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SMALLHOLDER MAIZE FARMERS MARKET PARTICIPATION ON A COMMODITY EXCHANGE: THE CASE OF GHANA COMMODITY EXCHANGE

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ABSTRACT
This article investigates smallholder farmers' market participation decisions on a commodity exchange and attempts to identify the most critical elements that impact smallholder farmers' decision to engage in the output market and trade their goods on the Ghana Commodity Exchange. The basic objective of this study was to look at the phenomena of smallholder farmers participating in a commodities exchange in Ghana from the standpoint of market participation. Heckman's two-step approach was used to access factors that influence smallholder farmers' decision to participate in GCX trading. The study relied on primary data gathered from 180 smallholder farmers spread across three (3) districts. The main findings of this study reveal that farmers participate at a somewhat modest level, with around 44 percent of farmers participating. Surprisingly, they participate with roughly 72 percent of their output. It was found that age, gender, farm size, land tenure, access to extension service and credit influences smallholder farmers' decision to participate in commodity exchange trading, and quantity of harvested maize, household size, and price risk exposure on Ghana Commodity Exchange (GCX) influences their level of participation. These findings also imply that if farm size, proportion of owned farmland, access to extension, access to financing, and amount of harvested maize are raised on the one hand, and price risk on GCX is reduced on the other, smallholder farmers would engage in the output market more and more. Finally, maize farmers should be educated on the need of making themselves available to extension and consulting services in order to increase their understanding of market platforms and make informed decisions to secure long-term agricultural productivity. Policymakers should guarantee farmers have access to agricultural loans as well as improved access to own acreage in order to boost productivity and marketable surplus. To encourage farmers to participate in exchange trade, price risk exposures on the exchange should be prioritized and stabilized/reduced.

KEY WORDS
Maize farmers, Ghana Commidty Exchange (GCX), heckman two-step model, price risk, participation decision.

Agriculture is the main support of most developing nations, particularly those in Sub-Saharan Africa (SSA), accounting for more than half of their gross domestic product (GDP) (Asravor, 2020) and critical for economic growth and also a major source of income for rural people in these nations (Adnan et al., 2020). Farmers' crop yields and revenue are affected by a variety of external variables, such as price variations, and risk is present in all agricultural decisions (Menapace et al., 2012). The agriculture industry is vulnerable to a variety of risks that emerge on a regular basis (Ayinde & Obalola, 2017). The five most significant risk sources are production, marketing (price risk), legal, financial, and human resource risks in agriculture. Stocks make up a substantial component of a farm household's portfolio in developing nations, and because market risk and ability to tolerate risk are connected with income, low-income farmers are likely to be price sensitive (Abokyi et al., 2018). According to Sulaiman (2015), increasing food costs have caused price rises in downstream and upstream products and services, and as a result, consumers prefer to eat less frequently and in smaller quantities, as well as cheaper and less nutritious food.

In many African nations, most households spend a large portion of their income on food (Abate et al., 2015), and as a result, high food costs pose significant dangers to the region's food security status (Yami et al., 2020). When price fluctuations dramatically diminish revenue in the short term, there can be serious ramifications without adequate risk management methods; hence, greater price variability can severely impact consumers and agricultural commodities producers (Abokyi et al., 2018). Price risk may also influence family behavior; hence, managing price risk has become an important part of farm management (Kouame & Komenan, 2012). Price risk management is frequently required since farmers do not know whether the prices obtained will be lower than predicted, making it difficult to pay input expenses and earn a profit (Nordier, 2013). Price risk management refers to the actions that a farmer makes to decrease the high level of risk that they confront in their line of business (Sarkodee, 2019). Markets and better market access are critical components of price risk management for smallholder farmers in developing countries, notably in Sub-Saharan Africa (Onuma et al., 2010).

