Science | Technology | Development

Ghana Journal of Science, Technology and Development | Vol. 10, Issue 2, March 2025
e-ISSN: 2343-6727
DOI: https://doi.org/10.47881/456.967x

Received: April 4, 2024
Accepted: December 30, 2024

Estimating profit efficiency of local beef traders in Tamale, Ghana: a stochastic frontier model approach

Vivian FIATUSEY BOATENG

Department of Agribusiness, Faculty of Agriculture, Food and Consumer Sciences, University for Development Studies, Tamale, Ghana

Corresponding email: vfiatusey@uds.edu.gh

ABSTRACT

The study used a stochastic frontier analysis to estimate profit efficiency and examine the sources of profit inefficiency of local beef traders in four major markets (Aboabo, Kukuo, Lamashegu, and Central) in Tamale, Ghana. Primary data were collected from a random sample of 160 beef traders using a structured questionnaire. Profits were evaluated as total sales revenue minus the sum of marketing cost and purchase price. The results showed that, on average, beef traders in the Tamale markets are approximately 68.3% efficient, suggesting that they are producing at about 32% below their potential. However, beef traders in the central market are more efficient than those in the other three markets due to its strategic location for attracting busier and well-off customers. The significant sources of profit (in) efficiency were age, education, household size, ownership of cold storage facility, access to marketing information, and membership of traders' associations. The study concludes that the beef trading business in Tamale is profitable, but traders' profit efficiency needs to be improved. Furthermore, there were several challenges confronting traders in Tamale that need to be mitigated. The two most prevalent challenges reported by traders were inadequate capital and inadequate cold storage facilities. The study recommends that the establishment of marketing associations could play a pivotal role in alleviating inefficiencies in beef marketing. Furthermore, educational programmes could help improve the profit efficiency of beef traders. Beef traders should also be trained with better cost minimizing packaging options that would maximize their profit. The study also recommends measures such as providing cold storage infrastructure to significantly alleviate the challenges faced by beef traders in Tamale. Also, policies should moderate the transportation charges for beef traders in order to reduce their marketing cost and increase their profit. Facilitating the establishment of marketing associations could help to alleviate inefficiencies in beef retailing. Hence, beef traders should be encouraged to join marketing associations

Keywords: *beef retailing, profit efficiency, stochastic frontier analysis, Tamale*

INTRODUCTION

Beef cattle play a considerable role in wealth creation and the enhancement of livelihoods within agrarian economies (Eyasmin and Ghosh, 2024). At the micro-level, beef cattle and other livestock hold several economic and social benefits (Bettencourt et al., 2013). They provide food (meat) and a window of escape (insurance) for producers in times of economic hardships and unforeseen events (FAO, 2022). Income from their sales contributes to paying for farm inputs, foods, and immaterial items such as school fees

(Nastasijevic et al 2019; FAO, 2022). They offer transport, draught power for mechanical tillage, and raw material (faecal matter) for manure in crop production (Upton, 2004; Devendra and Thomas, 2002) and have several social functions. In some regions of Africa, male herders indemnify their bride price with livestock at marriage (Bageant et al., 2017; Mair, 2018). Producers can also use their livestock as collateral or security to obtain other productive assets, such as land, fertilizer, and seeds for crop production.

