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Non-tariff measures and household welfare: Evidence from Ghana

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Abstract

Most studies on the impacts of non-tariff measures (NTMs) on economic outcomes are at the macro-level with limited micro-level studies. This study uses primary data on 604 commercial farm households in Ghana to examine the relationship between NTMs and household welfare outcomes. The results show that NTMs are positively associated with assets, household expenditure and income but negatively associated with food expenditure, household dietary diversity score (HDDS) and poverty probability index (PPI). We find that the results are not likely to be driven by unobserved heterogeneity. Our results suggest that the potential mechanisms through which NTMs influence welfare outcomes are household income and expenditure. The main implication of the study is that a reduction in the number of customs formalities and the cost of testing and certification can facilitate trade and contribute to the economic development of commercial farm households.

KEYWORDS
food security, Ghana, household expenditure, household income, non-tariff measures, poverty

1 | INTRODUCTION

According to UNCTAD (2015), non-tariff measures (NTMs) are policy trade measures that generate restrictions and affect trade flows and can potentially have an economic effect on international trade in goods, quantity traded and prices. These NTMs can also affect producer and consumer welfare outcomes (González-Mellado et al., 2011). In broad terms, NTMs can be categorised into (i) export-related measures, (ii) non-technical measures and

(iii) technical measures. The first two apply only at the border and include policy instruments like quantitative restrictions (quotas, non-automatic import licensing and voluntary restraints), price measures, forced logistics or distribution channels. Like tariffs, these NTMs are by construction discriminatory and their importance has waned over time. The technical measures include sanitary and phytosanitary (SPS) and technical barriers to trade (TBT) measures. These measures—for example, legislations on health, product safety and biosecurity—are prima facie introduced to address market failures (information asymmetries or negative externalities), mitigate food consumption risks, enhance sustainability signal product quality and strengthen consumer confidence in the product (OECD, 2015; USAID, 2018). In this paper, we extend the definition of technical measures to include voluntary sustainability standards such as Fairtrade and GlobalGAP standards.[1] However, the differences in the policy regimes across countries may lead to an increase in the cost for businesses seeking to access multiple markets.

Several studies have linked agricultural shocks (expected and unexpected) to welfare outcomes (Amolegbe et al., 2021; Asfaw & Maggio, 2018; Etang Ndip & Touray, 2019; Nguyen et al., 2020; Swinnen & Squicciarini, 2012). For example, Amolegbe et al. (2021) show seasonal and price volatility of maize and rice reduce household dietary diversity score (HDDS). Nguyen et al. (2020) examine the effects of extreme weather events such as floods, droughts and storms on welfare in Northeast Thailand and Central Vietnam. They find that these shocks have significant negative and differential effects on household income, consumption and poverty in both countries. A study in Sub-Saharan Africa by Sam et al. (2021) suggests that climate shock resulting in an increase in cereal prices is associated with double extreme poverty in urban areas and increased poverty in rural areas. In Sudan, Etang Ndip and Touray (2019) find that floods/droughts have a significant decrease in consumption per capita and assets but are more likely to be poor and have a lower dietary diversity. In terms of trade shocks, NTMs are correlated with welfare outcomes (poverty, food security, income and expenditure) either through consumption or production channels. The differential effects of NTMs on poverty vary across countries and populations, therefore the impact cannot be generalised but may largely depend on domestic price, the extent of household exposure to price fluctuations, price shocks through wage earnings and the magnitude of the price change (Goldberg & Pavcnik, 2004; Umaña-Alvarado, 2014). For example, Nicita (2009) finds that import tariff reduction in Mexico increased welfare gains of self-produced consumers but reduced welfare for poor producers given that reduction in import tariff is associated with a reduced price of agricultural and manufactured goods. Brambilla et al. (2012) show that higher import tariffs on catfish decreased production and investment and subsequently decreased the income of Vietnamese households that rely on catfish production as their main source of livelihood.

Most studies on the impacts of NTMs have largely focused on the macro-level (Beghin et al., 2012; Disdier et al., 2010; Fiankor, Curzi, & Olper, 2021; Fiankor, Haase, & Brümmer, 2021; Francois et al., 2011; Ghodsi, 2015; Nimenya et al., 2012) with limited study at the micro-level (Diao & Kennedy, 2016; Maziku & Mashenene, 2020; Porteous, 2012). For example, Maziku and Mashenene (2020) assess the effect of non-tariff barriers (NTBs) on the production and marketing of maize in Tanzania. Using the ordinary least squares (OLS) regression due to exogeneity in the NTB, they find that the quantity of maize produced and supplied decreased by 16% due to a unit increase in the cost associated with NTBs. Diao and Kennedy (2016) estimate the effect of export ban on agricultural growth and household welfare in Tanzania. They find that export bans on cross-border maize export decreased producer price, wage rate for low-skilled labour and returns to land while non-agricultural capital and wage rates for skilled labour increased with a ripple effect of increasing poverty in the country. Porteous (2012) examines the effect of export bans on agricultural markets using data from East and Southern Africa over 10 years. Based on their structural model, they find that export bans do not have a statistically significant effect on the price differences between origin and destination countries. Chapoto and Jayne (2009) also find a non-significant effect between export ban and the prices of maize. Other studies have shown that most of the price hikes due to export ban policies tend to negatively affect the poor since they are net food buyers (Ivanic & Martin, 2008; Wodon & Zaman, 2009).

Despite the increasingly widespread proliferation and use of NTMs in the regulation of global trade, their prevalence and effects on the local economy and the ripple effects on welfare outcomes are not well understood. Most of

the studies reviewed focused on export bans with a limited understanding of in-country trade. This creates a knowledge gap in the literature and limits the formulation of appropriate policies to enhance welfare outcomes.

Our study contributes to the extant literature in threefold. First, there is no existing micro-level study that links NTMs to household welfare within a developing country context. This is clearly important, as developing countries are usually standard-takers. As such, NTMs affect them disproportionately more compared to their developed country counterparts. This study fills the literature gap by identifying the various NTMs that confront commercial farmers and their effect on household welfare. The findings contribute significantly to policy formation in terms of possible interventions to reduce the high cost of NTMs. Second, we estimated the differential effects of NTMs on household expenditure to identify the main driver of household total expenditure. We find that the total household expenditure is largely driven by expenditures on consumer and durable goods and health. Third, the study identified the potential mechanism through which NTMs influence household welfare. The results of the potential mechanism enable policymakers to identify the specific approach to address the impact of NTMs.

