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PRICING-SUPPLY CHAIN ISSUES OF STAPLE FOOD CROPS IN RURAL-URBAN TANZANIA

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Abstract:
The current study explores the effect of supply chain issues (SCIs) on the market prices of staple food crops in rural-urban Tanzania using a cross-sectional questionnaire survey and simple random sampling. Data were sourced from 313 farmers and traders of staple food crops from five regions in rural and urban markets within Tanzania. Exploratory factor analysis (EFA) and marginal effect based on a binary logit model were used for data analysis. The results revealed that SCIs do not offer an equal and uniform effect on market prices of staple food crops. Specifically, deficient SC infrastructure, inflated farming costs, SC and logistics costs and an indirect distribution strategy demonstrated a significant positive effect on market prices of staple food crops. Conversely, intensive competition within agricultural SC and the bullwhip effect had a significantly negative influence. Towards stabilizing the market prices of staple food crops, the authors recommend centralizing market demand and supply information among farmers and traders, thereby eliminating the use of intermediaries by establishing and joining farmers' associations and cooperative societies. Also, to make transportation and distribution of staple food crops easier and more cost-effective, local governments should take streamlined measures to improve road conditions, especially in rural areas where farming mostly takes place. While previous studies address the causes of fluctuation in market prices of agricultural products from climatic, economic and legal perspectives, this study contributes to a better understanding of the causes of variations in market prices of staple food crops from SC perspective in rural-urban Tanzania.

Keywords:
Agricultural supply chain, supply chain issues, staple food crops, market prices.

JEL Codes:
E31, Q02, Q11, Q14, Q21.

1. Introduction

In today's era, staple food crops offer several business opportunities similar to cash crops across rural, urban and regional markets (Mgale and Yunxian, 2021; FAO, 2022). This is because they are essential food crops with assured demand necessary for life. Consequently, farmers and traders alike have been concentrating on the production and marketing of both cash crops and staple food crops, capitalizing on their trade opportunities. Besides their lucrative business prospects, staple food crops and the agricultural sector at large ensure food security for societies, create employment opportunities and make significant contributions to GDP (Mesic et al., 2018; Tuomala and Grant, 2022). In Tanzania, for instance, the agricultural sector accounts for approximately 25.89% of the GDP (URT, 2021), ranking third among the country's most vital economic sectors, preceding the service sector (34.34%) and the industrial sector (29.28%). Nevertheless, approximately 75% of the nation's population depends on agriculture to generate income, support their livelihoods and ensure food security (FAO, 2022; URT, 2021). Rural and urban communities alike benefit from a diverse array of agricultural activities, encompassing both farming and the marketing of staple food crops.

The national sample census of agriculture identifies millets, maize, wheat, rice and sorghum as the staple food crops predominantly cultivated and marketed in rural-urban Tanzania (URT, 2021). Maize leads the category, accounting for 62.6% of all staple food crops in production volume, followed by rice (21.6%), pulses (15.1%) and wheat (0.7%). The trends in the production and marketing of staple food crops fluctuate over time, varying from season to season due to several factors. For instance, in 2018/19, the total production of staple food crops was 10.76 million tonnes, decreasing to 9.3 million tonnes in 2019/2020 (URT, 2021). Experience indicates that the production and marketing of staple food crops are primarily managed by smallholder farmers who rely mainly on rainfall for irrigation. Approximately 99.6% of staple food producers are smallholder farmers who own an average of 1-5 acres of land for agricultural activities (Mchopa et al., 2020; FAO, 2022). Studies by Huka et al. (2014) have reported adverse weather conditions and biological factors such as drought, floods and pests as contributors that adversely affect the production and supply of staple food crops. Conversely, factors such as favourable climatic conditions with reliable rainfall, soil and seed quality, streamlined post-harvest management strategies and improved farming equipment like machinery and fertilizer favour agricultural production, leading to increased supplies of staple food crops (Assefa et al., 2016; Xie and Wang, 2017; Tshikororo, 2022).

The other major issue facing the production and marketing of staple food crops in rural and urban areas is the phenomenon of fluctuation in market prices of agricultural commodities. Experiences reveal that market prices of staple food crops have never been stable; they keep fluctuating (increasing or decreasing) over time due to one or more reasons (Ghazaryan et al., 2018; Maziku, 2019a; Mgale and Yunxian, 2021). Principally, the market prices of staple food crops vary on average from 9% to 68.85% per annum (European Commission, 2022). The ultimate impact of fluctuation in the market prices of staple food crops affects all agricultural tiers. For example, farmers' decisions regarding what to produce depend on the market price. More specifically, low market prices of staple food crops affect farmers' income and discourage on-farm investments. This results in scarcity of staple foods in rural-urban areas, leading to abrupt hikes in market prices (Mgale and Yunxian, 2021; Kumari et al., 2023; Assefa et al., 2016).