Beef production is one of the fastest-growing subsectors that have the capacity to meet protein demand. Beef is a popular meat in Africa and a key ingredient in many dishes. In Ghana, beef is the most traded meat and a cheap source of protein for many families (Mahaboubil-Haq and Adzitey, 2016). The demand for beef is increasing steadily in Africa due to urbanization, population growth, and rising incomes (Amankwah et al., 2012; Herrero et al., 2014). Such consumption is important in reducing protein deficiency diseases and improving nutrition in the continent (Nyantakyi-Frimpong et al., 2018; Amankwah et al., 2012). Increasing local meat production has been a central concern for the government of Ghana. In the 1970s, the government of Ghana established meat factories, such as the Bolgatanga Meat Factory, to process and supply meat to consumers, especially in cities (Dede, 1972). However, these factories collapsed due to limited structures and inefficient pricing and welfare gains in the livestock value chain. In 2007, the government introduced the Food and Agriculture Sector Development Policy (FASDEP) II, aiming to increase domestic food production, reduce poverty, and improve the overall agricultural sector (MoFA, 2007). The policy encompassed various subsectors, including livestock development, to enhance meat supply and contribute to poverty reduction. However, the policy's targets to achieve 80% supply of domestic livestock products and a corresponding reduction in poverty from 59% to 30% by 2015 was not achieved due to marketing challenges such as transportation costs. This issue has led to increasing beef importations and a decrease in profit for local meat (Annan et al 2018). To increase profits, local meat traders need to be efficient.

Understanding the factors that affect beef marketing efficiency is crucial for improving beef production and consumption. While many studies (Sidhu et al., 2011; Aidoo et al., 2012; Dastagiri et al., 2013; Tiri et al., 2015) have been conducted on marketing efficiency, they have largely ignored livestock and meat marketing. In Ghana, studies have focused on crops and neglected livestock and meat products. Importantly, specific studies on beef and other meat products have focused on quality issues and consumer preferences (Adzitey et al., 2018, Annan et al., 2018; Owusu-Sekyere et al., 2014), but to the best of the researcher's knowledge, none has examined the level and determinants of profit efficiency of local beef retailing, particularly in Ghana. Also, there is a limited application of stochastic frontier analysis (SFA) to profit efficiency in food marketing in the context of Ghana. Most research on SFA focus on crop production, ignoring livestock and meat marketing. Our understanding of this concept could help improve food commodity marketing efficiency. This improvement is crucial for transforming agribusinesses and reducing poverty in Africa (Haggblade, 2011). An efficient marketing system can lower marketing costs and consumer prices, raise economic output, and protect local businesses from international competition (Timmer, 2017). This study aims to improve the competitiveness of Ghana's beef industry by identifying the level and determinants of profit efficiency in Tamale. With increasing urbanization and population growth, there is a growing interest in exploiting the vast market

potential for food. In large cities, the location of markets can either encourage or discourage those involved in local beef retailing. Some markets may be more efficient in food marketing due to their strategic location and ability to attract more customers. However, as indicated earlier, there have been hardly any studies in Ghana that compare marketing margins and net return efficiency in different market zones, to the best of the researcher's knowledge. Hopefully, the study is the first to do so by analysing local beef marketing margins and net return efficiency in four market zones in Tamale. The remainder of this paper is as follows: literature review is provided in section 2, while the methodology, results and discussion, and conclusion and recommendations are presented in sections 3, 4, and 5.

The concept of food marketing

The concept of marketing has received considerable explanations in scientific research. Nearly each decade conceives its own definition of marketing. Cramer and Jensen (1982) reported that the term marketing could have a variety of meanings depending on who is defining it. For instance, to shoppers, it means purchasing groceries and all other household needs; for farmers, it means selling their commodities; from the handler's perspective, it means storing the commodity, transforming it into the form that consumers want, shipping it to retail outlets and promoting its sale. Asogwa and Okwoche (2012) indicated that marketing has economic value because it gives form, time and place utility to products and services. Marketing is sometimes narrowly defined as the changing of ownership of goods. It also means all those activities essential to the transfer of goods, physically or otherwise, from primary producers to ultimate consumers. In the broadest sense, marketing is a combination of activities designed to produce profit through ascertaining, creating, stimulating, and satisfying the needs/wants of a selected segment of the market. These activities include; packaging, storage, transportation, pricing, financing, risk bearing, and product design (Balogun et al., 2018). All these definitions consider the set of activities involved in getting goods from the producer to the final consumer. In marketing, agents secure the source of raw materials and the buyers that buy their products. They may undertake several operations such as storage, packaging, transportation and processing to keep the product in good shape and for better prices before it gets to the final consumer (Asogwa and Okwoche, 2012). If the marketing activities are enhanced to provide better product to customers, marketers tend to earn more income (Ukwuaba et al., 2018). In Ghana, the beef marketing chain consists of three main routes through which beef passes from the producer to the consumer. In the first route, the live animal moves from the farmers to the wholesalers mainly known as cattle dealers who buy cattle from the farmers and sell it to the butchers. The butcher transforms the animal into beef and sells it to the consumer. In the second route, live cattle pass from farmers to butchers who prepare beef for retailers and consumers. In the third stage, live cattle pass from farmers to butchers who prepare beef for cold stores, who finally sell to the final consumer. Both retailers and cold stores sell beef in smaller quantities compared to the wholesalers.