The rest of the paper is structured as follows: Section 2 describes the data and Section 3 presents the empirical strategy. Section 4 explains and discusses the empirical results, while Section 5 provides the concluding remarks.

2 | CONCEPTUAL FRAMEWORK: NTMS AND HOUSEHOLD WELFARE

In this section, we conceptualise the different pathways through which NTMs affect household welfare. We adapt the conceptual framework in Ural Marchand (2017) to the specific case of NTMs as a trade policy (see Figure 1). Farm households contribute to the economy both as producers and consumers. Thus, the effect of trade policy on household welfare operates through two main channels: income and consumption. The income channel operates via changes in returns to labour which influences wages and employment possibilities. The consumption channel works mainly via changes in product prices which affects household consumption and expenditure. Here, we discuss the two channels with a focus on commercial farms.

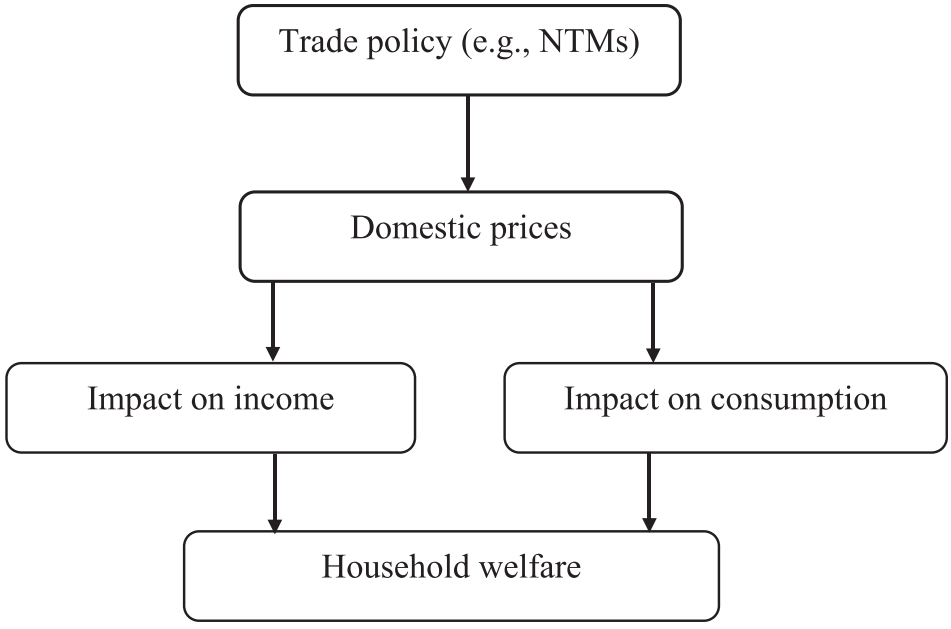

FIGURE 1 Effects of trade on household welfare. *Source*: Adapted from Ural Marchand (2017).

We begin with the income channel. First, NTMs come with significant increases in fixed costs—for example, investment in personal protective equipment for chemical application—and variable costs—for example, higher demand for hired seasonal labour—of production. To attain and maintain certification, farmers need to pay these compliance and certification costs. This ends up increasing the cost of production for farmers.[2] In this regard, NTMs are changing the structure and organisation of value chains, especially in developing countries, with consequences for various household welfare outcomes (Beghin et al., 2015). However, commercial farm households who meet these associated costs of certification can pass on parts—if not all—of the increased production costs to their consumers. This is especially the case for commercial farms producing mainly for high-value export markets in Europe and America.

Certification is a tool that links farmers to higher value export markets, which can be associated with higher and more stable prices (Chiputwa et al., 2015; Kleemann et al., 2014). There is a host of empirical evidence that farmers who comply with NTMs achieve higher yields, receive higher output prices with little variation across standards (Meemken, 2020), achieve higher and more stable incomes (Maertens & Swinnen, 2009; Minten et al., 2009), attain increased productivity (Rao et al., 2012) and achieve even higher levels of subjective well-being (Dedehouanou et al., 2013).

There is a potential income/expenditure effect that arises from a labour market effect. The proliferation of NTMs along value chains has seen the death of smaller farms and increased reliance on large-scale commercial plantations and vertically integrated farms (Beghin et al., 2015). This is because NTMs increase the need for labour-intensive post-harvest handling activities such as sorting and packing. As some households may be employed on these larger farms, some families may be better off because their labour wages, which partially or fully determine the total household budget, increase. Since certified crop production is typically the main income-generating activity of people employed as labour on commercial farms, we would expect that higher profits from the certified crop are reflected in overall household income (Meemken, 2020). Likewise, higher profits from the certified crop may enable households to invest in other income-generating activities with additional, positive effects on overall household income.

Then, there are the consumption and expenditure channels. The higher incomes that certified farm households earn, either as producers or labourers on commercial farms, can be used to enhance household expenditure and consumption.[3] However, NTMs may also increase product prices on the domestic market. This is because certified commercial farmers will not be willing to sell their certified products at a price lower than they could earn on the export market. This will drive domestic prices upwards. Consequently, food and non-food expenditures increase as households need more money to buy their initial consumption bundle. If the NTMs address a specific negative externality (e.g., a legitimate food safety or social concern), the higher domestic prices may reflect product quality upgrading and signalling. This increases consumer welfare. If, however, the NTMs are protectionist—for example, designed to protect foreign producers in the importing country—as consumers, domestic commercial farm households, will be worse off. Yet, it is also possible that not all certified production is sold on the export market. The supply of certified products has proliferated over time while demand for certified products remains limited, especially in developing countries. For instance, Meemken (2020) estimates that 30%–70% of certified crop production volumes are not sold as certified by farmers. This may mean that certified production may be sold on the domestic market as non-certified. If these certified products are sold for less than world market prices, local consumers are better off as they pay less for higher quality products.

In the end, whether a commercial farm household benefits from international trade because of compliance with NTMs is an empirical question. In theory, it depends on the relative magnitude and the direction of these consumption and income effects we discuss here (Ural Marchand, 2017).