On the other hand, the trends and variations in market prices of staple food crops are shaped by several factors, ranging from legal policies to economic and climatic perspectives. Samuel (2020) and Huka et al. (2014) revealed the significant role of macroeconomic factors such as currency exchange rates and inflation in shaping the market prices of staple food crops. Moreover, tariffs and non-tariff barriers such as import duties, quotas and total bans have been commonly used by European countries to control imports and market prices of agricultural products. For example, the economic partnership agreement relieves import duties for agro-food products between the EU and Japan, thus making imports and prices relatively cheaper (OECD, 2020). However, in some contexts, import and export control policies create scarcity in imported staple food crops, thereby increasing import costs and market prices (Maziku, 2019a). Farmer financial support and customer market price subsidies through the removal of tax levies are the most important agricultural programs on the African continent aimed at controlling the market prices of agricultural products. Moreover, the common boundaries for the Southern African Customs Union (SACU) are South Africa's primary method of maintaining stable prices for agricultural products (Chidede, 2018). In their studies, Ghazaryan et al. (2018) and Samuel (2020) extend the causes of fluctuation in the market price of staple food crops to adverse weather conditions.

Generally, staple food crops are grown in rural areas and transported to urban areas where lucrative markets are based. To fully exploit the trade opportunities enriched in staple food crops, the marketing of staple food crops requires efficient SC designs, coordination, systems and infrastructures (Badraoui et al., 2022; Saikouk et al., 2021). It is believed that how staple food crops are transported from the farm to the market areas has a significant effect on market prices (Headrick et al., 2020; Mesic et al., 2018). As part of these arguments, experiences show that China, Myanmar and South Africa have achieved better and stable market prices for agricultural products among smallholder farmers due to well-streamlined SC systems encompassing distribution channels, proper coordination, networking, improved SC infrastructures and better-quality products (Chidede, 2018; Kyaw et al., 2018; Matsane and Oyekale, 2014; Zhang et al., 2019). The situation is similar in Kenya, Ethiopia and Mali, where dairy, coffee and cotton farmers have experienced sustainable farming, distribution, marketing and better market prices through collaborative SC systems (Bolton, 2019; Mojo et al., 2015). From Tanzania's context, there is limited knowledge of what and how the SCIs affect the market prices of staple food crops. Prior studies examine the determinants of the market price of agricultural products from legal, macroeconomic factors and climatic perspectives (Maziku et al., 2015; Maziku, 2019b; Huka et al., 2014; Misaki et al., 2018). This study provides more insight into the determinants of market prices of staple food crops in rural-urban Tanzania from a SC perspective.

2. Literature Review

2.1. An overview of the determinants of the market prices of staple food crops

There is a stream of literature that assesses the determinants of the market prices of agricultural products from various perspectives. The market price is generally considered as the current price (price level) expressed in terms of the value at which products are bought or sold in a particular market (Borychowski and Czyżewski, 2015; FAO, 2022). Two basic concepts of variations in the concept of market prices exist, which are defined depending on the prevailing level of price at a particular time or season. These are the price ceiling (the maximum permitted market price level) and price flooring (the minimum permitted market price level). Studies reveal that market prices of staple food crops fluctuate over time due to several reasons. Studies connect the trends and fluctuations in market prices of staple food crops with the market forces of demand and supply (Nigatu et al., 2022; Abodi et al., 2021). From this perspective, the level of the market price is determined at a point in time when the quantity of staple food crops supplied to the market is equal to the quantity demanded (Ghazaryan et al., 2018). If the demand for staple food crops rises but supply does not keep pace, the prices will rise. When there is plenty of supply of staple food crops compared to the actual demand, market prices tend to decrease.

Moreover, studies by Maziku (2019b) in Tanzania and Mesic et al. (2018) in Croatia have identified variations in weather conditions as one of the prime factors affecting the supply, availability and market prices of staple food crops. Adverse weather conditions result in increased market prices of agricultural products, while good climatic conditions result in the opposite effect. Adverse weather conditions, such as floods and droughts harm agricultural production, thus creating a deficit in the supply of staple food crops. Subsequently, this deficit in supply results in rises in the market prices of staple food crops (Huka et al., 2014; Abodi et al., 2021; Tshikororo, 2022). On the other hand, good climatic conditions with adequate rainfall encourage farmers to produce more, leading to plenty of availability of staple food crops at relatively low market prices (Samuel, 2020; Piabuo et al., 2020). In their study, Wang et al. (2022) further reported that the market price of staple food crops is also shaped by the nature of the product itself. The market price for seasonal products is usually high during shortages and relatively low during peak seasons.

The other annotated issue determining the market price of staple food crops is the government's price control policy. These policies include legal minimum (floor) and maximum (ceiling) prices, which are occasionally set by governments to control the price of particular commodities or services (FAO, 2022; Dastagiri and Sindhuja, 2020). In some cases, prices for agricultural products are capped by government policies. The ceiling price aims at protecting consumers from inflation, while the floor price aims at protecting producers from deflation (Khan, 2022). From an economic perspective, Maziku (2019a) and Nigatu et al. (2022) mention currency exchange rates and inflation as non-tariff issues that shape the market prices of agricultural products. A weaker domestic currency to foreign currencies implies high prices and costs for foreign imported products, while a stronger domestic currency results in low prices of imported goods. Studies also note higher prices for agricultural inputs as one of the drivers of market prices of staple food crops. Higher costs for agricultural inputs result in higher farming costs and ultimately lead to increases in market prices of staple food crops (Mgale and Yunxian, 2021; Sadiq et al., 2022). Regarding inflation, experience shows that inflation increases transportation costs when products are moved from the farm to the market areas, which in turn adversely affects market prices of agricultural products (Zhang et al., 2019; Piabuo et al., 2020).