Modernization of the agricultural sector in Sub-Saharan Africa, notably in Ghana, necessitates boosting smallholder farmers' ability to create marketable surplus and participate in enhanced markets (Mmbando, 2015) through the establishment of a commodities exchange. On November 5, 2018, the government of Ghana inaugurated the Ghana Commodity Exchange (GCX) to assist agricultural stakeholders in such ways (GCX, 2019). A commodity exchange is a well-established market that brings together several buyers and sellers to trade commodity contracts that are standardized by the exchange's rules and regulations (Rashid, 2015). Commodity exchanges permit the trading of contracts whose values are linked to the prices of commodities such as maize, crude oil, metals, and rice, among others (Sarkodee, 2020). In a typical transaction, contract buyers accept delivery of commodities and contract sellers accept delivery of commodities (Pines, 2019) Despite this, it is not always the case in exchange operations. Some contracts may not result in the underlying commodity being physically delivered (Ferris et al., 2014). Forwards, futures, and options are among the most often utilized price-risk aversion contracts. This allows the farmer to establish a certain price and know what they will earn before growing the crop; this allows for better planning to guarantee that revenues meet production costs (Nordier, 2013). Despite this, involvement of smallholder farmers in commodity exchange trading remains low in most Sub-Saharan African nations including Ghana due to a variety of factors (Mmbando, 2015).

Ghana Commodity Exchange (GCX) was founded in November 2018 to allow Ghanaian farmers to connect with buyers. The Ghana Commodity Exchange has warehouses around the nation where farmers may deposit goods and trade with a variety of customers, ensuring the quality and quantity of commodities offered. Some farmers that trade through GCX have profited from price increases of up to 30% as a result of commodity grading and standardization, and so there is a need to enhance farmer involvement, however, smallholder farmers participation across the country has not been encouraging (GCX, 2019). Understanding the elements that impact smallholder farmers' willingness to participate and their level of participation on a commodity exchange market platform will be necessary for increasing their participation. Interstingly, very few studies have empirically investigated the factors that influence smallholder farmers' participation in commodity exchange and their level of participation in the sub-region and much is unknown about these farmers' direct or indirect participation in marketing on Ghana's commodities exchange. In light of this, the study intends to investigate the factors that determine smallholder farmers' market participation and level of participation on the Ghana commodity exchange.

METHODS OF RESEARCH

The maize growers for the research were chosen using a multi-stage sampling process. The strategy was chosen to minimize the challenges associated with randomly picking from a population that is greater than the available resources can manage (Okoffo et al., 2016). At the first step, the districts of Nkoranza North, Nkoranza South, and Techiman

were purposefully chosen. The districts were chosen based on their potential and lengthy experience in maize growing, as well as their strong output records. The second stage involved identifying farmer member groups and randomly selecting a proportional number of member groups from each zone. Specifically, three member groups from Nkoranza North and South districts, as well as two member groups from Techieman municipality. Finally, a random sample procedure was utilized to choose 180 farmers from each group in a proportional manner. There were 320 registered maize farmers in all.

A total of 180 smallholder maize farmers were chosen using Yamane's (1967) sample size determination:

$$n = \frac{N}{1+N(e)^2} \quad (1)$$

$$n = \frac{320}{1+320(0.5)^2} \quad (2)$$

$$n = \frac{320}{1+320(0.0025)} = 178 \quad (3)$$

Where: *n* is the sample size, *N* is the population size, and *e* is the level of precision.

The Heckman model was used in two stages to analyze the factors influencing farmers' decision in marketing on the Ghana commodities exchange and their level of market participation on the exchange. A two-step approach, allowing distinct mechanisms to decide the discrete probability of participation and the level of market participation is appropriate (Olwande & Mathenge, 2012). These models enable a distinction to be made between the initial decision to participate and the decision on the proportion of maize to market (trade) on GCX (Sebatta et al., 2014). Many studies indicates Heckman two-stage model to be superior to the other models as it accounts for sample selection bias by calculating lambda (λ) and using it as an independent variable to account for self selection (Negasa et al., 2020). The Heckman two-step approach compensates for selection by modeling the decision to participate with a probit model based on individual characteristics in the first stage. In the second stage, the outcome variable is regressed using least squares on the exogenous characteristics and the fitted values from the selection equation, which are in a function known as the inverse mill's ratio.