3 | DATA AND METHODS

3.1 | Data

This analysis is based on a survey of commercial farmers in five regions of Ghana, namely the Northern, Bono, Ashanti, Western and Volta regions. In consultation with the Ministry of Food and Agriculture and the Savanna Agricultural Research Institute (SARI), we obtained a list of commercial farmers in the study areas. To ensure that the list was reliable, we subjected it to several scrutiny and checks with support from agricultural extension officers in the operation area of the commercial farmers. The study employed a multi-stage sampling technique consisting of stratified and random sampling to select 604 commercial farmers. Commercial farmers who willingly agreed to participate in the survey were interviewed. We recruited and trained enumerators in the study areas and followed up with a reconnaissance survey to identify any potential issues with the survey instrument. The feedback from the pretesting was incorporated into the draft survey instrument and subsequently finalised.

The data for the study includes detailed information on household demographics (sex, education, marital status, household size, nativity etc.), farming activities (crops cultivated, area under cultivation, production and costs), market participation and quantity of crops sold; institutional factors (member of an organisation, access to credit, extension); awareness and knowledge of NTMs[4]; transaction costs related to NTMs and other constraints to production and marketing of agricultural produce, expenditure and general income, household assets, food security and poverty. The main outcome variables are asset index, food expenditure, HDDS, household expenditure and income and poverty. Following the example of Martey (2022), we computed the asset index using the principal component analysis (PCA) on the asset holdings of the households. The food expenditure is computed as the amount of money spent on purchasing food, while total income consists of all incomes from sales of food and tree crops, animals, agricultural and non-agricultural wages, petty trading, transport business, artisan, salaries and fishing and hunting. The household expenditure is computed as the sum of all expenditures related to education, consumer and durable goods, health, housing, food and others. We compute the HDDS as the number of different food groups consumed based on a 24-h recall. The food groups are cereals, fish and seafood, root and tubers, pulses/legumes/nuts, vegetables, milk and milk products, fruits, oil/fats, meat, poultry, offal, sugar/honey, eggs and miscellaneous. According to Swindale and Bilinsky (2006), HDDS is used as a proxy measure of the socio-economic level of the household. The poverty probability index (PPI) is based on 10 questions where each question has a weight that identifies the likelihood of a household living below the poverty line. The total score (non-negative integers) ranges from 0 (most likely to be below a poverty line) to 100 (most likely to be above a poverty line).

3.2 | Descriptive statistics

We present the summary statistics of the variables in Table 1. About 25% of the commercial farmers have incurred one form of non-tariff measures, and 84% of the farmers are males. The average age of the farmers is 47 years, and about 84% of the farmers are married, while 70% are formally educated. A farmer in our sample has a minimum of primary education, and 67% are able to read and write. The average number of household members who eat from the same pot and total dependents are 7 and 5, respectively. About 70%, 17% and 41% of the farmers are natives, have migrant household members and belong to farmer organisations, respectively. The average farmer in farmer in our sample has 21 years of farming experience while 30% and 66% of the farmers own farmlands and have access to extension services, respectively. The average annual extension contact is six. With reference to insurance, 4%, 48% and 16% of the farmers have insured their farm, are willing to insure their farm and engage in contract farming, respectively. About 28% and 13% of the farmers have access to credit and receive support from either government or customers, respectively.

TABLE 1 Summary statistics of variables.

Variable	Definition	Mean	SD
NTMs	1 if farmer experiences non-tariff measures, 0 otherwise	0.248	0.432
Sex	1 if farmer is male, 0 otherwise	0.838	0.369
Age	Age of farmer in years	47.346	11.252
Married	1 if farmer is married, 0 otherwise	0.841	0.366
Education	1 if household is formally educated, 0 otherwise	0.702	0.458
Literacy	1 if farmer is literate, 0 otherwise	0.671	0.470
Household size	Total number of household members	7.482	12.163
Dependents	Total number of dependents	5.031	3.812
Native	1 if farmer is a native, 0 otherwise	0.695	0.461
Migrate	1 if farmer has a migrant member, 0 otherwise	0.174	0.379
FBO	1 if farmer is a member of farmer organisation, 0 otherwise	0.406	0.491
Farming years	Number of years of farming	20.839	12.341
Own land	1 if farmer owns land, 0 otherwise	0.295	0.456
Extension access	1 if farmer has access to extension services, 0 otherwise	0.662	0.473
Extension contacts	Number of extension contacts	6.081	40.981
Farm insured	1 if farm is secured, 0 otherwise	0.035	0.183
Willingness to insure	1 if farmer is willing to insure farm, 0 otherwise	0.483	0.500
Contract status	1 if farmer engages in contract farming, 0 otherwise	0.156	0.363
Credit access	1 if farmer has access to credit, 0 otherwise	0.281	0.450
Government support	1 if farmer receives support from government/customers, 0 otherwise	0.134	0.341

Note: *SD* is standard deviation.

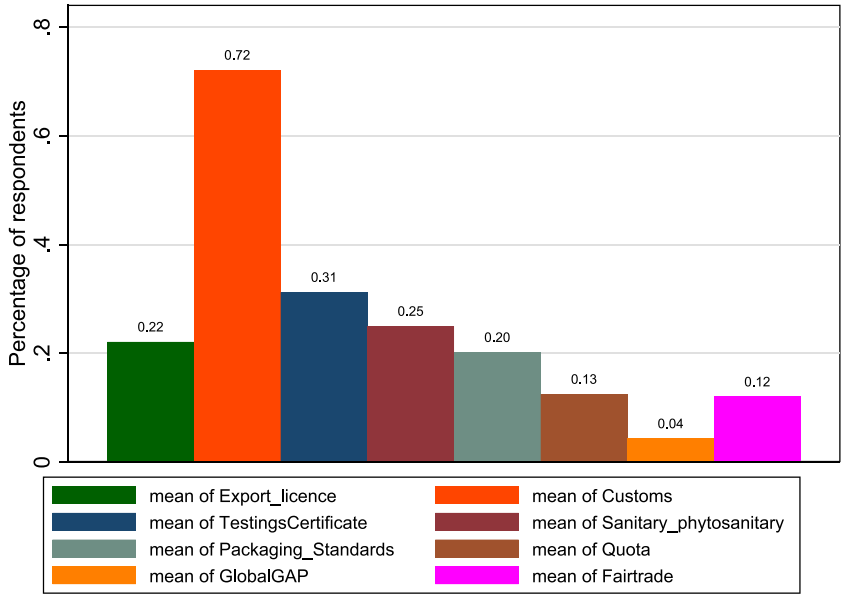

FIGURE 2 Awareness of non-tariff measures. [Colour figure can be viewed at wileyonlinelibrary.com]

We present farmers' awareness of NTMs in Figure 2. The data show that 72% of the farmers are aware of customs formalities (customs valuation at checkpoints) followed by testing and certification arrangements (31%), sanitary and phytosanitary measures (25%), export license (22%), packaging technical regulations and standards (20%), quota (13%), fairtrade (12%) and GlobalGAP (4%).