2.2. Supply chain issues in marketing of staple food crops

A SC is a network of individuals or companies linked through upstream and downstream activities that facilitate the movement of goods, funds and information from input suppliers to end users (Zhang et al., 2021; Israel, 2022). From agricultural and marketing perspectives, this study defines a SC as a network of interconnected activities involved in moving agricultural products from farm areas to market areas. The key actors along the SC of agricultural products are input suppliers, farmers, distributors, retailers and customers. The agricultural SC is connected by several activities, systems, designs and processes that determine how agricultural products are distributed from farms to market areas. For example, distribution strategies (direct or indirect channels), transportation modes and the number of intermediaries involved in moving agricultural products from farms to market areas are important issues in the SC of staple food crops. Moreover, coordination and networking among agricultural multi-tiers, demand and supply forecasts and SC infrastructure such as road conditions and distances are also significant factors in the SC and marketing of staple food crops (Borychowski and Czyżewski, 2015; Ghazaryan et al., 2018). Table 1 summarizes the SCIs that affect market prices of staple food crops extracted from reviewed literature.

Table 1. Summary of SCIs affecting the market price of staple food crops

Factors	Related issues	Supporting references
SC and logistics costs	• Transportation costs • Storage costs • Marketing costs	Ghazaryan et al. (2018), Eriksson et al. (2022) and Mwenda et al. (2023).
Competition within SC	• Increases or decreases in supplies • Increased or decreased demand • Number of producers/traders • Price of substitute products • Quality of staple food crops	Sadiq et al. (2022), Abodi et al. (2021) and Wang et al. (2022).
Farming costs	• Cost of agricultural inputs • Costs of labours • Cost of land rental	Dastagiri and Bhavigna (2019) and Ghazaryan et al. (2018).
Marketing and distribution strategy	• Indirect distribution channel • Direct distribution channel • Number of intermediaries	Nwafor (2021), Zhang et al. (2019) and Israel et al. (2022).
The bullwhip effect	• Networking and collaboration • Asymmetry of demand information • Asymmetry of supply information • Demand and supply forecasts	Adnan and Ozelkan (2019), Piabuo et al. (2020) and Saikouk et al. (2021)
SC infrastructure	• Distance from the farm to the markets • Road conditions • Storage facilities	Changalima and Ismail (2022). Ghazaryan et al. (2018) and Samuel (2020).

Efficient SC systems, designs and processes enhance the timely delivery of the right quality and quantities of staple food crops to the markets at a cost-effective. Conversely, deficient SC designs, systems and infrastructures may cause an abrupt rise in freight costs and the market price of staple food crops (Maziku, 2019a; Eriksson et al., 2022; Samuel, 2020). Therefore, SCIs are crucial in justifying the market prices of staple food crops. This is because SCIs mediate and enhance the availability of agricultural inputs, production, processing, marketing, distribution, storage and handling processes of staple food crops. However, the effect of SCIs on the market prices of staple food crops, particularly in rural-urban Tanzania has not been adequately explored. Discussion from the previous studies is centred on agricultural SC challenges (Changalima and Ismail, 2022; Misaki et al., 2018) and determinants of the market prices of agricultural products from legal, climatic and economic perspectives (Huka et al., 2014; Maziku, 2019b; Samuel, 2020). The influence of SCIs on the market price of staple food crops has been neglected. It is from this research gap, that this study explores the SCIs that affect the market price of staple food in rural-urban Tanzania. In line with the literature review conducted, the following hypotheses were formulated: -

H1. SC and logistics costs have a positive effect on market prices of staple food crops
H2. Competition within SC has a positive effect on market prices of staple food crops
H3. Farming costs have a positive effect on market prices of staple food crops

H4. Distribution strategies have a positive effect on market prices of staple food crops
H5. The bullwhip effect has a positive effect on market prices of staple food crops
H6. SC infrastructure has a positive effect on market prices of staple food crops

2.3. The conceptual framework
Figure 1 is the conceptual framework of this study which demonstrates the relationships between SCIs and market prices of staple food crops in rural-urban Tanzania. The framework was developed based on a literature review conducted and the six hypotheses formulated. The conceptual framework portrays and hypothesises that SCIs (H1, H2, H3, H4, H5 and H6) have a positive effect on market prices of staple food crops.

