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Behind-the-border non-tariff measures, agricultural transaction costs and profitability of commercial cereal farmers in Ghana

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Abstract

Purpose – This study examines how behind-the-border non-tariff measures (NTMs) affect the agricultural transaction costs and profitability of commercial cereal farmers in Ghana. Despite the growing importance of NTMs in international trade, empirical evidence on their effects remains mixed, with some studies suggesting that they facilitate trade by improving standards and market access, while others highlight their cost-increasing and trade-restrictive effects. In addition, most existing studies rely on aggregate trade data, leaving limited micro-level evidence on how behind-the-border NTMs affect producers, particularly commercial farmers in developing countries.

Design/methodology/approach – This study explores NTMs from both an extensive and intensive perspective using data from 455 commercial cereal farmers across five regions in Ghana. Employing ordinary least squares regression and instrumental variable (IV) techniques, the analysis assesses the association between NTMs, agricultural transaction costs and farm profitability.

Findings – The results reveal that customs formalities are the most frequently encountered NTMs. Commercial farmers who incurred NTMs conducted approximately 2.7 more cereal transactions per production season and faced an increase in compliance costs of GHS 2,533 (USD 346) per production season. In contrast, NTMs were associated with a reduction in produce perishability by 0.27 per production season and a decrease in profit of GHS 1,696 (USD 232) per production season. These outcomes persist even after controlling for potential endogeneity. The findings underscore that while NTMs may facilitate trade volume, they also raise compliance costs and reduce profitability, potentially constraining sustainable cereal production.

Research limitations/implications – The use of cross-sectional data limits our ability to fully establish causality. Future research could benefit from using panel data to explore the dynamic effects of NTMs to improve the depth of findings. Additionally, combining survey-based measures of compliance costs with official NTM data from sources such as the UNCTAD database could provide a more comprehensive understanding of how NTMs affect both domestic producers and international trade flows.

Originality/value – While most studies on non-tariff measures in developing countries focus on the macroeconomic level, this study examines the behind-the-border (i.e. within domestic markets) non-tariff measures that commercial farmers face, offering insights from a microeconomic perspective on their effects.

Keywords Non-tariff measures, Transaction cost, Commercial farmers, Profitability, Ghana

Paper type Research article

JEL Classification — F10, O24, Q13



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1. Introduction

Market access is reliant on and controlled by various rules and regulations that traded goods must comply with (UNCTAD, 2013; Shepherd and Peters, 2020). These monitoring measures are commonly ascribed to non-tariff measures (NTMs) and include economic policies that directly or indirectly affect transaction costs. Multilateral or regional tariff reductions have significantly lowered tariffs globally, and few emerging areas of trade policy are rationalizing NTMs (Devadason and Chenayah, 2014; Herghelegiu, 2018; Webb *et al.*, 2020). To develop effective initiatives to reduce these expenses and boost competitiveness, it is necessary to understand the nature of these trade expenses. Although non-tariff trade regulations are frequently used, their pervasiveness and effects are poorly understood. There has been a fragmented analysis of these measures due to the slow pace, which has increased their complexity and created a knowledge gap (UNCTAD, 2013).

According to UNCTAD (2012), NTMs are policy regulations that differ from standard customs tariffs and are plausible to affect trade by altering traded quantities and prices. Therefore, they are non-pecuniary in nature. NTMs could have a curative aspect by minimizing information asymmetry (Technical Barriers to Trade, TBTs, also known as behind-the-border measures). For example, through labelling, which provides consumers with specific information about the product, NTMs alleviate consumption-related risks and improve ecological community sustainability (Sanitary and Phytosanitary Standards, SPSs) related to human health, thereby guaranteeing food security for consumers and preventing the introduction of diseases and pests. In addition, non-technical NTMs affect import and export decisions and competition. The understanding of trade measures has evolved over time: the term "non-tariff barriers," which emphasizes their protective nature (e.g. quotas and export restraints), has mainly been replaced by NTMs to underscore their dual role in either hindering or facilitating trade (Grant and Arita, 2017).

Numerous studies have established the impact of transaction costs on trade. According to some research, countries' capacity to regulate "non-price" trade factors determines whether trade liberalization is successful (Balassa, 1961; DaSilva-Glasgow, 2020). Regarding NTMs, their transformation into non-tariff barriers does not primarily stem from the existence of compliance requirements or the stringency of regulatory measures themselves. Rather, this transformation occurs when the implementation of such measures becomes excessively burdensome, inefficient, or unnecessarily increases transaction and compliance costs for market participants beyond what is required to achieve legitimate public policy objectives. As stated by the Asia-Pacific Economic Cooperation [APEC] (2016), this concerns procedural issues with the effectiveness of import and export procedures and standards. Behind-the-border NTMs have turned out to be novel trade barriers, in opposition to the main objective of these policies, which is to safeguard the environment, people, animals, and plants in importing countries, as well as to address market failure and negative selection in free markets (Fernandes *et al.*, 2019; Liu *et al.*, 2019). Agricultural trade in Ghana is mainly affected by behind-the-border measures, particularly SPS measures and technical trade barriers, as well as customary regulations imposed on producers and exporters (UNCTAD and World Bank, 2018).

For diverse agri-food exporters in Africa, adhering to NTMs has diverse effects. However, such compliance could have a significant negative impact on countries with less diverse crops, including increased trade costs and reduced revenues (Liu *et al.*, 2019). Moreover, NTM-related costs are estimated to be three times higher than tariffs, especially for agricultural produce, and their effects are often disproportionate and prohibitive for producers and growing enterprises (Fugazza *et al.*, 2017). In addition to the complexity and disparities of these policy instruments and the fact that NTMs frequently have diverse effects on trade that are challenging to generalize, one limitation of these trade measures (behind-the-border regulations) is that, despite their extensive advantages, their impact on local trade is relatively understudied (UNCTAD, 2013; Martey *et al.*, 2023; Onumah *et al.*, 2024). Unlike tariffs, NTM data are not just figures. Therefore, their impact on trade is usually indirect and

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case-specific. Furthermore, the challenge of comprehending the significance of these trade measures stems from a lack of data (information asymmetry) and a lack of transparency (Fernandes *et al.*, 2019). Melo and Nicita (2018) concluded that while NTMs' data quality and accessibility are improving, there are still limitations in their availability, especially regarding NTMs from domestic procedures. This inadequate availability and accessibility of information continues to hinder the assessment of NTMs' impact on economic and socioeconomic outcomes (UNCTAD and World Bank, 2018).

NTMs elsewhere have hindered cereal production and commercialization, particularly in major cereal-producing countries such as India and the USA (Maziku and Mashenene, 2020). This is because NTMs act as a barrier (catalyst) to trade if they reduce (increase) domestic imports (Swinnen, 2016). NTMs implemented in the destination state imply increased compliance costs and higher import prices for exporters (Swinnen, 2016). Hence, domestic producers are likely to face smaller (more significant) implementation costs and are more likely to attain higher (lower) profits compared to foreign producers (Arita *et al.*, 2017; Santeramo and Lamonaca, 2019). From the producers' perspective, NTMs infer increased compliance costs, precisely fixed costs (e.g. conformity in marketing requirements, improvement on innovation facilities, and acquisition of certificates), and variable costs (e.g. extended delivery time due to inspection and testing procedures at customs checkpoints, rejection of specific consignments, and rejection of entry of certain shipments) (Xiong and Beghin, 2014; Crivelli and Gröschl, 2016). The high costs of complying with NTMs will likely reduce both profitability and the volume of commodities supplied to the market. Such costs, which can include expenses for meeting quality standards, certification processes, and regulatory requirements, place an added financial strain on producers and exporters. For commercial farmers and developing economies, these compliance costs can be a substantial barrier to market entry and expansion, thereby affecting overall agricultural productivity and trade competitiveness (UNCTAD, 2013).

This study focuses on behind-the-border NTMs, which include domestic regulations and administrative procedures that affect the production, marketing, and distribution of agricultural products. Although NTMs are commonly defined as policy instruments that regulate international trade, they can also generate indirect effects on domestic commercial producers. By influencing trade flows, market prices, and market access conditions, NTMs can alter the economic environment in which farmers operate. In this study, relevant NTMs include customs formalities, testing and certification requirements, SPS measures, and packaging standards. While these measures are often introduced to regulate cross-border trade and ensure food safety and quality standards, they may also apply to domestic products or influence domestic market transactions through compliance requirements. For instance, commercial farmers and traders may need to meet testing, certification, or packaging standards before their produce can be marketed or supplied to certain buyers or markets. Such requirements may increase transaction costs through additional administrative procedures, compliance costs, and delays, thereby affecting the profitability of commercial cereal farmers. Government agencies enforce these standards primarily to ensure food safety, quality assurance, and consumer protection. Moreover, traders operating in particular markets often require commercial farmers to comply with these standards by providing technical support, including on-field assistance, quality control mechanisms, technology adoption, and incentives to facilitate compliance.