The first stage is referred to as the selection equation, and the second as the outcome equation (Wolfolds & Siegel, 2019).

$$Y_{1i}^* = X_i\beta + u_i \quad (4)$$

$$Y_{2i}^* = Z_i\lambda + v_i \quad (5)$$

The u_i and v_i are assumed to follow a bivariate normal distribution. Consider that selection occurs such that Y_1 and Y_2 are the observed variables, where:

$$Y_{1i} = Y_{1i}^* \text{ and } Y_{2i} = 1, \text{ if } Y_{2i}^* > t \quad (6)$$

$$Y_{1i} \text{ not observed, } Y_{2i} = 0, \text{ if } Y_{2i}^* \leq t \quad (7)$$

Thus, if the latent variable, Y_{2i}^*, is greater than some threshold, t, the observation will be selected, such that $Y_{2i} = 1$ and the latent outcome variable, Y_1, will actually be observed in Y_{1i} using the distributional assumptions, that $u_i = pv_i + e_i$, the error term is plugged in to yield:

$$Y_{1i} = X_i\beta + pv_i + e_i \quad (8)$$

A regression of Y_{1i} on X_i would then omit the selection effect, captured by v_i. Heckman, on the other hand, derives the inverse Mills ratio from the property of a normally distributed variable:

$$E(v_i|v_i > -x) = \lambda(x) = \frac{\emptyset(x)}{\Phi(x)} \quad (9)$$

Finally, plugging lambda (λ) into the equation yields:

$$Y_{1i} = X_i\beta + \lambda(x) + e_i = X_i\beta + \frac{\emptyset(x)}{\Phi(x)} + e_i \qquad (10)$$

Where: λ_i is the inverse Mill's ratio, $\emptyset$ is the density, Φ is the distribution functions for the standard normal variable, β is a vector of regression parameters for variable X.

Ordinary Least Squares (OLS) was computed in the second step of the Heckman model to identify the level of participation indicated by the proportion (percent) of maize sales on the exchange. The model will be:

$$Y_{1i} = X_i\beta + p\lambda_i + e_i \qquad (11)$$

Where: Y_{1i} is farmers' proportion of maize the *ith* farmer sells on the exchange, X_i are the explanatory variables, β is unknown parameters to be estimated, p is a parameter that shows the impact of participation on the proportion of maize traded on the exchange by farmers and e_i is the error term.

For this study, two dependent variables were considered:

1. The dependent variable is a dummy variable that represents farmers' decision to participate in commodities exchange marketing. This is a variable in the probit model that has a value of 1 if a farmer sells on GCX and a value of 0 if otherwise;
2. Participation level is a continuous variable assessed in the proportion (percent) of harvested maize sold on GCX by a farmer.

Table 1 – Summary of independent variables used in the heckman two stage model

Variable	Measurement	A priori Expectation
Age of a farmer	Years	-/+
Gender	1=male, 0=female	+
Farming Experience	Years of maize farming	-/+
Education Level	Years of schooling	+
Household size	Number of individuals in a household	+
Farm size	Hectares	-/+
Land tenure	% of farmland owned by farmer	-/+
Access to credit	=1, if farmer has access to credit, 0 otherwise	-/+
Acess to extension	Yes=1, 0, otherwise	+
Price risk on GCX	=1, high, 0 otherwise	-/+
Access to market information	=1, Yes, 0 =No	+

Note: Author's construct.