Figure 3 shows the percentage of farmers who reported that their business activities have been influenced by NTMs. A higher proportion (35%) of the farmers reported that their farm enterprise has been negatively affected by customs formalities (customs valuation at checkpoints) followed by testing and certification arrangements (18%), sanitary and phytosanitary measures (13%), packaging technical regulations and standards (11%), quota (3%) and fairtrade (1%).

Figure 4 shows the mean annual income and expenditure for the sampled farmers. The mean annual income and expenditure are GHS288 616.56 (US$39 002[5]) and GHS22 835.85 (US$3086). The main income sources are sales of food and tree crops, animals, agricultural and non-agricultural wages, petty trading, transport business, artisan, salaries and fishing and hunting. The expenditure categories are education, consumer and durable goods, health, housing, food and other expenditures.

In Figure 5, we show the different components of household expenditure. The expenditures are education, consumer and durable goods, health, housing, food and others. Comparatively, expenditure on food is the highest followed by consumer durable goods, education, housing, others and health. The shares of the various expenditures are presented in Figure 6. The expenditure shares are consistent with the expenditure categories observed in Figure 5. However, the variations in terms of housing and health expenditures from the mean are wide, while the distribution of the share of food and education expenditures is normally distributed despite some data points over and above the distribution.

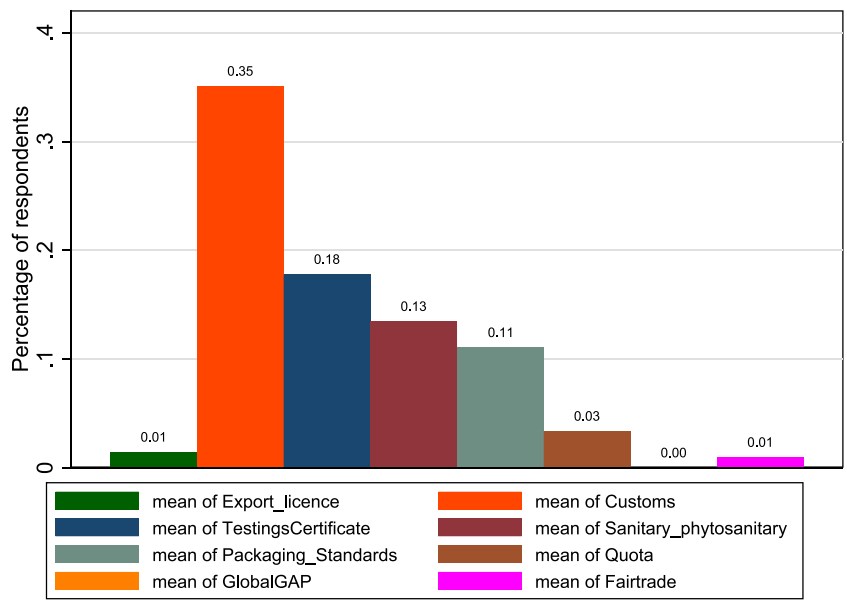

FIGURE 3 Percentage of respondents impacted by non-tariff measures. [Colour figure can be viewed at wileyonlinelibrary.com]

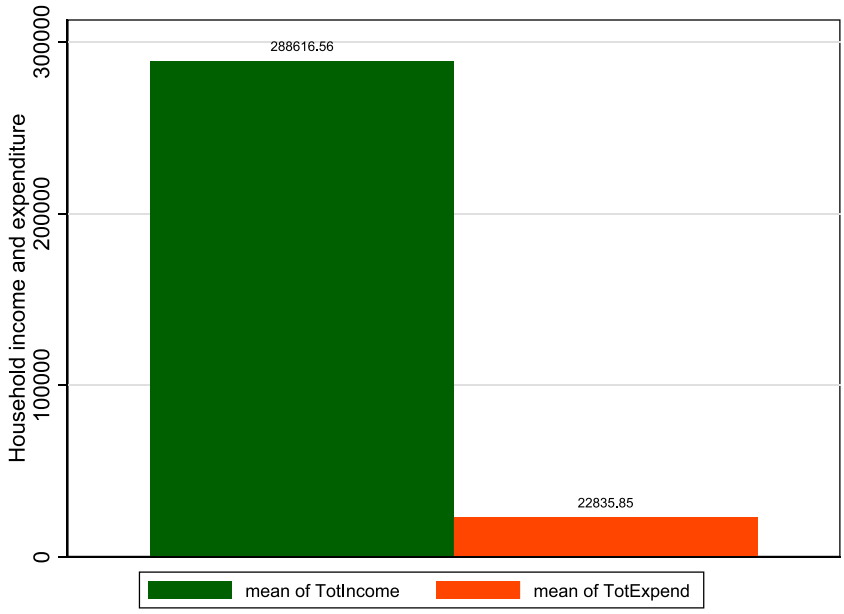

FIGURE 4 Mean annual income and expenditure. [Colour figure can be viewed at wileyonlinelibrary.com]

