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Warehouse receipt system: A shift to improve maize marketing in Ghana

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ABSTRACT

The study assessed the influence of warehouse receipt system (WRS) on market access using 400 smallholder maize farmers from six communities in the Northern Region of Ghana. Primary data were collected through the use of an open-ended questionnaire. The endogenous switching regression model and propensity score matching was employed for data analysis. The results showed that participation in the WRS was mostly influenced by loan accessibility, size of crop output, established buyers, and membership in farmer organizations. The implications of the results are discussed. The paper concludes that the sustainability of farmer participation in WRS lies in strengthening farmer organizations and access to high-end markets through forming trust relationships with buyers.

Keywords: Endogenous switching regression model; smallholder maize farmer; warehouse receipt system; maize marketing
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Introduction

Agricultural markets are characterised by price variability, which is influenced by the level of inventories as well as the forces of supply and demand (Andleeb *et al*., 2017; FAO, 2018). Smallholder farmers are confronted with poor access to formal markets; they have limited selling alternatives and find it difficult to enter contractual relationships due to a lack of trust and education (Coulter, 2009; Mutero *et al*., 2016). The local markets within which smallholders operate are characterised by uncertainties and price risks for their produce. Farmers are often obliged to sell at low prices and are usually cheated by buyers on weight or volume, and quality (FAO, 2016; IFAD, 2003). Yankson *et al*. (2016) reiterate that smallholder farmers in developing countries have challenges in increasing production and accessing remunerative output markets. Farmers are faced with high input costs but low output prices due to fewer intermediaries or buyers competing for their produce. They also have weak access to supporting services such as market advice and price information from institutions, resulting in their inability to adopt new technologies to expand production for the market (Magesa *et al*., 2020; Wood, 2007).

Osei-Asare *et al*. (2014) note that distance from farm to market centres is a major constraint to market participation by smallholder farmers. Similarly, Morgan *et al*. (2019) establish that transport constraints, which are linked to high costs of transport services, are important reasons why smallholder farmers are unable to get their produce to formal markets to obtain good prices.

Kyaw *et al*. (2018) attribute the lack of market access partly to the poor quality and quantity of goods being traded; this emanates from the absence of effective systems of standard grades and measures. Similarly, Lauw & Jordaan (2017) reveal that smallholder farmers in South Africa are excluded from the main markets due to low production, which is characterised by high production and transaction cost, and poor quality making them less competitive. Hamill (2017) and Lyon & Porter (2009) conclude that smallholder farmers can create better access to the market when they have access to market information and develop trust-based relationships with their buyers. Farmers can reduce marketing challenges by storing their grains in a reputable warehouse for a warehouse receipt (Miranda *et al*., 2019). Many development economists have promoted the warehouse receipt system (WRS) as an antidote to the lack of access to formal markets faced by smallholder farmers in developing countries (IFC, 2015). However, this study has specifically assessed the impact of WRS on market access by smallholder maize farmers.

Theoretical review

Thurman (1988) in his theory of storage admits that the future price of a stored grain is expected to exceed its price soon after harvest, but there will be a storage cost incurred. The theory strongly argues that the returns from later sales of grains should depend on the level of inventories. This is because inventories can be used to avoid supply or demand shock. When the level of inventory is large, returns from later sales will decrease due to an increase in quantity supplied and vice versa. This theory is consistent with the assertion of Williams & Wright (1991) that the producer price of grains immediately after harvest can be low or high depending on the level of inventory. When inventory soon after harvest is large (when few of those commodities are stored), leading to an increase in the quantity supplied, the spot price of the commodity will be depressed leading to low income for farmers. On the other hand, when most farmers store their grains after harvest, the spot price will be high due to a decrease in the quantity supplied which will lead to an increase in income.

Inventory management is an essential part of public warehousing which may determine the success of the whole business. Inventory control involves keeping records and accounting for the grains that are brought, stored, and taken from the warehouse. Grains lose weight at storage due to loss of moisture and removal of chaff. The best practice is therefore to make upward adjustments during weighing in order to make room for the cleaning and moisture loss. Again, good inventory management includes monitoring a number of activities, including minimization of handling losses and mitigating theft incidence.

Empirical review

Warehouse receipt is defined as "documents issued by warehouse operators as evidence that specified commodities, of stated quantity and quality, have been deposited at particular locations by named depositors" (Coulter &

Onumah, 2002). In a warehouse receipt system (WRS), the grain is deposited in a certified warehouse to obtain an electronic warehouse receipt that specifies the quantity, quality, and kind of commodity deposited. In a situation where the warehouse receipt is negotiable, the commodity in stock can be sold anywhere for the buyer to retrieve the grain at the warehouse. WRS can also help farmers to access the agricultural commodity exchange market to obtain good prices for their produce.

The WRS enables smallholder farmers to combine their products through their cooperatives or farmer-based organizations (FBOs) for deposit in a certified warehouse. Thiscompels them to adhere to quality standards and meet minimum quantity requirements. The guarantee of delivery by warehouse operators reduces the risk of non-performance of trade contracts, ensuring the trust of buyers in the system (DfID, 2009). This opens smallholders to remunerative markets and increases their profit margins. The system also ensures that buyers pay for the exact quality and quantity described on the warehouse receipt (Gatachew *et al*., 2011; Katunze *et al*., 2017). This brings transparency between buyers and farmers, which is usually absent in informal markets. The development of trusted delivery systems can also increase the hopes for the successful operation of commodity exchange markets (Ngmenipuo & Issah, 2015; Onumah, 2010).

