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Article

How does who-you-sell-to affect your extent of market participation? evidence from smallholder maize farmers in Northern Ghana

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*Corresponding author: Agness Mzyece, Department of Economics, California State University, Stanislaus, 1 University Circle, Turlock, CA, United States of America
E-mail: amzyece@csustan.edu

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Robert Read, Economics, University of Lancaster, United Kingdom

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DEVELOPMENT ECONOMICS | RESEARCH ARTICLE

How does who-you-sell-to affect your extent of market participation? evidence from smallholder maize farmers in Northern Ghana

Agness Mzyece^{1*}, Aleksan Shanoyan², Vincent Amanor-Boadu², Yacob Abrehe Zereyesus³, Kara Ross⁴ and John N. Ng'ombe⁵

Abstract: This study examines the effect of marketing channel choice on the extent of market participation, with the goal of helping farm managers and policymakers to identify ways of enhancing market participation outcomes. The study uses data from 383 smallholder maize farmers who were part of the respondents to the Agriculture Production Survey conducted in 2014 and the Population-Based Survey conducted in 2012 in Northern Ghana. Econometric analysis was performed using the double hurdle model to account for data censoring in a more flexible way. Findings indicate that smallholder farmers in Ghana sell larger maize quantities when they sell to aggregators than when they sell directly to consumers. By changing from selling to consumers to selling to aggregators, farmers can increase the amount of maize sold by 128.46 kg conditional on participation and by 43.41 kg unconditional on participation. This is potentially due to the scale advantages and non-pecuniary cost savings that aggregators present. The results imply that facilitating access to aggregator-type middlemen may improve market participation in markets where market infrastructure and institutions are not developed enough to substantially lower pecuniary and non-pecuniary marketing costs of selling directly to consumers.

Subjects: Rural Development; Economics and Development; Marketing Research

Keywords: double hurdle model; marketing channel; market participation; marketing costs; Northern Ghana

1. Introduction

Smallholder producers are considered market participants when they sell some or all of their surplus produce. The development community believe that market participation offers potential benefits to smallholder farmers in several ways. For example, it has the potential to increase farm

PUBLIC INTEREST STATEMENT

We examine the effect of marketing channel choice on the extent of market participation using survey data collected in 2014 and 2012 from 383 smallholder maize farmers in Northern Ghana. For econometric analysis, the double hurdle model was used to account for data censoring in a more flexible way. Findings indicate that smallholder farmers in Ghana sell larger maize quantities when they sell to aggregators than when they sell directly to consumers potentially due to the scale advantage and non-pecuniary cost savings that aggregators present. The results imply that facilitating access to aggregator-type middlemen may improve market participation in markets where market infrastructure and institutions are not developed enough to substantially lower pecuniary and non-pecuniary marketing costs of selling directly to consumers.

profitability (Alene et al., 2008; Barrett, 2008; Mzyece, 2021) and improve production efficiency resulting from exposure to new products and to competition (Bekele et al., 2010; Rios et al., 2009). Market participation also produces new income sources for a farm household, leading to improved household welfare (Jagwe et al., 2010; Musara et al., 2018). Despite these potential benefits, the empirical evidence from sub-Saharan Africa shows low levels of market participation by smallholder farmers (Mmbando et al., 2016; Okoye et al., 2016). High participation costs are the principal reason for this prevailing situation.

Various marketing channel options exist for farmers who choose to participate in the market. For example, they may choose to sell directly to consumers or to intermediaries (middlemen) such as aggregators and wholesalers who procure directly from farmers for resale. Aggregators are both small-scale and large-scale buyers who buy from farmers by setting up assembling/aggregation points/bases in villages and sell to other middlemen or directly to consumers (Adams, 2016; Bhanot et al., 2021). These marketing channels have their own distinct characteristics that would attract or deter farmers. Mzyece (2021) contends that the characteristics of a marketing channel could uniquely cater to the needs of different farmers depending on their socio-economic situation or geographical location. As such, the choice of marketing channel could be a useful tool for improving market participation and its outcomes. The current understanding on the relationship between marketing channel choice and market participation is, however, inadequate, leading to suboptimal market participation outcomes (Abu et al., 2014; Martey et al., 2012a, 2012b). Previous studies on market participation have mainly focused on the impact of demographic, production and transaction costs on market participation, while the literature on marketing channel choice and its influence on market participation has remained relatively underdeveloped. This study therefore seeks to fill this gap in literature by addressing the following research question: what is the effect of marketing channel choice on the amount of produce sold?