MATERIALS AND METHODS

Study area and sampling

The study was carried out in the Tamale Metropolis. The metropolis has a total estimated land size of 646.9 km sq. and geographically lies between latitude 9º16 and 9º 34 North and longitudes 0º 36 and 0º 57 West. Tamale is the capital of the Northern Region of Ghana with an estimated population of 758,000 (World Population Review, 2024). Tamale was chosen because of its huge market potential

for local food production and consumption. Among the major cities in Ghana, Tamale has seen the most tremendous urban growth with the concomitant rise in market demand for food products such as beef in recent years. Tamale is centrally located, making it a major assembling point for cattle and other livestock from all across northern Ghana (Vaskó et al., 2024). Trading is one of the major economic activities in the Metropolis (GSS, 2014). However, the metropolis provides vintage market space for other cities and neighbouring countries. Most people are also employed in agriculture, teaching, and manufacturing, making its economy diverse (GSS, 2014). Primary data were collected using structured questionnaires from a random sample of 160 beef traders. Primary data collected includes prices, cost and weights of beef obtained from retailers. Stratified sampling technique was employed in selecting the respondents. The study considered market zones when selecting its sample and ensured that an equal number of respondents were chosen from each of the four major markets (Aboabo, Kukuo, Lamashegu, and Central) in the Tamale Metropolis. Accurate data on beef retailers in each market was unavailable. Therefore, the study selected an equal number of respondents from each market zone to gather representative data, minimizing potential bias from over- or under-representing any particular market. These markets are located in different parts of the metropolis, with Lamashegu and Aboabo in the south and west respectively, and Kukuo and Central in the north and center of the metropolis respectively. The Tamale Metropolis provides ample market spaces for its 16 communities, with well-defined areas for meat sales. All the markets have well defined areas for the sales of meat. Fresh meat sellers use stall mainly within and outside the main markets. These markets operate everyday but with a designated day which comes off every six (6) days. Thus, the sixth day in every other week is a market day where traders come from within and outside the Metropolis to sell all kinds of foodstuffs.

Analytical approach: Stochastic profit frontier model

The study employed the stochastic profit frontier model to estimate profit efficiency in local beef marketing. The stochastic profit frontier function is a modification of the production function framework. Compared to the former, the latter fails to capture inefficiencies associated with different factor endowments and prices of output and inputs across markets (Ali and Flinn, 1989; Dziwornu and Sarpong, 2014). The net return's function is more flexible than the production function because it allows for estimation of traders at different optimal points (Kumbhakar, 1989). The model consists of two components: profit function and inefficiency term. The former shows the technical relationship between profit (herein profit) and prices of output and different inputs, while the latter term is generated by variation in socio-demographic and economic, institutional as well as market and marketing factors.