The WRS facilitates trade through the reduction of the marketing chain and narrowed distribution margins (Gunawan *et al*., 2019). The warehouses are used as delivery points where trading takes place. This reduces transaction costs and information asymmetry between market players and ensures transparent trade. In areas where warehouses are networked nationwide, bearers of warehouse receipts can take delivery of produce from the nearest licensed warehouse, further lowering transportation costs. In countries where the legal system supports the warehouse receipt being used as a negotiable instrument, the receipt can be sold at any place, enhancing sight- unseen trade (Coulter, 2014). According to Chitra (2014), WRS enables farmers to deal directly with downstream buyers and overcome asymmetric information within the market chain. This prevents the situation where farmers are chased by a small number of middlemen at the farm gate to buy at low prices.

The WRS in Ghana

The phenomenon of warehouse receipting in Ghana is traced to the late 1980s when the inventory credit system was first introduced in 1989 by Technoserve Incorporation to provide financial assistance and storage facility to smallholder farmers, thus enabling them obtain higher prices by delaying sales (Onumah, 2010). Technoserve Incorporation, a US-based non-governmental organization, began with maize deposits and later expanded to cowpeas, groundnuts, and rice. The program covered a greater part of the country and was successful in propping up the prices of these grains for farmers, and enabling them to access credit (Londner *et al*., 1999). In 1997, there was a large importation of maize into the country following government policies, and that reduced the local price of maize. This problem, coupled with small volumes of grains deposited by farmers as

well as the high operational cost incurred by Technoserve made the program unsustainable (Coleman & Valeri, 2006; Kwadzo, 2000).

In 2010, the idea of WRS was re-explored by the Ghana Grains Council (GGC) to improve the livelihoods of smallholder farmers in rural areas. In December 2012, the GGC launched the first Warehouse Receipt with financial and technical support from the United States Agency for International Development (USAID). By 2019, the GGC had 12 certified warehouses and 22 community warehouses in the Northern Region, with a total storage capacity of 54,600 MT and 2,480 MT, respectively (GGC, 2019).

Ngare *et al*. (2014) observe that the warehouse receipt system is more concentrated around ports and urban centres compared to the rural areas where the price variability of maize is prevalent due to a lack of adequate storage facilities. For example, three of the electronic warehouses in the Northern Region of Ghana are in Tamale, the regional capital. Tamale is far (more than 50 kilometres) from the locations of the 22 community warehouses. This makes it difficult for smallholder farmers transporting their produce assembled at the community warehouses to the main certified warehouses to access credit and formal markets for their produce. Despite the potential of WRS in Ghana, William & Kaserwa (2015) caution that the system only indirectly benefits a small number of smallholder farmers who are contracted by processors or exporters to produce and as a result, continue to sell their produce to them at harvest when prices are still low. Miranda *et al.* (2019) have also observed that although participation in WRS mitigates post-harvest losses suffered by smallholder farmers and increases the quality of their grains through the processing it goes through at storage, the system would not benefit farmers directly. This is because the improved grain quality may fail to attract prices high enough to recover the storage cost. This paper addresses the benefit dilemma by assessing the impact of WRS on access to the output market by smallholder maize farmers. Three specific issues addressed are; the likelihood of participation in the WRS by smallholder farmers, the factors of participation, and the additional gains made in output and price (impact) due to participation in the system.

Conceptual framework

The conceptual framework for the research is illustrated in Figure 1. The study conceptualises the participation of smallholder farmers, institutional support services and enabling environment as integral factors for the successful operation of both electronic and community WRS. The Ghana Grains Council (GGC) works in close collaboration with public organisations to formulate policies and establish institutions needed for the successful operations of WRS in Ghana, through promotional activities and feedback. Institutional support such as enabling policies and legislation, grain standardisation and grading, and market information systems sanitises the environment for the WRS and provides fertile grounds for stakeholders to operate.

The capacity of smallholder farmers to participate in WRS depends on the quality and quantity of output (KENFAP, 2011). It is therefore important for smallholder farmers to combine their products with other farmers through farmer-based organisations at the community warehouses system. This enables the farmers to obtain adequate quantities of output required to earn a warehouse receipt (WR) at the electronic warehouses and also benefit from other support services such as research and extension, market information, and financial services.

