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Social networks, rice value chain participation and market performance of smallholder farmers in Ghana

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Abstract

This paper examines the impact of rice value chain participation and social networks on smallholder farmers' market performance outcomes (paddy price, quantity of paddy traded, and net returns), using data from a recent survey of 458 smallholder rice farmers in northern Ghana. We employed a treatment effects model to account for potential selection bias associated with observable and unobservable factors. The empirical results reveal that smallholder farmers' participation in a rice value chain is associated with increased paddy price, quantity traded, and net returns. We also find that value chain participation decisions and market performance are positively and significantly influenced by social networks. The empirical results also suggest that sex, farm size, mobile phone ownership, and access to credit significantly increase paddy prices, quantity traded, and net returns of smallholder rice farmers in the value chain.

1 | INTRODUCTION

In the past 2–3 decades, agricultural value chains in developing countries have experienced dramatic structural transformation, driven by several factors such as population growth, rising urbanization, increasing consumer incomes, and varying consumer dietary requirements (Henderson & Isaac, 2017; Mensah, Adu, Amoah, Abrokwa, & Adu, 2016; Swinnen & Kuijpers, 2019). While the value chain transformation is considered important in reducing rural poverty, improving food and nutrition security, and ensuring overall economic growth, smallholder farmers' inclusion in these chains still remains a major challenge in developing countries. This is largely due to lack of institutional and infrastructural support, inadequate resources for effective value chain coordination, high transaction costs associated with accessing inputs and markets, and other challenges related to accessing services such as extension, finance, and transportation, all of which impact farm production and market performance (Trienekens, 2011; Verdier-Chouchane & Boly, 2017).

Developing country governments, non-governmental organizations (NGOs), and the private sector have increasingly recognized agricultural value chain development as an important area of donor interventions, and a centerpiece of agricultural development policies (Humphrey & Navas-Aleman, 2010). Motivated by concerns for agribusiness development, value chain development interventions do not only focus on strengthening the capacities of value chain actors, but also the institutions and enabling policy environment that ensure effective and efficient coordination and competitiveness of these chains (Anyanwu & Kponnou, 2017; Humphrey & Navas-Aleman, 2010). They facilitate vertical linkages, and foster governance of relationships between smallholder farmers and agribusinesses through written or

verbal contracts within value chains for improved welfare gains (Devaux, Torero, Donovan, & Horton, 2018). Smallholder farmers have been recognized as important actors for the diffusion of value chain innovations such as information and technology (Ramirez, Bernal, Clarke, & Hernandez, 2018). With the underlying assumption that the behavior of social network members influences farmers' decision-making with direct implications on welfare outcomes (Mano, Yamano, Suzuki, & Matsumoto, 2011; Wydick, Hayes, & Kempf, 2011), the important role of farmers' social networks in improving value chain efficiency and rural economic transformation needs to be highlighted in the empirical literature. The concept of social networks emphasizes the connections among individuals (e.g., farmers) through which goods and services, money, and information flow (Mano et al., 2011). Within the context of value chains, social networks focus on horizontal and vertical relationships that exist among value chain actors (Trienekens, 2011). Horizontal social networks reflect cohesive social relationships that promote collective action for successful inclusion in value chains (Ramirez et al., 2018). They can draw upon their social capital to strengthen vertical relationships with buyers and other actors within the value chain (Bijman, Omta, Trienekens, Wijnands, & Wubben, 2006). More importantly, smallholder farmers organized into a strong social network can benefit from improved access to credit and extension services, increased bargaining power, exchange of input and output price information, and buyer quality requirements through participation in such formalized value chains (Ma, Abdulai, & Goetz, 2018).