The profit function is given as:

$$\pi_i = f(p, k, \gamma) exp^{\varepsilon_i} \quad [1]$$

where π is the normalized profit (profit in Ghana cedis in a month) which is expressed as the difference between sales revenue (TR) and the sum of marketing cost and purchase price (TC); $p$is the normalized input prices, k is the normalized price of fixed factors. The normalization involves dividing the profit and prices by their respective means to ensure that the estimates are meaningful and comparable. It was also done to reduce the impact of outliers. γ is the vector of unknown parameters to be estimated and ε is the error component generally expressed as: $\varepsilon_i = v_i - u_i$. The variable u_i is assumed to have a half normal, truncated normal, exponential or gamma distribution (Aigner et al., 1977). v is symmetrical, identical and independently distributed. v, the white

noise, explains any random variation in profit, which is outside the farmers control, while u_i is a non-negative error term or the inefficiency term, which denotes the shortfall in profit associated with factors which the farmer has control over.

The inefficiency term is expressed as:

$$u_i = w_i\beta + \eta_i \quad [2]$$

where $u_i$is profit inefficiency; β is a vector of unknown parameters to be estimated; w is a vector of explanatory variables such as demographic factors and socio-economic as well as marketing factors hypothesized to influence profit inefficiency; and η is the random term. Profit efficiency is defined as the ratio of actual profit to potential (frontier) profit.

This is shown as:

$$u_i = \frac{\pi_i}{\pi_i^*} = \frac{f(p,k,\gamma)exp^{(v_i-\mu_i)}}{f(p,k,\gamma)exp^{(v_i)}} = exp(-\mu_i) \quad [3]$$

where π_i is the observed value of profit of beef/week that traders actually earn and π_i^* the frontier value of the profit of beef that traders are expected to earn per week. Profit efficiency, therefore, ranges from 0 to 1. If net return efficiency=1, then $\pi_i = \pi_i^*$, which would imply that beef traders are efficient because their profit fall on the frontier. However, if u_i <1, then beef traders are termed to be profit inefficient because the agents earn profits which are below the potential or frontier profit, given the prices of output and inputs. The estimation of profit efficiency requires prior selection of the appropriate functional form, which includes mainly the Cobb-Douglas functional form and translog functional form. As a result, the Likelihood ratio chi-square test was performed to select the appropriate functional form after estimating both models. This study adopts the Cobb-Douglas profit functional form based on the results presented in Table 1. Table 1 shows a statistically significant LR test, which implies that the Cobb-Douglas profit functional form fits the data better than the translog profit functional form. The Cobb-Douglas functional form offers the advantage of producing easily interpretable coefficients. Each parameter directly represents the elasticity of net returns with respect to its corresponding input, facilitating straightforward economic interpretation and implications. It is also computationally less intensive compared to the Translog model. Similarly, the test for inefficiency effect shows that the inefficiency effect is present.

Table 1: Hypothesis tests for the use of the stochastic model

Model	df	LR chi2	Prob > chi2
Cobb-Douglas functional form is appropriate	6/27	47.93	0.0000
No inherent inefficiency	9/10	61.78	0.0000

Source: Author's compilations from the stochastic frontier results.

The profit function was transformed to log after treating all data values as positive. To enable the application of natural logarithms, the dataset was adjusted by adding the absolute value of the largest negative value to all profit values, effectively treating losses as positive. The empirical Cobb-Douglas profit frontier is as follows:

$$ln\,\pi_i = \alpha_i + \sum_i \gamma_1\, ln\, p_i + \sum_i \gamma_2\, ln\, z_i + \sum_i \gamma_3\, ln\, c_i + V_i - U_i \quad [4]$$

where p is the normalized cost price per 215kg of live weight of beef; z is the

normalized cost of inputs; and c is the normalized depreciated cost of all fixed factors. γ is the vector of coefficients showing the partial effect of each independent variable on π and ε is the disturbance term.