The study was conducted in Ghana, one of the fastest-growing economies in Africa. The specific study area was Northern Ghana, a region characterized by smallholder agricultural production and relatively poor transportation and communication infrastructure (Lu et al., 2021; Mzyece & Ng'ombe, 2021). In the context of Northern Ghana and at the time at which this study was carried out, previous crop market participation studies were limited to two papers by Zanello (2012), and Zanello et al. (2014), which studied the impact of information communication technologies (ICTs) on market participation. Since then, more crop market participation studies have been conducted (e.g., Zakaria, 2017; Mustapha et al., 2017; Kondo, 2019; Mzyece, 2021; Bannor et al., 2022). While the number of crop market participation studies for Northern Ghana is burgeoning, studies that examine smallholder market participation in different marketing channels in the region are scanty. To the best of our knowledge, no other study has attempted to address the specific question of how the choice of marketing channel affects farmers' extent of market participation in the region. Our study attempts to shed light on this question.

In addition to extending literature on market participation in Northern Ghana, this study is specifically important because of the interventions that are being undertaken by development agencies, such as the US Agency for International Development (USAID) in Northern Ghana (Mzyece, 2021), which promise to expand agricultural production and improve agricultural commodity markets. The results of this study will provide empirical evidence on the role of marketing channel on farmers' market participation. Given the representativeness of farmer characteristics, commodities, market structures and infrastructure availability in the study area, the lessons from this study may be applicable to other areas within sub-Saharan Africa that exhibit similar characteristics.

2. History of maize and its production in Ghana

Maize (*Zea mays* L.) is one of the most cultivated crops in the world and has continued to be utilized by many people over the years (Ng'ombe et al., 2019). The crop is believed to have originated from wild grass in Central Mexico over 7000 years ago (Ranum et al., 2014). Maize

contains about 72% starch, 10% protein, and 4% fat, enabling it to supply an energy density of 365 Kcalories/100 grams (Ranum et al., 2014; Shiferaw et al., 2011) making it an important dietary staple in many parts of the world. Maize is also important for livestock feed and for other industrial uses including biofuel production (Shiferaw et al., 2011).

Due to its importance, global maize production has continued to steadily increase overtime. For example, between 1961 and 2010, the area allocated to maize production, globally, increased by more than 50%, with about 73% of this growth in low-income countries (Shiferaw et al., 2011). In terms of value of production globally, the value of maize has increased from about US\$ 51 million in 1991 to about 271 million in 2022 (Food and Agriculture Organization, 2023).

One of the properties of maize is that it can be grown over a wide range of altitudes and latitudes (Shiferaw et al., 2011). This is because plant breeders have managed to develop numerous maize varieties that enable it to grow well under different biophysical environments (Ng'ombe et al., 2019). This has made it possible for maize to be cultivated in most parts of the world. The top three maize-producing countries in the world are the United States of America, China, and Brazil, producing approximately 79% of the global 717 million metric tons/year (Ng'ombe et al., 2019; Ranum et al., 2014).

Maize production in Ghana has been going on for centuries (Darfour & Rosentrater, 2016). Between 1963 and 2021, maize production in Ghana has increased from 182,889 tons to 3,500,000 tons (Food and Agriculture Organization, 2023). Maize accounts for 50% of the total cereal production in Ghana (Darfour & Rosentrater, 2016). The continued dominance of maize in Ghana and Sub-Saharan Africa in general, is partly due to agronomic suitability, accessible milling technology and more favorable trade and market policies (Smale et al. 2011; Ng'ombe 2017). However, maize production in the country is commonly done under rain-fed conditions mostly by the poorly resourced smallholder farmers (Ghana Ministry of Food and Agriculture 2011; Muna et al., 2019). This not only constraints yields but also makes maize production susceptible to climatic changes.

Within the country, Muna et al. (2019) indicate that 84% of maize is produced in the middle-southern region of Brong Ahafo, Eastern, and Ashanti Regions in Ghana while the remaining 16% is produced in the Northern Belt of Northern, Upper East, and Upper West Regions of the country.

