Impacts of coffee price volatility on the livelihoods of smallholder farmers in Karagwe District, Tanzania

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ABSTRACT

Coffee is one of the most well-known potential cash crops, serving as the primary source of income for millions of farmers in various countries worldwide. Despite its significance in generating income and employment for many, its price remains unpredictable. This study aimed to assess the impacts of coffee price fluctuations on the livelihoods of smallholder farmers in Karagwe District. The study adopted the market-orientated agriculture theory. The theory posits that market-oriented agricultural production stimulates broader economic growth through linkages that encourage farmers to shift from subsistence farming to commercial-oriented farming. This aligns with the study, as most farmers in the study area have been involved in coffee production as a major cash crop, making competition in the coffee market both locally and internationally intense. A cross-sectional design and a mixed approach were used to achieve the study objectives. Data were collected from a sample of 90 smallholder farmers, representing 10% of the targeted population of coffee farmers registered with the Karagwe District Cooperative Union (KDCU Ltd), and from all six Agricultural Marketing Cooperative Societies (AMCOS) sampled to meet the study's requirements. Furthermore, 15 key informants from all six AMCOS and KDCU Ltd were also interviewed using a checklist of predetermined questions. Descriptive statistics and a multiple linear regression model were used to evaluate how coffee price volatility affects rural livelihoods. The findings indicated that the socio-economic stability of farmers in Karagwe District who live in rural areas is negatively impacted by unstable coffee prices at the 5% significance level. The study concludes that the persistence of price instability in coffee has forced the decline in family income of smallholder farmers, which consequently prevents them from meeting life's necessities, leading to the deterrence of their livelihoods' sustainability. Therefore, it is recommended that the government, along with other agricultural stakeholders and cooperatives, should strengthen regulation of the coffee trade both locally and internationally, offer financial assistance with simple credit terms, and provide relevant financial and agricultural education to farmers, which may act as a coping mechanism for any kind of price volatility.

Keywords: Coffee, Karagwe District, Livelihoods, Price Volatility, Smallholder Farmers

I. INTRODUCTION

Coffee is one of the most important crops (Kenya Coffee Platform, 2023) and one of the most popular beverages in the world (Tanzania Coffee Board, 2023). Over the years, coffee production has been a vital component of the economies of coffee-producing countries in Africa, Latin America, and Asia (Makangila & Ahmad, 2023). Globally, Brazil is the largest coffee producer, followed by Vietnam, Colombia, and Indonesia (Tanzania Coffee Board, 2023; Mhando, 2019; Ngambila et al., 2024; Mbunduki, 2024). Additionally, major sources of coffee supply worldwide are Central and Latin America, the Far East, Central Asian countries, and Africa (Mbunduki, 2024). Coffee is one of the world's most traded agricultural commodities, serving as a key source of income for many countries across Africa, Asia, and Latin America (Jamaldin, 2024; Mbunduki, 2024; Velmourougane &Bhat, 2017; Wambua et al., 2021; Bongers et al., 2015).

Globally, coffee dominates agricultural trade, with the industry providing livelihoods to about 60 million people in coffee-producing countries (Jamaldin, 2024). There are two main types of coffee grown worldwide: Arabica, which accounts for 70%, and Robusta, which makes up 30% (Velmourougane & Bhat, 2017). Economically, coffee is vital and is the second-largest traded cash crop in the world market, after petroleum (Velmourougane & Bhat, 2017; Kimaro, 2020). Coffee also plays a significant role in balancing trade between developed and developing countries (Ngambila et al., 2024). It is one of the top commodities globally and the third most consumed beverage after water and tea (Kimaro, 2020). Countries that grow coffee experience substantial economic impacts, as the sector supports the basic needs of over 125 million people (Ngambila et al., 2024).

In Africa, Ethiopia is the largest coffee producer and consumer (Mhando, 2019). The five largest coffee-producing countries in Africa include Ethiopia with 7.7 million bags, followed by Uganda with 4.9 million bags, Cote d'Ivoire with 2.2 million bags, then Tanzania in fourth with 900 thousand bags, and finally Kenya with 844 thousand

bags. In East Africa, coffee production varies among countries (Kimaro, 2020). Uganda leads the region as the top coffee exporter and the second-largest coffee producer in Africa (Robert, 2020; Kimaro, 2020). In Kenya, coffee ranks as the fourth leading foreign exchange earner after tourism, tea, and horticulture, contributing about 8% of the country's total agricultural output (Wambua et al., 2021). Uganda is the leading producer in the region, followed by Kenya, Tanzania, Burundi, and Rwanda. It is estimated that over 90% of coffee production occurs in developing countries, while consumption mostly happens in developed countries (Kimaro, 2020). Overall, Africa accounts for about 11% of global coffee production, with Ethiopia, Uganda, Côte d'Ivoire, Madagascar, and Tanzania as the top producers. These countries produce roughly 76% of Africa's total coffee output (Kassanga & Jovin, 2021).