A budgetary technique was employed to estimate beef marketing margins following Barnard and Nix (1979). Gross marketing margin (GMM) is given as the difference between total revenue (TR) and total variable marketing cost ($TVMC$) while profit (NR) is expressed as the difference between total revenue (TR) and total marketing cost (TMC). Mathematically, gross marketing margin and net return (also known as profit) are represented by Equation [5] and [6] respectively as shown below

$$GMM_i = TR_i - TVMC_i \quad [5]$$

$$NR_i = TR_i - TMC_i \quad [6]$$

where GMM_i is the gross marketing margin per 215kg of live weight of beef and $NR_i$is the net return per 215kg of live weight of beef; total revenue per 215kg of live weight of beef ($TR_i = P_{s/p}Q$); total variable cost per 215kg of live weight of beef is $TVMC = P_{c/c,i} + P_{s/c,i} + P_{lp/c,i} + P_{t/c,i}$ and total marketing cost per 215kg of live weight of is $TMC = P_{c/c,i} + P_{s/c,i} + P_{lp/c,i} + P_{t/c,i} + k_i$; $P_{s/p}$ is the cost per 215 kg of beef carcass; $P_{c/c}$is the commission charges per 215kg of live weight of beef; $P_{s/c}$cost of storage per 215kg of live weight of beef; $P_{lp/c}$is the cost of packaging per a 215 kg of beef carcass; $P_{t/c}$is the cost of transportation per 215kg of live weight of beef; and $k$is the mean depreciated cost of all fixed factors. The empirical model for identifying the determinants of profit inefficiency is

$$\mu_i = \delta_0 + \delta_1 w_{1i} + \delta_2 w_{2i} + \delta_3 w_{3i} + \delta_4 w_{4i} + \delta_5 w_{5i} + \delta_6 w_{6i} + \delta_7 w_{7i} + \delta_7 w_{7i} + \delta_8 w_{8i} + \delta_9 w_{9i} + \delta_{10} w_{10i} + \eta_i \quad [7]$$

The variables in equation [7] are summarized in Table 2 with their measurement and a *priori* expectation.

Table 2: Measurement of variables used in the study

Age of trader	Number of years
Education of trader	Number of years
Household size	Number of people eating from the same pot in the household
Marketing experience	Number of years
Engagement in other self-employments	Dummy; 1 if the trader has other self-employments; 0 otherwise
Records keeping	Dummy; 1 if the trader keeps records; 0 otherwise
Ownership of cold storage facility	Dummy; 1 if the trader owns a cold storage facility; 0 otherwise
Access to marketing information	Dummy; 1 if the trader accessed marketing information; 0 otherwise
Access to credit	Dummy; 1 if the trader accessed credit; 0 otherwise
Membership to traders' association	Dummy; 1 if the trader belonged to traders' association; 0 otherwise

Source: Author's construct, 2023

RESULTS AND DISCUSSION

Descriptive statistics

The results in Table 3 show the summary statistics of variables used in the study. The mean age of the traders was 36.66 years. However, traders in Kukuo market were older (40.90 years) than those in central market (36.73 years), Aboabo market (35.16 years), and Lamashegu market (33.84 years). The results also show that the respondents were within the economic age bracket. This result is consistent with

previous studies (Ojogho et al., 2012; Eze, 2007), who found that majority of beef traders were between 30 and 40 years of age. Traders have spent about 7 years in formal schooling. However, traders in Kukuo market have lower education (1.90 years) compared to traders in central market (8.35 years), Aboabo market (8.63 years), and Lamashegu market (8.00 years). The results suggest that the mean education years for the sample is low. In the Ghanaian context, it corresponds to Junior High School education. This result is contrary to Marandure et al. (2016) and Ojogho et al. (2012), who found that more than half of their traders had secondary education. The low level of education could impede beef marketing efficiency as less-educated traders may have limited knowledge of good marketing strategies and information for improving profitability. It may also hinder business planning and access to external capital due to the inability of the trader to keep records and write good business proposals for formal financial institutions. Also, the study found that less than half of the traders keep records in their businesses. This result has implications for their inventory and financial management. Beef traders are highly experienced (9.96 years). There is a marginal difference in marketing experience of beef traders between the central market (9.98 years), Aboabo market (10.10 years), Lamashegu market (9.84 years), and Kukuo market (8.72 years). This result is contrary to Ojogho et al. (2012), but consistent with Eze (2007). The result suggests they have a relatively low level of expertise in beef retailing. A higher marketing experience could contribute to the efficient utilization of resources.