This is in line with the increasing calls for smallholder collective action (e.g., collective marketing) to improve farmers' bargaining power, while enhancing value chain efficiency (Bernard, Spielman, Taffesse, & Gabre-Madhin, 2010; Dillon & Dambro, 2017). In addition, smallholder farmers often rely on their social connections and goodwill with other farmers in their communities to enjoy cost advantages associated with production and sales, as well as achieve optimum benefit from participating in agricultural value chains (Ramirez et al., 2018). Such social connections are based on agreed-upon norms, and established trust, as well as facilitate sharing of value chain information, skills, labor, and financial resources. Some recent studies have examined the welfare gains associated with smallholder farmers' participation in value chains in developing countries (e.g., Henderson & Isaac, 2017; Ma & Abdulai, 2017; Maertens & Vande Velde, 2017; Michelson, 2013). Michelson (2013) found that value chain participation is associated with increased productive asset holdings among smallholder farming households in Nicaragua. Other studies also found that smallholder participation in value chains significantly improves prices received, farm profit, and gross income (e.g., Ma & Abdulai, 2017), farm yields, household income, and net farm income (e.g., Maertens & Vande Velde, 2017), and land and labor redistribution (e.g., Henderson & Isaac, 2017). However, there is also increasing interest in the role of social networks on the economic behavior and decision-making of smallholder farmers in developing countries. For example, the study by Bandiera & Rasul (2006) reveals that social networks influence smallholder farmers' sunflower adoption decisions in northern Mozambique. Moreover, the role of social networks in improving households' access to credit, income diversification, and non-farm employment decisions has also been revealed by past studies (e.g., Kinyondo & Kagaruki, 2019; Mano et al., 2011; Wydick et al., 2011).

This study examines the implications of social networks and value chain participation on smallholder farmers' market performance, using recent survey data collected by the authors from northern Ghana. In particular, this study makes three contributions to the empirical literature. First, we explore the role of social networks and other farm and household characteristics in influencing smallholder farmers' participation in a rice value chain. Second, we examine how social networks and rice value chain participation influence smallholder rice farmers' market performance outcomes: prices received, quantity traded, and net returns. Finally, we examine whether rice value chain participation effects vary with farm size. Insights from this study could be relevant from a development policy perspective. The study focuses on the rice sub-sector, because value chain development efforts to revamp the cereal staples sub-sector are already in progress in Ghana (Donkor, Matthews, & Ogundeji, 2018). The government, donor agencies, and the private sector have collaboratively rolled out a number of value chain development interventions with the objective of ensuring smallholder market competitiveness, and rural economic transformation. These interventions promote value chain development by linking smallholder farmers with large agribusinesses and other produce buyers for output transactions. Findings from this study can inform policy on the design and implementation of value chain development programs for the benefit of smallholder farmers in Ghana.

The rest of this paper is organized as follows: Section 2 describes the conceptual framework that guides the empirical analysis, followed by specification of the empirical model in Section 3. Section 4 presents the data and descriptive statistics of the variables used in the analysis. Section 5 presents and discusses the empirical results, while conclusions and policy implications are provided in the final section.

2 | CONCEPTUAL FRAMEWORK

2.1 | Rice value chain participation decision and the role of social networks

In this section, we explore the effects of social networks on rice value chain participation by smallholder farmers. Social network effects on individual behavior include endogenous effects, exogenous (contextual) effects, and correlated effects. The influence of a network member's behavior on the individual's decision-making, such as value chain participation, is termed an endogenous network effect, while the effect that a network member's specific characteristics (e.g., age, education, sex etc.) may have on the individual's decision to participate in a value chain is referred to as an exogenous (contextual) effect (Manski, 2000). Correlated network effects stem from controlling for unobservable invariant characteristics between network points in a community or district that may influence a farmer's value chain participation decision (Mekonnen, Gerber, & Matz, 2018). It is accounted for in an empirical analysis by controlling for location dummies in the model.

To examine the effects of social networks on rice value chain participation, we assume that farmers make binary decisions whether to participate or not to participate in a rice value chain, depending on his/her characteristics. This decision is determined by comparing the expected utility from the participation, (U_i^P), and the expected utility from non-participation, (U_i^N). Intuitively, a farmer decides to participate in a value chain if the utility difference (VC_i^*) is positive, that is, $VC_i^* = U_i^P - U_i^N > 0$, which implies that the utility the farmer derives from participating in the value chain outweighs the utility derived from non-participation. However, VC_i^* is a latent variable, and cannot be directly observed. In this context, what is observed is the actual decision by the farmer to participate in a value chain, VC. Therefore, we specify it as a function of observable farm, household, and social network characteristics as follows:

$$VC_i^* = \mathbf{Z}_i\boldsymbol{\delta} + D_i\phi + \eta_i, VC_i = \begin{cases} 1 \text{ if } VC_i^* > 0 \\ 0 \text{ if } VC_i^* \leq 0 \end{cases}, \quad (1)$$

where VC_i is a binary indicator variable that equals one if a farmer participates in a rice value chain, and zero otherwise; $\mathbf{Z}$ is a **vector** of farm and household characteristics believed to influence rice value chain participation decision. These include age, education, sex, farm size, distance to market, bicycle ownership, road status, mobile phone ownership, access to credit, and market perception; D_i denotes variables representing social networks; $\boldsymbol{\delta}$ is a **vector** of parameters capturing the direct effects of exogenous observable characteristics in $\mathbf{Z}$ while φ measures the endogenous, contextual, and correlated network effects on farmer's decision to participate in the rice value chain; and η_i is an error term, with zero mean and variance σ^2. The choice of the explanatory variables in this study was based on existing literature, and observations from the field survey.