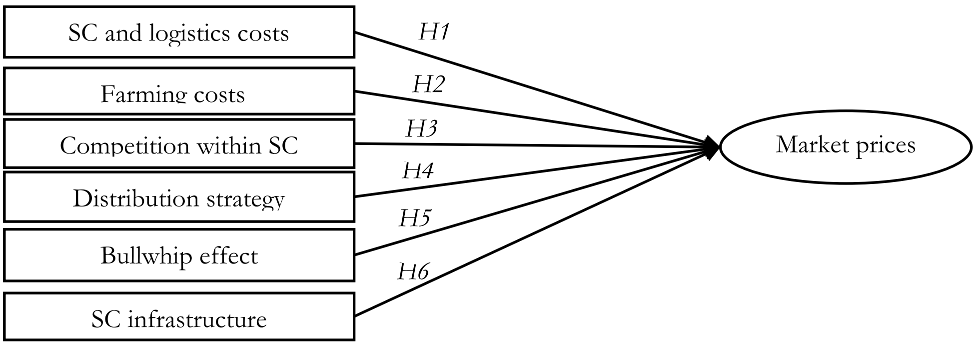

Figure 1. Research model and hypotheses

3. Methods and Data

3.1. Research design and study area
A quantitative research approach and cross-sectional research design were used for this study. According to Saunders et al. (2019), the quantitative research approach is specifically deployed when researchers seek to establish and gain more insight into the relationships between study variables. The current study was conducted to investigate the relationships between SCIs and market prices of staple food crops in rural-urban Tanzania, thus forming the basis for a quantitative research design. Additionally, a cross-sectional research design aligns well with this study because the authors sought to establish a causal relationship between the study variables at a single point in time (Saunders et al., 2019). The study was carried out in Dodoma, Morogoro, Mbeya, Songwe and Tabora regions within Tanzania. These areas were selected based on the fact that the regions are potential producers of a variety of staple food crops and offer wide availability of the same in the markets throughout the year (URT, 2021).

3.2. Sampling and sample size
The target population for this study comprised farmers and traders (distributors and retailers) of staple food crops in rural-urban markets across the selected five regions. Since establishing the total number of the target population in the study areas was difficult, we employed Cochran's (1977) formula for infinite population to estimate a sample size of 385 farmers and traders at a 5% confidence level. Respondents were sampled proportionally from each region using a simple random approach. Farmers were sampled in rural areas where the farming of staple food crops takes place, while traders were sampled from both rural and urban markets where staple food crops are commonly sold. The staple food crops selected for analysis included sorghum, millet, wheat, maize and rice. These are major food crops for most populations in Tanzania (URT, 2021), thus providing the basis for their selection in this study. Table 2 presents a summary of descriptive statistics for the sampled staple food crops and SC-related issues. Among other findings, the analysis reveals that the market prices of staple food crops fluctuate over time due to one or more SCIs. For instance, the market price for maize fluctuated by 1.51%, from Tsh. 47.8 to Tsh. 120.2, within a period of six months.

3.3. Data collection

To leverage the cost-effectiveness based on the geographical diversity of the study areas, a cross-sectional questionnaire survey containing a set of closed questions was used for data collection. Questionnaires were circulated to the target respondents through a drop-off and pick-up later approach. Initially, questionnaires were distributed to 385 respondents. However, due to a non-response rate, only 81.3% (n = 313) were returned and found useful for final analysis. Data collection lasted for a period of six months, encompassing three months before the start of the season and three months after the start of the season, to ensure uniformity in data collection and capture trends in market prices of staple food crops. The two data collection periods were from March to May 2023, which is before the start of the season, and from June to August 2023, which marks the start of the season. Information about distribution strategy, distance from the farm to market areas, transport and logistics costs, the efficacy of transport infrastructure, networking and collaboration among farmers and traders were sought from respondents to establish their effect on market prices of staple food crops. With a quantitative research approach and cross-sectional research design, the authors managed to explore how SCIs drive the market prices of staple food crops within a short period.

Table 2: Descriptive statistics for sampled staple food crops

Characteristics	Sorghum	Millet	Wheat	Maize	Rice
Distance - farm to the markets (Km)	187.40	197.5	176.8	138.6	209.5
Production volume (Tons "000"/year)	601	148	93	6,536	3,380
Transportation costs (Tsh "000" /ton)	10	10	10	10	10
Group category (% of total observations):					
• Farmers	14.70	13.10	14.70	12.46	11.18
• Distributors	31.31	26.52	25.88	27.80	28.43
• Retailers	53.99	60.38	59.42	59.74	60.38
Market areas (% of total observations):					
• Dodoma	20.13	19.81	19.17	18.53	18.85
• Morogoro	20.77	20.45	19.49	19.17	18.21
• Mbeya	19.81	20.13	20.77	21.09	21.41
• Songwe	19.81	19.81	20.45	20.45	20.45
• Tabora	19.49	19.81	20.13	20.77	21.09
Marketing and distribution strategy (% of total observations):					
• Direct channel	15.02	17.57	21.41	18.21	23.64
• Indirect channel	84.98	82.43	78.59	81.79	76.36
Extent of networking (% of total observations):					
• Good	39.62	40.58	43.77	42.49	41.53
• Poor	60.38	59.42	56.23	57.51	58.47
Level of price (Tsh "000" per Kg):					
Minimum	65.0	157.5	70.0	47.8	152.5
Maximum	145.0	185.0	115.0	120.2	235.0
Average price per year	104.8	168.7	93.03	84.1	198.5

3.4. Measurements, validity and reliability

The constructs of SCIs used in this study were adopted from previous literature (Ghazaryan et al., 2018; Wang et al., 2022; Nwafor, 2021; Mahuwi and Israel, 2023). Zhang et al., 2019; Siwandeti et al. 2023). The constructs include SC and logistics costs, the extent of competition within SC, farming costs, marketing and distribution strategy, the bullwhip effect and SC infrastructure. Four constructs out of six were measured by three items each (see Table 4). The remaining two constructs, marketing and distribution strategy were measured by two items, while the bullwhip effect was measured by four items. Each item was measured using a 5-point Likert scale ranging from "1 = not at all" to "5 = very great extent" to ascertain the extent to which SCIs affect market prices of staple food. Before data collection, a pilot study was carried out to confirm the content validity of the research questionnaires. A total of 21 questionnaires were issued to farmers, distributors and retailers of staple food crops who were not part of the study population to assess the content validity using a test-retest approach. Questions were asked three times in different approaches within six days to validate whether they elicited the same response. Changes were reworded appropriately to suit the study objectives. On the other hand, Cronbach's alpha (α) was used to assess the internal reliability of the research questionnaires. According to Hair et al. (2020), the internal reliability of research tools is attained provided that the constructs have Cronbach's alpha values ≥ 0.70 (Nawi et al., 2020).