The mean household size for the traders was 5.52. Traders in central market (5.53 people), Aboabo market (5.59 people), Lamashegu market (5.42 people), and Kukuo market (5.52 people) have approximately the same household size. A similar result was observed in Ojogho et al. (2012). The percentage of traders receiving credit is higher in Kukuo market (76%) than central market (51%), Aboabo market (47%), and Lamashegu market (55%). But most traders had access to credit for their business. When traders' capital is inadequate, they require credit for the purchase of beef. A greater percentage (over 50%) of the traders, especially those in the central market own cold storage facilities for preserving the meat. The results showed that, majority of the traders belonged to traders' associations, except for those in the Aboabo market. At least 80% of the retailers engaged in other businesses apart from the beef marketing. This result shows that traders pursue diversification to manage risk. However, this result is contrary to Marandure et al. (2016). Over half of the traders had access to marketing information, which was mainly information about price and source of beef. A higher percentage (87.4%) of traders in the central market had access to marketing information than those in the other markets.

Table 2: Summary statistics of the sampled respondents

Variable	Aboabo market	Central market	Lamashegu market	Kukuo market	All traders
Continuous variables	**Mean**	**Mean**	**Mean**	**Mean**	**Mean**
Age (years)	35.16 (5.45)	36.73 (5.96)	33.84 (2.13)	40.90 (3.98)	36.66 (4.23)
Education (years)	8.63 (2.53)	8.35 (2.20)	8.00 (1.06)	1.90 (3.13)	6.72 (2.41)
Household size (years)	5.59 (2.00)	5.53 (1.70)	5.42 (1.50)	5.52 (0.87)	5.52 (1.65)
Marketing experience (years)	10.10 (4.99)	9.98 (4.64)	9.84 (2.67)	8.72 (1.49)	9.66 (2.87)
Categorical variables	**%**	**%**	**%**	**%**	**%**
Access to credit					
Yes	51.0	47.0	55.5	76.4	57.48
No	49.0	53.0	44.5	23.6	42.52

Ownership of the cold facility					
Yes	89.9	91.43	78.3	83.6	85.81
No	9.1	9.57	21.7	16.4	14.19
Engagement in other self-employments					
Yes	82.0	91.6	79.6	85.0	84.55
No	18.0	8.4	20.4	15.0	15.45
Records keeping					
Yes	23.0	32.0	44.7	29.2	32.23
No	77.0	68.0	55.3	70.8	67.77
Access to marketing information					
Yes	65.0	87.4	76.5	53.0	70.48
No	35.0	12.6	23.5	47.0	29.52
Membership in traders' association					
Member	47.7	53.0	61.4	78.0	60.02
Not a member	52.3	47.0	38.6	22.0	39.98

Note: Standard deviations are in parentheses
Source: Author's construct, 2023.