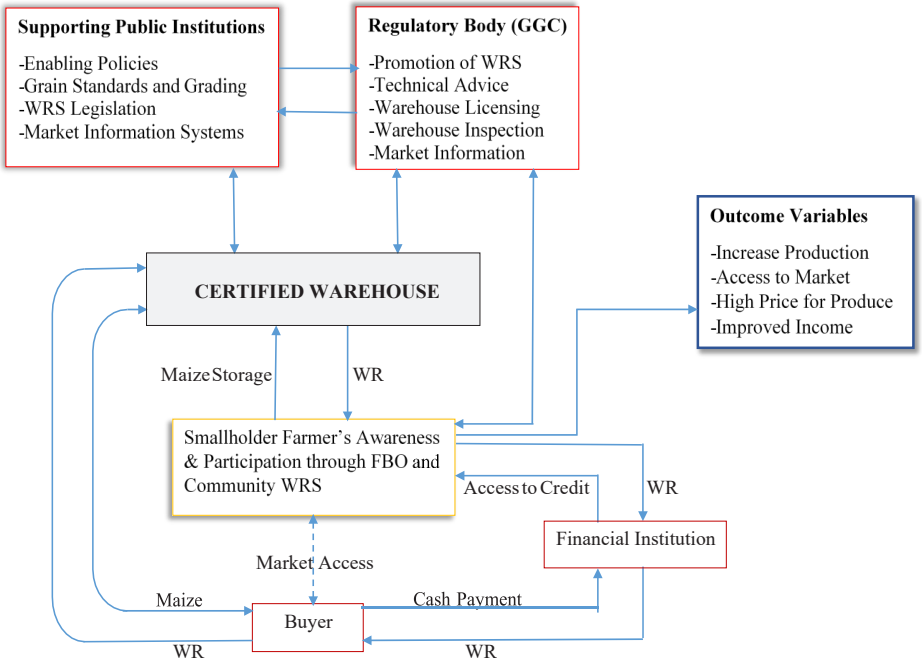

Fig. 1: Conceptual framework for the activities and functions of WRS. Source: Adapted from Onumah (2012)

The warehouse receipt obtained from the electronic warehouse is used as collateral against the commodity in stock to access credit from formal financial institutions which is shared among the individual participating farmers. The credit is used to acquire quality inputs to improve farming activity which helps to increase productivity. The improvement in productivity paves the way for farmers to access formal markets (Towo & Kimaro, 2014). Increased productivity and high price from later sales enable farmers to improve their income tremendously.

Materials and Methods

Analytical procedures

The study employed the endogenous switching regression model (ESRM) and verified the conclusions with propensity score matching (PSM). The Statistical Package for the Social Sciences (IBM SPSS Statistics 22) and STATA 14 were employed as the software for analysis. ESRM corrects any potential endogeneity and sample selection bias, which may arise from other interventions for farmers (Alene & Manyong, 2007). PSM as a supplementary

model allows a comparison of the observed outcomes of participants of a program with the outcomes of counterfactual non-participants (Heckman *et al*., 1998). PSM ensures that any interventions earlier made that could have affected the outcome variable are balanced between the treated and untreated parameters (Abadie, 2005). It can also reduce the overall bias in estimating differences in treated and untreated parameters (Austin, 2011).

Model specification

Participation of warehouse receipt system (WRS) is modeled under the Random Utility Theory (RUT), which states that farmers will choose to participate or not participate in WRS based on the utility they derive from it. The theory assumes that farmers are risk neutral, and their decision to participate in WRS is influenced by the utility they obtain. It is therefore, assumed that smallholder maize farmers will choose management system that optimizes their access to output market (Abdulai & Huffman, 2014).

To estimate the causal impact of WRS on access to market, score of 1 was assigned for farmers who participate in WRS and 0 for farmers who do not participate:

$$Y_i = \beta_0 + \beta_1 T_i + X_i'\delta + u_i \quad \text{..... (1)}$$

Where,

Yi is the i[th] farmer's access to the output market, and is measured as the proportion of maize sold by farmers at the time of the survey. Ti is a binary indicator for whether or not the i[th] farmer participates in the WRS, and X_i is a vector of farmer's characteristics. u_i, the error term, is uncorrelated with Ti and is of mean zero. This was estimated by the regression model:

$$Y = \beta_1 WRS + \beta_2 Age + \beta_3 Gender + \beta_4 FarmSize + \beta_5 Education + \beta_6 Savings + \beta_7 Experience + \beta_8 \text{FBO} + \beta_9 EstablishedBuyer + \beta_{10} Price + \beta_{11} Phone + \beta_{12} MarketDistance + \beta_{13} Tax + \beta_{14} Loan + \beta_{15} Extension + \beta_{16} Storage + \beta_{17} MaizeOutput + \beta_{18} Input + \varepsilon i \quad \text{..... (2)}$$

The independent variable of interest, participation in WRS (Treatment), is a dummy variable taking a value of 1 if the farmer participates, and 0 otherwise. The other explanatory variables are defined in Table 1.

Hypothesis

H0: WRS has no effect on smallholder farmers' access to the output market. H1: WRS has an effect on smallholder farmers' access to the output market.

Source of data

The data employed were obtained from maize farmers in the Northern Region. The region was purposively selected for the study due to the operation of both electronic and community warehouse receipt systems in the area. A total of 400 individual maize farmers were selected from six communities in three Districts. The communities were Diare and Tamaligu in Savelugu District; Kpatinga, Kpugi, and Gaa in Gushegu District; and Shelilanyili in Karaga

District. To ensure a fair representative sample for the study, the farmers were stratified into participants and non-participants of WRS. A total of 142 participants and 258 non-participants were randomly selected based on a list obtained from the Agricultural Department of each District Assembly and executives of farmer organizations in the communities. The participants are those who stored grains in the community warehouse. Table 1 presents a summary of the explanatory variables of participation.