In Tanzania, coffee is one of the most popular cash crops, accounting for about 5% of total exports (Otieno et al., 2019). Sales records since independence reveal coffee's significant contribution to Tanzania's economy. For example, in 2023, coffee contributed a total of $231 million to the government's revenues (Makangila & Ahmad, 2023). Coffee remains the backbone of the country's agricultural sector, cultivated in regions including Mbeya, Ruvuma, Songwe, Kilimanjaro, Arusha, Kigoma, and Kagera (Jamaldin, 2024; Mbunduki, 2024; Bengesi et al., 2015). Tanzania was once the largest exporter of coffee and one of its top sources of export earnings, having recently been overtaken by tourism and mining (Mhando et al., 2013). Production is mainly carried out by small-scale farmers, who make up about 90% of producers in the country (Kassanga & Jovin, 2021). About 120,000 farmers in Kagera Region engage in Robusta coffee production (Silivano et al., 2023). Coffee is the second most important agricultural export product after tobacco, providing direct income to over 400,000 households and supporting the livelihoods of approximately 2.5 million people in Tanzania (Kimaro, 2020; Tanzania Coffee Industry Development Strategy 2021-2025). It is a vital source of export earnings for many nations, including Tanzania (Maro et al., 2024). The sector supports more than 450,000 smallholder households directly, with an estimated 2.4 million people indirectly engaged in the industry locally (Silivano et al., 2023). Tanzania, as a major coffee producer, has continually faced the challenge of price volatility (Kimaro, 2020).

Price volatility refers to fluctuations in coffee prices in both domestic and international markets. Market forces like demand and supply are the main factors driving these fluctuations (Kassanga & Jovin, 2021). Such volatility primarily results from changes in global demand and supply, causing prices to rise or fall on the international market (United Nations, 2018). Price volatility disrupts household welfare among coffee farmers (Kweka, 2018). It remains a critical issue for all stakeholders along the coffee value chain, especially for those in vulnerable producing countries that rely heavily on coffee revenues (United Nations, 2018). Despite the socio-economic importance of coffee production for smallholder farmers in Tanzania, prices have been continuously fluctuating, negatively affecting their livelihoods. Therefore, this study aims to examine the impacts of price fluctuations on farmers' welfare in Karagwe District, Tanzania. The findings will benefit coffee growers in the area, Agricultural Marketing Cooperative Societies (AMCOS), the Karagwe District Cooperative Union (KDCU), and the Ministry of Agriculture.

1.1 Research Objectives

To assess the impacts of Coffee price volatility to the livelihoods of smallholder farmers.

II. LITERATURE REVIEW

2.1 Theoretical Review

2.1.1 Market-Oriented Agriculture Theory (Hirschman, 1958)

This study was guided by Market-Oriented Agriculture Theory developed by Hirschman. The Hirschman in the strategy of economic development pointed out that market-oriented agricultural production stimulates broader economic growth through linkages, i.e., backward and forward (Hirschman, 1958). Farmers shift from subsistence to commercial, engaging with the input market and processing. For instance, in the Global Coffee Commodity Chain revealed that the volatility of the global coffee market has forced small-scale coffee farmers in Costa Rica to react. Some farmers support their coffee earnings with supplemental income they receive from other activities beyond agriculture; others diversify their fields with other crops they hope to sell in the market. Additionally, Kalemile et al. (2024) argued that farmers prefer to produce crops and commodities that have higher market value and demand. Market overdependence also puts small-holder farmers to price shocks and volatility, which directly affects farmers' livelihood. In Karagwe, peasants rely more on coffee production as a cash crop sold in the market. The theory explains that this shift from subsistence crops to market-oriented crops is obvious because of the need to seek income, employment, and local development. According to Hirschman, dependence on international markets makes farmers vulnerable to price instability. In Karagwe, for instance drop in coffee prices leads farmers' income, decline stands as a root cause of other consequences such as food insecurity, inability to sponsor education, health, farm inputs, and reduced further investments. Price volatility directly affects farmers' welfare because coffee is their primary source of

income. The theory emphasizes that the government to strengthen linkages and reduce vulnerabilities by supporting value-added cooperative systems and alternative markets for coffee products.