Despite the growing literature on NTMs, most studies have focused on cross-border trade and non-technical barriers, examining their effects on international trade flows (Peterson *et al.*, 2013; Dal Bianco *et al.*, 2016; Cho *et al.*, 2020; Fiankor *et al.*, 2019). This leaves a gap in understanding how behind-the-border NTMs affect domestic agricultural trade, particularly at the farm level. Few empirical studies (Martey *et al.*, 2023; Onumah *et al.*, 2024) have examined how these domestic regulations affect key economic outcomes, including cereal production allocation and household welfare. Moreover, few studies have examined the effects of NTMs on transaction volume, perishability, compliance costs, and profitability among

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commercial farmers. This study addresses these gaps by providing micro-level evidence from Ghana on the effects of behind-the-border NTMs on cereal production, marketing, and trade outcomes, thereby extending the existing body of knowledge on NTMs beyond international trade contexts.

This study contributes to the understanding of agricultural transaction costs and the profitability of cereal production in two ways. First, most studies have primarily focused on non-technical non-tariff measures (NTMs) and broader non-tariff barriers (NTBs) associated with cross-border trade procedures, while relatively limited attention has been given to technical measures such as sanitary and phytosanitary (SPS) requirements and associated conformity assessment procedures, including testing, inspection, and certification. Second, most policy formulations in developing countries are not research-based and tend to have negative long-term effects. The study findings will enable policymakers and development practitioners to better understand the mechanisms by which behind-the-border procedures influence the profitability of cereal commercialization for Ghanaian farmers.

The rest of the paper is organized as follows: Section 2 describes the conceptual framework, while Section 3 presents the data and empirical strategy. Section 4 presents and discusses the study's empirical results, while Section 5 provides the conclusion and policy recommendations.

2. Conceptual framework

In this section, we conceptualize the pathways through which NTMs influence agricultural transaction costs and profits, drawing on transaction cost and Global Value Chain (GVC) theory. This theory highlights the key factors that affect transaction costs and shape a producer's or firm's economic exchange decisions (Williamson, 1973) while also incorporating insights from GVC theory (Gereffi *et al.*, 2005), market access, agricultural commercialization, and quality compliance literature. Transaction cost theory emphasizes the costs associated with economic exchange, including information search, negotiation, coordination, monitoring, certification, and compliance, that shape producers' decisions to participate in markets and their performance outcomes. GVC theory also highlights how standards and regulatory requirements can influence producers' integration into modern value chains and higher-value markets. From this perspective, NTMs are not only sources of trade and compliance costs but also mechanisms for quality assurance, coordination, and product upgrading within agricultural value chains. Compliance with standards may therefore enhance competitiveness, improve market access, and stimulate technological and organizational improvements among producers. Figure 1 presents the conceptual framework of the study.

The framework illustrates that NTMs influence profitability indirectly through trade and transaction-related channels that affect commercial farm performance. Specifically, the causal structure follows the sequence: NTMs → Trade/Transaction Effects → Commercial Farm Performance → Profitability. In this context, NTMs are expected to influence production and marketing decisions by altering compliance requirements, transaction costs, market access conditions, and transaction risks associated with the commercialization of cereal products. The framework further recognizes the dual nature of NTMs. On one hand, NTMs may increase compliance and transaction-related costs through certification requirements, testing and inspection procedures, product traceability obligations, labelling standards, and administrative processes. These requirements may increase transaction risks, delays, coordination costs, and market uncertainty, thereby constraining market participation and reducing profitability. NTMs may raise search, monitoring, and coordination costs, especially for farmers operating in imperfect or poorly integrated markets. Such constraints may also increase the risk of product perishability due to delays in market exchanges and compliance procedures.

On the other hand, NTMs may also generate positive spillover effects by serving as quality assurance mechanisms that improve market confidence, product standardization, and consumer trust. Compliance with SPS measures, technical standards, certification

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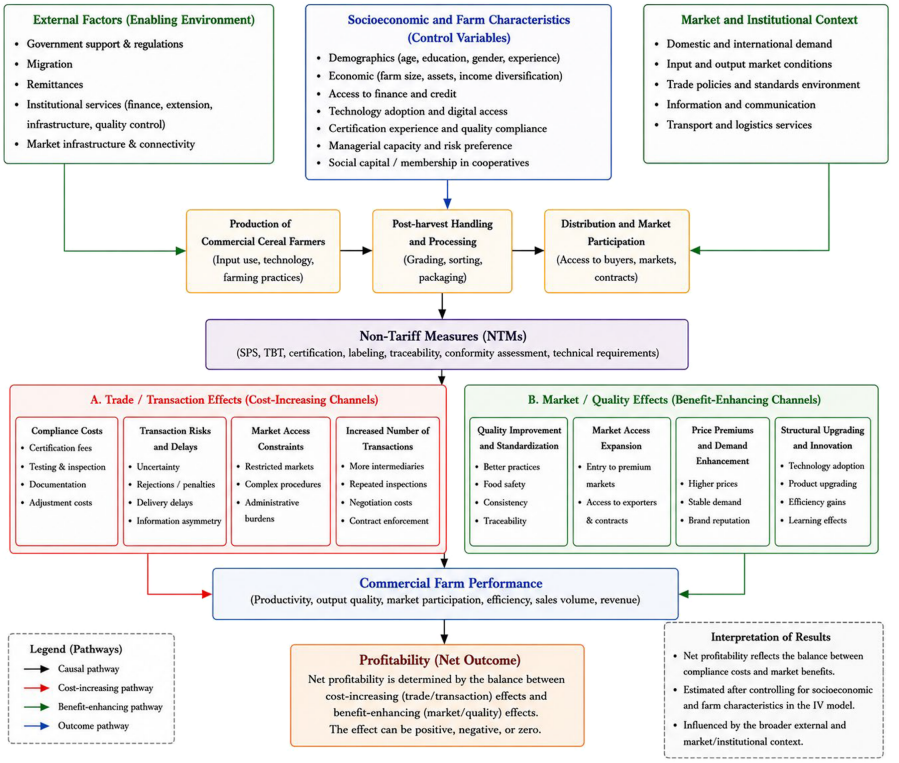


Figure 1. Conceptual framework of NTMs and agricultural transactions and profitability. Source: Authors' own work

procedures, and quality requirements may facilitate access to premium markets, improve demand conditions, enhance price premiums, and stimulate product upgrading and innovation among commercial cereal farmers. Consequently, NTMs may induce structural changes in production systems by encouraging improved farming practices, technology adoption, post-harvest management, and quality enhancement strategies. Thus, the overall profitability effect of NTMs is expected to depend on the net outcome between the revenue gains associated with improved market opportunities and the compliance-related costs incurred by farmers.

Commercial farm performance serves as the intermediate transmission channel through which NTMs affect profitability. Farm performance in this study reflects productivity, output quality, market participation, efficiency, sales volume, and commercialization outcomes. The framework, therefore, suggests that NTMs may either positively or negatively influence profitability depending on how they affect commercial farm performance and the balance between associated benefits and costs.

Production and commercialization decisions are further influenced by socioeconomic, farm-specific, institutional, and contextual factors. These include demographic characteristics (sex, age, marital status, household size, nativity, and migration status), human capital factors such as literacy and education, and farm-level characteristics including land ownership, farm size, technology adoption, certification experience, and access to finance. Institutional and enabling factors such as extension services, remittances, credit, government support programmes, insurance, contracts, market infrastructure, and regional characteristics are

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also expected to influence both commercialization intensity and the degree of exposure to NTMs.

Socioeconomic and farm characteristics are included as control variables in the empirical model to account for observed heterogeneity in the relationship between NTMs, commercial farm performance, and profitability. For example, farmers with larger farm sizes, better market access, stronger social networks, certification experience, and greater access to finance may be better positioned to absorb compliance costs and benefit from improved market opportunities associated with NTMs (Maziku and Mashenene, 2020). The gender of the farmer may influence agricultural production (Adaku *et al.*, 2023; Anaglo *et al.*, 2014), which in turn affects the intensity of commercialization and the types of NTMs likely to be encountered. Similarly, education and literacy are expected to improve farmers' ability to understand regulatory requirements, adopt technologies, and comply with quality standards, thereby improving commercialization outcomes and profitability (Ninh, 2021).

Household size may influence commercialization through labour availability, thereby increasing production scale and market participation (Urgessa, 2015). However, larger households may also increase household consumption and resource constraints, potentially reducing marketable surplus. Extension services are expected to raise awareness of and disseminate improved agricultural technologies and compliance requirements, thereby enhancing farmers' ability to meet market standards and participate in regulated markets.

Transfers and institutional support mechanisms such as remittances, credit access, government programmes, insurance, and contractual arrangements are hypothesized to improve commercialization and market participation by relaxing financial constraints and enhancing farmers' investment capacity. Conversely, migration may reduce the availability of local labour and increase labour costs, potentially affecting production decisions, commercialization intensity, and exposure to NTMs (Castelhano *et al.*, 2016).

In this study, the instrument used for the instrumental variable estimation is the ratio of commercial farmers exposed to NTMs to the total number of commercial farmers within the community. Although NTMs are applied to traded products rather than directly to farmers, commercial cereal farmers incur compliance and transaction-related costs when marketing their produce. The instrument is considered appropriate because commercial farmers often operate within strong local information-sharing networks, where knowledge regarding compliance requirements, certification procedures, inspections, and market standards diffuses through peer interactions and community networks. The instrument satisfies the relevance condition because community-level exposure to NTMs is expected to strongly influence individual farmer exposure to NTMs through localized learning effects, peer influence, and market interactions. At the same time, conditional on the included farm-level and institutional controls, the instrument is assumed to satisfy the exclusion restriction because it is not expected to directly affect individual farm profitability except through its influence on individual NTM exposure. To minimize potential violations of this assumption, the empirical model controls for institutional services, market access, extension services, farmer organizations, and other contextual factors that may independently influence profitability. The proportion of community members engaged in cereal cultivation and facing NTMs may serve as a potential indicator of prevailing opportunities within the community, as noted by Onumah *et al.* (2024). Additionally, NTMs are expected to influence outcomes; therefore, they are modelled as a function of NTMs and the reduced-form determinants of household characteristics, extension contact, transfers such as remittances, credit, government support programs, insurance, contracts, and commercial farmers who are exposed to or incur NTMs.