Building on the existing literature on the effects of social networks on technology adoption (e.g., Bandiera & Rasul, 2006), and on modern supply chain participation (e.g., Herforth, Theuvsen, Vasquez, & Wollni, 2015; Ramirez et al., 2018), we include in our analysis a variable representing farmer's horizontal social network relationship, which is assigned a value of one if a farmer belongs to such a network, and zero otherwise. In addition, a variable that captures the number of value chain participants in a farmer's social network is included in the analysis. These social network variables measure the existence of endogenous effects on value chain participation. However, measurement of these effects poses simultaneity issues, resulting from the fact that the behavior of an individual is influenced by the mean behavior of the group, who also in turn influences the group's behavior. Manski (1993) refers to this identification problem as a reflection problem.

Moreover, smallholder farmers are normally organized horizontally into farmer groups, and taken through capacity building training to become a strong and cohesive social network group for participation in value chains. Conversely, agribusiness companies and other produce buyers normally prefer to engage with smallholder farmers in the form of strong and cohesive groups to reduce transaction costs associated with having to aggregate paddy from individual farmers. Therefore, farmers may decide to be members of the horizontal social networks to be able to participate in the value chain, making both decisions jointly determined. We also argue that a farmer's network members who are already participants in a value chain can serve as sources of useful information, and potential avenues for sharing valuable experiences about the marketing opportunities in a value chain. The information and experience sharing between farmers and their network members are expected to influence the decisions of this category of farmers to participate in the value chain. On the other hand, produce buyers can also rely on participants for the information and recommendation of their network members for inclusion in the value chains. Similarly, access to credit variable in Z may

also pose potential endogeneity problems in the value chain participation equation. In the study area, government and NGOs who facilitate smallholder participation in value chains, also facilitate farmers' access to credit through linkages with financial service providers. In that case, some farmers may decide to participate in a value chain to be able to access credit to expand their farming operations, and to benefit from a guaranteed market. This makes the decisions to participate in a value chain and to access credit jointly determined.

To address these issues, some approaches have been suggested in the literature. Manski (2000) suggests the introduction of dynamism to the model whereby an individual's behavior is influenced by the lagged behavior of his/her network instead of contemporaneous values of mean behavior of the group. Another approach is to use instruments to address these challenges (Manski, 2000). Due to data limitation, we use the latter approach in the present study, which is a two-stage approach clearly outlined in Wooldridge (2015). The procedure and first-stage regression results are not reported due to space limitation but are available upon request. Following Mekonnen et al. (2018), we control for contextual network effects by averaging the values of observable exogenous characteristics of the farmers in the sample, based on the subsamples drawn from each study community. Based on our data, the exogenous characteristics used are the averages of age, education, sex, and farm size. We also control for correlated network effects by controlling for district dummies in the model.

2.2 | Impact of social networks and rice value chain participation

As indicated previously, we also examine the impact of social networks and rice value chain participation on smallholder rice farmers' market performance. The market performance outcome measures considered in this study include paddy price received, quantity traded, and net returns. To link value chain participation decision to the market performance outcomes, we assume a linear function between a **vector** of the outcome measures and a **vector** of farm, household, and social network characteristics ($\mathbf{X}_i$), and a dummy variable representing value chain participation (VC_i), specified as:

$$\mathbf{Y}_i = \mathbf{X}_i\theta + VC_i\beta + \mu_i, \tag{2}$$

where $\mathbf{Y}_i$ is a **vector** of outcome variables: θ and β are parameters to be estimated; and μ_i is the error term. Farmer's value chain participation decision involves self-selection, which is influenced by unobservable factors such as farmers' risk preferences, motivation, and innate skills. These factors may also influence the market performance outcomes leading to potential selection bias ($\text{corr}(\eta_i, \mu_i) \neq 0$), and using ordinary least squares method would generate biased estimates. However, propensity score matching (PSM) method accounts for selection bias from only observable factors. In the present study, we use treatment effects model in the empirical analysis (Cong & Drukker, 2000), which accounts for observable and unobservable factors.