Some farmers in Ghana produce maize for purposes of selling, while others produce for consumption, selling only the excess production after consumption. The maize marketing system in Ghana is comprised of many actors including farmers, small-scale traders, local aggregators, commission agents, long-distance wholesalers and market-based wholesalers (who can also be market-based retailers), the government and consumers (Akowuah et al., 2015; Muna et al., 2019). Therefore, when farmers sell their produce, they have different marketing channels that they can sell through based on which market actors they sell to. The choice of the marketing channel that the farmer makes will be influenced by the farmers' recognition and interpretation of definite and implicit information about the potential net benefits that may be accrued from the different channels (Mzyece, 2016). The differences in perceived net benefits across channels are partly due to differences in the nature and magnitude of pecuniary and nonpecuniary marketing costs and benefits (LeRoux et al., 2010; Hardesty and Leff 2010; Woldie & Nuppenau, 2009; Woldie & Nuppenau, 2011; Okoye et al., 2016).

Aggregator channels may offer farmers the advantage of buying large volumes at or near the farm gate resulting in higher revenues and low costs (e.g., transport, storage, search costs; Bhanot et al., 2021). Aggregators, may, however, buy at low prices, a purchasing behavior, which has sometimes been criticized as being opportunistic and predatory (Getnet, 2008; Mitchell, 2011; Woldie & Nuppenau, 2011). Consumer channels, on the other hand, may offer farmers the advantage of buying at a high price albeit in small quantities and involving higher marketing costs. While the number of marketing channels available for farmers may be large, the information

available on smallholder maize farmers' participation in areas like Northern Ghana is limited, and this study contributes to the extant literature.

3. Data and methods

3.1. Data

The data used for this study were part of a larger dataset collected in the 2014 Agricultural Production Survey (APS) conducted by the Monitoring, Evaluation and Technical Support Services (USAID-METSS) project of the Economic Growth Office of USAID/Ghana. The APS encompassed the Ghana Mission of USAID's Feed the Future interventions' focus area in Ghana. This focus area, referred to as the Zone of Influence (ZOI), covered the area above Latitude 8°N, which included all or parts of Ghana's four northernmost regions except the area falling in the Volta Region (See Figure A1 in Appendix 1). This study used data collected from the 383 of the 528 respondents in the APS. We focused on the 383 respondents only because they indicated having produced maize. Maize is one of the focus crops of the Ghana Mission under its Feed the Future initiative, and the crop was grown by more than 83% of households in the survey. Data on respondents' age and household characteristics were from a previously conducted Population-Based Survey (PBS). PBS covered the same households as the APS such that data on "age of household head" was extracted from the PBS and merged with the APS data for purposes of this study. To be more clear, the data were not panel because the PBS only supplemented the APS with demographic data of the same households, specifically age of household head, which was not captured in the APS. Thus, the APS data provided production-related data, while the PBS provided data on some demographic variables of the same household.

Production data in the APS were collected over the entire 2013 cropping season, i.e., from late June to mid-November. Marketing data were collected during three follow-up visits in January, February, and March of 2014 to capture data on sales at and after harvest. Marketing data included information on the marketing channels through which farmers sold their produce. These channels included consumers, aggregators, processors and government. The consumer and aggregator channels were the most commonly used (57 farmers sold to aggregators and 55 to consumers). A small number of farmers reported selling to processors (four farmers) and to government (two farmers). The processor and government channels were excluded from the analysis due to the small number of observations. The 18 other farmers reported selling but did not indicate who they sold to. These were also excluded due to lack of information on channel choice. Additionally, 11 farmers reported selling to both aggregators and consumers. These farmers were excluded from the estimation model due to the small number of observations but were instead examined as a separate case study in the analysis. Descriptive statistics on the two marketing channels used are discussed in Table 1 and 2.

3.2. Conceptual framework

It is not uncommon for farmers in developing countries to produce primarily for their own consumption. When farmers produce essentially for consumption, they might market their surplus output, defined as excess production after accounting for own consumption. The sale decision, then, is conceived of as a two-step process: deciding to sell; and how much to sell. Thus, the observed extent of market participation data is generally characterized by many zeros (reflecting decision not to sell) and a continuous distribution of positive numbers (reflecting amount sold). A data structure of this nature may be analyzed using either a Heckman sample selection (two-step) model (Benfica et al., 2006; Boughton et al., 2007; Goetz, 1992) or Cragg's (1971) double hurdle model. Both of these approaches address the corner solution limitations of Tobit models (Wooldridge, 2009).