In line with the transaction costs and GVC theory, NTMs could influence transaction costs by raising search, coordination, and compliance requirements. It could also cause delays in market exchanges, thereby influencing perishability of farmers' commodities and profitability at large (Williamson, 1973; Gereffi *et al.*, 2005). In our study, we address four main hypotheses regarding the association between NTMs, agricultural transaction costs, and profitability:

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H1. NTMs increase the number of cereal transactions undertaken by commercial farmers;

H2. NTMs reduce the perishability of cereals by enforcing quality standards and proper handling;

H3. NTMs increase compliance costs for commercial farmers;

H4. NTMs negatively affect the profitability of commercial cereal production due to higher compliance costs.

3. Data and measurement of key variables

3.1 Data

The study focused on commercial cereal producers in five regions of Ghana: Northern, Bono, Ashanti, Western, and Volta. The data used were drawn from a cross-sectional household survey conducted by the LEAP-Agri: Agricultural Trade and Market Access for Food Security (ATMA4FS) project. This secondary dataset was selected because it captured detailed information relevant to this study. The survey was conducted from May to June 2022 through face-to-face interviews, with all participants providing informed consent. To ensure nationally and regionally representative data, the survey used a multistage sampling technique that combined stratified and random sampling. The Ministry of Food and Agriculture (MoFA) and the Savanna Agricultural Research Institute (SARI) provided the sampling frames (lists of commercial farmers). A total of 604 commercial farmers [1] were interviewed for the survey. The sample size was initially determined using Yamane (1967): $n = (N/1 + Ne^2)$ where N denotes the population of commercial farmers in the five regions (approximately 10,000) and e denotes the margin of error (4%), corresponding to a 96% confidence level. This yielded a minimum sample size of approximately 588 farmers. To ensure adequate representation and account for potential non-responses, the final sample was increased to 604 commercial farmers. However, for the purpose of this study, the analytical sample was restricted to 455 farmers who specifically produce cereals. Thus, while the survey had a broad coverage, the results reported in this study are based on the sub-sample of cereal-producing commercial farmers.

The data indicate that most commercial farmers produce cereals, with the highest number of farmers experiencing NTMs located in the Northern Region, followed by Bono, Ashanti, Volta, and Western regions. The major maize-producing regions in Ghana include Eastern, Ashanti, Bono, Northern, and Volta (MoFA, 2018), while rice is predominantly produced in Volta, Northern, Upper East, Ashanti, and Western regions (MoFA, 2018). Figure 2 presents the administrative regions of the study area.

The ATMA4FS Project data relevant to this study include demographics (sex, education, marital status, household size, nativity, etc.), farm characteristics (crops cultivated, area under cultivation, production, and costs), market participation, quantity of produce sold, quantity of produce consumed, quantity of produce given out as gifts, institutional factors (member of farmer organization, access to credit, extension), knowledge on NTMs, NTMs incurred, transaction costs associated with NTMs, and other constraints to production and marketing of agricultural produce, and regional control dummies. The primary outcome variables for this study include the number of cereals transacted during a season, the perishability of the produce, costs associated with NTMs, and profitability. In this study, agricultural transaction costs are conceptualized using three indicators: the number of cereals transacted during a season, the perishability of the produce, and the compliance costs associated with NTMs. The number of cereals transacted was measured by the frequency with which commercial farmers sold their cereals over a year to gain insights into the volume of transactions. The perishability of produce refers to the extent to which farmers' cereals are susceptible to damage or quality deterioration due to delays encountered during marketing and distribution. Such delays may arise from checkpoints, customs procedures, inspections, or other regulatory requirements

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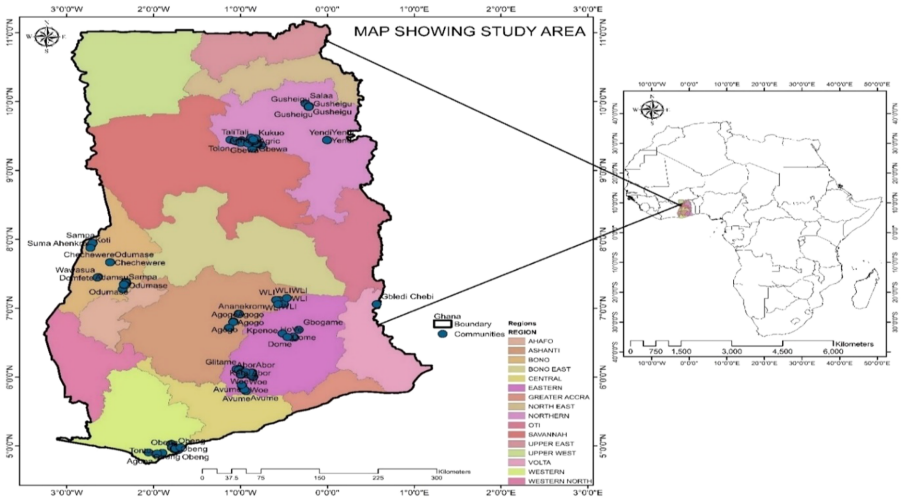


Figure 2. Map of the study area. Source: Authors' own work

associated with NTMs. In addition, perishability captures the potential losses and marketing constraints resulting from storage limitations and product deterioration, which contribute to transaction-related inefficiencies faced by commercial cereal farmers. Moreover, the costs associated with NTMs were quantified by capturing farmers' monetary expenditures incurred to comply with trade regulations, including customs fees, inspection charges, testing and certification costs, and other non-tariff requirements. These compliance costs represent a substantial burden for farmers, particularly when compounded by indirect effects such as delays in marketing, reduced product quality, or constraints on trade flows. Collectively, these direct and indirect costs provide a comprehensive measure of the economic impact of NTMs on commercial cereal farmers. Profitability was calculated by subtracting both the total production costs and the costs associated with NTMs from the total revenue generated from crop sales.

3.2 Non-tariff measures

The study employed behind-the-border NTMs, as these trade measures are enforced internally within the domestic or local economy by government agencies or traders, with a focus on quality, safety, and environmental standards. These trade measures comprise primary technical measures resulting from domestic legislation that covers product standards addressing health, environmental, technical, and other concerns (Melo and Nicita, 2018). The study focused on four (4) behind-the-border NTMs: (1) Customs formalities → involve the detailed inspection of goods transported for sale within a country. Customs officers conduct these checks at various checkpoints in the country. The purpose of customs formalities is to determine the volume of transported goods accurately, reduce revenue losses for the government, and prevent deceptive practices such as fraudulent documentation; (2) Testing certification → verifies whether commercial cereal farmers adhere to production procedures in accordance with environmental laws, including the types of fertilizers and agrochemicals used. Compliance with these standards can lead to higher prices for their produce or to access to higher-value markets, thereby reducing risk. The government enforces these standards through extension agents and research institutions that disseminate information on farmers' use of inputs. Also, traders selling to specific markets make sure farmers adhere to some standards through technical support through education and training, market information and technology adoption; (3) The SPS

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measures → reduce the utilization of some substances, hygienic requirements, or other measures for preventing the spread of diseases, as well as conformity assessment measures related to food safety intended for safeguarding plant, animal, and human health and safety, precisely certification, testing and inspection, and quarantine (UNCTAD, 2013). Government agencies enforce these measures, and traders who have contractual agreements with producers on specific requirements through contractual arrangement; (4) Lastly, packaging standards → refer to the materials and products used to store, protect, and transport agricultural produce, extending its shelf life and keeping it fresh and safe for consumption. These standards help protect food from pests and diseases, including poly bags, Purdue Improved Crop Storage (PICS) bags, paper boxes, and wooden and plastic boxes. Key government agencies, including the Ghana Standards Authority (GSA), Food and Drugs Authority (FDA), and Environmental Protection Agency (EPA), implement these standards. They promote environmentally friendly materials by educating farmers on appropriate packaging options that help reduce post-harvest losses and pest attacks. Additionally, farmers who adopt sustainable packaging practices can reduce their environmental footprint and appeal to environmentally conscious consumers, potentially opening new market opportunities. Martey *et al.* (2023) indicate that storage protection technologies such as PICS play a crucial role in addressing food security challenges and low incomes, especially among the rural poor.