3 | EMPIRICAL SPECIFICATION

3.1 | Treatment effects model

In this context, the treatment effects model estimates the factors influencing smallholder rice farmers' decisions to participate in a rice value chain, and their impacts on paddy price received, quantity traded, and net returns. Aside accounting for selection bias, the model provides direct marginal effect of value chain participation on market performance. Following Cong and Drukker (2000), we specify the model as:

$$E(\mathbf{Y}_i|VC = 1) = \mathbf{X}_i\theta + \beta + E(\mu_i|VC = 1) = \mathbf{X}_i\theta + \beta + \rho_{\eta\mu}\sigma_{\eta\mu}\frac{\phi(Z_i\delta)}{\Phi(Z_i\delta)} \tag{3}$$

$$E(\mathbf{Y}_i|VC = 0) = \mathbf{X}_i\theta + E(\mu_i|VC = 0) = \mathbf{X}_i\theta - \rho_{\eta\mu}\sigma_{\eta\mu}\frac{\phi(Z_i\delta)}{1 - \Phi(Z_i\delta)}, \tag{4}$$

where $\phi(.)$ is the standard normal density function, and $\Phi(.)$ denotes the standard normal cumulative distribution function. The ratio of $\phi(.)$ and $\Phi(.)$ is referred to as the inverse Mills ratio. θ and β are vectors of parameters to be estimated; $\sigma_{\eta\mu}$ is the covariance between the two error terms, η, μ; $\rho_{\eta\mu}$ is the correlation coefficient, and an indicator of selection bias on unobservable factors. The average treatment effects (ATE) of value chain participation on the outcomes for sample N can be computed as the difference between the expected outcome from participation (Equation 3), and the expected outcome from non-participation (Equation 4), specified as:

$$ATE = \frac{1}{N}\sum_{i=1}^{N}\Big[E(\mathbf{Y}_i|VC=1) - E(\mathbf{Y}_i|VC=0)\Big]. \tag{5}$$

The model is identified using the variable representing farmer's perception of high market demand for paddy in the previous year as instrument, measured as dummy, where farmer's perception of high market demand for paddy in the previous year is assigned a value of one, and zero otherwise. A simple falsification test (Di Falco, Veronesi, & Yesuf, 2011) reveals that the instrument is valid. The test results are not presented in the interest of brevity, but are available upon request.

4 | DATA AND DESCRIPTIVE STATISTICS

The data used in this study were collected from a recent farm household survey (June–August, 2016) conducted by the authors in five selected districts of northern Ghana; Tolon, Kumbungu, Sagnarigu districts, Savelugu Nanton municipal, and Tamale metropolis. We employed a multi-stage sampling approach in drawing our sample for the study. First, we used a purposive sampling method to select the five study districts because of their geographic accessibility, and the intensity of rice production in these districts. About two to three communities from each district were randomly selected, based on the number of communities in each district. Finally, we used random matching within sample, whereby at least 20 households were randomly selected in each community. Each household was then matched with five farmers randomly drawn from the community sample. In total, we sampled 458 smallholder rice farmers, comprising 206 value chain participants and 252 nonparticipants. In the context of this study, value chain participants are smallholder farmers who are beneficiaries of the ongoing rice value chain development project (USAID Feed the Future [FtF]) in northern Ghana, and have established contractual relationships (written or verbal) with produce buying or processing companies under the facilitation and coordination of officials of the project (formalized value chain) (Birthal et al., 2016; Seville, Buxton, & Vorley, 2011). These farmers have received capacity building and input support from the project, and have also successfully supplied paddy to these produce buying and processing companies for at least the past three years. On the other hand, nonparticipants are smallholder farmers who produce and supply paddy in the traditional or open market (informal value chain) (Birthal et al., 2016; Seville et al., 2011). These farmers normally supply to traders/aggregators, who do not usually hold farmers to quality and packaging standards. Both categories of farmers were then engaged in face-to-face interviews, using a structured questionnaire.