RESULTS AND DISCUSSION

Table 2 summarizes the variables utilized in the Heckman two-step model estimate. As observed, around 66 percent of the sampled farmers were males, indicating that the majority of farmers in the research region are males. The average age of the household head was 51 years, and the average number of dependants in a farmer's home was around 6 individuals. Furthermore, just 35% said that trading on GCX entailed a substantial average price risk. Farmers' average years of schooling were determined to be around 12 years, which is still at the basic school level of education. Farmers farmed 4.36 hectares of farmland on average, indicating that the majority of farm households in the research region are smallholder farm households. The sample shows that 47.71% of farmers cultivate their own land.

In addition, 77 percent of the farmers surveyed have access to agricultural extension services, 58 percent of farm households have access to loans, and 72 percent of farmers have access to market information. Specifically, 44 percent of respondents trade or have traded on the Ghana commodity market since its creation, and their participation level is

estimated about 72 percent. That is, they are prepared to trade up to a 72% share of their produce after harvest.

Table 2 – Descriptive Statistics

Independent Variable	Mean	Std. Deviation	Min	Max
Age	51.47	11.06	20	75
Gender	0.66	0.48	0	1
Experience	24.26	13.36.	2	50
Education	11.52	2.79	0	16
Farm Size	4.36	2.59	0.8	15
Landtenure	47.71	48.87	0	100
Acess to Extension	0.77	0.42	0	1
Acess to credit	0.58	0.49	0	1
Quantity of harvested maize	73.75	42.72	10	200
Household size	5.61	1.77	2	10
Price risk on GCX	0.35	0.48	0	1
Acess to market information	0.72	0.45	0	1
Dependent Variable(s)				
Decision to sell on GCX	0.44	0.50	0	1
Level of participation on GCX	71.66	15.93	26.4	100

Note: Author's construct.

Farmers' decisions to sell on GCX are influenced by factors such as age, gender, farm size, land tenure, access to extension services, and loans. A farmer's age has a strong favorable effect on his or her decision to sell on GCX. Furthermore, the age of the farmer had a substantial ($P \leq 0.01$) influence on the decision to participate in GCX marketing. This is due to the fact that many household decisions, such as whether to sell or not, are influenced by one's place in the family's hierarchy of headship. Older family members are more likely to make important decisions that influence the well-being of the entire family. According to Heltberg and Tarp (2001), age is an indicator of a household's position and capacity to comprehend and use accessed market information. Gebremedhin and Hoekstra (2007) discovered a positive relationship between age and farmer market involvement, with older farmers selling more of their goods to the market.

Furthermore, gender was found to have a significant positive relationship with market participation. The positive relationship indicates that male farmers are more likely than female farmers to participate in maize marketing on GCX. The findings are consistent with the findings of Mmbando et al. (2015), who discovered a similar trend. The explanation could be that female farmers are resource constrained, lacking access to productive assets (land, labor, and capital), which limits their production capabilities and thus market participation (Mmbando et al., 2015). Sebatta et al., (2014) discovered that male farmers had higher chances of selling in the market because male farmers have more social contacts with both maize buyers and their agents, whom they frequently meet at trading centers. Males dominate in agricultural product sales to the market, as predicted, because they make decisions that effect all family members. Female farmers lack such relationships and, in most circumstances, are restricted from engaging in direct commercial talks with buyers. Wang'ombe (2008) discovered that male farmers positively and significantly affected farmers' market sales decisions. He noted that women spend the majority of their time on household duties and devote less time to other activities such as market transactions.

Furthermore, farm size was found to have a considerable positive effect on farmers' decision to sell on GCX. Because of the favorable link, farmers with greater farm holdings may be able to sell on GCX. The findings are congruent with those of Azam et al. (2012) and Basha (2022), who discovered in their study that farmers with more land per worker are more inclined to engage in marketplaces. Heltberg and Tarp (2001) discovered that the area of cultivable land was an essential factor in encouraging smallholder farmers to participate in market. He discovered that farmers with more cultivable land were more likely to join because of their potential to produce larger quantities, ensuring marketing surpluses.