TABLE 1

Explanatory variables of participation of WRS and their expected signs

Explanatory Variable	**Description**	***a priori* expectation**
Age	Age of farmer measured in years	+
Farm Size	Size of farmland in hectors	+
Education (Edu)	The formal educational level attained by the respondent, measured in years	+
Gender	Dummy for gender (1 if a farmer is male and 0 otherwise)	+/-
Savings	Dummy for savings (1 if a farmer saves financially and 0 otherwise)	+
Member of FBO	Dummy for FBO membership (1 if a farmer is a member of FBO and 0 otherwise)	+
Distance to market	Distance to market measured in km	+
Cost of Input	Cost of input measured in cedis	-
Loan Access	Dummy for loan access (1 if farmer has access to loan and 0 otherwise)	+
Extension Services	Dummy for extension (1 if farmer has access to extension services and 0 otherwise)	+
Maize Output	Quantity of maize harvested measured in kg	+
Storage facility	Dummy for storage facility (1 if a farmer owns storage facility and 0 otherwise)	-
Mobile phone	Dummy for a phone (1 if farmer has a mobile phone and 0 otherwise)	+
Experience	Farmer's experience in farming, measured in years	+
Established buyer	Dummy for an established buyer (1 if the farmer has an established buying relationship with someone and 0 otherwise)	+
Labour offer	Dummy for labor offer (1 if farmer offers his / her labor to work at other farms and 0 otherwise)	-
Tax	Amount of money paid as tax on maize sold, measured in cedis	-
Maize price	Price in which a bag of maize is sold, measured in cedis	+

Source: Authors Compilation

Data collection procedure

A cross-sectional survey and ethnographic method of in-depth interviews were used to generate quantitative and qualitative data. Structured questionnaires were administered to smallholder maize farmers. Key informants, including officers of the Agricultural Department of the District Assemblies, Ghana Grains Council, warehouse operators, and heads of farmer-based organizations were also interviewed. Secondary data on the prices of maize was obtained from the MOFA department of the Northern Region to assess the trend of maize prices. "Smallholder farmers are those marginal and sub-marginal farmers that cultivate less than two hectares of land in a particular growing season" (Singh et al., 2002).

Results and Discussion

Socio-economic characteristics of respondents

The majority of respondents are Muslims (99.5%) and mainly Dagombas (98.5%) (Table 2). The other ethnic groups are Mamprusi, Fulani, Frafra and Moshi, making up to 1.5% of the sample. The mean age of respondents is 39 years old with the majority aged between 26 years and 50 years (82.2%). The majority are married (91.8%) and the mean household size is 9 (Table 2). Only 29.8% had attained formal education, dominated by junior high school (10.3%). This is followed by primary school (9.8%), and senior high school (6.3%). Maize farming in the research area is a male dominated activity whilst females are often engaged in legume production.

TABLE 2

Socioeconomic characteristics of respondents

Characteristics	Frequency	%age
Age distribution		
21 – 25	21	5.25%
26 – 30	68	17%
31 – 35	88	22%
36 – 40	76	19%
41 – 45	48	12%
46 – 50	49	12.25%
51 – 55	23	5.75%
56 – 60	17	4.25%
> 60	10	2.5%
Age statistics		
Minimum	23	
Mean	39	
Maximum	65	
Standard deviation	9.66	
Ethnic group:		
- Dagomba	393	98.5%
- Others (Mamprusi, Fulani, Frafra and Moshi)	7	1.5%
-Religion:		
-Islamic	398	99.5%
-Others (Christianity and Traditional)	2	0.5%
Education:		
-Formal education	119	29.75%
-No formal education	281	70.25%
Marital status:		
-Married:	367	91.75%
-Single:	33	8.25%
Gender:		
-Male	365	91.25%
-Female	35	8.75%

Household size distribution		
1 – 5	126	31.5
6 – 10	153	38.2
11 – 15	72	18%
16 – 20	26	6.5%
> 20	23	
Household size statistics		
Minimum	1	
Mean	9.2	
Maximum	35	
Standard Diviation	6.4	

Source: Authors Compilation

Descriptive Statistics

Marketing of maize and the corresponding prices obtained in the Northern Region is seasonal and controlled by market forces of demand and supply. Consumers depend on maize for their household consumption early in the harvesting periods when other staple foods such as yam are not adequately available on the market (Angelucci, 2012). The price of maize is therefore low in January when market supply is in abundance and increases steadily until July where the maximum price is obtained (Figure 2). In August, other staple foods become available on the market, therefore, maize prices begin to fall once again. It is important for farmers to study the market and sell their produce in June, July (peak period) or August. The time of harvesting and the ability of farmers to get access to market price information was an important factor that determined how much a bag of maize was sold.

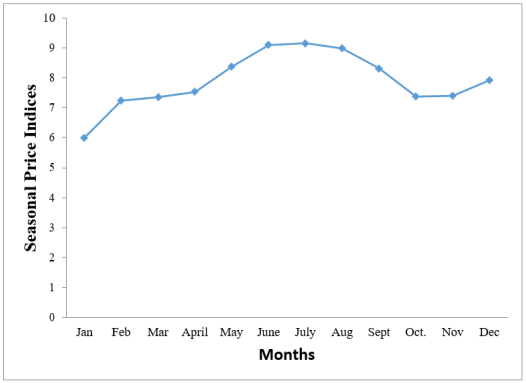

Fig. 2: Seasonal price indices of maize in the Northern Region (2012 – 2019)