The social network variables captured include horizontal social networks and number of value chain participants in a farmer's network. In addition, information was gathered from farmers on the number of farmers in their social networks who are also participants in the rice value chain. This was based on whether resources such as credit, labor, and/or land, farming and marketing information have ever been exchanged between the farmer and the network members. In addition, we considered whether they are relatives, friends, neighbors (farm-plots or residential), belong to the same religion, or ever visited each other. Other information gathered include farm and household characteristics, asset ownership, production, and marketing activities related to the 2015 growing season. Table 1 presents the variable definition and statistical difference between participants and nonparticipants. The outcome variables include average selling price of paddy per kilogram, quantity of paddy traded in kilograms, and net returns. We measured net returns as the difference between value of rice output and variable input costs per hectare. Table 1 shows that value chain participants sold higher quantities of paddy rice, received higher paddy price, and generated higher net returns than nonparticipants. In addition, participants are mostly members of horizontal social networks, and have a higher number of network members who are also value chain participants.

Table 1 also reveals that value chain participants constitute a higher proportion of farmers who accessed enough credit and/or are not credit constrained than nonparticipants. In this study, the access to credit variable is constructed in the context of whether the farmer is credit constrained or not. It is captured as a dummy variable, whereby one is assigned to a farmer who did not need credit, or the one who needed credit, applied for it and received the required

TABLE 1 Variable definition and differences in characteristics of farmers by rice value chain participation

		Participants		Nonparticipants		
Variable	**Definition**	**Mean**	**SD**	**Mean**	**SD**	**Diff. (*t*-stat.)**
Age	Age of respondent (years)	39.29	11.94	35.97	11.22	3.05***
Education	Education of respondent (years)	3.09	4.60	2.40	4.20	1.66*
Sex	1 if farmer is male, 0 otherwise	0.89	0.30	0.87	0.33	0.83
Farm size	Size of farm (hectares)	1.19	1.27	1.10	1.24	0.75
Distance to market	Distance to market (km)	7.20	4.37	6.06	3.76	2.99***
Bicycle	1 if a farmer owns bicycle, 0 otherwise	0.69	0.46	0.71	0.45	−0.37
Road status	1 if market road is motorable, 0 otherwise	0.81	0.39	0.66	0.47	3.49***
Mobile phone	1 if farmer owns mobile phone, 0 otherwise	0.56	0.49	0.36	0.48	4.21***
Access to credit	1 if farmer is not credit constrained, 0 otherwise	0.53	0.50	0.30	0.45	5.17***
Market perception	Farmer perception of market demand (1 = high, 0 = low)	0.50	0.50	0.22	0.41	6.47***
Horiz. social network	1 if farmer is member of HSN, 0 otherwise	0.76	0.42	0.15	0.35	16.85***
VCP in farmer's network	No. of value chain participant farmers in network	7.89	13.91	2.25	5.29	5.93***
Average age	Average age of farmers in the sample	37.95	2.92	36.97	3.19	3.40***
Average education	Average value of education of farmers in the sample	2.00	0.86	2.04	0.95	−0.48
Average sex	Average value of sex of farmers in the sample	0.87	0.09	0.88	0.10	−0.54
Average farm size	Average value of farm size of farmers in the sample	1.12	0.49	1.15	0.49	−0.72
Tolon	1 if farmer is located in Tolon district, 0 otherwise	0.24	0.43	0.20	0.40	1.05
Kumbungu	1 if farmer is located in Kumbungu district, 0 otherwise	0.23	0.42	0.24	0.43	−0.32
SaveluguNanton	1 if farmer is located in Savelugu Nanton Municipal, 0 otherwise	0.12	0.32	0.26	0.44	−3.89***
Price	Average selling price of paddy rice (GH¢/kg)	1.33	0.35	1.11	0.12	9.22***
Quantity sold	Quantity of paddy rice sold (kg/ha)	1,191.27	800.63	820.17	695.69	5.305***
Net returns	Gross revenue from paddy production minus input cost (GH¢/ha)	1,057.95	1157.21	453.31	667.36	6.99***
Sample size		**206**		**252**		

Note: *, *** represent significance at 10% and 1% levels, respectively; GH¢ is Ghanaian currency (US$1 = GH¢ 4.19); SD, standard deviation.

amount (not credit constrained). On the other hand, zero is assigned to a farmer who is credit constrained. This group of farmers include those that needed credit, but did not apply for it, or applied for it and did not receive the required amount, or had their credit applications rejected (Jappelli, Pischke, & Souleles, 1998).