Boughton et al. (2007) investigated patterns of household market involvement in Mozambique using an asset-based methodology. The authors discovered that private family assets, particularly land, influenced agricultural market participation favorably. In his research of market involvement in staple grains, Barret (2007) discovered that one of the obstacles to market participation by smallholders was the landholdings required to create a surplus, which affected market participation. Because of economies of scale, the higher the farm size, the more it allows the household to have a surplus output above subsistence needs and excess to sell (Osmani & Elias Hossain, 2015). On the other hand, farmland ownership boosts a farmer's proclivity to sell on a commodities exchange. This is supported by the favorable association between land tenure and GCX participation. The relationship was significant at 1%. The study of Mmbando et al. (2015) support this by claiming that families with bigger land holdings engage in market decisions and sell more of their produce in the market than those with smaller land holdings. Finally, farm households with big farm sizes might allocate their land between diverse crop production, putting them in a stronger position to participate in the output market (Osmani & Hossain, 2015).

Access to extension services by smallholder maize farmers influences their decision to sell on the GCX. The findings revealed a substantial ($P \leq 0.01$) influence on the choice to engage in marketing on GCX. The findings are consistent with those of Sebatta et al. (2015), who discovered a positive link between access to extension and market participation. This is because extension workers often offer information on market availability as well as information on new and innovative technologies that improve a farmer's expertise and provide a variety and choice of market options. Furthermore, according to Ferris et al. (2014), extension services play an important role in connecting smallholder farmers to markets, and it is one of the fundamental duties for any long-term development plan to eliminate poverty and hunger. According to Khaza et al. (2019), access to information has a strong positive effect on the decision to engage in agro-processing, and smallholder farmers who have access to information are more likely to participate in agro-processing. These services enable smallholder farmers to connect to markets in a more efficient and effective manner, lowering access barriers, allowing them to negotiate more effectively, and offering greater stability than mainstream markets (Borrella et al., 2015).

Table 3 – Heckman regression result

Variable	Coefficient	Standard Error
Participation Decision on GCX		
Age	0.0364	0.1305***
Gender	0.4045	0.2201*
Farming experience	0.0065	0.1338
Education	-0.0534	0.0359
Farm size	0.2522	0.4213***
Landtenure	0.0094	0.0022***
Acess extension	1.4614	0.2627***
Acess to credit	1.7110	0.241***
Constant	-6.2241	0.7022***
Level of participation on GCX		
Age	0.1289	0.1402
Gender	1.9683	3.3307
Household size	1.8100	0.9192**
Quantity of harvested maize	0.7797	0.0329**
Price risk on GCX	-4.3568	2.5709*
Acess to market information	3.0768	4.4706
Constant	43.2410	4.3098**
Mills		
Lambda	5.7128	3.4064*
Rho	0.4065	
Sigma	14.0541	
Wald $chi^2 = 19.99$**		

*Note: *, **, and *** indicates the significance level at 10%, 5%, and 1% respectively.*

Finally, a farmer's access to financing increases his or her market involvement on a commodities exchange (GCX). The association was favorable and significant at 1%. Access to finance is a wealth indicator that tends to increase a farmer's ability to handle risk. Surprisingly, a gain in wealth encourages the usage of risk-aversion methods. Credit is an investment resource that enables a farmer to implement risk-mitigation measures, particularly those that need the payment of a premium (Bashiru et al., 2014). They also suggested that farmers with access to credit have a higher average intensity of adoption. This is because access to credit is a production-enhancing asset that facilitates productivity, and thus availability of credit increases marketed surplus in influencing market participation (Mmbando et al., 2015). Also a farmer's access to credit support could be considered as trade benefit which significantly, is likely to influence his/her a choice of alternative and reliable market platforms (Mujawamariya et al., 2013).

