Tier 2)		
	Coef	Std. err.	Marginal effect	Coef.	Std. err.	P > z
Sex of the household head	− 0.204	0.170	− 0.0560	0.198*	0.119	0.095
Education level	− 0.116***	0.028	− 0.0274	0.013	0.019	0.502
Farming experience	− 0.016**	0.007	− 0.0042	− 0.001	0.005	0.815
Cooperative Membership	0.277*	0.153	0.0600	− 0.117	0.106	0.272
Family size	− 0.008	0.028	− 0.0070	− 0.036*	0.021	0.092
Land allocated for maize	0.094	0.132	0.0038	0.789***	0.085	0.000
Number of oxen owned	0.149**	0.074	0.0404	0.181***	0.052	0.001
Distance to the nearest market	− 0.043**	0.022	− 0.0136	− 0.040**	0.016	0.015
Credit amount received (log)	0.033*	0.019	0.0116	0.019	0.013	0.154
Off/non-farm income (log)	− 0.069***	0.020	− 0.0234	− 0.021	0.015	0.168
Access to training	0.220	0.141	0.0614	− 0.068	0.099	0.490
Livestock ownership (TLU)	0.002	0.041	− 0.0067	− 0.183***	0.030	0.000
Perception on lagged price	0.068***	0.019	0.0240	0.058***	0.015	0.000
Maize quantity produced (log)	0.617***	0.093	0.1595			
Distance to nearest road				− 0.021	0.027	0.428
_cons	− 3.703***	0.697		5.537***	0.303	0.000
Sigma				0.896***	0.032	0.000
Wald/LR chi-square	127.630			178.750		
Number of observations	546					
Wald Chi ² (14) =	97.520					
Prob > Chi ²	0.000					
Log likelihood (double-hurdle)	− 769.546					

***, ** and * represent statistical significance of factors at 10, 5 and 1% levels, respectively

were wealthier and had sufficient number of oxen to plough their field timely as a result of which they quickly decided to participate in the agricultural production activity. Oxen ownership was very important for farm operations. The same results were reported by [38, 65]. This implies that oxen ownership has an influence on the participation decision in marketing in different areas.

Distance to nearest market has negative effect on maize market participation and found to be statistically significant at 10% significance level. The negative relationship indicates that the further is a household from the maize market, the more difficult and costly it would be to get involved in the maize market. The nearer a farmer is to the market, the easier to take the products to the market since the farmer may not incur a high cost for transportation. The marginal effect also confirms that an increase in walking minutes to the nearest market by one minute in maize market from the farm owner reduces the probability of participation decision in maize market by 1.36%. This result is in agreement with the work of [63] and [66] who found the negative relationship between distance to market and the probability of participation in milk market. A study done by [19] also revealed that the longer

the distance to the nearest market, the lower the participation of smallholder farmers in the marketing of their produce.

Credit amount received (log) has positively and significantly affected market participation decision of maize farmers at 10% significance level. The results of the study revealed that as the households obtained 1% of the amount of credit the probability of maize market participation will increase by 1.16%, all other factors held constant. This suggests that an increase in amount of credit improves the financial capacity of farmers to buy improved inputs, thereby increasing production which is reflected in the market supply of maize. This finding is in line with [57] who found that credit access had positive and significant influence on farmers' decision to participate in grain marketing. [14] also showed that positive and significant relationship between amount of credit and market participation decision.

As hypothesized, off/non-farm income (log) of the household heads had negatively affected maize market participation decision at 1% significance level. The marginal effect of the variable confirms that on average, if a maize producer gets off/non-farming income

increment by 1% causes 2.34% reduction in probability of participating in maize market. This may be explained by the fact that farmers who have better non-farm income will not tend to generate cash from the selling of agricultural commodities (maize) rather from their non-farm income and consumes all produced maize for their household members. The possible reason is that maize commercialization is risk-bearing agricultural activities as compared to non/off-farm income-generating activities. Furthermore, engagement in non/off-farm activities easily generates income in a short period of time. This finding is in line with the finding of [42] who found that getting more non/off-farm income represents additional wealth which constrains households not to participate in cash crops.

As it was expected, perception on lagged market price affected the farmer's decision to participate in maize market positively and significantly at 1% significance level. This result indicates that, as the farm household perceives previous year price was good the decision to participate will increase the probability of farmers to participate in maize marketing by 2.4%, all other factors held constant. In line with this, a study conducted by [67] found that lagged price had a positive and significant effect on tomato farmers' decision to participate in the tomato market.

Quantity of maize produced (log) positively and significantly affects the probability of participation at 1% significant level. The positive and significant relationship between the variables indicates that as the amount of maize output produced increases, the probability of maize market participation also increases. The marginal effect of the variable also confirms that a 1% increase in amount of maize produced leads to the rise of the probability of maize household participation by 15.95%. This can be explained by the fact that the higher the produce, the higher the farmers' motivation to participate more to generate additional income. This may also suggest that building the capacity of households to produce surplus production could be critical in improving households' participation in the market. This finding tallies with that of [21] who found that in Ethiopia when farmers produce more red bean, it motivates them to sell more. The higher the output, the higher is the farmer willing to participate in the market. [58] study found that in Ethiopia an increase in the number of livestock increased livestock farmers' market participation decision [55]. also found that when farmers produce more pepper, they are more likely to participate in the output market.

Factors influencing intensity of maize market participation

The estimates factors affecting intensity of market participation second-stage of double-hurdle (log truncated) model was employed. Thus, the second hurdle result confirmed that seven variables—sex, family size, land allocated for maize, number of oxen owned, distance to nearest market, livestock holding and perception about lagged price—significantly affect the level market participation by smallholder maize producer.