Marketing margin analysis for the sale of live beef carcass

Table 3 shows the average gross and net margin per 215kg of live weight of beef. Marketing costs and returns were calculated in order to derive the net marketing margins, which are a more accurate reflection of profit than gross margin. The marketing cost is the cost of undertaking all the utility-adding activities for a particular product, while margins represent the returns to intermediaries for their marketing services (Baker, 1983). The results show that the purchased cost of live weight of beef carcass was GH¢5920.63. This amount is a bit higher for traders in the central market, followed by the Aboabo market, Lamashegu market, and Kukuo market. The cost of the live weight of beef carcass was followed by cost of transportation from the cattle market to abattoir and then to the market (GH¢141.02), commission charges (GH¢120.08), cost of storage (GH¢114.81), and cost of packaging (GH¢63.85). The fixed costs items were depreciated value of equipment: these costs do not vary with the cost of marketing beef. The mean value of fixed cost was GH¢7.47. The fixed cost comprised the cost of cutlass, knife, pan, and chopping board. The total marketing cost was calculated as GH¢6367.85 per 215 kg of beef against revenues (sales receipts) of GH¢8558.12 per 215 kg of beef. The study used the straight-line method to compute the depreciated values. Unlike the declining balance method or the units-of-production method, the straight-line method is simple to compute and assumes a constant depreciation rate over an asset's useful life. Thus, the gross margin for 215kg of live weight of beef carcass was GH¢2197.74, giving a net return to the trader of GH¢2190.27. This net return from the marketing operations is an indication of a profitable business (Marshal, 2007). The results further show differences in cost-returns between traders in the four markets. Traders in the central market had the highest profit (GH¢2756.08).

Table 3: Average cost-returns and marketing margins for the sale of dressed beef

Item	Aboabo market Mean	Central market Mean	Lamashegu market Mean	Kukuo market Mean	All traders
Cost of 215 kg of live weight of beef carcass	6000.56	6200.48	5980.54	5500.92	5920.63
Cost of transportation per 215 kg of live weight of beef carcass	140.78	131.40	142.50	149.40	141.02
Commission charges per 215 kg of live weight of beef carcass	120.34	123.45	113.12	123.42	120.08
Cost of storage per 215 kg of live weight of beef carcass	116.67	114.75	113.46	114.36	114.81
Cost of packaging per 215 kg of live weight of beef carcass	62.54	64.21	61.08	67.55	63.85

Total variable cost (TVC) per 215 kg of live weight of beef carcass	6440.89	6634.29	6410.70	5955.65	6360.38
Depreciated value of equipment	8.18	7.23	8.32	6.13	7.47
Total fixed cost (TFC)	8.18	7.23	8.32	6.13	7.47
Total marketing cost (TMC) per 215 kg of live weight of beef carcass	6449.07	6641.52	6419.02	5961.78	6367.85
Revenue (R) per 215 kg of live weight of beef carcass	8281.05	9397.6	8223.54	8330.29	8558.12
Gross margin per 215 kg of live weight of beef carcass (R less TVC)	1840.16	2763.31	1812.84	2374.64	2197.74
Profit per 215 kg of live weight of beef carcass (R less TMC)	1831.98	2756.08	1804.52	2368.51	2190.27

Source: Author's construct, 2023

Determinants of profit

The results of the SFPM are presented in Table 4. However, the study confirms the validity of the model and functional form used before delving into the determinants of profit. The Cobb Douglas functional form, with a likelihood ratio of 41.51 (p-value =0.0000), is considered to be a better fit for the data than the translog profit functional form, as it accurately represents profit function of beef traders in the study area. The generalized likelihood ratio tests are specified as: $-2[(L(H_0) - L(H_1)]$, where $L(H_0)$ and $L(H_1)$ are the values of the log likelihood functions under the null and alternative hypothesis. The estimated value of the variance parameter gamma ($\gamma = \sigma_u^2/\sigma^2$) is 0.770 for the Cobb-Douglas stochastic profit frontier function. This result shows the existence of profit inefficiencies in beef retailing, with 77% variation in profit due to technical inefficiency and 23% variation in profit due to factors beyond traders' control.

Table 4 showed that the cost of packaging, transportation and depreciated cost of capital had a significant influence on profit. The cost of packaging had significant and positive influence on the profit of beef traders. Better packaging might enhance the perceived quality of the beef among consumers. This added value can increase beef profit. Beef traders who invest in better packaging enjoy higher prices from consumers who are willing to pay a price for well-packaged beef. However, Eze (2007) found that packaging cost had no effect on the profit of traders in Nigeria.