2.2 Empirical Review

2.2.1 Impacts of Coffee Price Volatility on the Livelihood of Smallholder Farmers

The term livelihood refers to the way in which people earn income to afford different basic needs such as clothes, food, shelter, and medication, or the ability to achieve the functioning to constitute a better life. According to Chambers and Conway (1992), livelihood comprises the capabilities, assets, and activities required by people for a means of living. This necessitates how people can secure the necessities of life and the ability of a person to pay for different basic needs such as clothes, food, shelter, and medication. According to Kimaro (2020), livelihood signifies the ability of small-scale coffee farmers to meet their daily basic needs and their power in acquiring farming inputs and extension services. Coffee is an important crop, since it is a major source of income for millions of smallholder farmers and is a significant source of export earnings to many nations, including Tanzania. It generates export earnings and provides direct income for more than 450,000 households and also benefits the livelihoods of 2.4 million Tanzanians indirectly. It is one of the primary sources of foreign exchange earnings and provides employment opportunities and empowers livelihoods for millions of individuals (Makangila & Ahmad, 2023; Otieno et al., 2019; Jamaldin, 2024; Kweka, 2018). The coffee industry serves as a substantial source of income and livelihood, providing direct and indirect employment to 2.6 million people (Makangila & Ahmad, 2023). The direct benefits derived from coffee provide earnings for small-scale farmers to fulfil their basic needs (Mbunduki, 2024).

Coffee price increase is an important indicator that stimulates farmers to advance their welfare (Kassanga & Jovin, 2021), and vice versa is true. Therefore, coffee volatility affects expectations about future good prices because of changes in demand and interest rates (Mhando et al., 2013). The number of studies on small-scale coffee farmers has concentrated on assessing the related impacts of coffee price volatility on the farmers' livelihoods. Some of these impacts due to this certain in particular factor were discussed in the existing literature and will be used in the whole context of this study as variables to assess.

Reduced investment in coffee farming and farmers' livelihoods: The volatility poses an adverse impact on both developing and developed economies (Maro et al., 2024). When coffee prices are lower, it results in farmers investing less in coffee farming, and in so doing, the agricultural marketing cooperative fails to earn enough income to provide its members with adequate extension and technical services (Kassanga & Jovin, 2021). Failure of price stability in coffee results in farmers operating in an uncertain environment, a situation that discourages them from making meaningful investments in coffee farms, hence affecting their income and welfare stability. Consequently, farmers either abandon coffee farming or adopt alternative crops like vanilla and rice (Bengesi et al., 2015). Changes in coffee prices lead to dramatic effects on export earnings, tax revenues, and foreign exchange as well as income instability for the producers (United Nations, 2018).

Inability to meet the education and health services for farmers' livelihoods: Several studies have shown that, due to price volatility, farmers fail to sponsor the various welfare needs of the households. Peasants fail to pay for children's school needs, healthcare services for household members. Normally, price changes tend to be low and reduce the ability of the farmers to afford household needs, such as expenses for clothing for household members, food, and cause hardships in accessing farm inputs and implements. Failure to have inputs extends vulnerability to farmers, hence leading to extreme poverty. Farmers cannot afford to maintain their livelihoods, such as constructing improved or modern housing, extending coffee production, and sponsoring other life expenses. The reports of (URT, 2024) had signified that instability in coffee prices undermines education and other social services as households struggle to pay school fees and other necessities, leading to irregular attendance for students at their schools.

Prolonged debt crises and income instability: Debt becomes common as farmers borrow against expected sales but struggle to repay when prices fall, creating a cycle of debt crisis. The other effect of price fluctuations leads to migration of youth from rural to urban leading to a shortage of labor, especially energetic youth in rural areas. Traditional care and support systems become weak as most peasants face economic difficulties (Kassanga & Jovin, 2021). Household conflicts increase when poor prices create stress over limited resources (Ruben, 2023). Because of price volatility, farmers delay in conducting management practices such as pruning, pest control, and re-planting due to financial stress. Some farmers shift to other crops like vegetables, beans, and maize to which may get quick money. This causes farms to have old coffee trees, and being a case reduces productivity (Silvano et al., 2023).

Reduced savings for the future of the household's livelihood: The price volatility contributes to poor savings and leads peasants to be in a position to face shocks during an emergency. The study by Ruben (2023) on why coffee farmers stay poor signified that cash transfers for coffee sales in Sub-Saharan Africa have a strong positive households' resilience in terms of improved Savings, payoff debits, and generally increased the volume and value of crop production. He further explained that if a steady and predictable source of income for coffee sales is provided, then cash obtained could build both social and human capital, improve food security, and strengthen households'

ability to cope with exogenous coffee price shocks. Significantly, low price expectations deter producers from making investments to improve their production capacity, hence reduce savings resilience, which can increase both capital and operational expenditure of a coffee producer (George & Jonathan, 2020). Additionally, Ntimba and Akyoo, (2016) reported that lack of savings in cash and assets have contributed to extreme poverty for many coffee farmers households hence hampering their livelihood standards.