3.5. Data analysis approach

Exploratory factor analysis (EFA) based on principal component analysis (PCA) was used to scale out the most apparent SCIs that affect market prices of staple food crops before they were subjected to statistical analysis to determine the level of significance. Factor loading for each variable was extracted by running PCA using Varimax rotation with Kaiser Normalization. The rule of thumb for PCA with varimax rotation is that factor loading should be ≥ 0.7 (Nawi et al., 2020). Items with factor loading below 0.7 should be removed from the final analysis because they reveal weak contributions. Before conducting factor analysis, the Kaiser-Mayer-Olkin (KMO) measure of sampling adequacy and Bartlett's test for sphericity were carried out. According to Hair et al. (2020), the probability associated with Bartlett's test for sphericity should be less than the selected critical value ($p < 0.05$). Moreover, sampling adequacy is confirmed when the value of KMO is ≥ 0.5 (Field, 2013). Based on factor loadings obtained from EFA, we scaled out one variable for each SCI. Finally, marginal effect analysis based on the binary logit model was conducted to ascertain the relative effect of supply chain factors on market prices of staple food crops. The marginal effect tells the likely effects of predictor variables on the outcome variable. The binary logit model is one of the regression models in which the outcome variable is considered dichotomous with values between 0 and 1 (Gujarati 2004). In this study, the outcome variable was captured as the trend of market prices of staple food crops and was measured by dichotomous style as follows: -

$$Y_i = \begin{cases} 1 = \text{ if market prices have changed} \\ 0 = \text{ if market prices have remained constant} \end{cases} \dots\dots\dots\dots\dots\dots 1$$

According to Gujarati (2004), the logit model guarantees the estimation of probabilities and marginal effects that are not linearly related to predictor variables. With the logit model, it is more convenient and easier to capture estimations compared to the linear probability model. In this study, a logit model was deployed to examine the effect of SCIs on market prices of staple food crops. The logit model used in this study is given by: -

$$Logit[p(Yi)] = \log\left[\frac{p(y)}{1-p(y)}\right] = \beta_0 + \beta_1 x_1 + \dots.\beta_6 x_6 + e \dots\dots.2$$

Table 3. Definition of variables and unit of measurement

Variable	Unit of measurement
Dependent Variable: Market prices	Binary response: 1 = if market prices have changed, 0 = if market prices have remained constant
Independent Variables:	
X1 SC and logistics costs (Cost in Tsh for moving 100kgs of staple crops to the market)	
X2 Extent of competition within SC (number of farmers or traders)	
X3 Farming costs (estimated farming costs per acre)	
X4 Marketing and distribution strategy (1 = direct channel, 0 = indirect channel)	
X5 The bullwhip effect (1 = if farmers and traders collaborate, 0 = otherwise)	
X6 SC infrastructure (1 = if conducive, 0 = otherwise)	

The marginal effect of the SCIs affecting market prices of staple food crops which was estimated based on binary logit model is expressed in equation 3. Based on equation 3, β_1 is the parameters estimates from the binary logit model for the i^th^ factor. P_1 is the estimated marginal effect of SCIs on market prices of staple food crops.

$$\frac{dy}{dx} = \beta_1\{P(1 - P_1) \qquad (3)$$

4. Findings and Discussion

4.1. The EFA for study constructs and model fit indices

The data analysis in this study was conducted in two main steps. In the first step, EFA was performed to examine the data structure underlying dimensions of SCIs. Factor loadings for the items of the construct (see Table 4) ranged between 0.7028 and 0.8919, all falling within the recommended threshold of 0.7 (Nawi et al., 2020; Field, 2009). A KMO measure of sampling adequacy of 0.758 and Bartlett's test of sphericity was significant ($p = 0.003 < 0.05$), indicating sufficient sampling adequacy and appropriateness of the constructs for further statistical analysis. Furthermore, the analysis revealed the attainment of internal consistency of research tools, where Cronbach's alpha for each construct was above the recommended threshold of 0.7 (Hair et al., 2020). Besides, the model fit indices (see Table 5) indicate a $\chi 2$ value of 0.0000 for each staple food crop. The LR chi2 values were 42.61 for sorghum, 47.39 for millet, 39.45 for wheat, 44.88 for maize and 48.26 for rice. Pseudo R2 values of 0.556 for sorghum, 0.5018 for millet, 0.4815 for wheat, 0.5192 for maize and 0.4509 for rice were obtained. The Log-likelihood values were -68.7658 for sorghum, -61.1276 for millet, -55.4981 for wheat, -73.0057 for maize and -57.7525 for rice. Importantly, the study confirmed that multicollinearity was not a serious problem among the variables in the model, with an average VIF of 2.0440. These analyses reveal that the model fits well with the data, and the adopted SCIs explain variations in market prices of staple food crops.