Most farmers (98%) harvested their produce from September to December. Marketing was however throughout the year, depending on access to a storage facility and financial needs of a farmer. There were four types of output markets used by farmers: farm-gate or home, local market (spot sale space provided by the District Assembly), WRS market, and purchase by private organizations also known as buying companies. In the study, farmers sold to the local market (27%), wholesalers at home (36%), or the community warehouse (36%) for those who participated in WRS. Only 2.5% of the respondents had ever sold their produce to private organizations such as Premium Foods Limited. When farmers were asked why they did not normally sell to private organizations, 45% and 53% respectively said it was due to the low quantity of produce, and lack of information about the companies and their requirements. This confirms the findings of

Balgah & Buchenrieder (2011) which disclose that smallholder farmers lack access to formal markets due to insufficient production and inability to meet desired quality and standards. Farmers who did not participate in WRS expressed dissatisfaction about the price they obtained from sales. While most participants (85%) obtained GH¢130 to GH¢150 (highest price on the market) per 110 kg bag of maize, only 12% of non-participants obtained GH¢130 to GH¢150. This result is consistent with the findings of Katunze *et al.* (2016) that confirms that WRS boosts market performance by increasing access to markets with high prices. Many non- participants (88%) obtained GH¢120 or below, per sale of a 110 kg bag of maize.

Again, non-participant farmers depended on their colleague farmers (54%), and retailers (25%) for their market price information. This explains why they obtained lower prices. This is because it is likely that wholesalers or retailers quoted prices to their advantage. Farmers who participated in community WRS, however, obtained high prices for their produce because they always got access to market price information from Esoko Limited, a private market information service provider, through the GGC as text messages on their mobile phones. One farmer expressed the following: "I always get up to date market price information on my mobile phone from GGC. I also have a ready market for my produce since I am part of Gundaa farmers (Smallholder farmers whose community warehouses are linked to Gundaa electronic warehouse)" (Yakubu Alhassan, Diare Community). This is consistent with the results of Hamill (2017) that affirm that smallholder farmers in Ghana could create better access to the market and obtain higher prices when they had access to credible market information.

Factors that influence the participation of WRS by smallholder farmers

The likelihood of farmers participating in WRS of the GGC is 36%. The selection estimates of the ESRM (Table 3) show that access to loan, increase in maize output, being a member of a farmer organization, and farmers having established buyers for their produce are positive factors that determine the participation of WRS. On the other hand, farmers who owned storage facilities are less likely to participate in WRS. Farmers who have access to loans are 92% more likely to participate in the WRS. A kilogram increase in maize output increases the likelihood of participation by 8%. Although there is no quantity limit to participate in the community WRS, farmers who had low harvests explained that they did not feel confident storing their maize at the warehouse; family demand for the maize for consumption is high. Many farmers (61%) therefore gave low produce as the reason why they did not participate in WRS.

The results further show that being a member of a farmer organization is likely to increase participation of WRS by 73%. The community WRS is closely linked to the effective farmer organization. The members collectively benefited from workshops, seminars and other assistance from GGC, the Ministry of Food and Agriculture (MoFA) and other electronic warehouse operators. Farmers, therefore, stood a better chance to understand how the WRS operates, and the benefits that come with it. Again, farmers might receive agronomic training, which increased their production to encourage them to participate in WRS. Finally, the establishment of customer relationship with buyers is 91% likely to encourage farmers to participate in WRS.

TABLE 3
FIML estimate on the endogenous switching regression for log of output market

Variables	**FIML Endogenous Switching Regression Model**		
	Selection (1 / 0)	Participants = 1 (Adopters =142)	Non-participants = 0 (Non-adopters=258)
Gender	0.123 (0.421)	0.037 (0.141)	0.157 (0.119)
Age	0.031 (0.020)	-0.008 (0.006)	-0.012 (0.005)**
Education	0.042 (0.032)	0.002 (0.007)	0.008 (0.083)
Market distance	0.010 (0.032)	0.003 (0.010)	0.029 (0.010)***
Input cost	-0.001 (0.000)	0.000 (0.000)	0.000 (0.000)
Experience	0.001 (0.019)	0.003 (0.006)	0.006 (0.006)
Extension services	0.202 (0.276)	0.076 (0.067)	0.149 (0.070)**
Savings	0.307 (0.378)	0.014 (0.102)	0.080 (0.106)
Labor offer	-0.125 (0.259)	-0.017 (0.067)	-0.047 (0.070)
Storage facility	-0.834 (0.398)**	-0.164 (0.092)*	-0.001 (0.138)
Access to loan	0.920 (0.463)**	0.374 (0.107)***	0.074 (0.141)
Maize output	0.081 (0.014)***	0.057 (0.003)***	0.022 (0.004)***
Farm size	0.037 (0.062)	0.014 (0.014)	0.065 (0.020)***
Mobile phone	0.473 (0.373)	0.056 (0.113)	0.103 (0.098)
Established buyer	0.915 (0.509)***	0.424 (0.210)**	0.260 (0.088)***
Taxation	-0.028 (0.031)	-0.001 (0.002)	0.021 (0.016)
F.B.O. membership	0.734 (0.289)**		
Price of maize		0.001 (0.003)	0.003 (0.019)
Constant	-5. 505 (1.181)***	2.856 (0.571)***	0.759 (0.338)**
/lns0	-0.746 (0.048)***		
/lns1	-0.988 (0.071)***		
/r0	0.776 (0.261)***		
/r1	-1.136 (0.425)***		
sigma0	0.474 (0.023)		
sigma1	0.372 (0.026)		
rho0	0.651 (0.150)		
rho1	-0.877 (0.098)		
LR test of indep. eqns. : chi2(2) = 18.86		Log likelihood = -267.74	Prob > chi2 = 0.0000
Wald chi2(18) = 467.73			