Generally, coffee plays a significant role in the livelihood of small-scale farmers' households. It is the source of income for paying school fees, house construction, food, medical services, and other socio-economic activities. Millions of small-scale producers in developing countries make their livelihood through coffee production (Kimaro, 2020). Coffee production provides farmers' livelihood, since it serves as a primary source of income. The income derived from coffee farming is a determinant of rural households' quality of life, influencing their ability to reinvest in farming activities (Jamaldin, 2024). These with other numerous studies, have shown the importance of coffee production on farmers' livelihoods and welfare. However, its price volatility in both local and international markets emerges as a huge frailty hampering farmers' livelihoods, especially in Karagwe district, which rises a critical gap to fill through this article.

III. METHODOLOGY

3.1 Study Area

The current study was conducted in Karagwe district, located in the North-western zone of the Kagera region, Tanzania. Karagwe District Cooperative Union (KDCU Ltd) is the 2nd grade Coffee Cooperative Organization incorporated according to the Tanzania Cooperative Society Act 2013. It has a total of 117 primary cooperatives, out of which 30 primary cooperatives are fair trade and organic certified. The union covers an average production area of 7,716 square Kilometres within Karagwe and Kyerwa Districts. It is a wholly farmer-owned cooperative organization with a membership of over 66,000 small-scale farmers with more than 8,000ha of coffee farms. According to (URT, 2024), the district is the leading district for Robusta coffee production across the whole Kagera region, and the records show that the produced 78% of the total regional crop production is coffee (Bengesi et al., 2015). This enriched the meaningful logic to conduct the current study.

3.2 Research Design

The study adopted a cross-sectional design and a mixed approach. Specifically, the approach enabled the triangulation of data to enhance the clear understanding of the impacts of coffee price volatility on the livelihoods of smallholder farmers in Karagwe district.

3.3 Target Population

The target population included all small-and medium-scale farmers engaged in coffee production from the Karagwe district. A list of experienced farmers owning more than 2 hectares of coffee farms per respondent, who are registered by both rural AMCOS and KDCU Ltd, was interviewed to assess the impacts of any kind of coffee volatility on their livelihoods. These farmers were obtained from five high coffee-selling AMCOS in the Karagwe district, namely Nyakakika, Kigemu, Kamagambo, Kamahungu, and Nyakagoyagoye, all found in different wards of the Karagwe district.

3.4 Sample Size and Sampling Technique

A total of 105 respondents participated in the current study. This sample was chosen based on a stratified sampling technique, taking 10% of the whole population from all six selected AMCOS as similar as proposed in Creswell's (2012) guidelines for survey research design. Among these respondents, 90 were farmers from all six primary AMCOS (15 from each AMCOS) who were selected based on their farming experience, age, and education level. Then 6 FGDs containing 15 farmers from each AMCOS were interviewed using a semi-structured questionnaire sheet containing 17 checklist questions. Moreover, 15 key informants, 12 from all six AMCOS (two from each AMCOS), and 2 officers from KDCU Ltd, and 1 Agriculture and Livestock officer were interviewed using predetermined questions to obtain a thematic qualitative analysis of the study.

3.5 Data Collection

Data were collected through a structured checklist of 17 items and 7 questions for key informants from all six AMCOS and KDCU Ltd, with both a quantitative and an explanatory approach to capture the current state and underlying factors contributing to farmers' vulnerabilities. The questionnaire sheet focused on measuring how far Livelihood indicators, such as better housing, health services, accommodations, clothing affordability, savings for the

future, and good housing, are affected by all forms of coffee volatility. Multiple Linear Regression Model, the study assessed the impacts of coffee volatility on the livelihood of these farmers.