In this paper, Cragg's double hurdle model was selected as a basis for the conceptual framework and empirical analysis due to its ability to more effectively distinguish between the factors affecting the decision to sell (i.e. market participation) from those affecting the decision on how

much to sell (i.e. intensity of market participation) in the sequential decision-making process (Burke, 2009; Reyes et al., 2012). In the double hurdle model, the first hurdle is structured as a binary decision (sell or not sell) and modeled as a probit function, while the second hurdle, based on the outcome of the first hurdle, examines the effect of factors influencing the quantity of product sold once the sell choice is selected, and it is modeled as a truncated regression. The foregoing is summarized in Equation (1) and Equation (2) as follows:

$$P_i = x_{1i}\alpha + e_i \quad (1)$$

$$y_i = x_{2i}\beta + v_i \quad (2)$$

where P_i is the likelihood of the farmer to participate in the market under x_{1i} , which denotes a vector of variables explaining the participation decision, y_i is the observed dependent variable reflecting amount of output sold by the farmer under x_{2i} . x_{2i} is a vector of variables explaining the decision on the amount, e_i and v_i are the respective errors. The vectors x_{1i} and x_{2i} define the demographic and socio-economic characteristics of the farmer and the farmer's production and marketing characteristics.

The Craggit routine in Stata 15® (Burke, 2009) facilitates the simultaneous estimation of both hurdles, i.e., Equation (1) and Equation (2). The post-estimation routines of the Craggit estimate the Average Partial Effects (APE) on the probability of selling, i.e., $\Pr(y_i > 0 | x_{1i})$, the expected quantity of products sold, given the foregoing condition, i.e., $E(y_i | y_i > 0, x_{1i})$, and the unconditional expected quantity of produce sold, i.e., $E(y_i | x_{1i}, x_{2i})$. The standard errors for inference on APE were obtained using the delta method, described in Burke (2009). Standard economic theory responses to market conditions were assumed to hold for the analyses. The explanatory variables, x_{1i} and x_{2i} , considered in the analysis are:

- (1) Farm output, which determines the size of marketable surplus, and hence ability and willingness to sell (Abu et al., 2014; Barrett, 2008; Omiti et al., 2009; Reyes et al., 2012). While there are a number of variables that can affect the amount of marketable surplus (e.g., land size, technology, etc.), it is reasonable to assume that their effect on marketing decisions can be captured through the quantity of the output variable. This assumption is in line with previous literature on market participation (Fafchamps & Hill, 2005; Zanello et al., 2014);
- (2) Marketing channel used, because they reflect differences in pecuniary and non-pecuniary costs and benefits associated with selling to different buyers. Because fixed and variable transaction costs as well as marketing distance are embedded in the channel choice, we do not include transaction costs and market distance as separate explanatory variables. The two marketing channels considered in this study are as follows: (i) Consumers—those in the village and in the urban or peri-urban markets and (ii) Aggregators—small and large-scale middlemen who set up assembling/aggregation points in villages. As mentioned previously, descriptive statistics under the two channels are presented in Table 2.
- (3) Price, because, consistent with economic theory, at higher selling prices, farmers are expected to sell more of their marketed output (Abu et al., 2014; Jagwe et al., 2010). The currency used to measure price is the United States Dollar (USD), which at the time of the study exchanged at about 3.41 Ghana Cedi to the US dollar;
- (4) Household size, which acts as a proxy for the production and consumption situation facing the household (Moraka Thomas, 2001);
- (5) The farmer's age, which is associated with farming experience (Omiti et al., 2009);
- (6) Marital status of the farmer, to represent intra-household risk sharing (Choo et al., 2008; Jackson, 2007);

- (7) Education because it has been shown to influence productivity and management ability (Mzyece & Ng'ombe, 2020; Obianefo et al., 2021; Randela et al., 2008);
- (8) Farmer's sex, to represent differences in market orientation between males and females (Omiti et al., 2009);
- (9) Access to market information through electronic media, which represents exposure to communication technology, e.g., cell phones that can be used as a marketing tool (Zanello, 2012). Of the respondents who reported accessing extension information in 2013, majority of them (50%) received information through the electronic media (Amanor-Boadu et al., 2015). Thus, it is reasonable to assume that electronic media is the main platform used to access production and market information.

Based on previous literature, additional variables that were considered during analysis included ownership of transport assets (bicycle, motorcycle, car and tractor), value of production assets owned and membership in farmer group. A summary of the variables discussed above and eventually used in the analysis is presented in Table 1. In the context of channel selection behavior in northern Ghana, these variables did not seem to be relevant as evidenced by results from the Akaike Information Criteria (AIC) for model selection.

4. Results

4.1. Descriptive statistics

One characteristic of the study's sample is that 71%, i.e., 271 out of the 383 farmers considered in this study, did not sell any maize produce during the study period. Among the 112 farmers who sold their produce, 50.89% sold their produce to aggregators and the rest sold to consumers. Consistent with the *a priori* expectation that costs may differ by marketing channel, Table 2 shows that, on average, the transport cost incurred by farmers who sell directly to consumers is almost three times higher than that of farmers who sell to aggregators.