3.3 Descriptive statistics

Table 1 shows the summary statistics of the explanatory variables [2] used in the regression. The average number of cereal transactions annually is three. The mean of perishable produce is 0.20, indicating that about 20% of the respondents' cereals go bad, possibly due to the number of checkpoints encountered. Also, the average compliance cost incurred by cereal commercial farmers is GHS535 (USD74), and a farmer's profit level is GHS9.85 (USD1.36). The percentage of farmers who incurred any form of NTMs used for this study is 24%. The majority (84%) of sampled farmers are male, and the average age is 48 years, indicating that Ghanaian farmers are of economically active age. The data revealed that most (85%) of the sampled commercial farmers in Ghana are married, while about 17% are single. The study further shows that 66% of commercial farmers have high levels of formal education, to the point that they can read, write, and construct simple sentences. Additionally, a typical farming household in Ghana comprises about five persons. The majority of the sampled commercial farmers (66%) are natives. The study's findings show that about 19% of the sampled population had a household member who was a migrant. Access to farmland is an essential agricultural productive asset; land ownership is an indicator of wealth. Also, the mean weekly food expenditure and log total household expenditure are GHS 679.48 and GHS 9.42, respectively. From the study's findings, 28% of the sampled farmers own their farmland. Agricultural extension services are a primary means of disseminating good agricultural practices (GAPs) to farmers. The mean number of extension contacts is four times a year. The results show that 4% of farmers have insured their farms, while about 48% of sampled farmers are willing to insure them. About 13% of the commercial cereal farmers are engaged in contract farming. The result revealed that only 24% of the sampled commercial farmers accessed credit for farming activities. Also, about 12% of the sampled commercial farmers had government support.

Figure 3 presents the NTMs incurred by commercial farmers in Ghana. The results revealed that most (36%) of the sampled commercial cereal farmers incurred customs formalities (customs valuation at checkpoints). According to Barka (2012), the number of border agencies increases bureaucracy at border posts, resulting in congestion and delays (the time it takes for a vehicle or container to pass a border can range from 3 min to 2.8 days). Furthermore, APEC (2016) stated that staple produce, such as grains and cereals, is one of the most contentious products traded. Moreover, testing and certification arrangements also affect 17% of the sample respondents. Figure 3 shows that 12% of the sampled commercial farmers incurred

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Table 1. Summary statistics of dependent and explanatory variables

Variables	Definition	Mean	SD	Min	Max
Dependent variable					
Sales of produce	Number of transactions in a year	3.398	2.986	0	20
Perishability	Dummy: 1 = if yes; 0 = otherwise	0.198	0.399	0	1
Compliance cost	Compliance cost associated with NTMs (GHS) in a production season	535.876	2095.792	0	16,500
Profit of produce	Log Profit of produce (GHS) per production season	9.846	1.781	0	12.514
NTMs incur	Dummy: 1 = if incur NTMs; 0 = otherwise	0.240	0.427	0	1
Explanatory variables					
Socioeconomic and farm characteristics					
Sex of respondent	Dummy: 1 = if respondent is a male; 0 = otherwise	0.240	0.427	0	1
Age of respondent	Age of respondent (years)	0.841	0.365	0	1
Marital status	Dummy: 1 = if respondent is married; 0 = otherwise	47.820	11.436	18	85
If respondent can read	Dummy: 1 = if respondent can read; 0 = otherwise	0.835	0.370	0	1
Household size	Number of persons living in the household of respondent	0.657	0.475	0	1
Nativity	Dummy: 1 = if respondent is a native; 0 = otherwise	7.892	13.782	1	30
Member migrated	Dummy: 1 = if a household member migrated; 0 = otherwise	0.664	0.473	0	1
Own land	Dummy: 1 = if respondent owns land; 0 = otherwise	0.189	0.392	0	1
Weekly food expenditure	Weekly food expenditures (GHS)	679.48	538.89	24	2,790
Total household expenditure	Log Total household expenditure (GHS)	9.417	1.005	4.615	12.376
Institutional characteristics					
Extension access	Dummy: 1 = if farmer access to extension; 0 = otherwise	0.275	0.447	0	1
Farm insured	Dummy: 1 = if respondent has insured his farm; 0 = otherwise	4.116	5.923	0	1
Willing to insure farm	Dummy: 1 = if respondent is willing insured farm; 0 = otherwise	0.037	0.190	0	1
Contract farming	Dummy: 1 = if respondent engage in contract farming; 0 = otherwise	0.481	0.500	0	1
Accessed credit	Dummy: 1 = if respondent had access to credit; 0 = otherwise	0.132	0.339	0	1
Government support	Dummy: 1 = if respondent had government support; 0 = otherwise	0.235	0.425	0	1
Geographical characteristics					
Location	Dummy: 1 = if respondent is from Bono region; 0 = otherwise	0.136	0.343	0	1
Location	Dummy: 1 = if respondent is from Volta region; 0 = otherwise	0.219	0.414	0	1
Location	Dummy: 1 = if respondent is from Western region; 0 = otherwise	0.190	0.393	0	1

Note(s): SD means standard deviation. The exchange rate at the time of the survey (2022) was 1 US$ = GHS 7.4. (Bank of Ghana, 2022)

Source(s): Authors' own work

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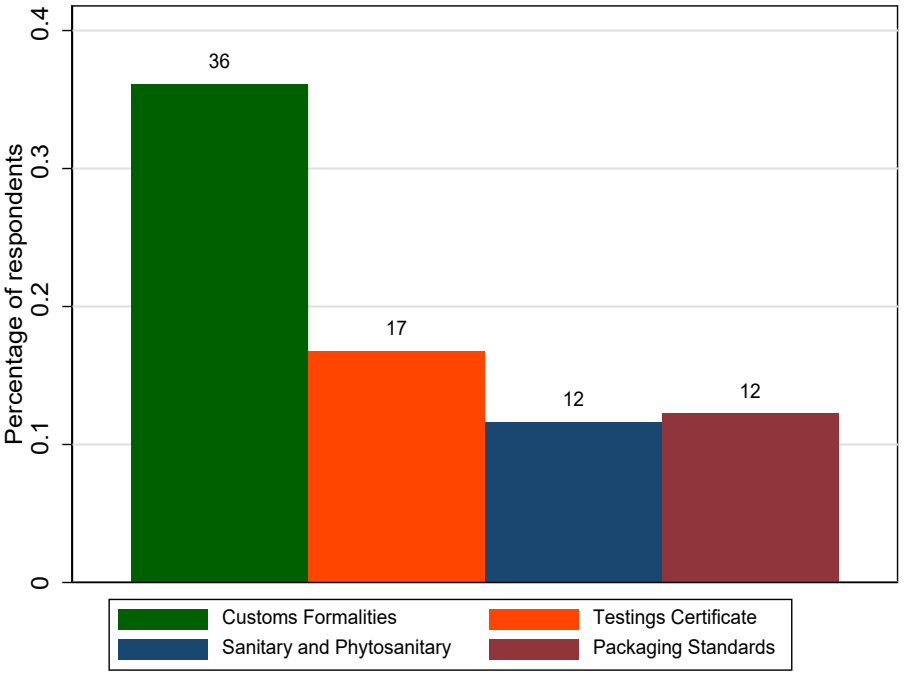


Figure 3. NTMs incurred by commercial farmers in Ghana. Source: Authors' own work

SPS and packaging standards. However, the certification standard is based on a framework of good agricultural practices (such as pesticide and fertilizer use), guaranteeing adherence to public food safety requirements. This also includes other factors, such as traceability, worker safety, and farm management practices (Subervie and Vagneron, 2013).

Figures 4–7 present the results of the non-parametric local polynomial regression analysis examining the relationship between NTMs and the outcome variables. Figure 4 illustrates a positive relationship between the number of NTMs incurred and the number of transactions in a year. This suggests that an increase in yearly transaction volume by three (3) is associated with a reduction in the number of NTMs incurred by four (4). In addition, we observed a negative and positive relationship between the number of NTMs incurred and the perishability of produce among commercial cereal farmers. Within a range of two (2) to four (4) NTMs incurred, there is a decrease and an increase in produce perishability, respectively (Figure 5). Furthermore, Figure 6 demonstrates a generally positive relationship between the number of NTMs incurred and associated costs. An increment range of approximately three (3) to four (4) NTMs is associated with higher NTM costs. However, Figure 7 presents a mixed relationship between the number of NTMs incurred and the profitability of commercial cereal farmers. Specifically, there is a positive range of one (1) to two (2) NTMs associated with profitability, while a reduction range of approximately three (3) to four (4) NTMs is correlated with decreased profitability. Although we have established a relationship, it is essential to note that causality cannot be asserted because observable and unobservable factors may be contributing to this relationship. In the subsequent sections, we examine the effects of NTMs on agricultural transaction costs and on the profitability of cereal production, while controlling for relevant covariates.