3.6 Model Formulation

The impacts of coffee price volatility (CPV_i) on different aspects of the livelihood of farmers will be assessed as independent variables of a multiple linear regression model. These variables include price drop sales, farming input affordability, health service accessibility, education services, and coffee farming investment. Other considered variables are food security, middlemen exploitation, future savings, trees uprooting, premature sales, clothes affordability, debt crises, and housing. Control variables (X_i) such as age, education level, and farm size, will be assessed too. The use of the Multiple Linear Regression (MLR) model makes it possible to assess the combined and individual associations between these variables and the dependent livelihood indicators in a single coherent model. Also, MLR helps in integrating control variables to isolate the impacts of CPV_i from background characteristics. The ordinary least squares method is used to estimate the coefficients of the MLR model using SPSS software.

$$Y_i = \beta_0 + \beta_i CPV_i + \alpha_i X_i + \varepsilon$$

Where:

Y_i The livelihood outcome of a farmer

CPV_i Does the coffee price volatility impact experience by the farmer i

β_0 Is the model constant?

β_i Are the model coefficients for which $i = 1,2,3\ldots$

X_i are control variables (age, education level, and farm size) for which $i = 1,2,3$

α_i Are the coefficients of the control variables

ε It is an error term.

IV. FINDINGS & DISCUSSION

4.1 Findings

4.1.1 Demographic Information of the Respondents

From the study, it was found that 71.11% of the respondents were aged between 36-59 years, showing that a higher active workforce group of respondents among the target population were interviewed. It was also observed that among of respondents, 75.55% have acquired primary education only, indicating the existence of a low level of education among these farmers. Interestingly, 81.1% of the respondents owned between 2-6 acres of coffee farms, showing that most of the respondents were smallholder farmers and could satisfy the study objectives (Table 1).

Table 1

Age, Education, and Farm Size Owned by the Respondents (n = 90)

Age Group of the Respondents			
SN	**Age Group**	**Frequency**	**Percent (%)**
1	18- 35	10	11.11
2	36-59	64	71.11
3	60+	16	17.78
Education Level of the Respondents			
1	No Formal Education	5	5.56
2	Primary Education	68	75.55
3	Secondary Education	12	13.33
4	Higher education	5	5.56
Farm Size Owned by the Respondents in Acres			
1	2 -4 Acres	40	44.44
2	4 - 6 Acres	33	36.67
3	6 - 8 Acres	9	10.00
4	8 - 10 Acres	3	3.33
5	Above 10 Acres	5	5.56

4.1.2 Coffee Volatility and Farmers' Livelihoods

The results from the study, revealed the tendency of instability of coffee prices showing the rise and fall of prices between the years. This shows the persistence of volatility of coffee prices even under relative very low prices.

The results present prices per kilogram of coffee for the previous ten years consecutively i.e. from 2015-2024 (Table 2) showing high rate of price volatility by highlighting the regular rise and fall of coffee prices between one year after another. On the other hand, it was found that majority of farmers who owned 8-10 acres of land had more depended on coffee as their main source of income by more than 75% (Table 3) showing that they were much investing in coffee farming rather than any other agricultural activity. Moreover, the overall results of the remaining farmers who owned more than 4 acres of land had depended on coffee income by more than 63% of their total annual income signifying that the livelihood sustainability of these farmers was much relied on income generated by coffee. Therefore, these findings imply that coffee is a major source of income to the farmers in Karagwe via its contribution to the households' welfare in relation to their annual income for the year 2024 as shown in Table 3.

Table 2

Robusta Coffee Prices per Kilogram from 2015-2024

Year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Price in TZS	1,650	1,200	1,100	1,250	1,200	1,300	1,450	1,800	2,200	5,000

Table 3

Coffee Income Contribution to the Livelihoods of Smallholder Farmers in 2024

Farm size	Average coffee produced in kg @ farmer	Selling Price Per kg in TZS	Total sales in (000') TZS	Average household income per year (000') TZS	Coffee income contribution in %
2-4	2,500		12,500	18,500	67.6
4-6	3,800		19,000	30,000	63.3
6-8	5,500	5,000	27,500	39,000	70.5
8-10	6,850		34,250	45,500	75.3
Over 10	8,200		41,000	55,000	74.5

4.1.3 Multiple Linear Regression (MLR) Results

A multiple linear regression model was run to examine the effect of coffee price volatility on the livelihood of smallholder farmers in Karagwe district. The analysis focused on the influence of multiple socioeconomic and farming-related variables on household welfare as the dependent variable. This discussion aligns with the study's objective of identifying the key dimensions through which price volatility in the coffee sector disrupts the well-being of farming households. Moreover, control variables such as farmers' age, education level, and farm size were also included in the model to ensure robustness and validity of the study.

4.1.1 Reliability Test

Prior to regression, a reliability test was conducted on the questionnaire items related to the effects of coffee price volatility. The Cronbach's Alpha value was 0.983, showing excellent internal consistency among the items and confirming their suitability in use for further analysis (Table 4).