The difference in transport costs can partly be explained by the longer distances travelled by farmers who sell to consumers (2.19 km on average) compared to those who sell to aggregators (0.52 km on average). To compensate for the high marketing costs involved, farmers receive a price premium of USD 0.02/kg when selling to consumers relative to selling to aggregators. Differences in transportation costs, distance to market and average price across the marketing channels are statistically significant at 99% confidence level.

Net price is the unit price received for a sale, less the accounting costs (transportation, loading and offloading costs) associated with that sale. Table 2 shows that, although selling to consumers offers a higher net price, farmers choose to sell larger volumes to aggregators, i.e., an average of 218.97 kg sold to aggregators compared to an average of 75.31 kg sold to consumers. High non-pecuniary costs involved in selling to consumers could partly explain this discrepancy. To sell 1000 kg of maize in the consumer market, a farmer may have to incur the implicit cost of negotiating hundreds of individual transactions, the risk of competition or low sales, the risk of having their inventory stolen, the opportunity cost of time (which could be days or weeks) spent at the market, etc. After accounting for these non-pecuniary costs, the net benefit from selling to consumers may be much lower than that implied by the net price. Aggregators, on the other hand, may buy 1000 kg of maize in a single transaction at or close to the farm gate, affording the farmer savings in terms of non-pecuniary costs. On the basis of total (pecuniary and non-pecuniary) net benefits, the aggregator channel may prove to be a more attractive channel. Empirical evidence in Northern Ghana has shown that implicit factors such as trust in buyers influence the choice of marketing channel (Zanello et al., 2014). Fafchamps and Hill (2005) have also shown that farmers in Uganda potentially consider the opportunity cost of time in deciding where to sell their produce.

Table 1. Summary statistics on variables used in study (n = 383)

Variable Name	Variable Description	Mean	Median	Std. Dev
<i>Dependent Variables</i>				
Market participation	1 if household sold; 0 if household did not sell	0.29		
Intensity of participation	Amount of maize sold (kg)	85.83	0.00	215.19
<i>Independent Variables</i>				
Household size	Number of people living in a household	10.84	10.00	5.80
Age	Age of respondent in years	44.27	40.00	16.78
Married	Marital status (1 if married; 0 otherwise)	0.91		
Educated	1 if respondent has at least primary education	0.11		
Male	1 if respondent is male	0.90		
Access to information	1 if household member received agricultural information through electronic media	0.13		
Farm Output	Total annual quantity of maize produced in kg	986.18	600.00	4622.39
Sold to aggregators	1 if aggregator is the channel used; 0 if otherwise	0.15		
Sold to consumers	1 if consumer is the channel used; 0 if otherwise	0.14		
Price	Average price received by household in USD/kg	0.06	0.00	0.11

Note: Median and standard deviation are calculated for continuous variables only.

4.2. Empirical estimation results

The results of maximum likelihood estimation and the average partial effects for the double hurdle decision problem of the main model are presented in this section. Several model specifications were estimated as a robustness check, and the results were consistent across the different specifications.

Table 3 presents the estimated coefficients and partial effects of the first hurdle. The results show that farm output has a positive and significant impact on the decision to sell maize at 1% significance level. A 100 kg increase in farm output increases the likelihood of selling by 0.2 percentage points. This finding parallels Haile et al. (2022) who found that increased quantity of maize created incentives for farmers to participate the maize market in Southwest Ethiopia. The results

Table 2. Descriptive statistics on price, quantity sold and marketing costs by marketing channel									
Variable by	Aggregators					Consumers			
	Mean	Std. Error	Min	Max	Mean	Std. Error	Min	Max	
Average distance travelled to market (km)	0.52***	0.19	0.00	15.00	2.19***	0.41	0.00	20.00	
Transport cost (USD/kg)	7.3×10^{-3} *	2.7×10^{-3}	0.00	1.47×10^{-2}	2.0×10^{-3} *	4×10^{-4}	0.00	2.4×10^{-3}	
Load and offload cost (USD/kg)	5×10^{-5}	4×10^{-5}	0.00	2.93×10^{-3}	3×10^{-4}	1.6×10^{-4}	0.00	1.8×10^{-2}	
Price of Maize (USD/kg)	0.09	0.01	0.00	0.45	0.11	0.01	0.00	0.41	
Quantity sold of Maize (kg)	218.97***	32.53	0.00	1900.00	75.31***	10.64	0.00	700.00	
Net Price (USD/kg)	0.09	0.01	0.00	0.45	0.11	0.01	0.00	0.41	
Observations (Total = 112)	57				55				