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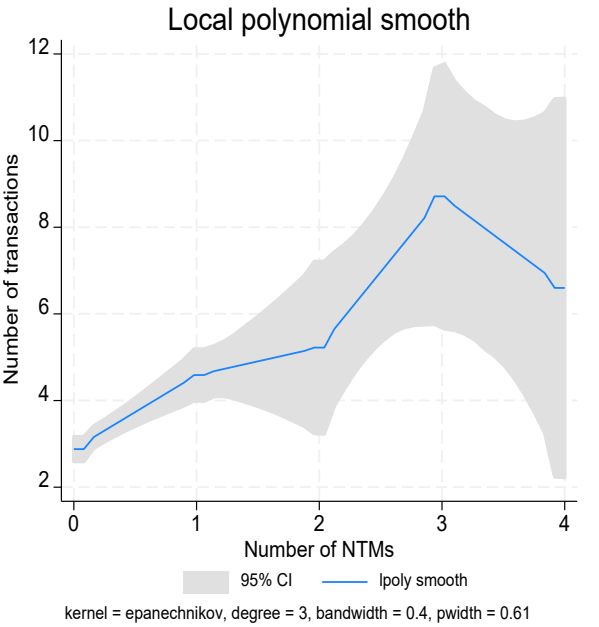


Figure 4. Number of NTMs and transactions. Source: Authors' own work

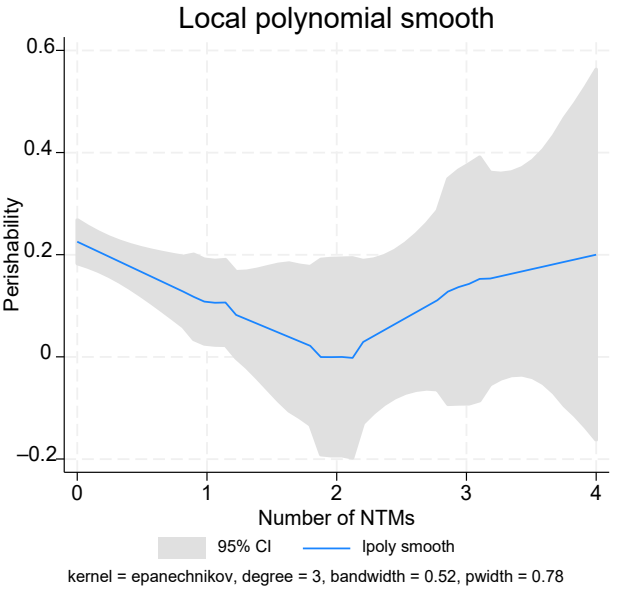


Figure 5. Number of NTMs and perishability. Source: Authors' own work

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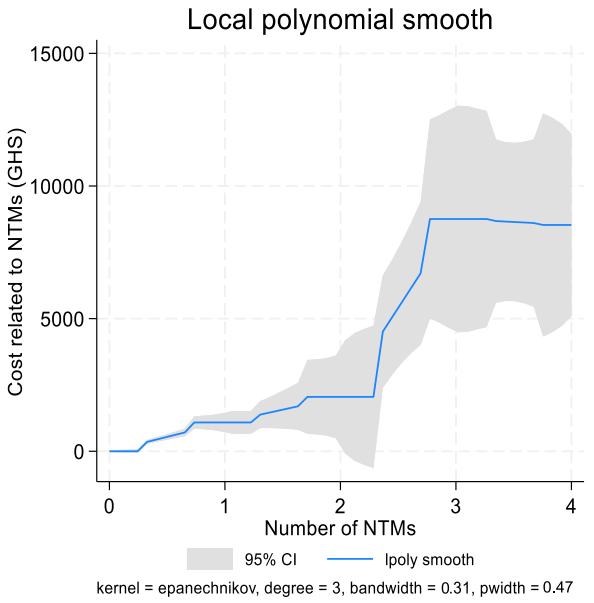


Figure 6. Number of NTMs and related cost. Source: Authors' own work

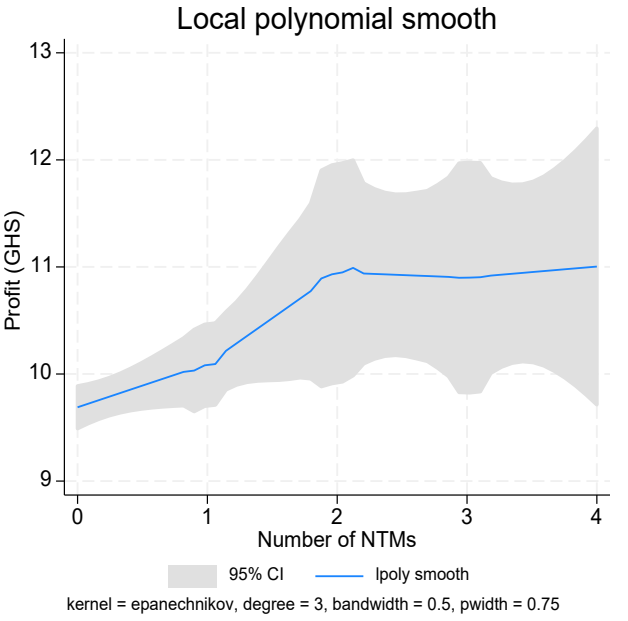


Figure 7. Number of NTMs and profit. Source: Authors' own work

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3.4 Empirical strategy

The research employs the OLS method to determine the relationship between the outcome variables (agricultural transaction costs and profitability) and the trade measures (NTMs). The primary estimation model for the outcome variables is a linear function of NTMs, a vector of other explanatory variables, and regional dummies. Based on the exogeneity assumption of NTMs, the OLS approach is well-suited to estimate the association between the outcome variables (Y_i), and the NTMs (T_i) coefficient on T_i is expected to be significant and positive ($\gamma > 0$) on agricultural transaction costs and profitability of cereal farming, indicating that an increase in NTMs incurred is associated with increasing agricultural transaction costs and the profit of cereal farming. The model is specified as shown in Equation (1)

$$Y_i = \alpha + \boldsymbol{\gamma} NTM_i + \beta X_i + \varphi_i + \mu_i \quad (1)$$

Where Y_i represent the outcome variables (agricultural transaction costs and profitability) for an individual i 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, marital status, years of education, household size, nativity, land ownership, migrant household, extension contact, access to credit, participation in contract farming, farm insurance, willingness to insure farm, government support, and regional heterogeneities captured by household location), φ_i is the region-level fixed effects and μ_i is the stochastic error term. The coefficient of interest γ measures the effect of NTMs on welfare outcomes.

Estimating Equation (1) using OLS will yield a biased and inconsistent estimate of the start equation gamma because NTMs (*Y* sub i) are correlated with the error term (mu sub i), possibly due to reverse causality. This reverse causality arises because NTMs influence agricultural transaction costs and profitability, and conversely, transaction costs and profitability influence NTMs. Specifically, strict regulatory requirements imposed by NTMs may increase compliance costs, thereby affecting profitability. Conversely, higher profitability in cereal production may prompt regulatory bodies to implement stricter NTMs to protect domestic industries or ensure product quality and safety. Additionally, higher transaction costs incurred by cereal commercial farmers may spur regulatory reforms to reduce trade barriers. On the other hand, increased profitability of commercial cereal farmers may lead to greater investments in technology and infrastructure, which is likely to reduce transaction costs and potentially the types of NTMs that may be experienced. Furthermore, the biased estimate might be due to a correlation between an omitted variable (observed and/or unobserved) that influences NTMs and outcome variables. To address this potential bias, possible confounders that may influence agricultural transaction costs and profitability are controlled for in the identified covariates *X* sub *ij* (specific exogenous variables – sex, age, marriage, and education), (explanatory variables – household size, native, own land, total migrants, extension contact, remittances, credit, farm insured, and government support) and region-level fixed effects, script phi sub *ij* (dummy variables) to avoid region-specific effects on agricultural transaction cost and profitability due to the different types of NTMs incurred or unobservable effects such as time-invariant, topographical and climate conditions, ethnicity, social norms, and cultural traditions (Umberger *et al.*, 2015; Martey *et al.*, 2023).

The NTMs incurred may also be affected by unobservable characteristics (e.g. innate abilities/motivation, managerial skills, and innovativeness) that might be correlated with the outcome variables. An upward bias will result when the most skilled individual's preferences lead them to use innovative production technology that ensures high yields and improves outcome variables. Regarding the framework of this regression, μ_{ij} will be correlated with NTMs incurred, NTM_i and ε_i in Equation (2), which may lead to endogeneity. In this instance, OLS would yield biased estimates of NTMs on the outcome variables; hence, the IV estimation technique is used to address potential endogeneity.

The first stage estimation is modelled such that NTMs are determined by a set of exogenous covariates and instruments as follows:

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$$NTM_i = \vartheta + \xi H_i + \varepsilon_i \quad (2)$$

Where $H_i = [X_i, Z_i]$ is a vector of explanatory variables X_i and the instrument Z_i; ϑ and ξ are parameters to be estimated, and ε_i is the random error term. The study used neighbours in the reference commercial-farmer community who had experienced NTMs as a potential instrument. The external instrument is constructed based on the peer-effect and social learning literature, which suggests that commercial farmers' knowledge and awareness of regulatory requirements and market conditions are often shaped through interactions with other commercial farmers within their communities. Through social learning and information sharing, commercial farmers are more likely to become aware of NTMs when neighbouring commercial farmers encounter such regulatory measures during marketing activities (Bandura, 1977; Foster and Rosenzweig, 1995; Conley and Udry, 2010; Onumah *et al.*, 2024; Martey *et al.*, 2024). Therefore, the experience of NTMs by neighbouring farmers is expected to influence an individual farmer's likelihood of encountering NTMs through information diffusion and shared marketing networks. At the same time, this variable is not expected to directly influence the farmer's transaction costs or profitability except through its effect on exposure to NTMs. Hence, it satisfies the relevance and exclusion conditions required for a valid instrumental variable.