Table 4. Exploratory factor analysis and Cronbach's alpha results

Constructs and items	Code	Loadings	Cronbach's alpha
Supply chain and logistics costs (SCLC)			0.8743
• Transportation costs	SCLC1	0.8772	
• Storage costs	SCLC2	0.7028	
• Marketing costs	SCLC3	0.8127	
Competition within supply chains (CPSC)			0.7663
• Number of producers/traders	CPSC1	0.8766	
• Price of substitute products	CPSC2	0.7685	
• Quality of staple food crops	CPSC3	0.7863	
Farming costs (FCST)		0.8745	0.7015
• Cost of agricultural inputs	FCST1	0.7677	
• Costs of labours	FCST2	0.7291	
• Cost of land rental	FCST3	0.7605	
Marketing and distribution strategy (MKDS)			0.8023
• Indirect distribution channel	MKDS1	0.8738	
• Direct distribution channel	MKDS2	0.8738	
The bullwhip effect (BUEF)			0.7338
• Networking and collaboration	BUEF1	0.7883	
• Asymmetry of demand information	BUEF2	0.7358	
• Asymmetry of supply information	BUEF3	0.8919	

• Accuracy of demand and supply forecasts	BUEF4	0.7837	
Supply chain infrastructure (SCIF)			0.7365
• Distance from the farm to the markets	SCIF1	0.7235	
• Road conditions	SCIF2	0.8145	
• Storage facilities	SCIF3	0.8806	

4.2. SCIs and market prices of staple food crops

Table 5 presents the parameter estimates of the binary logit model, indicating the direction (positive or negative) of the hypothesized relationship between the predictor variables (SCIs) and the outcome variable (market prices). SC and logistics costs, farming costs, marketing and distribution strategy and SC infrastructure demonstrated a significant positive effect on market prices. Conversely, the bullwhip effect and intensive competition between agricultural supply chains revealed a significant negative effect on the market prices of staple food crops. Therefore, the adopted SCIs are considered both negative and positive predictors of market prices of staple food crops from a supply chain perspective. Since it is difficult to establish the extent of the effect of predictor variables on the outcome variable using parameter estimates, we utilized the average marginal effects (Table 6) to estimate the effect of SCIs on market prices of staple food crops. The average marginal effects provide insight into the likely effects of predictor variables on the outcome variable (Gujarati, 2004).

Table 5: Parameter estimates for SC factors affecting market prices of staple food crops

Constructs	Coefficients					VIF
	Sorghum	Millet	Wheat	Maize	Rice	
SCLC	2.0845* (0.0483)	1.0534* (0.0912)	0.9478* (0.0762)	1.2005* (0.0532)	3.0115* (0.0828)	2.9005
CPSC	-0.5402** (0.0725)	-0.5970** (0.0653)	-1.1984** (0.0536)	-0.7974** (0.0804)	-0.9137** (0.0538)	1.9212
FCST	2.1407*** (0.0817)	1.0934*** (0.0498)	1.2570*** (0.0639)	1.0476*** (0.0467)	1.7186*** (0.0590)	2.3623
MKDS	0.9151** (0.0194)	0.5753** (0.0356)	1.0946** (0.0465)	0.7653** (0.0386)	0.8002** (0.0396)	2.1920
BUEF	-3.1503* (0.0428)	-0.8518* (0.0603)	-2.0763* (0.0509)	-1.3105* (0.0902)	-4.3067* (0.0925)	1.0006
SCIF	2.1202*** (0.0915)	1.0985*** (0.0705)	0.9225*** (0.0863)	1.3659*** (0.0508)	2.0183*** (0.0728)	1.8873
Constant	1.1853* (0.0496)	1.2050* (0.0901)	0.5783* (0.0763)	1.2650* (0.0613)	1.2359* (0.0714)	
Model fit indices:						
$\chi 2$	0.0000	0.0000	0.0000	0.0000	0.0000	
LR chi2 (6)	42.61	47.39	39.45	44.88	48.26	
Pseudo R^2	0.556	0.5018	0.4815	0.5192	0.4509	
Log-likelihood	-68.7658	-61.1276	-55.4981	-73.0057	-57.7525	

Log-likelihood -68.7658 -61.1276 -55.4981 -73.0057 -57.7525

Legends: *, **, *** Donates statistical significance level at $p < 0.1$; $p < 0.05$ and $p < 0.01$ respectively. Standard errors are in parentheses; Average VIF = 2.0440.

4.2.1. Supply chain, logistics costs and market prices

The results presented in Table 6 indicate that SC and logistics costs are positive and significant predictors of market prices of staple food crops with $p < 0.05$. The results support H1, which posits that SC and logistics costs have a positive effect on market prices of staple food crops. These findings suggest that a one-unit increase in SC and logistics costs leads to respective increases in market prices: sorghum by 17.46%, millet by 20.15%, wheat by 18.27%, maize by 15.65% and rice by 22.18%. This could be attributed to the high storage, marketing, and transportation costs involved in moving staple food crops from the farm to the market areas. When SC and logistics costs are substantially high, they can contribute significantly to increases in the market prices of staple food crops. These findings align with Samuel's (2020), Nwoko et al.'s (2016), and Maziku et al.'s (2015) findings, which also revealed a positive influence of SC and logistics costs on the market price of staple food crops in Nigeria and Tanzania. Conversely, low SC and logistics costs result in lower market prices of staple food crops (Wang et al., 2022; Asibey et al., 2019).