Table 4

Reliability Statistics

Cronbach's Alpha	N of Items
.983	12

4.1.2 Model Summary

The model shows a very high explanatory power, with an R^2 of 0.928, meaning that 92.8% of the variation in perceived household welfare is explained by the selected independent variables. The adjusted R^2 (0.908) confirms the model's robustness even after accounting for the number of predictors (Table 5).

Table 5

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.963[a]	.928	.908	.256

4.1.3 Analysis of Variance (ANOVA)

The Analysis of variance (ANOVA) results ($F = 50.514$, $p < 0.001$) indicate that the regression model is statistically significant. This implies that the set of independent variables, including economic, agricultural, and social

factors related to coffee price volatility, collectively has a significant effect on household welfare. The high F-value and low significance level confirm the robustness of the model and justify the inclusion of these predictors in analysing the livelihoods (welfare outcome) of smallholder farmers in Karagwe district (Table 6).

Table 6

ANOVA

Sum of Squares	df	Mean Square	F	Sig.
59.353	17	3.491	50.514	.000[b]
5.115	74	.069		
64.467	91			

4.2.4 Regression Results

The Multiple Linear Regression model results of household welfare as the dependent variable and a series of predictors linked to coffee farming challenges are presented in Table 4. The unstandardized coefficients (B), standardized coefficients (Beta), t-values, and significance levels (p-values) were used to determine the strength and statistical significance of each variable's effect. The analysis revealed several statistically significant predictors ($p < 0.05$), suggesting that these factors have a meaningful impact on household welfare among smallholder coffee farmers (Table 7).

Table 7

Impacts of Coffee Price Volatility on Livelihood of Smallholder Farmers (n=90)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.178	.299		.596	.553
	Price drop sales enforcement	-.089	.137	-.138	-.649	.519
	Farming input affordability	.355	.093	.398	3.817	.000
	Health services accessibility	.284	.133	.422	2.137	.036
	Education services acquisition	.358	.127	.441	2.818	.038
	Coffee farming investment	.323	.100	.471	3.242	.002
	Food security	.147	.113	.248	1.310	.194
	Middlemen exploitation	-.170	.085	-.280	-.2.000	.048
	Savings for the future	-.160	.114	-.245	-1.396	.067
	Coffee trees uprooting	-.165	.127	-.211	-1.300	.198
	Pre-mature coffee Sales (OBUTURA)	-.180	.129	-.247	-1.396	.037
	Clothing affordability	.384	.109	.465	3.516	.061
	House improvement	.189	.111	.272	1.693	.095
	Debt crisis	-.396	.111	-.610	-3.574	.001
	Quality meals affordability	-.147	.142	-.250	-1.031	.306
	Age	-.208	.155	-.137	-1.346	.182
	Education Level	.399	.122	.289	3.259	.002
	Farm Size	-.029	.120	-.040	-.243	.809

Dependent Variable: household welfare

Unstandardized Coefficients show the actual impact on household welfare per unit change in each predictor, while standardized coefficients (β) allow comparison of relative importance across all variables. From Table 4, it is observed that any unit increase in affording coffee farming inputs significantly increases household welfare. Notably, debt crises had the most substantial negative impact ($\beta = -0.610$, p = .000), indicating that households burdened by debt experience a severe decline in welfare. Other strong predictors included reduced investment in coffee farming ($\beta = 0.471$, p = 0.002), middlemen exploitation ($\beta = -0.280$, p = 0.048), and disruptions to education services (β = 0.441, p = .038). All of these predictors were statistically significant, showing that any increase per unit of each must improve or reduce the income welfare of the farmer, depending on the nature of the variable. Additionally, accessibility to health services is also positively associated with better household welfare, proving that any kind of coffee price shocks should hamper the welfare of farmers significantly. On the other hand, variables such as farm size, age, food security, and clothing purchases fulfilment do not show significant effects in Table 4, suggesting their impacts are either indirect or mediated through other factors. Interestingly, the level of education of a farmer was positively associated with better household welfare (β=0.289, p=0.002), indicating the role of knowledge and literacy

in coping with economic volatility consequences. Education may enable farmers to better understand market dynamics, adopt improved farming techniques for producing high-quality coffee products, and expand income sources, thereby acting as a major coping mechanism for any kind of coffee price shocks.