The validity of the instruments is based on satisfying two core assumptions: (1) relevance and (2) exogeneity. First, the instrument must be relevant, implying that it should be strongly correlated with the endogenous variable, non-tariff measures (NTM_i). The first-stage regression results show that the instrument is positive and highly statistically significant (Table 4). Specifically, neighbours' exposure to NTMs is highly significant in the first-stage estimation, confirming the relevance of the proposed instrument and indicating that community-level NTM exposure strongly predicts individual farmer exposure to NTMs.

Second, the instrument must satisfy the exogeneity condition, implying that it should not directly affect cereal profitability except through its influence on individual NTM exposure. To address this concern, the empirical model controls for several farm- and community-level characteristics that could potentially affect profitability directly, including market access, extension services, farmer organizations/cooperatives, technology adoption, and other institutional factors. These controls help minimize the possibility that community-level NTM exposure captures broader development or institutional conditions that independently influence farm profitability.

Furthermore, the theoretical justification for the exclusion restriction is that neighbouring farmers' exposure to NTMs primarily affects an individual farmer through localized information spillovers, learning effects, and market interactions related to NTM compliance rather than directly altering the farmer's profitability outcomes. Conditional on the included controls, the instrument is therefore expected to influence profitability only indirectly through individual exposure to NTMs.

The diagnostic tests for endogeneity and weak instruments are reported in Table 4. The endogeneity test based on the robust regression F-statistic confirms the presence of endogeneity in the NTM variable, thereby justifying the use of the instrumental variable approach. Similarly, the weak instrument diagnostics indicate that the instrument is sufficiently strong, as evidenced by the effective F-statistics exceeding conventional thresholds. Additionally, to assess the robustness of the estimates to potential omitted variable bias, we followed the approaches proposed by Altonji *et al.* (2005) and Oster (2019). These methods quantify the degree of unobserved selection required to fully account for the estimated effects of NTMs on agricultural transaction costs and cereal profitability. The results suggest that the estimated effects remain robust even after accounting for potential omitted variable bias.

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4. Results and discussion

4.1 NTMs, agricultural transaction cost and profit

This section presents the OLS estimate of the empirical link between NTMs, the number of cereal transactions, cereal perishability, NTM compliance costs, and profit, as reported in Table 2. The detailed result is presented in Tables AI and AII in the Supplementary Material. Columns (1), (2), (3), and (4) include explanatory variables and also regional dummy variables to control for macro-level variables, specifically regional variances in prices, access, and type of market, transportation access, and economic empowerment.

Table 2 shows that NTMs are positively associated with the number of cereal transactions. The magnitude of the effect suggests that commercial farmers who incur NTMs undertake about two more cereal transactions than those who do not. This result contrasts with several empirical studies that argue that NTMs hinder trade and increase production costs (Peterson *et al.*, 2013; Dal Bianco *et al.*, 2016; Martey *et al.*, 2023; Onumah *et al.*, 2024). For example, Maziku and Mashenene (2020) found that a unit increase in the cost of non-tariff barriers reduced the quantity of maize produced and supplied in Tanzania by 16%. Similarly, Cho *et al.* (2020) reported that NTMs, particularly sanitary and phytosanitary measures, have negative effects on agricultural trade. However, other studies suggest that NTMs can facilitate trade under certain conditions. For instance, Cardamone (2011) found that NTMs increased trade in fresh grapes and oranges across European countries. Likewise, Djimgou Tchakounte and Fiankor (2021) reported that non-tariff measures increase trade volumes, while Akrong *et al.* (2022) showed that certification increased the quantity sold to high-value markets by 12% among certified farmers. These findings partly support the positive association observed in this study.

The results in column (2) indicate that NTMs are negatively associated with the perishability of cereals. This suggests that commercial cereal farmers who incur NTMs are less likely to experience losses from grain perishability, with a reduction of about 0.121 (12%). This finding is consistent with APEC (2016), which noted that staple commodities such as grains and cereals are widely traded regionally and typically face strict regulatory requirements. Unlike fresh produce, cereals generally have a lower risk of spoilage, which may explain the reduced perishability observed among farmers complying with NTMs.

The results further show that NTMs are positively associated with compliance costs. As shown in column (3), commercial farmers who incur NTMs experience an increase in compliance costs of about GHS 1,810 (USD 247). This finding aligns with APEC (2016) and

Table 2. OLS estimates of NTMs on agricultural transactions cost and profit

Variables	(1) Transactions	(2) Perished	(3) Compliance cost	(4) Profit
Non-tariff measures (1/0)	2.324***	−0.121***	1810.022***	−0.986**
	(0.376)	(0.042)	(315.486)	(0.440)
Controls	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes
Mean (control)	[3.17]	[0.29]	[0.00]	[9.69]
Observations	452	452	452	414
R^2	0.206	0.108	0.266	0.483

Note(s): NTMs are non-tariff measures. Profit is logged. Robust standard errors are in parentheses. The values in brackets are the mean values of the outcomes for commercial 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. ***$p < 0.01$.**$p < 0.05$. Refer to Tables AI and AII in the appendix for the full results

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Fugazza *et al.* (2017), who report that NTM-related costs can be three times higher than tariffs, particularly in agricultural trade. These costs are often disproportionately high for producers and small and medium enterprises. Similarly, Djimgou Tchakounte and Fiankor (2021) found that NTMs increase trade costs, while Martey *et al.* (2023) showed that NTMs raise production and transaction costs, leading to higher household expenditures.

Finally, column (4) shows that NTMs are associated with lower profitability of cereal production. A unit increase in NTMs incurred by commercial farmers reduces profit (log) by 0.986 (167%). This finding is consistent with previous studies suggesting that NTMs impose both fixed and variable compliance costs (Xiong and Beghin, 2014; Crivelli and Gröschl, 2016), which can lower farm profitability. In addition, earlier studies argue that NTMs may hinder trade (Peterson *et al.*, 2013; Dal Bianco *et al.*, 2016). Since NTM-related costs are often significantly higher than tariffs, their burden can be particularly high for producers and small- and medium-sized enterprises (UNCTAD, 2013; Fugazza *et al.*, 2017), thereby reducing profits.

4.2 Unobserved heterogeneity and coefficient stability

The study conducted a coefficient stability test using the methods of Oster (2019) and Altonji *et al.* (2005) to confirm that the research estimates are reliable and robust to the addition of controls. This study follows Oster (2019) to determine whether unobserved heterogeneity could bias estimates, assuming that the relationship between the covariate of interest and unobservables can be recovered from its relationship with observables. In the assessment, firstly, the study assumes that the selection of observables is proportional to the selection of unobservables and the calculated bias-adjusted coefficient values of the effect of NTMs on agricultural transaction cost (the number of cereals transacted in a year, perishability of cereals, and compliance cost associated with these trade measures) and profitability of cereal production. In the subsequent stage, the calculated delta value suggests that the degree of selection on unobservables relative to the observables would be required to explain away the estimated association among NTMs, agricultural transaction costs, and cereal profitability. Per the findings in Table 3, the bias-adjusted coefficients for all the outcome variables are relatively similar in magnitude and sign to the old estimates. The estimated Oster deltas in

Table 3. Check for coefficient stability

	Uncontrolled		Controlled		Bias-adjusted		Oster delta
	(1) Coeff	(2) R^2	(3) Coeff	(4) R^2	(5) Coeff	(6) R^2	(7)
Transactions	2.131***	0.092	2.324***	0.206	2.355***	0.206	6.773***
	(0.358)		(0.376)		(0.351)		(14.963)
Perishable	−0.122***	0.017	−0.121***	0.108	−0.121**	0.120	10.724*
	(0.037)		(0.042)		(0.059)		(25.616)
Compliance	2025.693***	0.208	1810.022***	0.268	1792.106***	0.26	2.343***
	(336.853)		(315.486)		(328.421)		(0.319)
Log profit	−0.580***	0.020	−0.961**	0.484	−1.528**	0.50	−2.934**
	(0.187)		(0.447)		(2.358)		(7.663)

Note(s): 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 the 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. ***$p < 0.01$.**$p < 0.05$

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column (7) of Table 3 indicate that selection on unobservables would have to be 6.8 times the selection on observables to explain away the estimated positive relationship between NTMs and the number of cereals transacted in a year, and statistically significant at a 1% level of significance.

Additionally, for the estimated Oster delta value concerning the perishing of cereal, the findings in column (7) show that selection on unobservables would have to be 10.7 times the selection on observables to describe away the estimated negative association between NTMs and produce getting perished. Furthermore, regarding compliance costs associated with NTMs, the selection of unobservable would have to be 2.3 times that of observables to explain away the estimated positive relationship between NTMs and NTM-related costs. Lastly, the results on the profitability of cereal production show that the selection of unobservable would have to be 2.9 times the selection of observables to account for the estimated negative relationship between NTMs and cereal profitability. Based on the research findings, the estimated results seem robust to unobserved heterogeneity.