4.2.2. Competition within supply chains and market prices

The extent of competition within the SC was assessed based on factors such as the number of farmers or traders of the sampled staple food crops, the quality of staple food crops and the prices for substitute commodities. The findings of this study revealed a significant negative effect of intensive competition within the SC on market prices of the sampled staple food crops ($p < 0.1$). Therefore, we failed to accept H2, which asserted that competition within the SC has a positive effect on market prices of staple food crops. The findings indicate that intensive competition within agricultural SC fosters decreases in market prices of staple food crops by 34.64% for sorghum, 10.27% for millet, 17.38% for wheat, 31.76% for maize and 8.17% for rice. Consistent with these findings, prior studies reveal that the presence of many farmers and traders and adequate availability of substitute products foster the production and supply of staple food crops, thus leading to decreases in market prices (Asibey et al., 2019; Mesic et al., 2018). However, fewer farmers and traders of staple food crops with inadequate availability of substitute crops create shortages and high demand, which exceed supply, thereby leading to increases in market prices (Borychowski and Czyżewski, 2015). Additionally, better-quality staple food crops tend to be sold at relatively higher prices compared to low-quality staple food crops.

4.2.3. Farming costs and market prices

The study's third hypothesis (H3) proposed that farming costs have a positive effect on market prices of staple food crops. Results presented in Table 6 demonstrate that farming costs are positively and significantly associated with market prices of staple food crops ($p < 0.01$). Therefore, H3 was accepted. The findings suggest that a unit increase in farming costs is more likely to inflate the market prices of sorghum by 24.98%, millet by 19.22%, wheat by 12.38%, maize by 17.75% and rice by 23.19%. In particular, the production of staple food crops is associated with several costs, including input costs, labour costs and land rental. Increased farming costs lead to higher market prices of staple food crops, while low farming costs have the opposite effect. This is because farmers aim to sustain themselves and set the prices of staple food crops to cover the costs incurred in production while achieving some profit margin. These findings are consistent with those of Ghazaryan et al. (2018) and Mgale and Yunxian (2021), who asserted that the market price of agricultural commodities is determined by the total farming costs incurred at the farm level.

Table 6. Marginal effects for supply SC factors affecting market prices of staple food crops

Constructs	Marginal effects (dy/dx)					Remarks
	Sorghum	Millet	Wheat	Maize	Rice	
H1: SCLC→ MP	0.174** (0.015)	0.201** (0.009)	0.182** (0.009)	0.156** (0.017)	0.221** (0.013)	Accepted
H2: CPSC→ MP	-0.346* (0.024)	-0.102* (0.015)	-0.173* (0.017)	-0.317* (0.039)	-0.081* (0.048)	Accepted
H3: FCST→ MP	0.249*** (0.021)	0.192*** (0.065)	0.123*** (0.019)	0.177*** (0.070)	0.231*** (0.043)	Accepted

H4: MKDS→ MP	0.190* (0.065)	0.218* (0.0398)	0.098* (0.081)	0.219* (0.031)	0.100* (0.048)	Accepted
H5: BUEF→ MP	-0.341** (0.016)	-0.139** (0.050)	-0.169** (0.051)	-0.098** (0.016)	-0.261** (0.041)	Accepted
H6: SCIF→ MP	0.250*** (0.031)	0.102*** (0.041)	0.142*** (0.019)	0.130*** (0.017)	0.120*** (0.076)	Accepted

Legends: *, **, *** Donates statistical significance level at $p < 0.1$; $p < 0.05$ and $p < 0.01$ respectively. Standard errors are in parentheses.

4.2.4. Marketing, distribution strategy and market prices

The descriptive analyses in this study (see Table 2) reveal that the marketing and distribution strategy for staple food crops is predominantly indirect in nature. Subsequently, the study's findings in Table 6 demonstrate that the distribution and marketing strategy is positively and significantly related to the market prices of staple food crops ($p < 0.05$). Thus, we accepted H4, which hypothesized that marketing and distribution strategies have a positive effect on market prices of staple food crops. The results suggest that the use of indirect marketing and distribution channels contributes to a 19.05% increase in market prices of sorghum, 21.86% for millet, 9.86% for wheat, 21.91% for maize and 10.09% for rice. This finding aligns with Zhang et al.'s (2019) findings, who suggested that an indirect distribution system creates a long marketing channel, additional expenses, and conflicting objectives among intermediaries, which in turn inflates the final market prices. Furthermore, intermediaries are often exploitative, buying staple food crops at low prices from farmers and selling them at unreasonably high prices to ultimate customers (Changalima and Ismail, 2022; Ketema and Lika, 2023; Nwafor, 2021). This exploitation is less prevalent when a direct channel is used, as farmers can sell staple food crops directly to customers at fair and reasonable prices.