***, **, * statistical significance at 10%, 5%, and 1% significance level, respectively.
Source: Authors' analysis

imply that farmers with a higher output could also have a larger marketable surplus and therefore more likely to participate in the market. This result supports the use of production-enhancing interventions that boost maize production to allow farmers to have enough for consumption as well as a surplus for the market, as a way to increase the likelihood of smallholder farmers' participation in the market. A case in point is what Barrett (2008) observes could be critical at improving farmers' market participation in developing countries. Particularly, Barrett (2008) encourages such interventions as those aimed at aiding smallholder collections through reduced between-market commerce costs as well as boosting poorer households' access to improved technologies and productive assets as crucial at stimulating farmers' market participation in sub-Saharan Africa.

Table 4 presents the estimated coefficients, conditional and unconditional average partial effects of the second hurdle decision. The conditional average partial effects (CPE) are the effects of explanatory variables on the amount sold given that the farmer decided to sell in the first hurdle. The unconditional average partial effects are the effects of explanatory variables on the amount sold for all farmers irrespective of whether they sold or not in the first hurdle.

In line with economic theory, the second hurdle results show that price has a positive effect on quantity sold. Conditional on participation, a unit increase in average price is associated with a 61.35 kg increase in amount sold. Unconditional on participation, price is associated with a 20.73 kg increase in the amount sold. Average price is statistically significant at 99% confidence level. These findings are in line with other related studies, particularly those by Musara et al. (2018), Haile et al. (2022), and Ng'ombe et al. (2022). Musara et al. (2018) observed that the weighted average market price positively affects the amount of sorghum that farmers in semi-arid Zimbabwe would sell. They also found that higher sorghum prices were positively associated with

Table 3. Maximum likelihood estimates from first hurdle and the average partial effects (n = 383)

Market Participation Hurdle		
Variables	Estimated Coefficient	Average Partial Effects
Household size	−0.03*	−0.01
	(0.01)	(0.65)
Age (years)	0.004	0.19
	(0.004)	(0.22)
Married	0.17	0.05
	(0.28)	(12.10)
Education	0.44**	0.14
	(0.22)	(12.15)
Male	0.12	0.04
	(0.27)	(12.39)
Farm Output (100 kg)	0.001	0.002***
	(0.001)	(0.06)
Access to information	0.70***	0.23
	(0.20)	(15.21)
Constant	−0.88***	
	(0.35)	

Notes: Robust standard errors are in parentheses. *, **, *** statistical significance at 10%, 5%, and 1% significance level, respectively. The Collin test for multicollinearity for this model gave a Variance Inflation Factor of 1.37 implying very low correlation among the predictor variables. Heteroscedasticity was corrected for by using White's robust standard errors

Source: Author's analysis

Table 4. ML estimates from second hurdle and average partial effects (n = 383)

Intensity of Participation Hurdle

Variables	Estimated Coefficient	Conditional Average Partial Effects	Unconditional Average Partial Effects
Household size	21.84 (16.46)	3.34*** (0.62)	-0.93 (0.64)
Age (years)	-1.46 (4.10)	-0.22* (0.13)	1.45*** (0.22)
Married	-47.38 (251.17)	-7.24 (7.78)	14.90 (13.53)
Education	-80.43 (225.22)	-12.28* (7.17)	37.15*** (11.85)
Male	235.00 (412.58)	35.89*** (13.14)	10.64 (18.22)
Farm Output (100 kg)	30.93*** (8.18)	4.72*** (0.44)	1.63 *** (0.45)
Access to information	195.44 (173.15)	29.85*** (6.16)	67.28*** (19.41)
Sold to Aggregators	841.03*** (264.78)	128.46*** (13.21)	43.41 *** (13.21)
Average Price (USD/kg)	401.70 (335.15)	61.35*** (11.83)	20.73* (11.83)
Sigma ³	374.83*** (75.34)		
Constant	-1651.97*** (840.13)		

Notes: Robust standard errors are in parentheses. ***, **, * statistical significance at 10%, 5%, and 1% significance level, respectively. The Collin test for multicollinearity for this model gave a Variance Inflation Factor of 1.37 implying very low correlation among the predictor variables. Heteroscedasticity was corrected for by using White's robust standard errors

³The constant term in the section labeled sigma is the maximum likelihood estimator of sigma (Burke, 2009)

Source: Author's analysis

the farmers' choice of participating in the market.. Ng'ombe et al. (2022) found that dairy farmers were more likely to sell larger amounts of milk for every average milk price increase in Zambia, while Haile et al. (2022) found that a higher previous year's price of maize positively affects the likelihood of farmers to participate and sell more maize in a market in Southwest Ethiopia. Our finding is therefore plausible as it is consistent with producer theory and the forgoing empirical studies on how a higher maize price can encourage farmers' participation in markets.