5 | EMPIRICAL RESULTS AND DISCUSSION

5.1 | Social network and other factors influencing rice value chain participation decisions

The results of the factors influencing farmers' decisions to participate in a rice value chain are presented in Table 2. The coefficients of the residuals predicted from the first-stage regression for the potentially endogenous variables such as

TABLE 2 Factors influencing smallholder farmers' rice value chain participation decisions

Variable	Value chain participation	
	Coefficient	**Standard Error**
Constant	−11.624***	3.407
Horizontal social network	1.530***	0.220
VCP in farmer's network	0.043***	0.012
Average age	0.036	0.043
Average education	0.097	0.133
Average sex	5.310***	2.040
Average farm size	0.222	0.229
Age	0.010	0.012
Education	0.016	0.020
Sex	0.138	0.314
Farm size	0.049	0.068
Distance to market	0.051**	0.024
Bicycle	−0.006	0.205
Road status	0.111	0.354
Mobile phone	0.072**	0.022
Access to credit	0.454***	0.164
Tolon	0.243	0.415
Kumbungu	−0.386	0.333
Savelugu Nanton	0.733	0.575
Market perception	0.712***	0.170
Residual (HSNR)	−3.298	2.995
Residual (VCPN)	0.011	0.036
Residual (Access to credit)	−0.736	2.061
Sample size	458	

Note: *, **, *** represent significance at 10%, 5%, and 1% levels, respectively.

horizontal social network relationship, number of value chain participants in farmer's network and access to credit are not significantly different from zero, suggesting that these variables have been consistently estimated (Wooldridge, 2015). As shown in Table 2, the coefficients of horizontal social network and number of value chain participants in farmer's network are positive and significantly different from zero, suggesting that farmers who are members of a horizontal social network, and those with a higher number of value chain participants as network members are more likely to participate in a value chain. This finding presents evidence of the role of social network externalities in rice value chain participation.

The coefficients of all the average exogenous characteristics of the farmer's peers, with the exception of sex, were not statistically different from zero, suggesting absence of contextual effects. This means that farmer's rice value chain participation decision is not correlated with the exogenous characteristics of his network members in the sample. Similarly, we did not find evidence of correlated network effects in our results, as revealed by the statistically insignificant effects of the district dummies on rice value chain participation decisions. Other factors influencing value chain participation decisions include access to credit, distance to market, and mobile phone ownership. As shown in the results, farmers with access to sufficient credit, and who are not credit constrained are more likely to participate in value chains, as revealed by the positive and statistically significant effect of this variable on value rice chain

participation. Farmers with access to credit from financial institutions participate in value chains to ensure guaranteed market for their paddy and probably timely credit repayment.

5.2 | Impact of social networks and rice value chain participation on market performance

The estimation results of the impact of value chain participation and social networks on paddy price, quantity traded, and net returns are presented in Table 3. As can be observed, the correlation coefficient $\rho_{\varepsilon\mu}$ is found to be negative and significant in all the model specifications, suggesting the presence of selection bias due to unobservable factors, which means that farmers with below average paddy price received, quantity traded, and net returns have a higher probability of participating in the rice value chain. This finding is consistent with other recent studies that participation in value chains tends to benefit smallholder farmers in developing countries (e.g., Ma & Abdulai, 2017; Michelson, 2013).

TABLE 3 Impact of value chain participation and social networks on market performance

	Paddy price		Quantity traded		Net returns	
Variable	**Coefficient**	**SE**	**Coefficient**	**SE**	**Coefficient**	**SE**
Constant	0.859***	0.124	5.043***	0.754	5.222***	1.537
VC participation	0.120***	0.021	0.612***	0.181	0.863**	0.408
Horizontal social network relationship	0.011**	0.005	0.771***	0.113	0.260**	0.140
VCP in farmer's network	0.007**	0.004	0.018***	0.006	0.062***	0.006
Average age	0.003	0.002	0.024*	0.013	0.019	0.026
Average education	0.009	0.006	0.064*	0.037	0.013	0.076
Average sex	0.032	0.087	0.267	0.529	0.302	1.077
Average farm size	0.000	0.011	0.215***	0.071	0.140	0.147
Age	0.003	0.010	0.003	0.002	0.004**	0.002
Education	0.001	0.001	0.009	0.006	0.010	0.013
Gender	0.004	0.017	0.319***	0.100	0.592***	0.201
Farm size	0.008**	0.003	0.228***	0.023	0.072***	0.026
Distance to market	−0.001	0.001	−0.005	0.007	−0.012	0.015
Bicycle	0.000	0.011	−0.014	0.065	0.079	0.133
Road status	−0.014	0.010	0.039	0.064	−0.039	0.131
Mobile phone	0.009**	0.004	0.029**	0.013	0.071**	0.029
Access to credit	0.008***	0.003	0.013*	0.060	0.354***	0.122
Tolon	0.028	0.017	0.147**	0.010	0.584***	0.217
Kumbungu	0.039**	0.015	0.346***	0.092	1.168***	0.187
Savelugu Nanton	0.733	0.575	0.151	0.104	0.595***	0.215
ath($\rho_{\varepsilon\mu}$)	−0.222***	0.012	−0.359***	0.100	−0.211***	0.024
$\rho_{\varepsilon\mu}$	−0.218***	0.011	−0.344***	0.106	−0.208***	0.021
ln(σ)	−2.340***	0.034	−0.576***	0.022	0.120***	0.037
Wald test ($\rho_{\varepsilon\mu} = 0$)	12.26***, prob = 0.000		15.06***, prob = 0.000		25.82***, prob = 0.000	
Sample size	458		458		458	