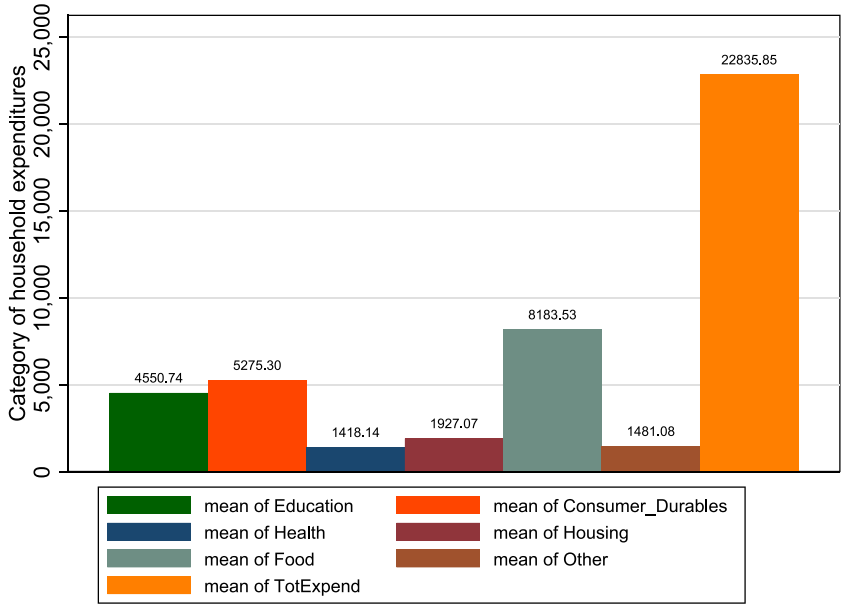

FIGURE 5 Household expenditure categories. [Colour figure can be viewed at wileyonlinelibrary.com]

3.3 | Empirical strategy

This study estimates the relationship between NTM, market participation and household welfare outcomes while controlling for socio-demographic, farm, institutional and geographic characteristics. The primary estimation model

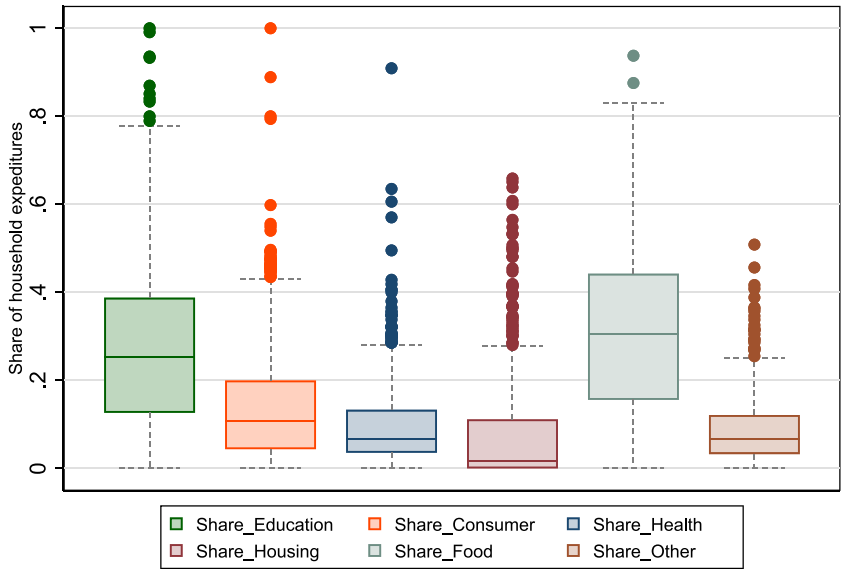

FIGURE 6 Share of household expenditures. [Colour figure can be viewed at wileyonlinelibrary.com]

for welfare outcomes is a linear function of NTM, a vector of other explanatory variables and regional dummies. In view of this, we estimated the following model:

$$Y_i = \alpha + \gamma NTM_i + \beta X_i + \mu_i, \tag{1}$$

where Y_i represents the outcome variables (HDDS, total expenditure, asset index, food expenditure and poverty) for an individual i at the time of the interview and NTM_i is the non-tariff measure (dummy variable as defined in Table 1); X_i is a vector of individual characteristics (such as sex, age, years of education, household size, extension contact, access to credit, membership in a producer organisation, participation in contract farming, farm insurance, participation in off-farm activities, assets and village heterogeneities captured by household location) and other relevant controls and μ_i is the stochastic error term. The coefficient of interest γ measures the effect of NTMs on welfare outcomes. We hypothesise that the high cost of production due to NTMs may reduce household income (Brambilla et al., 2012) and food expenditure but increase asset accumulation, household expenditure and poverty (Nicita, 2009). However, there is evidence that farmers who successfully comply with NTMs achieve higher yields, receive higher output prices and achieve higher and more stable incomes (Maertens & Swinnen, 2009; Minten et al., 2009). The high income can also be achieved through labour market effect as households now engage more in large-scale farms (Beghin et al., 2015).

We employ the ordinary least squares (OLS) regression to estimate the effect of NTMs on household welfare. In all models, we controlled for individual characteristics, such as sex, age, years of education, household size, extension contact, access to credit, membership in a producer organisation, participation in contract farming, farm insurance, participation in off-farm activities, assets and village heterogeneities captured by household location. The model accounts for the heterogeneity in the region that may influence the outcome variables.

We argue that conditional on the location of households, the NTMs can be considered plausibly exogenous and uncorrelated with unobserved characteristics influencing outcome variables. Following the framework of Altonji et al. (2005) and Oster (2019), we quantified the level of omitted variables that would be required to explain the relationship between NTMs and welfare outcomes.

4 | RESULTS AND DISCUSSION

4.1 | NTMs and welfare outcomes

Table 2 shows the results of the estimates of non-tariff measures on household welfare outcomes (assets, food expenditure, HDDS, household expenditure, household income and poverty probability index). The detailed result is presented in Table A1 in the Supplementary Material. Columns (1), (3), (5), (7), (9) and (11) show the results of the model with no controls while Columns (2), (4), (6), (8) and (10) include explanatory variables. Including the explanatory variables in the model did not significantly change the magnitude of the coefficient of NTMs. NTMs increase asset index, log of household expenditure and log of household income by 0.825 standard deviations, 0.535 (71%) and 0.061 (6%), respectively. The results suggest that households who incur NTMs are more likely to accumulate assets as a long-term investment to guard against future negative economic shocks. Similarly, NTMs increase production and transaction costs which subsequently increase the total household expenditure.