4.3 Discussion

The results have revealed that there has been inconsistency in coffee prices for the last 10 years (Table 2). The findings have also shown that most of farmers in Karagwe have more depended on coffee as their main source of income by more than 70% average contribution to their overall annual income (Table 3). similar related findings determining over-dependence of farmers on coffee income were also reveled in (Jamaldin, 2024; Bengesi et al., 2015; Ntimba & Akyoo 2016). Consequently, this shows that any kind of coffee price volatility is a major constraint to the livelihood welfare of farmers in Karagwe district. Furthermore, Regression analysis in Table 6 has indicated several statistically significant predictors ($p < 0.05$), suggesting that these factors have a meaningful impact on household welfare among smallholder coffee farmers in Karagwe district. The predictors, such as farming input affordability, access to health and children's education services, investment in coffee farming, pre-mature sales and middlemen exploitation, were statistically relevant to farmers' welfare and hence affected by coffee price volatility.

4.3.1 Farming Input Affordability (p=0.000) to Farmers' Welfare

This has stood as a strong positive predictor of household welfare of farmers, as shown in Table 4. Households with access to buy agricultural inputs are significantly strong enough to increase the productivity of coffee in their farms and directly improve the income welfare of farmers. Therefore, coffee price instability caused the inability to afford essential farming inputs among smallholder farmers, especially in rural areas, who depend most on coffee as a major source of income. It is explored that when farmers are unable to purchase fertilizers, pesticides, or improved seedlings, their productivity decreases directly limiting income and their living standards. These are similarly aligned in the findings of (Silvano et al., 2023; Kimaro, 2020). Additionally, the input farming access is very critical for smallholder farmers' sustainability, as supported by Food and Agriculture Organization of the United Nations (FAO, 2020).

4.3.2 Access for Health Services (p=0.036) to Livelihood Welfare

Health service accessibility was statistically significant and positively associated with household welfare. This signifies that coffee price fluctuations compromise households' ability to afford medical care. Therefore, when income falls, health becomes a neglected expenditure, increasing household poverty and reducing overall well-being. In a similar way, URT, (2024) reports the same issue.

4.3.3 Education Services Affordability to Farmers' Livelihoods

The result revealed that investment in children's education is a key determinant of household well-being and future opportunity recognition. This significant relationship highlights that a decline in income from coffee sales forces parents who depend on coffee products to withdraw their children from better schools or reduce some educational expenditures. One of the AMCOS leaders replied, "*Smallholder farmers who mostly depend on seasonal coffee income fail to meet general family needs like sponsoring their children to study in better schools and affording medical bills payments due to unpredictable price markets*". The majority of farmers whose income is generated from coffee sales are unable to afford their students' educational needs whenever coffee market prices fluctuate. In a similar vein, Jamaldin (2024), URT, 2024; Kimaro, (2020) reported the same results.

4.3.4 Investment in Coffee Farming and the Farmer's Livelihood Welfare

Long-term investment in coffee farming could establish a standard welfare of a farmer. This was one of the most explanatory variables in the model, with higher β-value and strong statistical significance ($\beta = 0.358, p = 0.002$). Conversely, unstable coffee prices have demoted farmers from planting new trees or purchasing inputs, hence reducing future yields and incomes hence leading to a decline in the farmers' livelihood, which was also supported by (Mhando, 2019 & TCB, 2023). The prolonged coffee price fluctuations have led many coffee farmers to turn their attentions to other crops, such as beans, maize, and rice, which are also more commonly grown in the district, as also shown in (Kassanga & Jovin's 2021; Kalemile et al., 2024) observations. One of the key respondents recognized this by saying, *"Due to price volatility, many farmers have changed their attention to invest in other food cash crops like maize, beans, and bananas rather than coffee"*. The related consequence is to reduce productivity and indirectly affect agricultural marketing cooperative unions as they fail to earn enough income to provide their members with adequate extension and technical services. Furthermore, Bengesi et al. (2015) cemented that the effect of inconsistent market coffee prices influences farmers to either abandon coffee farming or adopt alternative crops like vanilla and rice.