The results from the second hurdle also show that the choice of marketing channel has a significant effect on the intensity of participation at 99% confidence level. By changing from selling to consumers to selling to aggregators, a farmer can increase the amount of produce sold by 128.46 kg conditional on participation and by 43.41 kg unconditional on participation. This result is in line with the findings of Gabre-Madhin (2001) that show that intermediaries positively affect trade volumes of grain traders in Ethiopia. The higher intensity of participation associated with the aggregator channel could be attributed to the scale advantage and non-pecuniary cost savings that aggregators can provide in comparison to consumers. These findings are consistent with Kotey et al., (2021) and Adams et al. (2022) who, respectively, found similar results among

cowpea and maize farmers in Ghana. Selling a large volume at a discounted price to aggregators can result in higher revenue compared to selling a small volume at a high price to consumers. Essentially, this could be because of the fewer transactions involved when farmers sell to aggregators (due to their higher purchasing capacity), leading to savings on non-pecuniary costs of engaging in many transactions and/or selling over long periods of time (Hardesty and Leff 2016; Okoye et al., 2016). This result suggests that a wider availability of aggregator-type middlemen may increase the intensity of smallholder farmers' market participation.

To more clearly compare the benefits across the aggregator and consumer channels, we examined 11 farmers who decided to sell to both channels. These farmers were not part of the empirical estimation because the low number of observations did not provide statistical confidence of analyzing them as an independent group. On average, the 11 farmers decided to sell 363.64 kg to aggregators and 249.09 kg to consumers despite aggregators paying a lower price of USD 0.09 compared to USD 0.11 paid by consumers. However, for selling to aggregators, the farmers made an average net revenue of USD 33.80 compared to USD 23.23 for selling to consumers. Thus, the price premium paid by consumers did not necessarily translate into higher net revenue. This finding is consistent with a study by Hardesty and Leff (2010). Hardesty and Leff (2010) studied marketing channels used by organic farmers in California and demonstrated that the higher prices that farmers receive from direct to consumer channels relative to intermediary wholesale channels are not pure profits but compensation for the high costs they incur. In contrast to similar market participation studies in sub-Saharan Africa (e.g., Bellemare & Barrett, 2006; Omiti et al., 2009; Randela et al., 2008; Zamasiya et al., 2014), our results show that, in addition to farmer characteristics and endowments, the channel that a farmer uses can also influence their extent of market participation. Specifically, the study shows that "high volume—low price" channels may be more lucrative than the "high price—low volume" channels in Northern Ghana.

The results from the second hurdle decision also indicate that, among other variables, access to information and farm output have a positive significant effect on intensity of market participation at 1% significance level. By gaining access to information, farmers increase the quantity of maize sold by 29.85 kg conditional on participation. For all farmers in the sample, irrespective of participation, gaining access to information increases their quantity sold by 67.28 kg. These findings are consistent with Bellemare and Barrett (2006); Musara et al. (2018), Kotey et al., (2021), Mzyece (2021), Adams et al. (2022), Ng'ombe et al. (2022) and Haile et al. (2022). Furthermore, a 100 kg increase in farm output increases the quantity sold by 4.72 kg conditional on participation. Unconditional on participation, a 100 kg increase in farm output increases the quantity sold by 1.63 kg. Findings by Omiti et al. (2009) also show a positive significant relationship

Table 5. Marginal effects by land area disaggregated into quartiles

Land Area (Acres)	Conditional Average Partial Effects	Unconditional Average Partial Effects
First Quartile (n = 141)		
Sold to aggregators	80.03	26.79
Second Quartile (n = 61)		
Sold to aggregators	110.62	41.64
Third Quartile (n = 89)		
Sold to aggregators	128.76	49.71
Fourth Quartile (n = 92)		
Sold to aggregators	206.76	64.90

Source: Author's analysis

between total farm output and marketed produce, which is plausible as farmers that produce more than what they consume are more likely to sell the surplus amount (Burke et al., 2015; Mzyece, 2021).