Source: Author's Compilation. Standard Errors in Parenthesis. *Significant at the 10% level; **Significant at the 5% level; ***Significant at the 1% level

Impact of WRS on access to output market

The ESRM result of the estimation of the impact of WRS on access to the output market (Table 4) shows that smallholder farmers who were participants of WRS sold more produce than non- participants by 3%. This, again, confirms the results of Katunze *et al.* (2016) that the WRS increases smallholder farmers' access to remunerative market. The counterfactual results, however, show that had the farmers who participated in WRS decided not to participate, they would have suffered fewer sales of produce by 18%. Alternatively, had the smallholder farmers who did not participate in WRS participated, they would have gained additional sales by 48%.

The results on the heterogeneity effect of WRS show that smallholder farmers who participated in WRS would have sold more produce than non-participants by 51%, even if the non- participants had participated. Furthermore, if the participants had not participated, they would have sold less produce than smallholder farmers who did not participate by 15%. Last, there is a positive transitional heterogeneity which implies that the impact of WRS on smallholder farmers' access to the output market is significantly higher for farmers who participated than those who did not participate.

TABLE 4
Expected access to output market, treatment and heterogeneity effect of WRS by the ESRM

Log Access to Output Market	**Decisions stage**		**Treatment Effect**
	To Participate	Not to Participate	
Farmers who Participated	(a) 3.18	(c) 3.00	0.18 (3.01)***
Farmers who did not Participate	(d) 2.67	(b) 3.15	-0.48 (66.54)***
Heterogeneity effects	$BH_1 = 0.51$	$BH_2 = -0.15$	TH = 1.04

Source: Author's Compilation. Absolute value of t-statistics in parenthesis. *Significant at 10% level; **Significant at 5% level; and ***Significant at 1% level

To assess the robustness of results, propensity score matching (PSM) was also used to analyze the impact of WRS on the output market of smallholder maize farmers. Kernel matching and nearest neighbor matching methods were used to estimate the impact of participation in the warehouse receipt system (WRS) on the output market and the result is presented in Table 5. The result shows that access to the output market by farmers is determined by the quantity of maize sold and the price of a 110kg bag of maize.

The results show that participants of WRS sold approximately 12 bags of maize more than non-participants, and gained an additional value of GH¢34.39, all significant at 1%. This is consistent with the result of the ESRM. The null hypothesis, which states that

participation in WRS has no significant effect on smallholder farmers' access to the output market, is therefore rejected in favour of the alternative. This means that participation in WRS has a positive influence on smallholder farmers' access to the output market.

TABLE 5
Average treatment effect on treated (ATT): Impact of participation of WRS on output market by PSM

Outcome variable	ATT	t-statistic	Treated	Control	S.E
Quantity sold	11.89***	3.996	142	258	2.97
Price of maize	34.39***	9.285	142	258	3.70

Source: Author's Compilation

The reason behind access to output market by participants of WRS

Gaining access to formal markets by smallholder farmers who participate in the community WRS does not come on a silver platter. Apart from increased production and access to market information, the GGC has trained farmers who participate in the system on how to determine moisture content, clean, treat, and store their maize well to attract buyers from electronic warehouse operators and other produce buying organizations. Maize is often graded from grade one (the best grain) to grade five.

The Ghana Standard Authority (GSA) is the only institution mandated by law under the Standard Act 1973 (NRCD 173) to do the grading of grains. Although maize is currently not graded in the community WRS, the farmers clean their maize well such that the maize would attain at least grade three if it was graded. The Gundaa Electronic warehouse operator had this to say: "I prefer to buy maize from the community warehouses to feed my certified electronic warehouse because the farmers who participate in the community WRS clean the maize well to a standard of about grade three, such that I do a little further cleaning to obtain grade one when graded by the GSA" (Warehouse Operator, Gundaa Electronic Warehouse, Tamale).

Maize stored in the GGC-certified electronic warehouses is sent to the GSA to be graded. The current grading of maize is based on Ghana Standard Authority GSS 211: 2013: Specification for Maize. The GSA follows the following procedure to grade maize; samples are taken randomly from many bags brought by a depositor. These samples are mixed to obtain a unit representative sample for laboratory analysis. About 200 g or 500 g of maize sample is taken from the unit representative sample and are sorted out into various blemishes such as diseased grains, discoloured grains, broken grains, stained grains, germinated grains, shrivelled or immature grains, insect damaged grains, other grains, and filth. Each blemish, after sorting, is weighed and calculated as a percentage of the total sample.

The various percentages obtained are combined and compared to standards as follows: if the combined blemishes are less than 11%, the grains are labelled as grade one, less than 17% are labelled grade two, and less than 24% is recorded as grade three, less than 30% is grade four, and less than 38% is

assigned grade five. The only limitation in the grading system was that theoffice of the GSA in the Northern Region conducted only physical grading of maize since they had no machines to test for aflatoxin and heavy metal content in the grains. Such a test had to be conducted at the head office in Greater Accra Region.