The model result shows that, sex of the household significantly and positively influenced maize market participation level less than 10%. Keeping other factors constant, as compared to the female-headed household male-headed household levels of maize market participation increase by 19.8%. Because female-headed households are busy in doing of additional tasks like child caring, cooking in addition to farm activities. Besides, male-headed households have strong bargaining power in the marketing of the product and easy access of resources than their counter side. The result is consistent with the findings of [5, 22, 28, 41]. They argued that males are more accessible to land and can cultivate large plots of land as compared to their female counterparts.

As presented in Table 5, family size affected the level of market participation negatively and significantly at less than 10% level of significance. This entails that keeping other factors constant, an increase in family size by one result in a decrease in the level of maize market participation by 3.6%. This indicates the volume of maize marketed would be determined by the number of family in the household. The higher the number of families, the higher amount of quantity would be required for consumption. That is, households with large family sizes need to feed their family first and take the remaining small portion surplus to the market Then this results in a lower amount of maize quantity would be marketed and it brings a low level of market participation. The result is consistent with the finding of [28, 40, 49, 54, 68].

Land allocated for maize production had a positive and significant contribution to the level of maize market participation at less than 1% level of significance (Table 5). An increase in landholding by one hectare results an increase in the level of participation in the maize market by 78.9% of maize. This is due to the reason that owning of the large area of land enables them to produces for market purposes and supply more amount of maize product to the market. This result was in confirmatory with the finding of [28, 51, 52] found that land allocated for output production positively affected marketable surplus of outputs.

Oxen ownership was found to have a positive and significant influence on the level of participation in maize market at less than 1% level of significance. An increase

in the number of oxen ownership by one unit results in an increase in maize market participation level by 18.1%. Since oxen are used as traction power which enables farm households to produce in large quantity and enhances the market participation level. This result was in line with the finding of [13, 49–51], confirming that the number of oxen influences market participation level positively.

As hypothesized, the distance to the nearest market had negatively and significantly affected the intensity of maize market participation at a 5% significance level. The result showed that an increase in walking minutes to the nearest market by one minute, the level of participation in maize market decreased by 4%. Since maize is one of the agricultural products which was difficult to carry and travel long distance for long hour. The result is in line with the findings of [40, 50] that state as the longer the distance of the market it is more costly and time-consuming to travel holding more output especially if there is no transportation facility.

The number of livestock owned by households is negatively and significantly affects the intensity of market participation at less than 1% level significance. The model result revealed that an increase in the number of livestock by one tropical livestock unit results in a decrease in market participation level by 18.3%. It is known that livestock and crop production are competing enterprises for the available resources. This means that households who have large size livestock give more resources and more time in deployment. Hence, this in turn results decrease in the market participation level of farm households. This result was in line with the finding of [50, 54, 68, 69] found that large size of livestock ownership reduces the market participation level of the crop.

Finally, as indicated in Table 5, households' perception towards lagged year market price significantly and positively affected the level of maize market participation at less than 1%. It was expected that farmers could have different perceptions regarding with maize market lagged year price. According to model results as compared to households who perceive low lagged year prices, households who perceived high lagged year price level of participation increases by 5.8%. The finding is in line with the finding of [28, 40, 62, 70] who state that high perception of lagged year enabled level of market participation.

Conclusions

Considering the smallholder farmers' market participation is a critical issue in improving household welfare in rural areas and poverty reduction in developing countries like Ethiopia. However, given the area coverage and high production of major food cereal crops such as maize by smallholder farmers, they face several constraints that make it difficult for them to participate

in the agricultural markets. The study result generated good information through employing double-hurdle model approaches on constraints hindered the smallholder farmers' participation decision on maize market. Results of cross-sectional survey indicates that, out of total 546 maize producers, 381 households are maize market participants and 165 households are non-participants in 2018/2019 production year. The double-hurdle model approaches findings suggest that education level, farming experience, quantity of maize produced, cooperative membership, distance to nearest market, amount of credit received, off/non-farm income, number of oxen owned and perception about lagged price significantly affect the market participation decision of smallholder maize producer farmers. While, sex of household head, family size, land allocated for maize, number of oxen owned, distance to nearest market, livestock holding and perception about lagged price significantly affect the level market participation by smallholder maize producers. The findings of this research indicated that higher levels of crop production enhanced smallholders' market participation, implying that strategies that aim at improving household capacity to produce surplus production through optimal allocation of resources like land, oxen and enhancing productivity, could have high returns in promoting smallholders' commercial transformation. Government sectors should work together on strengthening, time allocation for non-farm activities, and family planning programs through control policies on improving rural family planning to enhance farmers' livelihood and market participation and become commercial oriented producers. Based on the findings of this study, it is recommended that strengthening supportive institutions such as credit access would create financial capacity of farm households to purchase agricultural inputs and other expenses; thereby increase market supply and improve their market participation decision. In addition, findings indicate that promotion of better access to infrastructure like market networks, price information, road and transport facilities and other institutional services to promoting market participation among smallholder farmers. Therefore, understanding these socio-economic factors is very important for policy-making to address the problem of market participation decision and its intensity among small holder farm households.

Abbreviations

CSA: Central Statistical Agency; ETB: Ethiopian Birr; HH: Household head; IFPRI: International Food Policy Research Institute; kg: Kilogram; NGOs: Non-governmental organizations; MoARD: Ministry of Agriculture and Rural Development; PPS: Probability proportion to size; SNNPRS: South Nations Nationalities and Peoples Region State.

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Authors' contributions

KH, EG and AW equally contributed to conceptualization; methodology; software; formal analysis; investigation; resources; data curation; writing—original draft preparation; writing—review and editing; visualization; supervision; project administration; funding acquisition. All authors read and approved the final manuscript.

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Availability of data and materials

The data used to support the findings of this study are available from corresponding author upon request.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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