4.2.5. Bullwhip effect and market prices

The study also hypothesized that the Bullwhip effect has a positive effect on market prices of staple food crops. However, results presented in Table 6 indicate that the bullwhip effect is a negative predictor of market prices of staple food crops ($p < 0.05$) for each of the sampled staple food crops. Therefore, H5 was not supported as a significant and positive predictor of market prices of staple food crops. The study's findings imply that any root causes of the Bullwhip effect can contribute to decreases in market prices of sorghum, millet, wheat, maize and rice by 34.11%, 13.93%, 16.92%, 9.85%, and 26.17%, respectively. Specifically, the Bullwhip effect creates an asymmetry of demand and supply information, ineffective collaboration, and networking along the SC, which are imperative determinants of market prices. This, in turn, results in imbalances between demand and supply, fear of future shortages and thus price variations. These findings align with Megerssa et al. (2020) and Israel and Mahuwi (2022), who argued that ineffective collaboration and information sharing adversely affect farmers' and traders' bargaining power, leading to limited access to market information and ultimately lower prices of staple food crops.

4.2.6. Supply chain infrastructure and market prices

The last hypothesis of the study posits that SC infrastructure has a positive effect on market prices of staple food crops. The results summarized in Table 6 indicate that SC infrastructure indeed has a positive and significant relationship with the market prices of staple food crops ($p < 0.05$). With this result, H6 was accepted. This finding implies that any perceived deficiencies in SC infrastructure, such as long distances from the farm to the markets, poor road conditions, and ineffective storage and transport facilities, result in an increase in market prices of staple food crops by 25.06% (sorghum), 10.27% (millet), 14.25% (wheat), 13.08% (maize) and 12.02% (rice). Farmers and traders often encounter challenges such as long distances, poor road conditions and inadequate storage facilities when transporting staple food crops to the markets, particularly from rural areas where farming predominantly occurs. These challenges make transportation and storage more expensive, thus leading to higher market prices of staple food crops (Changalima and Ismail, 2022; Maziku et al., 2015). However, contrary to these findings, Ketema and Lika (2023) and Eriksson et al. (2022) argue that good SC infrastructures make transportation much easier and cost-effective, ensuring the availability of staple food crops at the markets at fair and reasonable prices.

5. Conclusion and managerial implications

This study delved into the factors influencing the market prices of staple food crops from a SC perspective. Beyond climatic conditions, economic and legal factors, our findings highlight several supply chain-related issues that impact staple food crop prices in both directions. Specifically, SC and logistics costs, farming costs, marketing and distribution strategies and SC infrastructure emerged as significant positive predictors of market prices of staple food crops across surveyed rural and urban markets in Tanzania. Conversely, the bullwhip effect and intense competition within agricultural SC exerted a negative and significant influence on price variations. These SCIs sway staple food crop prices in diverse directions, contingent upon prevailing SC practices. Issues such as deficient SC infrastructure, indirect distribution channels, long distances from farms to markets, high transportation costs and supply-demand imbalances contribute to price increases. SCIs exert a substantial and noteworthy influence on shaping staple food crop prices in rural-urban Tanzania.

Based on the study's findings, the authors recommend several actions. Firstly, farmers are encouraged to form and actively participate in farmers' associations, such as agricultural marketing cooperatives and transportation cooperatives. These associations foster collaboration and joint problem-solving among farmers, thereby reducing farming, marketing, and transportation costs, which have been shown to significantly impact the market price of staple food crops. Additionally, farmers' associations facilitate the elimination of intermediaries and enhance information symmetry along the SC. Secondly, local government authorities should implement measures to improve road conditions, particularly in rural areas. Enhancing road infrastructure will streamline the transportation of agricultural commodities from rural farms to urban markets, making it more efficient and cost-effective. Lastly, fiscal policies should be enacted to stabilize the market price of staple food crops at a particular time. This can be achieved by setting ceilings and flooring prices, which would help mitigate the domino effect of price fluctuations for staple food crops in both rural and urban areas.

6. Contribution, limitations and direction for future studies

Existing literature indicates a lack of systematic research on the SCIs influencing the market price of staple food crops in rural-urban Tanzania. Previous studies have predominantly focused on the root causes of agricultural product price fluctuations from climatic, economic and legal perspectives (Huka et al., 2014; Nigatu et al., 2022; Samuel, 2020). This knowledge gap has left scholars with a limited understanding of the factors affecting staple food crop prices from a SC perspective. This study addressed this gap and enhanced scholars' comprehension by exploring and documenting the SCI impacting the market price of staple food crops, using rural-urban Tanzania as a case study. Despite its contribution, the study has certain limitations. Firstly, its scope is confined to the SCI affecting staple food crop prices in Tanzania's rural-urban context, employing a cross-sectional research design. As a result, a comprehensive examination of factors influencing staple food crop prices beyond SCIs were not considered. Secondly, the study was limited to a quantitative approach, employing a questionnaire survey to explore the issues under investigation. Other methods of data collection were not considered. To enhance the comprehensive understanding of the factors influencing the market price of staple food crops, future studies should focus on the following research domains. First, longitudinal case studies can be conducted to assess the influence of climatic conditions, economic factors, and legal issues on the market price of staple food crops, considering the mediating role of SCIs over time. Second, the study recommends adopting a triangulation approach, combining interviews, surveys, group discussions, and document reviews. This approach will provide a more holistic and nuanced understanding of the factors affecting staple food crop prices. Lastly, future research should broaden the scope to include cash crops and other geographical regions. This will contribute to enriching the literature and understanding of the factors influencing the market price of staple food crops from various perspectives.

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