The positive effect of NTMs on expenditure is consistent with Knößlsdorfer et al. (2021) who find that fairtrade increases household expenditure in Côte d'Ivoire. The magnitude of the effect of NTMs on total household expenditure indicates that a further increase in the value of NTMs may have a dire consequence on consumers given that producers are likely to transfer such costs to consumers (Goldberg & Pavcnik, 2004; Harrison, 2007 and Umaña-Alvarado, 2014). Despite the negative effects of NTMs on production and transaction costs, it does not necessarily translate to a higher probability of being poor among commercial farmers. The long-term investment in assets and transfer of the cost associated with NTMs to consumers and traders may offset the immediate impact of a decline in household income by 6% thus reducing the probability of households falling below the poverty line. The result is consistent with Amanta and Wibisono (2021) who find that removing non-tariff measures on rice and meat would lead to an overall reduction of the poverty rate by 2.8 percentage points.

In terms of food security, we find that NTMs significantly decrease food expenditure by GHS231 (US$31[6]) and reduce HDDS by 0.410. Our results suggest that NTMs are negatively associated with food security. The result is expected given that commercial farm households do not only consume their own production but depend on purchased food to supplement household food requirements. In view of this, any negative shock to the household may reduce food purchases and also restrict the variety of food purchased and consumed. One plausible reason for the food expenditure reduction effect is due to high food prices as producers transfer the high transaction costs to traders and consumers. An increase in food prices may affect the affordability and quality of food consumed. Contrary to our findings, Knößlsdorfer et al. (2021) did not find any significant effect of NTMs on food security.

4.2 | NTMs and household expenditures

We conducted a differential effect of NTMs on household expenditure to ascertain which components are driving the total household expenditure. The result is presented in Table 3. The detailed result is presented in Table A2 in the Supplementary Material. Our results show that the increased expenditure due to NTMs is largely driven by consumer and durable goods, housing and health-related spending. NTMs increase consumer and durable goods and health expenditures by GHS14 165 (US$1914) and GHS811 (US$110), respectively. The differential effect indicates that NTMs are likely to affect household expenditures differently with the largest effect on consumer and durable goods. Housing and other expenditures are impacted positively by NTMs though not statistically significant. Our result is consistent with Knößlsdorfer et al. (2021) who find that total household expenditure is entirely driven by non-food expenditures which consist of basic living (housing and clothing), transportation and communication and social events. However, they find the largest effect of fairtrade on total expenditure to be due to education expenditure, which is contrary to our findings though not statistically significant.

TABLE 2 OLS estimates of non-tariff measures on welfare outcomes.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Variables	**Assets**	**Assets**	**Food**	**Food**	**HDDS**	**HDDS**	**Expenditure**	**Expenditure**	**Income**	**Income**	**Poverty**	**Poverty**
NTBs	0.841***	0.825***	−209.586***	−231.320***	−0.312*	−0.410**	0.535***	0.474***	0.070**	0.061*	−1.652	−2.627
	(0.123)	(0.115)	(40.614)	(47.369)	(0.164)	(0.184)	(0.110)	(0.104)	(0.030)	(0.032)	(1.768)	(1.719)
Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Region FE	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Mean (control)	[−0.209]	[−0.209]	[753.853]	[753.853]	[9.606]	[9.606]	[9.338]	[9.338]	[12.501]	[12.501]	[47.678]	[47.678]
Observations	604	604	604	604	604	604	604	604	604	604	604	604
R^2	0.132	0.238	0.026	0.228	0.005	0.165	0.051	0.247	0.009	0.069	0.001	0.162

Note: NTMs are non-tariff measures. Income and expenditure are logged. Robust standard errors are in parentheses. The values in brackets are the mean values of the welfare outcomes for farmers who do not incur NTMs. Controls are variables reported in Table 1. The percent of the NTMs effect is computed using the formula $100(e^C - 1)$, where C is the coefficient on the variable of interest and e is exponential.

***$p < 0.01$.**$p < 0.05$.*$p < 0.1$. Refer to Table A1 in the appendix for the full results.

TABLE 3 OLS estimates of NTMs on household expenditures.

	(1)	(2)	(3)	(4)	(5)
Variables	**Education**	**Consumer**	**Health**	**Housing**	**Other**
NTMs	−225.401	14 164.978***	811.072***	883.089	0.035
	(450.783)	(2365.725)	(173.834)	(553.211)	(0.031)
Other controls	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes
Mean (control)	[4530.476]	[1741.181]	[1179.178]	[1708.817]	[0.868]
Observations	604	604	604	604	604
R^2	0.127	0.225	0.177	0.152	0.063

Note: NTMs are non-tariff measures. Robust standard errors are in parentheses. The values in brackets are the mean values of the expenditure categories for commercial farmers who do not incur NTMs. Controls are variables reported in Table 1. ***$p < 0.01$.**$p < 0.05$.*$p < 0.1$. Table A2 in the appendix shows the full results.

4.3 | Unobserved heterogeneity and coefficient stability

To ensure that our estimates are credible and robust to the addition of controls, we perform a coefficient stability test following the approach of Oster (2019) and Altonji et al. (2005). We conclude that since the inclusion of controls in our model does not significantly change our estimates, omitted variable bias is not a major problem in our model. We follow the Oster (2019) approach to determine if the existence of unobserved heterogeneity could bias the estimates based on the assumption that the relationship between the covariate of interest and unobservables can be recovered from its relationship with observables. In our estimation, first, we assume that selection on observables is proportional to selection on unobservables and calculate bias-adjusted coefficient values of the effect of NTMs on welfare outcomes. To assess the magnitude of the change in the estimated coefficients, we use 1.03 (R^2). Second, we calculated a delta value which suggests the degree of selection on unobservables, relative to the observables that would be required to explain away the estimated association between NTMs and welfare outcomes.

Per the results in Table 4, the bias-adjusted coefficients for all the outcome variables are fairly similar in both magnitude and sign to the old estimates (Tables 2 and 3). The estimated Oster deltas in column (7) of Table 4 indicate that selection on unobservables would have to be 4.63 times the selection on observables to explain away the estimated positive relationship between NTMs and assets. For food expenditure and HDDS, the selection on unobservables would have to be 16.77 and 32.89 times the selection on observables to explain away the estimated negative relationship between NTMs and food expenditure and HDDS. The selection on unobservables would have to be 5.30 (−5.43) times the selection on observables to explain away the estimated positive (negative) relationship between NTMs and household expenditure (household income). In the case of PPI, the selection on unobservables would have to be 11.29 times the selection on observables to explain away the estimated positive relationship between NTMs and PPI. We conclude that our estimates seem to be robust to unobserved heterogeneity.