4.3 Robustness check–instrumental variable regression (2SLS) result

Although the analysis assumes the exogeneity of NTMs, it remains possible that unobserved factors may correlate with NTMs. The result indicates that the instrument highly correlates with commercial farmers' probability of incurring NTMs. The strength of the instrument is tested using the F-statistic test proposed by Stock and Yogo (2005). The F-value is greater than 10, signifying the instrument is not weakly associated with NTMs (Table 4). Relatively and more generally, the association between NTMs and agriculture transaction costs (number of cereal transactions in a year, perishability of cereal, and compliance cost associated with NTMs) and cereal farming profitability based on the IV estimate is consistent with the result of the OLS model (Table 2). Regarding the magnitude of the effect, the OLS model showed a smaller effect than the IV model, indicating that the OLS result was underestimated (downward bias). Columns 1 and 3 of Table 4 show that commercial farmers who incurred NTMs were associated with increases in the number of cereal transactions and compliance

Table 4. 2SLS estimates of NTMs on agricultural transaction cost and profitability

Variables	(1) Transactions	(2) Perished	(3) Compliance cost	(4) Log profitability
Non-tariff measures (1/0)	2.701***	−0.271***	2532.670***	−1.696***
	(0.607)	(0.089)	(512.562)	(0.510)
Controls				
Household controls	Yes	Yes	Yes	Yes
Institutional controls	Yes	Yes	Yes	Yes
Region fixed effects	Yes	Yes	Yes	Yes
First stage				
Neighbours who incur NTMs	0.900***	0.900***	0.900***	0.727***
	(0.058)	(0.058)	(0.058)	(0.082)
Diagnostic tests				
F-values	240	240	240	78
Robust χ^2	0.652**	4.205**	4.331**	8.168***
Observations	452	452	452	414
R-squared	0.204	0.088	0.246	0.438

Note(s): Robust standard errors are in parentheses. Controls are variables reported in Table 1. ***$p < 0.01$.**$p < 0.05$.*$p < 0.1$. Refer to Table AII in the appendix for the full results

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costs of 2.7 points and GHS 2,533 (USD 346), respectively. In contrast, columns 2 and 4 indicate a 0.27 decrease in produce perishability and a GHS 1,696 (USD 232) reduction in profit (Table 4). The detailed results of Table 4 are presented in Table AIII in the Supplementary Material.

5. Conclusion and policy implications

Several studies have confirmed the importance of agriculture in improving livelihoods and reducing food insecurity in many developing countries. This study focuses on how NTMs affect agricultural transaction costs and the profits of commercial farmers in Ghana. Most empirical work on NTMs focuses on inter-regional trade, with inadequate research on intra-regional trade, particularly within developing countries with high levels of agricultural production and commercialization and high transaction costs. Generally, NTMs are exogenous; commercial farmers incur them when transacting their produce. However, there is limited knowledge about the types of NTMs commercial farmers incur and how they translate into agricultural transaction costs and the profitability of cereal production in Ghana. To achieve the study objective, cross-sectional data were collected from 455 commercial cereal farmers in Ghana. Additionally, NTMs were analyzed from both an extensive (experience with nontariff measures) and an intensive (cost of nontariff measures) perspective.

The results indicate that NTMs are positively associated with increases in the annual volume of cereals transacted and with the costs incurred to comply with these measures. NTMs are negatively associated with reduced perishability of produce and farmers' profits. Additionally, the result is implausible to be driven by unobserved heterogeneity. The positive effect of NTMs on the number of transactions and the negative effect on profit are likely due to the magnitude of the (positive) revenue gain relative to the size of the (negative) costs incurred (compliance costs associated with NTMs).

Following the study's conclusion, we draw three main implications. First, reducing the high costs associated with NTMs is essential to facilitate trade and enhance household profits, potentially leading to improved welfare outcomes; hence, the Ghana Revenue Authority and the Ministry of Trade should simplify customs documentation and adopt risk-based inspections. Reducing unnecessary procedures and checkpoints can lower transaction costs, improve profit margins for commercial cereal farmers, and facilitate both inter-regional and intra-regional trade. Second, to enhance trade efficiency and support economic and food security goals, the focus should be on streamlining customs formalities, particularly customs valuation at checkpoints, which is critical as these checkpoints contribute to high costs and delays in transporting agricultural goods. Reducing the number of customs checkpoints can effectively lower transaction costs and boost both inter-regional and intra-regional trade. Finally, while NTMs are often intended to protect local producers and consumers by ensuring high standards for food production and security, their rigidity may undermine progress toward the SDGs and poverty reduction if not carefully managed. For instance, even though commercial farmers conduct the same number of transactions per season, increased transaction costs due to NTMs erode their profit margins. To address this, the government should prioritize the efficient implementation of NTMs to enhance trade outcomes, thereby benefiting the local economy. To reduce compliance costs and improve adherence to trade standards, the government could adopt strategies such as streamlining domestic regulations, providing clear guidelines, and aligning local standards with international benchmarks where relevant. While this study focuses on domestic trade, harmonization of standards can also facilitate cross-border trade in the future, support SDG-related goals, and enhance overall efficiency and profitability for farmers and other stakeholders in the agricultural sector. By prioritizing both domestic compliance and gradual alignment with international standards, policymakers can ensure that farmers face lower transaction costs while maintaining product quality and safety.

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We acknowledge several limitations in this study. First, although we argue that our measure of NTMs is reasonably exogenous, caution is required when making strong causal inferences given the nature of the NTM construct. The use of cross-sectional data restricts our ability to capture temporal dynamics and fully establish causality between NTMs and the transaction costs faced by producers and traders. Future studies could address this limitation by employing panel data to examine the dynamic effects of NTMs over time and better control for unobserved heterogeneity. In addition, our analysis relies primarily on survey-based measures of compliance costs reported by producers. While this provides valuable micro-level insights, integrating such data with official NTM records from sources such as the UNCTAD database would strengthen the empirical evidence. Combining household or firm-level data with administrative and trade data could therefore help future research provide a more comprehensive assessment of how NTMs influence both domestic production decisions and broader trade outcomes.

Notes

1. A commercial farmer is defined as a cereal producer whose primary objective is market-oriented production rather than household consumption. Specifically, commercial farmers were those who sold a minimum threshold quantity of maize or rice during the survey season, as captured in the ATMA4FS dataset.
2. To assess potential multicollinearity among the explanatory variables used in the study, a Variance Inflation Factor (VIF) test was conducted. Following the rule of thumb, VIF values greater than 10 indicate severe multicollinearity (Gunst, 1984); the results show all variables have VIF values below this threshold. Specifically, the VIF values range from 1.05 to 1.34, with a mean VIF of approximately 1.17, indicating low multicollinearity in the model. The results have been reported in the supplementary material (see Table AIV and Table AV) presents detailed information on total production costs, total revenue, and unlogged profit.

Supplementary material

The supplementary material for this article can be found online.

References

Adaku, A.A., Tsiboe, F. and Clottey, J. (2023), "Taking stock of gender gaps in crop production technology adoption and technical efficiency in Ghana", *Agrekon*, Vol. 62 No. 1, pp. 31-48, doi: 10.1080/03031853.2022.2150664.

Akrong, R., Akorsu, A.D., Jha, P. and Agyenim, J.B. (2022), "Assessing the trade and welfare effects of certification schemes: the case of global GAP in Ghana's mango sector", *Scientific African*, Vol. 18, e01425, doi: 10.1016/j.sciaf.2022.e01425.

Altonji, J.G., Elder, T.E. and Taber, C.R. (2005), "An evaluation of instrumental variable strategies for estimating the effects of catholic schooling", *Journal of Human Resources*, Vol. 40 No. 4, pp. 791-821, doi: 10.3368/jhr.xl.4.791.

Anaglo, N., Boateng, S.D. and Boateng, C.A. (2014), "Gender and access to agricultural resources by smallholder farmers in the Upper West Region of Ghana", *Journal of Education and Practice*, Vol. 5 No. 5, pp. 13-19.

APEC (Asia Pacific Economic Cooperation) (2016), *Non-tariff Barriers in Agriculture and Food Trade in APEC: Business Perspectives on Impacts and Solutions*, APEC Business Advisory Council, Los Angeles, CA, University of Southern California, Marshall School of Business.

Arita, S., Beckman, J. and Mitchell, L. (2017), "Reducing transatlantic barriers on US-EU agri-food trade: what are the possible gains?", *Food Policy*, Vol. 68, pp. 233-247, doi: 10.1016/j.foodpol.2016.12.006.

Balassa, B.J. (1961), *The Theory of Economic Integration*, George Allen & Unwin, London.

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Bandura, A. (1977), "Self-efficacy: toward a unifying theory of behavioral change", *Psychological Review*, Vol. 84 No. 2, pp. 191-215, doi: 10.1037/0033-295x.84.2.191.

Bank of Ghana (2022), "Bank of Ghana Banking sector report", available at: https://www.bog.gov.gh/economic-data/exchange-rate/

Barka, H.B. (2012), "Border posts, checkpoints, and Intra-African trade: challenges and solutions", *OPEV Newsletter*, pp. 1-18.

Cardamone, P. (2011), "The effect of preferential trade agreements on monthly fruit exports to the European union", *European Review of Agricultural Economics*, Vol. 38 No. 4, pp. 553-586, doi: 10.1093/erae/jbq052.

Castelhano, M., Lawell, C.Y.C.L., Sumner, D.A. and Taylor, J.E. (2016), "The effects of migration and remittances on productive investment in rural Mexico", University of California Davis Working Paper.

Cho, S.J., Oh, S. and Lee, S.H. (2020), "The impact of structure similarity of nontariff measures on agricultural trade", *Sustainability*, Vol. 12 No. 24, 10545, doi: 10.3390/su122410545.