Note: *, **, *** represent significance at 10%, 5%, and 1% levels, respectively; SE, standard error.

With regards to the factors influencing the market performance outcomes of interest, we find a positive and significant marginal effect of the value chain participation dummy on paddy prices, quantity traded, and net returns by about 12.0%, 61.2%, and 86.3%, respectively. This finding is consistent with the notion that farmers who join cooperatives or participate in group marketing tend to have benefits such as lower search costs for input and higher output markets, and better bargaining position for lower input and higher output prices (Ma et al., 2018). This finding confirms the role of value chains in improving smallholder market performance.

The results also reveal that social networks do not only influence farmers' decisions to participate in value chains, but also play a significant role in enhancing the market performance outcomes for value chain participating farmers, relative to those who produce and market paddy rice on their own. In particular, the variable representing horizontal social network relationship is found to have a positive and significant effect on paddy price, quantity traded and net returns by about 0.011, 0.771, and 0.260, respectively, suggesting that farmers who are members of such a social network tend to benefit from these outcomes. As stated previously, horizontal social networks promote sharing of information on input and output prices, which serve as a guide for collective negotiations with buyers for increased bargaining power and prices. Moreover, a horizontal social network can serve as a conduit for the introduction and adoption of improved productivity-enhancing technologies and practices (Conley & Udry, 2001), which tend to increase farm yields, quantities traded, and net returns.

The results further reveal that the number of value chain participants in a farmer's network also exerts a positive and significant effect on paddy price, quantity traded, and net returns, suggesting that an increase in the number of value chain participants in a farmer's network tends to enhance market performance. As argued earlier, network members who are also value chain participants can share information on value chain opportunities, which encourages participation and improvement in market performance outcomes. Similar to the effects on farmers' value chain participation decisions, the coefficients of the average characteristics of farmers' peers were found to be weakly significant on quantity traded, but insignificant on prices received and net returns, suggesting lack of evidence of contextual network effects on these outcomes. The coefficients of the location variables have a positive and statistically significant effect on paddy prices, quantity traded, and net returns.

Other factors influencing paddy prices received, quantity traded, and net returns, by value chain participants include farmer's age, farm size, sex, mobile phone ownership, access to credit, and location variables. Access to credit exerts a positive and significant impact on prices received, quantity traded, and net returns at least at the 10% level. This finding suggests that farmers who are not credit constrained tend to receive higher prices for paddy rice, trade in higher quantities, and also receive higher net returns. Depending on the measurement of smallholder market access, farmers with access to credit can negotiate for better prices for their produce to ensure timely credit repayment and satisfactory net returns. In addition, farmers who are not credit constrained are able to procure production inputs to increase output, as well as pay for expenses associated with hiring labor for production activities, thereby increasing quantity traded and net returns.

5.3 | Average treatment effects

In this section, we compute the average treatment effects (ATEs), which measure the difference (causal impact) in the predicted market performance outcomes between value chain participants and nonparticipants. The results, which are presented in Table 4, reveal a significant positive impact of rice value chain participation on market performance. In particular, smallholder farmers' participation in the rice value chain is associated with about 10%, 7%, and 6% increase in paddy price received, quantity traded, and net returns, respectively. This finding is consistent with the notion that smallholder farmers benefit from value chain participation (Maertens & Vande Velde, 2017).