4.4 | Robustness check—Lewbel 2SLS

Despite assuming exogeneity of NTMs, there is the possibility of unobservables that may correlate with NTMs. Farmers who are more entrepreneurial and highly motivated may engage in economic activities that are likely to attract some form of NTMs. For example, farmers who engage in export are more likely to acquire an export license, testing certificate, sanitary and phytosanitary certificates and fairtrade relative to farmers who engage in intra-trade (within country). In such a situation, NTMs may be highly correlated with the error term leading to endogeneity. Due

TABLE 4 Check for coefficient stability.

	Uncontrolled		Controlled		Bias-adjusted		Oster delta
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Coeff.	R^2	Coeff.	R^2	Coeff.	R^2	
Assets	0.841***	0.13	0.391***	0.34	0.366***	0.35	4.631**
	(0.123)		(0.120)		(0.119)		(2.049)
Food	−209.586***	0.03	−195.284***	0.40	−194.431***	0.41	16.772
	(40.614)		(65.554)		(65.656)		(19.329)
HDDS	−0.312*	0.01	−0.211	0.23	−0.209	0.24	32.890
	(0.164)		(0.239)		(0.233)		(82.558)
Expenditure	26 418.999***	0.11	11 778.061***	0.31	11 048.830**	0.32	5.302***
	(4936.861)		(3550.548)		(4558.942)		(1.774)
Income	20 208.798**	0.01	−33 235.912***	0.26	−36 738.000***	0.27	−5.429**
	(9686.102)		(11 459.292)		(10 900.000)		(2.687)
PPI	−1.652	0.01	3.732*	0.32	4.077**	0.33	−11.209
	(1.768)		(2.085)		(1.935)		(12.665)

Note: Columns (1) and (2) report the results of the uncontrolled OLS model, while Columns (3) and (4) present the results with the inclusion of controls. Columns (5) and (6) present the bias-adjusted estimate which assumes that the degree of selection on unobservables is equal to selection on observables. The Oster delta values in Column (7) indicate how large selections on unobservables must be, relative to observables to explain away the estimated relationships. Coefficients are reported with robust standard errors in parentheses.
***$p < 0.01$.**$p < 0.05$.*$p < 0.1$.

TABLE 5 Lewbel estimates of non-tariff measures on welfare outcomes.

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	Asset	Food	HDDS	Expenditure	Income	PPI
NTMs	0.618***	−228.259***	−0.538	11,749.334**	−17 078.578	−5.488*
	(0.161)	(87.742)	(0.336)	(5817.990)	(16 345.232)	(2.861)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes	Yes	Yes
Diagnostics						
F-Statistic	20.63	20.63	20.63	20.63	20.63	20.63
J p-value	5.8e-08	3.2e-07	5.0e-05	1.9e-04	1.3e-07	0.014
	[−0.209]	[753.853]	[9.606]			[47.678]
Observations	604	604	604	604	604	604
R^2	0.254	0.257	0.199	0.209	0.132	0.196

Note: NTMs are non-tariff measures. Robust standard errors are in parentheses. The values in brackets are the mean values of the expenditure categories for commercial farmers who do not incur NTMs. Controls are variables reported in Table 1.
***$p < 0.01$.**$p < 0.05$.*$p < 0.1$. Table A3 in the appendix shows the full results.

to the challenge of identifying a good instrument, we employ the Lewbel (2012) 2SLS technique to address endogeneity and check for the robustness of our results. The Lewbel 2SLS exploits heteroskedasticity in the data to generate internal instruments that are used to address endogeneity. This method is useful when valid external instruments are unavailable or considered potentially weak.

Table 5 shows the results from the Lewbel 2SLS method. The detailed result is presented in Table A3 in the Supplementary Material. Consistent with the OLS results, we find that NTMs significantly increase asset index and household expenditure by 0.618 standard deviations and GHS11 749.33 (US$1587.75), respectively but decreased food expenditure and PPI by GHS228.26 (US$30.85) and 5.49, respectively. NTM reduces HDDS and income though not significant.

Table 6 reports the heterogeneous effects of NTMs on household expenditure. The detailed result is presented in Table A4 in the Supplementary Material. The positive effect of NTMs on household expenditure is significantly determined by expenditures due to consumer and durable goods and health with consumer and durable goods constituting the largest effect. Our result is consistent with the OLS estimates suggesting the robustness of NTMs on household welfare.

4.5 | Underlying mechanism: NTMs and household welfare

The potential pathway analysis proceeds in two steps. First, we regress current income and expenditure on NTMs and other controls. The results in Columns (1) and (2) of Table 7 (The detailed result is presented in Table A5 in the Supplementary Material) show that NTMs are associated with an increase in income and expenditure.

$$Y_i = \alpha + \gamma \widehat{NTM}_i + \varphi G_i + \beta X_i + \mu_i \quad (2)$$

Second, we added income and expenditure (G_i) as an extra control in the welfare outcomes model, as specified in Equation (2) to ascertain the effect of NTMs. Income and expenditure are valid as a potential mechanism if including them in the welfare outcome models reduces the magnitude of the previously estimated coefficient of NTMs (Table 2) or renders it statistically insignificant. In Columns 1 and 2 of Table 8 (The detailed result is presented in Table A6 in the Supplementary Material), we observed that an increase in income is associated with an increase in asset index (Column 1) and a reduction in food expenditure, HDDS and PPI (Columns 2, 3 and 4 of Table 8). Comparing the magnitude of the coefficient of NTMs in Table 2 to the magnitude of the coefficient of NTMs in Table 8

TABLE 6 Lewbel estimates of NTMs on household expenditures.