Conclusion and Recommendation

The study assessed the likelihood of maize farmer participation in WRS, factors of participation and the resultant impact on access to the output market, by smallholder maize farmers in the Northern Region of Ghana. The study revealed that there is adequate likelihood of farmer participation and that, loans, volume of output, consistent customers and effective farmer organization were key determinants of participation in WRS. Participation in WRS increased farmers' access to the output market and enabled them to obtain a higher market price.

It is recommended that the operators of the warehouse receipt system (Ghana Grains Council) partner with the local level Agricultural Department and other relevant stakeholders to strengthen farmer organizations. This will thus incentivise farmers to maintain membership and new members would be attracted to get on board as well. The farmer organizations are platforms for consistent learning on agronomic practices that will boost production and motivate them to participate in the community WRS. The partnership among the public (local agriculture department) and private (GGC) should also support farmers to obtain loans to buy essential inputs that will help them increase production. This will encourage the farmers to participate in WRS, which will eventually help them gain access to formal markets for high prices. Access to market price information was proven to be essential services to farmers that enabled them to sell their produce at the right time to obtain higher prices. The GGC is, therefore urged to ensure a continuous flow of such information to farmers who are participants of the WRS to encourage other farmers to join.

REFERENCES

Abadie, A. (2005) Semi-parametric difference-in-difference estimators. *Review of Economic Studies*, **72**.

Abdulai, A. & Huffman, W. (2014) The adoption and impact of soil and water conservation technology: An endogenous switching regression application. *Land Economics*, **90**(1), 26–43. doi:10.3368/le.90.1.26.

Alene, A. & Manyong, V.M. (2007) The effect of education on agricultural productivity under traditional and improved technology in Northern Nigeria: An endogenous switching regression analysis. *Empirical Economics*, **32**, 141–159.

Andleeb, I., Ihsan, H., Khan, S.A. & Jabeen, M. (2017) Price volatility of food and agricultural commodities: A case study of Pakistan. *Journal of Economic Cooperation and Development*, **38**(3), 77–120.

Angelucci, F. (2012) Analysis of incentives and disincentives for maize in Ghana. Technical notes series. MAFAP, FAO, Rome.

Austin, P.C. (2011) An introduction to propensity score methods for reducing the effects of confounding in observational studies. *Multivariate Behavioral Research*, **46**, 399–424.

Balgah, R.A. & Buchenrieder, G. (2011) Does technology adoption reduce risks for smallholder farmers in Cameroon? *Pakistan Journal of Sciences*, **8**, 13–22.

Chitra, P.S. (2014) Factors influencing the use of warehouse receipts as a financial instrument in Kenya, University of Nairobi.

Coulter, J. (2009) Review of warehouse receipt system and inventory credit initiatives in Eastern & Southern Africa. UNCTAD, All ACP Agricultural Commodities Program (AAACP).

Coulter, J. (2014) Study on appropriate warehousing and collateral management systems in Sub-Saharan Africa. Volume I – key findings.

Coulter, J. & Onumah, G. (2002) The role of warehouse receipt systems in enhanced commodity marketing and rural livelihoods in Africa. *Food Policy*, **27**(4), 319 – 337.

Coleman, A. & Valeri, L.M. (2006) Storage and warehouse receipts as financing instruments. http://www.eea-esem.com/files/papers/EEA-ESEM/2006/2046/WR_malaguzzivaleri.pdf.

DfID (2009) "Road to market", field record of interviews of beneficiaries of market development projects in Africa produced for the crop post-harvest research project, January 2005. Department for International Development (DfID).

FAO (2016) Contract farming and the law: What do farmers need to know. Food and Agriculture Organizations of the United Nations (FAO), Rome, Italy. http://www.fao.org/3/a- i7581e. pdf.

FAO (2018) The state of agricultural commodity markets. Agricultural trade, climate change and food security. Food and Agriculture Organizations of the United Nations (FAO), Rome, Italy. http://www.fao.org/3/I9542EN/i9542en.pdf.

Gatachew, A., Batekass, A. & Christopher, P. (2011) Market access for local food through the conventional food supply chain. *International Food and Agribusiness Management Review*, **14**, 1–10.

GGC (2019) List of Certified Warehouses in Ghana [Online]. Ghana Grains Council (GCC). http://www.ghanagrainscouncil.org/en/warehouse-receipt-system/list-of-certified- warehouses/. (Accessed 3 May 2020).

Gunawan, E., Kuwornu, J.K.M., Datta, A. & Nguyen, L.T. (2019) farmers' perceptions of the warehouse receipt system in Indonesia. *Sustainability,* **11**, 1690.

Hamill, S. (2017) Strengthening agricultural market access with ICT. ICT in Agriculture (Updated Edition): Connecting Smallholders to Knowledge, Networks, and Institutions, World Bank publication, June 2017.

Pages 225–265. https://elibrary.worldbank.org/doi/10.1596/978-1-4648-1002-2_Module9.

Heckman, J.J., Ichimura, H. & Todd, P. (1998) Matching as an econometric evaluation estimator. *Review of Economic Studies*, **65**, 261–294.

IFAD (2003) Promoting market access for the rural poor to achieve the millennium development goals. Roundtable discussion paper for the 25th anniversary session of IFAD's governing council.