We also estimate the causal impact of value chain participation on the market performance outcomes to reveal the heterogeneity of farm size effects. Based on our data, we classify farm size into three categories: small (≤1.0 ha), medium (1.1−1.5 ha), and large (>1.5). As shown in Table 4, rice value chain participation significantly increases paddy prices, quantity traded, and net returns for all the farm size categories, relative to nonparticipation. However, differential increments of these outcomes have been observed for the different farm sizes, although not statistically significant. As shown in Table 4, relative to nonparticipants, participants with small rice farm sizes receive the highest paddy price, trade in highest quantities and generate the highest net returns, followed by farmers with medium farm sizes, and then those with large farm sizes. This finding suggests that farmers with small farm sizes tend to benefit the most from improved market performance. These findings are contrary to the assertion by Swinnen, Vandeplas, &

TABLE 4 Average treatment effects (ATE) of rice value chain participation on market performance outcomes

	Mean outcome				
Outcome variables	**Participants**	**Nonparticipants**	**ATE**	***t*-value**	**Change (%)**
Paddy price	0.830	0.753	0.077***	16.01	10.22
Quantity traded	7.540	7.031	0.509***	48.68	7.23
Net returns	6.614	6.229	0.385***	74.03	6.18
ATE of outcome variables disaggregated by farm size					
Paddy price					
Small (≤ 1.0 ha)	0.824	0.747	0.077***	12.68	10.30
Medium (1.1–1.5 ha)	0.838	0.760	0.078***	6.74	10.26
Large (>1.5)	0.843	0.765	0.078***	9.70	10.19
Quantity traded					
Small (≤1.0 ha)	7.451	6.844	0.607***	38.72	8.86
Medium (1.1–1.5 ha)	7.614	7.202	0.412***	20.50	5.72
Large (>1.5)	7.778	7.560	0.218***	21.70	2.88
Net returns					
Small (≤1.0 ha)	6.480	6.097	0.383***	58.96	6.28
Medium (1.1–1.5 ha)	6.841	6.451	0.389***	31.26	6.03
Large (>1.5)	6.926	6.535	0.391***	32.85	5.98

Note: *** refers to significance at 1% level; the dependent variables are the log of outcome variables; ATE calculation is based on log of the predictions.

Maertens (2010), but consistent with the study by Mishra, Kumar, Joshi, and D'souza (2018) that smallholder farmers tend to benefit significantly from value chain participation for low-value crops such as rice in a developing country like Ghana.

6 | CONCLUSIONS

In this study, we examined the role of rice value chain participation and social networks in improving smallholder rice farmers' market performance outcomes such as paddy price received, quantity of paddy traded, and net returns, using data from a recent survey of 458 smallholder rice farmers from five districts in northern Ghana. We employed a treatments effects model in the empirical estimations to account for potential selection bias associated with both observable and unobservable factors. The estimation results revealed the presence of negative selection bias, implying that rice farmers with below average paddy price, quantity traded, and net returns are more likely to participate in a value chain. The empirical results show that participation in a value chain contributes significantly to increased paddy prices, quantity traded and net returns by 10%, 7%, and 6%, respectively. Relative to nonparticipants, value chain participating farmers with small farm sizes tend to benefit the most from these market performance outcomes, compared to those with medium and large farm sizes.

Social networks significantly influence smallholder farmers' participation in rice value chains, and improve market performance. Smallholder farmers who are members of horizontal social networks, and those with network members who are already value chain participants, are more likely to also participate in a value chain. This category of farmers also tends to benefit from increased paddy prices received, quantity traded, and net returns. Similarly, value chain participation decisions are positively and significantly influenced by distance to market, mobile phone ownership and access to credit. The empirical results also revealed that mobile phone ownership, and access to credit exert positive and significant effects on paddy prices, quantity traded, and net returns of smallholder rice farmers in the value chain.

Important policy implications can be drawn from the findings of this study. There is the need for stakeholder collaboration towards implementing rice value chain development programs for the benefit of smallholder farmers. Government policies that promote credit access by facilitating smallholder farmers' linkages with financial service providers in value chain interventions could ease smallholder credit constraints for improved production and market performance. The promotion of social networks within the context of value chains can contribute to upgrading the

developing country cereal staple sector. It remains important that in value chain development interventions, smallholder farmers are organized into groups, and their capacities built to become strong and cohesive social network groups for effective participation in value chains. The capacity building can strengthen the connectedness of network members, and promote sharing of diversity of knowledge and resources for improved power balance and bargaining position in the value chain.

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