	(1)	(2)	(3)	(4)	(6)
Variables	**Education**	**Consumer and durables**	**Health**	**Housing**	**Other**
NTMs	−1541.795	5777.191**	765.621**	1713.432	0.045
	(1033.624)	(2835.957)	(310.841)	(1064.483)	(0.061)
Other controls	Yes	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes	Yes
Diagnostics					
F-Statistic	20.63	20.63	20.63	20.63	20.63
J p-value	0.406	1.8e-04	7.2e-04	0.495	0.121
Mean (control)	[4530.476]	[1741.181]	[1179.178]	[1708.817]	[0.868]
Observations	604	604	604	604	604
R^2	0.115	0.183	0.177	0.148	0.063

Note: NTMs are non-tariff measures. Robust standard errors are in parentheses. The values in brackets are the mean values of the expenditure categories for commercial farmers who do not incur NTMs. Controls are variables reported in Table 1.
**$p < 0.05$. Table A4 in the appendix shows the full results.

TABLE 7 First step—Estimates of non-tariff measures on income and expenditure.

	(1)	(2)
Variables	**Income (log)**	**Expenditure (log)**
NTMs	0.061*	0.474***
	(0.032)	(0.104)
Controls	Yes	Yes
Region FE	Yes	Yes
Observations	604	604
R^2	0.069	0.247

Note: NTMs are non-tariff measures. Robust standard errors are in parentheses. Controls are variables reported in Table 1. ***$p < 0.01$. Table A5 in the appendix shows the full results.*$p < 0.1$.

TABLE 8 Second step—Estimates of non-tariff measures on welfare outcomes.

	(1)	(2)	(3)	(4)
Variables	**Asset**	**Food expenditure**	**HDDS**	**Poverty**
NTMs	0.818***	−210.387***	−0.343*	−3.114*
	(0.115)	(46.419)	(0.183)	(1.734)
Income (log)	0.113	−341.828***	−1.103***	7.946***
	(0.107)	(63.137)	(0.265)	(2.224)
Controls	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes
Observations	604	604	604	604
R^2	0.239	0.263	0.194	0.180

Note: NTMs are non-tariff measures. Robust standard errors are in parentheses. Controls are variables reported in Table 1. ***$p < 0.01$.*$p < 0.1$. Table A6 in the appendix shows the full results.

indicates that including income in the asset, food expenditure, HDDS and PPI models reduced the size of the NTMs coefficient. In view of the above, we conclude that income is a potential channel through which NTMs influence asset index, food expenditure, HDDS and PPI. Our result is consistent with Cadot et al. (2018) who find that changes in border prices affect household welfare through the consumption channel.

5 | CONCLUSION

Microlevel studies linking the effect of NTMs to household welfare in a developing country context are limited although there are several studies on the impacts of NTMs at the macro-level. Our study analyzes the effect of NTMs on assets, food security (food expenditure and HDDS), household income, household expenditure and poverty in Ghana. We further examined the underlying potential mechanism through which NTMs influence assets, food security and poverty.

The main results indicate that NTMs increase assets, household expenditure and household income. The positive association between NTMs and asset index indicates that when commercial farm households experience external shocks such as NTMs, they tend to accumulate wealth in asset holdings as a long-term strategy. The increase in household expenditure is mostly driven by consumer and durable goods and health expenditures with consumer and

durable goods being the highest contributor to total household expenditure. The increase in income due to NTMs suggests that commercial farmers do not internalise the high transaction cost but rather pass it on to consumers, which has several implications for consumer welfare. In terms of food security, we observed a decline in food expenditure and HDDS due to an increase in NTMs. The immediate response to food price hikes is a reduction in the household food budget and a reduction in diversified food. The effect is largely driven by household income and expenditures. Household income and expenditures are the potential mechanisms through which NTMs influence assets, food expenditure, HDDS and poverty.

The implications of the study are twofold. First, it is important to reduce the high costs of NTMs to facilitate trade and improve household welfare outcomes. In terms of NTM reduction, we recommend that the focus should be on the customs formalities (customs valuation at checkpoints), which attract the highest costs and delays in transporting agricultural produce. Reduction in the number of custom checkpoints can reduce transaction costs and improve both inter-regional and intra-regional trade. A reduction in the cost of testing and certification may encourage commercial farmers to test and obtain certificates for the transportation of their agricultural produce which may ensure consumer safety, increase the volume of trade and subsequently increase household income. Second, development interventions that increase farm households' income and encourage income diversification such as the keeping of livestock must be promoted to reduce the risk of the negative impact of income shock due to NTMs. Such interventions must be supported with capacity building to achieve higher returns.

We acknowledge three main limitations of our study. First, we are guided in making any causality claim despite arguing that our measure of NTMs can be considered considerably exogenous. The use of cross-sectional data makes it difficult to make a strong causality claim. Future studies can use panel data to explore the effect of NTMs on household welfare. Second, the study is unable to examine the effects of NTMs on other important pillars of food security which is an important development challenge enshrined in the sustainable development goals (SDG2). Although we acknowledge these limitations, we used other measures of food security such as HDDS and food expenditure. Third, while we acknowledge the importance of gender analysis, the gender imbalance of the data (a large proportion of the data consists of males and adults[7]) affected the analysis of the results based on sex and age dimensions. Future studies will consider addressing all the limitations.

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no competing interests both financial and non-financial.

DATA AVAILABILITY STATEMENT

The data are available upon request.

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ENDNOTES

[1] The formal UNCTAD (2015) definition of NTMs does not include private standards. This is probably because a formal definition of what constitutes a private standard is still deadlocked at the WTO.

[2] The exception is mainly for Organic certification where production costs can be lower due to reduced due to the ban on the use of modern farming inputs.

[3] Note that higher prices due to compliance in themselves are not enough. They may not always be enough to raise household incomes and living standards (Akoyi & Maertens, 2018). They may increase household consumption expenditures but not food expenditures (Meemken et al., 2017).

[4] In our study, we focus on NTMs required by the destination countries for the agricultural commodities produced by the commercial farmers in Ghana.

[5] The exchange rate at the time of the survey is 1 US$ = GHS7.4 (Source: Bank of Ghana, 2022).

[6] Exchange rate at the time of the survey (2022) is 1US$ = GHS7.4. (Source: Bank of Ghana, 2022).

[7] Our data show that 84% of the respondents are males and 94% are adults. Commercial farming is capital intensive thus women are less likely to engage in such business and given that the youth lack financial resources, they are less likely to also engage in commercial farming business though they are likely to succeed if given the necessary financial support.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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