4.3.5 Middlemen Exploitation and Premature Sales for Farmers' Welfare

Both middlemen exploitation and premature coffee sales were found to negatively affect the welfare of a farmer and were statistically significant with p-values of 0.048 and 0.037, respectively. This demonstrates that all forms of coffee price shocks discourage rural farmers from waiting and sell their coffee in the registered AMCOS unions nearby, hence deciding to sell it to unregistered middlemen even under very low prices, as also stated in Ntimba and Akyoo (2016) findings. The process of selling coffee while on their farms before the harvesting season arrives is termed as premature sales, whereas in the Karagwe district, this business is locally OBUTURA business. Middlemen in the Karagwe district usually conduct a pre-paid coffee business, i.e., OBUTURA, in order to enable farmers to meet their daily needs due to the existence of prominent poverty among them. Due to a lack of funds among most coffee farmers in Karagwe forces they are forced to sell their coffee before the planned harvesting season, which stands as a major coping mechanism to coffee volatility. The continuously unstable prices of coffee and other crops produced in the Kagera region have been mentioned by respondents as the major reason for this OBUTURA business, which has sent them to prolonged extreme poverty. This has pushed many family members to undergo a chronic debt crisis, which was also statistically significant in this study, contributing to failure in savings for daily household needs The key informant who was of one of the top leaders of KDCU Ltd cemented this by quoting the observations reported by Strategies for International Development (SID) saying, "*smallholder farmers in Karagwe district lose up to TZS 275,000 per 100kg Suck of coffee for every harvesting season due to OBUTURA(Pre-mature) coffee sales"*. This has been the consequence of premature coffee sales associated with middlemen businessmen, who are subjecting most of the farmers, especially in rural areas, leading them to extreme poverty. Other mentioned factors, such as debt crises within the households, which were statistically significant with p= 0.001, and failure in savings after coffee price shocks (non-significant), could be the key drivers of this business.

4.3.7 Education Level of a Farmer and Household Welfare.

Interestingly, the education level among coffee farmers showed a positive effect on farmers' livelihood being statistically significant with (p=0.002). However, it was explored that many respondents possessed low of education (Table 1) which could affect them with poor farming methods failing to produce quality and desirable coffee products, lacking understanding on market systems, failure to make follow up on media information about coffee prices and productivity. For instance, Ntimba and Akyoo, (2016) supported this by concluding that more educated farmers may have better income broadening skills, budgeting skills, or access to market information and opportunities guiding them to sell their coffees at desirable prices, all of which buffer against welfare decline. Apart from that, other indicators such as price drop, sales enforcement, access to clothing purchases, food security, demographic data of gender, and farm size ownership were not statistically significant at ($P<0.05$). However, some of these factors, such as improved food security, better housing, and clothing, have been mentioned in different literature, including George and Jonathan (2020), Bengesi et al. (2015), and Kimaro (2020), to have positive impacts on farmers' livelihoods. Notably, clothing and house improvements were not statistically significant, but they were close to significant values since their p-values lay between $0.05<p<0.1$. Therefore, they could have been important indicators of the quality of life of farmers in case of broader samples, implying that their impacts on social welfare and the general economic well-being of farmers can't be fully nullified.

4.3.8 Aligning the Study Results with the Sustainable Livelihood Framework (SLF)

This study adopts the Sustainable Livelihoods Framework (SLF) to explain how coffee price volatility affects the livelihood outcomes of smallholder farmers in Karagwe district. The SLF posits that household welfare is always shaped by the interaction between the vulnerability context, livelihood assets, and transforming structures and processes, which together influence livelihood outcomes and sustainability (Chambers & Conway, 1992; Natarajana et al., 2022). The results presented in Table 7 strongly support this theoretical framework by showing that coffee price volatility, as a key vulnerability factor, negatively affects the livelihood assets of smallholder farmers in Karagwe and their welfare. Human and financial capital emerge as the most influential livelihood capitals of these farmers, although they are affected by unstable coffee prices, while institutional constraints, such as middlemen exploitation, exaggerate the vulnerability. Strengthening livelihood assets and transforming market structures are therefore essential for achieving sustainable household welfare among smallholder coffee farmers in Karagwe district and beyond.

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

This study examined the impacts of coffee price volatility on the livelihood of smallholder farmers in Karagwe district. Based on the findings, it was evident that price volatility in coffee, as a major cash crop produced at Karagwe in Kagera region, negatively affects the socio-economic stability of smallholder farmers. This has led to

reduced income stability, which in turn constrains the ability of households to afford life necessities and further investments.

5.2 Recommendations

The study recommends that smallholder farmers adopt income diversification projects when coffee prices are stable to support farmers during price volatility. In addition, Karagwe District Agricultural and Livestock Development Department together with KDCU Ltd should adhere regulations of the coffee trade, particularly addressing the role of middlemen, to ensure fair pricing of coffee products in favour of farmers. Also, the Ministry of Agriculture should set consistent minimum price guarantees for smallholder farmers to stabilize income and reduce the impacts of price volatility when it arises. Lastly, the Ministry of Agriculture and other Agricultural stakeholders to cooperate with financial institutions such as banks, micro-credit firms and other financial agencies in Tanzania to establish Coffee Stabilization Fund (CSF). This fund will offer financial services for farmers, such as low-interest credits and micro-insurance, to minimize the incidence of debt crises during low prices and to minimize the consequences of premature coffee sales for middlemen.

Declaration of Interest

The authors declare that they do not have any known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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