Conley, T.G. and Udry, C.R. (2010), "Learning about a new technology: pineapple in Ghana", *The American Economic Review*, Vol. 100 No. 1, pp. 35-69, doi: 10.1257/aer.100.1.35.

Crivelli, P. and Gröschl, J. (2016), "The impact of sanitary and phytosanitary measures on market entry and trade flows", *The World Economy*, Vol. 39 No. 3, pp. 444-473.

Dal Bianco, A., Boatto, V.L., Caracciolo, F. and Santeramo, F.G. (2016), "Tariffs and non-tariff frictions in the world wine trade", *European Review of Agricultural Economics*, Vol. 43 No. 1, pp. 31-57, doi: 10.1093/erae/jbv008.

DaSilva-Glasgow, D. (2020), "Transactions costs perspective of non-tariff barriers to trade: an analysis of food and agricultural exports from Guyana using survey data", *International Trade Journal*, Vol. 34 No. 3, pp. 339-364, doi: 10.1080/08853908.2019.1664354.

Devadason, E.S. and Chenayah, S. (2014), "Proliferation of non-tariff measures in China—their relevance for ASEAN", *Singapore Economic Review*, Vol. 59 No. 2, 1450015, doi: 10.1142/s0217590814500155.

Djimgou Tchakounte, A. and Fiankor, D.D. (2021), "Trade costs and demand-enhancing effects of agri-food standards: consequences for Sub-Saharan Africa", *Journal of African Trade*, Vol. 8 No. 1, pp. 51-64, doi: 10.2991/jat.k.210907.001.

Fernandes, A.M., Ferro, E. and Wilson, J.S. (2019), "Product standards and firms' export decisions", *The World Bank Economic Review*, Vol. 33 No. 2, pp. 353-374, doi: 10.1093/wber/lhw071.

Fiankor, D.D.D., Martínez-Zarzoso, I. and Brümmer, B. (2019), "Exports and governance: the role of private voluntary agri-food standards", *Agricultural Economics*, Vol. 50 No. 3, pp. 341-352, doi: 10.1111/agec.12488.

Foster, A.D. and Rosenzweig, M.R. (1995), "Learning by doing and learning from others: human capital and technical change in agriculture", *Journal of Political Economy*, Vol. 103 No. 6, pp. 1176-1209, doi: 10.1086/601447.

Fugazza, M., Olarreaga, M. and Ugarte, C. (2017), "On the heterogeneous effects of non-tariff measures: panel evidence from Peruvian firms", (No. 77), *United Nations Conference on Trade and Development*.

Gereffi, G., Humphrey, J. and Sturgeon, T. (2005), "The governance of global value chains", *Review of International Political Economy*, Vol. 12 No. 1, pp. 78-104.

Grant, J.H. and Arita, S. (2017), "Sanitary and phyto-sanitary measures: assessment, measurement, and impact", IATRC Commissioned Paper No. 21, available at: https://iatrc.aaec.vt.edu/

Gunst, R.F. (1984), "Comment: toward a balanced assessment of collinearity diagnostics", *The American Statistician*, Vol. 38 No. 2, pp. 79-82, doi: 10.2307/2683238.

Herghelegiu, C. (2018), "The political economy of non-tariff measures", *The World Economy*, Vol. 41 No. 1, pp. 262-286, doi: 10.1111/twec.12582.

Liu, C., Li, Y., Lin, D. and Liu, J. (2019), "Quantifying the effects of non-tariff measures on African agri-food exporters", *Agrekon*, Vol. 58 No. 4, pp. 451-471.

Downloaded from www.emerald.com/jadee/article-pdf/doi/10.1108/JADEE-04-2025-0146/11761333/jadee-04-2025-0146en.pdf by University of Ghana user on 01 September 2026

Martey, E., Etwire, P.M., Suraj, M.M. and Goldsmith, P. (2023), "PICS or poly sack: traders' willingness to invest in storage protection technologies", *Journal of Agriculture and Food Research*, Vol. 14, 100691, doi: 10.1016/j.jafr.2023.100691.

Martey, E., Onumah, E.E., Onumah, J.A. and Fiankor, D.D.D. (2024), "Non-tariff measures and household welfare: evidence from Ghana", *Journal of International Development*, Vol. 36 No. 2, pp. 1150-1169, doi: 10.1002/jid.3859.

Maziku, P. and Mashenene, R. (2020), "Effect of non-tariff barriers on maize production and marketing by smallholder farmers in Tanzania", *Global Business Review*, Vol. 25 No. 1, p. 161, doi: 10.1177/0972150920953545.

Melo, J. and Nicita, A. (2018), "Non-tariff measures: data and analytical tools", in *Non-Tariff Measures: Economic Assessment and Policy Options for Development*, available at: https://drive.google.com/file/d/1VJiZVcFZZ7b_1zEdfvidrkW25rslLR1H/view?usp=sharing

Ministry of Food and Agriculture (MoFA) (2018), "Agriculture in Ghana", Facts and Figures 2018, Statistics, Research and Information Directorate (SRID), Ministry of Food and Agriculture, Accra, Ghana.

Ninh, L.K. (2021), "Economic role of education in agriculture: evidence from rural Vietnam", *Journal of Economics and Development*, Vol. 23 No. 1, pp. 47-58, doi: 10.1108/jed-05-2020-0052.

Onumah, E.E., Martey, E. and Brümmer, B. (2024), "Nontariff measures and production allocation decisions of cereal farmers in Ghana", *Agribusiness*, Vol. 40 No. 4, pp. 749-772, doi: 10.1002/agr.21845.

Oster, E. (2019), "Unobservable selection and coefficient stability: theory and evidence", *Journal of Business and Economic Statistics*, Vol. 37 No. 2, pp. 187-204, doi: 10.1080/07350015.2016.1227711.

Peterson, E., Grant, J., Roberts, D. and Karov, V. (2013), "Evaluating the trade restrictiveness of phytosanitary measures on US fresh fruit and vegetable imports", *American Journal of Agricultural Economics*, Vol. 95 No. 4, pp. 842-858, doi: 10.1093/ajae/aat015.

Santeramo, F.G. and Lamonaca, E. (2019), "The effects of non-tariff measures on agri-food trade: a review and meta-analysis of empirical evidence", *Journal of Agricultural Economics*, Vol. 70 No. 3, pp. 595-617, doi: 10.1111/1477-9552.12316.

Shepherd, B. and Peters, R. (2020), "Brexit beyond tariffs: the role of non-tariff measures and the impact on developing countries", UNCTAD Research Paper No. 42.

Stock, J.H. and Yogo, M. (2005), "Testing for weak instruments in linear IV regression", in Andrews, D.W.K. and Stock, I.H. (Eds), *Identification and Inference for Econometric Models: Essays in Honor of Thomas J R Othenberg*, Cambridge University Press.

Subervie, J. and Vagneron, I. (2013), "A drop of water in the Indian Ocean? The impact of GlobalGap certification on lychee farmers in Madagascar", *World Development*, Vol. 50, pp. 57-73, doi: 10.1016/j.worlddev.2013.05.002.

Swinnen, J. (2016), "Economics and politics of food standards, trade, and development", *Agricultural Economics*, Vol. 47 No. S1, pp. 7-19, doi: 10.1111/agec.12316.

Umberger, W.J., He, X., Minot, N. and Toiba, H. (2015), "Examining the relationship between the use of supermarkets and over-nutrition in Indonesia", *American Journal of Agricultural Economics*, Vol. 97 No. 2, pp. 510-525, doi: 10.1093/ajae/aau111.

UNCTAD (2012), "International classification of non-tariff measures", available at: https://unctad.org/en/Pages/DITC/Trade-Analysis/Non-Tariff-Measures/NTMs-Classification.asp

UNCTAD (2013), *United Nations Conference on Trade and Development. Non-tariff Measures to Trade: Economic and Policy Issues for Developing Countries*, Geneva, available at: http://unctad.org/en/PublicationsLibrary/ditctab20121_en.pdf

UNCTAD and World Bank (2018), *The Unseen Impact of Non-tariff Measures: Insights from a New Database (UNCTAD/DITC/TAB/2018/2)*, United Nations and World Bank Group, New York and Washington, DC.

Urgessa, T. (2015), "The determinants of agricultural productivity and rural household income in Ethiopia", *Ethiopian Journal of Economics*, Vol. 24 No. 2, pp. 63-91.

Downloaded from www.emerald.com/jadee/article-pdf/doi/10.1108/JADEE-04-2025-0146/11761333/jadee-04-2025-0146en.pdf by University of Ghana user on 01 September 2026

Webb, M., Strutt, A., Gibson, J. and Walmsley, T. (2020), "Modelling the impact of non-tariff measures on supply chains in ASEAN", *The World Economy*, Vol. 43 No. 8, pp. 2172-2198, doi: 10.1111/twec.12955.

Williamson, O.E. (1973), "Markets and hierarchies: some elementary considerations", *The American Economic Review*, Vol. 63 No. 2, pp. 316-325, available at: https://www.jstor.org/stable/1817092

Xiong, B. and Beghin, J. (2014), "Disentangling demand-enhancing and trade-cost effects of maximum residue regulations", *Economic Inquiry*, Vol. 52 No. 3, pp. 1190-1203, doi: 10.1111/ecin.12082.

Yamane, T. (1967), "An introductory analysis", in *Statistics*, 2nd ed., Harper & Row.

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