Like farm output, land area can be used as a measure of the size of the farm enterprise. Table 5 presents results of a disaggregated analysis based on land area (in acres) to provide further insight on the effect of marketing channel on amount sold while taking into account the size of farm enterprise. The disaggregation shows that both the conditional and unconditional average partial effects for selling to aggregators generally increase as land area increases across the four quartiles. These findings parallel those by Donkor et al. (2021) in Ghana among rice farmers and those by Adu (2018) among paddy rice farmers in Northern Ghana. More specifically, our findings imply that supporting aggregator-type middlemen to promote the intensity of smallholder market participation may be even more effective for relatively larger farms compared to smaller ones.

5. Conclusion

The purpose of this paper was to expand understanding on the factors that influence farmers' participation in markets and particularly on the effect of channel choices on the amount farmers sell when they decide to participate. We used the double hurdle approach for testing the hypothesis that the quantity sold is higher when farmers use intermediary marketing channels compared to when they use the direct-to-consumer channel. The analysis is based on data from 383 smallholder households involved in the production of maize in Northern Ghana. The results indicate that farmers sell larger quantities when they sell to aggregators (middlemen who set up aggregation centers in the villages) compared to when they sell to consumers. This is potentially due to economies of scale advantages and non-pecuniary cost savings associated with the aggregator channel. The results therefore provide evidence that the wider availability of aggregator-type middlemen as a marketing channel option will likely enhance the smallholder farmers' market participation and net revenue in Northern Ghana. The findings further show that factors such as farm output, access to information and price significantly influence the extent of market participation. These findings are consistent with Ouma et al. (2020).

The contribution of this paper is two-fold: firstly, the results imply that facilitating access to aggregator-type middlemen may improve market participation and net revenue in remote markets where market infrastructure and institutions are not developed enough to substantially lower both pecuniary and non-pecuniary marketing costs of selling directly to consumers. Consequently, although market participation efforts have focused on increasing smallholder farmers' access to consumer markets, promoting a wider availability of intermediary buyers could be another way of overcoming barriers to smallholder market participation. Secondly, this study contributes additional empirical evidence on smallholder agricultural production and marketing in Northern Ghana, a region of growing interest among international development practitioners, regional policy-makers and private sector players. It sheds light on the effect of factors such as farm output, access to information and price on the likelihood and intensity of market participation. The results support production-enhancing interventions and increased access to information as strategies for encouraging farmer market participation, a suggestion that parallels those by Barrett (2008) and Donkor et al. (2021).

The limitations of this study and the potential direction for further research are related to the fact that only two channels were investigated, and the sample of farmers involved in maize market is not sufficiently large. First, it would be useful to examine how the different types of middlemen, ranging from wholesaler-type to briefcase man-type, would affect smallholder farmer market participation. Future research with a broader set of marketing channels is likely to shade a clearer picture on the effect of channel on market participation once more

marketing channels are considered. In terms of the sample size, the total sample considered is large (i.e., 383) but the limitation is in the number of smaller number of actual participants in the market—the 112 smallholder maize farmers. While we agree that this is a small number, most smallholder farmers in developing countries grow maize for subsistence use (Fischer, 2022; Mzyece, 2021) which suggests this is plausible. However, it would be interesting for future research to build on this study with larger sample sizes of maize farmers participating in markets in a similar context.

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Author details

Agness Mzyece¹
 E-mail: amzyece@csustan.edu
 ORCID ID: <http://orcid.org/0000-0002-4229-5607>
 Aleksan Shanoyan²
 Vincent Amanor-Boadu²
 Yacob Abrehe Zereyesus³
 Kara Ross⁴
 John N. Ng'ombe⁵
 ORCID ID: <http://orcid.org/0000-0002-1410-1350>
¹ Department of Economics, California State University, Stanislaus, 1 University Circle, Turlock, CA, USA.
² Department of Agricultural Economics, Kansas State University, Manhattan, KS, USA.
³ Market and Trade Economics Division, Economic Research Service, USDA (United States Department of Agriculture).
⁴ Department of Agricultural Economics, Kansas State University, Manhattan, KS 66506, USA.
⁵ Department of Agribusiness, Applied Economics and Agriscience Education, North Carolina A&T State University, Greensboro, NC, USA.

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Appendix I

Figure A1. A Close-up Picture of Map of Ghana within Africa Showing the General Study Area.

Source: <http://www.pinkballoon.nl/Ghana-on-africa-map.html/>.





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