The study result showed quantity of harvested maize, household size, price risk on GCX and access to market information influences a farmer's level of market participation on GCX. The quantity of harvested maize is thought to have a considerable beneficial impact on a farmer's degree of engagement in the exchange market. As a result, increasing the quantity of maize harvested will raise a farmer's degree of involvement in the commodity trade because increased output assures marketable surplus (Sebatta, 2015). As a result, a smallholder farmer with a substantial volume of output is likely to trade roughly 78 percent of his/her produce on the exchange. Khoza et al. (2019) also found farmers intensity of participation of their output to be more than 50% (59.3%). The findings are consistent with those of Omitti et al. (2009), who observed that rural farmers sell a bigger proportion of their maize yield. He goes on to say that a farmer's decision to sell more maize reflects his or her awareness of the market dynamics surrounding the produce, and therefore, the overall output produced has a substantial impact on the amount of maize sold in the maize market by a farmer.

A significant positive relationship was found between household size and level of a farmer's participation on the commodity exchange. The result concur with that of Bahta and Bauer (2012), Mmbando et al., (2015) and (Khoza et al., 2019). The study of Khoza et al. (2019) suggests that high number of people in a household is more likely to increase the extent of participation and the adoption of value-addition approaches and also found a significant relation between household size and extent of participation decision among smallhoder farmers. The result form the study can also be explained as, larger household size means higher family labour and cheap labour force which reduces production cost (Osmani &Hossain, 2015). That has an expected result of increasing quantiy of maize output produced by a farm household to increase market surplus to a farm household which expectedly would increase a farmer's level of participation on an exchange market (Mmbando et al., 2015). To add to that, Kouame (2010) asserts that an increase in family size means more people to feed, to care which increases the level of vulnerability of the household. Hence, taking into account the amount of uncertainty regarding the future, it is reasonable for large households to smooth their present consumption (by saving) on an exchange in order to secure their future welfare.

Price risk on GCX had an inverse relationship with the level of of a farmer's participation in the on the exchange and the result was significant. The results imply that lower level of price risk incurred by a participating farmer on the commodity exchange would propel him/her to intensify his/her level of participation. The evidence also indicates that the opposite might be true in that, price volatility remains high in the traditional forms of market which give rise to persistently high transactions costs and therefore allow farmers to search better options (Sitko & Jayne, 2012). Lower level of price risk suggests better market security related to instability of the final market due to price fluctuations and limited marketing options (Borrela et al., 2015). The result from the study is supported by the Proactive Continuous Risk Assessment Reference Theory (Ngwenya et al., 2017) which suggests that potential market risks is fundamental in decision making towards market orientation of a decision maker. Farmer's revenue, investment decisions and resource allocation is impacted significantly by volatile price movements so therefore, a farmer may trade more on a

commodity exchange to control price risk (Basha, 2022). The result is consistent with that of Ngwenya et al. (2017), who also found a significant relation between market risk (price risk) and level of market participation and commercialization among smallholder farmers. They assert that smallholder and marginal farmers usually are more cormfortable to hedge their crops using commodity exchange trading platforms.

Finally, a significant positive relationship was found between access to market information of farmers and their level of participation on the exchange The result is similar with the study of Zelalem (2008) and Ngasa et al., (2020). They suggeststhat farmers with better market information are in a better position to supply their surplus production to the market. The result however, was not significant.

CONCLUSION

Smallholder maize farmers decision to participate is determined by age, gender, farm size, landtenure, access to extension service and credit while access to level of participaton decision was determined by quantity of harvested maize, household size, price risk on GCX and access to market information of farmers influences a farmer's level of participation on GCX. The significant of the constants in the model suggests that participation of smallholder farmers on the exchange is signicant for agricultural productivity and policy formulation.

In light of those findings, it is therefore recommended that:

1. Opportunities should be made available for farmers to increase their farm sizes and own a larger proportion of their farm lands;
2. Smallholder maize farmers be sensitised on the need to make themselves available to extension and advisory services to improve their knowledge on market platforms and make informed decisions to ensure sustainable agricultural production;
3. Policy makers should ensure farmers have access to agricultural credit to inprove their productivity and increase marketable surplus;
4. Price risk exposures on the exchange should be priortised and stabilized/reduced to attract farmers to participate on the exchange.

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