IFC (2015) Money in the barn: How warehouse receipts can improve the life of farmers. International Finance Corporation (IFC).

Katunze, M., Kuteesa, A., Mijubi, T. & Mahebe, D. (2016) Uganda warehousing receipt system: Improving market performance and productivity. Economic Policy Research Centre.

Katunze, M., Kuteesa, A., Mijubi, T. & Mahebeuganda, A. (2017) Warehousing receipt system: Improving market competitiveness and service delivery. Economic Policy Research Centre; towards sustainable development. Research series No. 137, June 2017.

KENFAP (2011) The role of warehouse receipt system and financial services in improving produce marketing by smallholder farmers in Kenya. Kenya National Federation of Agricultural Producers (KENFAP).

Kwadzo, G.T-M. (2000) Inventory credit: a financial product in Ghana. Paper presented at Conference on "Advancing microfinance in rural West Africa". Bamako, February 22– 25, 2000.

Kyaw, N.N., Ahn, S. & Lee, S.H. (2018) Analysis of the factors influencing market participation among smallholder rice farmers in Magway Region, Central Dry Zone of Myanmar. *Sustainability*, **10**, 4441.

Louw, A. & Jordaan, D. (2017) Supply chain risks and smallholder fresh produce farmers in the Gauteng province of South Africa. Southern African Business Review Volume 20.

Londner, S.I., Hicks, F., Kwadzo, G.T.-M. & Panlibuton, H. (1999) Financing rural growth: farm inventory credit in Ghana. Findings paper, Technoserve, Inc.

Lyon, F. & Porter, G. (2009) Market institutions, trust and norms: exploring moral economies in Nigerian food systems. *Cambridge Journal of Economics*, **33**(5), 903–920.

Magesa, M.M., Kisangiri, M. & Jesuk, K. (2020) Access and use of agricultural market information by smallholder farmers: Measuring informational capabilities. The electronic journal of information systems in developing countries. First published: 03 April 2020 https://onlinelibrary.wiley.com/doi/full/10.1002/isd2.12134.

Miranda M.J., Mulangu, M.F. & Kemeze, F.H. (2019) Warehouse receipt financing for smallholders in developing countries: Short on logic, long on imagination. 2019 Annual Meeting, July 21–23, Atlanta, Georgia 291012, Agricultural and Applied Economics Association.

Morgan, A.K., Dogbey, E., Arimiyaw, A.W. & Foster, A.S.W. (2019) Effect of road transport accessibility on agricultural produce marketing and livelihoods of farmers in the Kasena-Nankana West District of Ghana. *Journal of Development Practice*, **5**(1), 2394-0476.

Mutero, J., Munapo, E. & Seaketso, P. (2016) Operational challenges faced by smallholder farmers: A case of Ethekwini Metropolitan in South Africa. *Environmental Economics*, **7**(2), 40–52. doi:10.21511/ee.07(2).2016.4.

Ngare, L., Simtowe, F. & Massingue, J. (2014) Analysis of price volatility and implications for price stabilization policies in Mozambique. *European Journal of Business and Management*, **6**(22), 160–173.

Ngmenipuo, M.I. & Issah, O. (2015) Developing an organized commodity exchange in Ghana: Challenges and economic prospects. *International Journal of Finance and Banking*, **3**(2), 41–54.

Onumah, G.E. (2012) Warehouse receipts and securitisation in agricultural finance to promote lending to smallholder farmers in Africa: Potential benefits and legal/regulatory issues. *Unif. L. Rev*., **17**, 351.

Onumah, G. (2010) Implementing warehouse receipt systems in Africa: Potential and challenges. In: Fourth African agricultural markets program policy symposium; organized by the Alliance for Commodity Trade in Eastern and Southern Africa (ACTESA) of the Common Market for Eastern and Southern Africa (COMESA).

Osei-Asare, Y., Abu, B. & Wayo, S. (2014) Market participation of smallholder maize farmers in the upper west Region of Ghana. *African journal of agricultural research*, **9**(31), 2427–2435. July, 2014.

Singh, R.B., Kumar, P. & Woodhead, T. (2002) Smallholder farmers in India: Food security and agricultural policy. FAO Regional Office for Asia and the Pacific; Bangkok, Thailand. March 2002.http://www.apaari.org/wp-content/uploads/2009/08/small-farmers-in- india1.pdf.

Thurman, W.N. (1988) Speculative carryover: An empirical examination of the U.S. refined copper market. The RAND Journal of Economics.

Towo, N.N. & Kimaro, P.J. (2014) Warehouse Receipt System: A solution towards smallholder farmers' financial constraints. MUCCoBS Working Papers.

William, J.G. & Kaserwa, N. (2015) Improving smallholder farmers' access to finance through warehouse receipt system in Tanzania. *International Journal of Economics and Financial Research*, **1**(92), 41–49.

Williams, J.C. & Wright, B.D. (1991) Storage and commodity markets. Cambridge University Press.

Wood, S. (2007) Spatial dimensions of the regional evaluation of agricultural livelihood strategies: Insights from Uganda.

Yankson, P., Frimpong, S. & Owusu, A. (2016) Challenges and strategies for improving the agricultural marketing environment in developing countries: Evidence from Ghana. *Journal of Agricultural and Food Information*, **7**(1), 49–61.