Table 4: Stochastic (profit) frontier estimates

Variable	Coeff.	Std. Err.
Cost of packaging	0.148***	0.053
Cost of beef	0.024	0.021
Cost of transportation	- 0.060*	0.031
Cost of storage	- 0.24**	0.066
Depreciated cost of capital	- 0.253	0.425
Commission charges	0.018	0.07
Constant	19.581	2.05
Inefficiency		
Age	0.350***	0.107
Education	- 0.285*	0.155
Household size	0.137***	0.053
Ownership of cold storage facility	- 2.621**	1.071
Engagement in other self-employments	0.315	0.329
Records keeping	- 0.811	0.974
Access to marketing information	- 3.289**	1.351
Access to credit	- 0.102	0.406
Membership in a marketing group	- 1.332***	0.338

Constant	- 8.841	3.363
σ^2	0.433	0.06
γ	0.770	0.077
σ_u^2	0.333	0.068
σ_v^2	0.1	0.03

Note: *** = p<0.01, ** = p<0.05, and * = p<0.1.
Source: Author's construct, 2023

The cost of storage had a negative effect on the profit of local beef traders. Higher storage costs may imply longer storage time, but this could exceed the shelf life of the beef thereby attracting lower consumer prices. High storage costs can lead to a decrease in profit if the revenue decrease exceeds the marginal cost of adding more beef kilograms. This finding is contrary to Osondu et al. (2014) who indicated that, the storage cost of fresh products such as carrots have a positive impact on the profit of traders. The cost of transportation had a significant and negative effect on the profit of local beef traders. Traders experience lower profit when the transportation cost is higher. Traders are price takers in the beef market, which is fairly competitive. Hence, traders may struggle to increase the price of beef to compensate for the increase transportation costs, potentially leading to lower profit. This result is in consonance with Osondu et al. (2014), but contrary to Eze (2007), who revealed that the cost of transportation has a positive effect on the profit of beef traders in Nigeria.

Sources of profit inefficiency of beef traders

Table 4 also shows the sources of profit inefficiency of local beef retailers in Tamale, Ghana. Here, variables with a negative sign reduce inefficiency, while those with a positive sign increase inefficiency. The results reveal that the coefficient of age (0.350) is positive and significant. The result indicates that older traders experience higher inefficiencies. This may be due to their reduced adaptability to new market trends or slower adoption of technological advancements. Older traders may rely on traditional practices, limiting their ability to optimize profit margins. This finding is consistent with Bahta and Baker (2015), who revealed a positive and significant effect of age on profit inefficiency of beef farmers in Botswana. Household size (0.137) also has a positive and significant effect on profit inefficiency. This result is consistent with Kibona et al. (2023). Traders with larger households may have divided financial priorities, leading to less reinvestment in their beef retail business. Larger household responsibilities might also limit the time and energy available for expanding the beef business. In contrast, education has a negative and significant effect (-0.285) on profit inefficiency. This result agrees with that of Bahta and Baker (2015), who revealed a negative effect of education on profit inefficiency. Educated traders have lower inefficiencies because they have better access and understanding of information necessary for gaining a competitive advantage. Well-educated farmers save money (cost-effectiveness) and have important implications for the social and cultural capital benefits that literacy may help to organize (Kibona et al., 2023). The coefficient of ownership of cold storage facility (-2.621) is negative and significant, implying that retailers who owned cold storage facility have lower inefficiency in beef retailing. Traders with cold storage facilities can reduce spoilage and extend the shelf life of their products, thereby minimizing losses and maintaining a consistent supply to the market. This efficiency directly translates into improved

profitability, as retailers can better manage inventory and respond to market demand. Access to marketing information also has a negative and significant effect (-3.289) on profit inefficiency of beef traders. This result implies that access to marketing information reduces profit inefficiency of beef retailers. Traders with access to market information can better understand pricing trends, consumer preferences, and supply chain dynamics, enabling them to make informed decisions that enhance profitability. This finding is contrary to Bahta and Baker (2015), who revealed a positive and significant link between information access and profit inefficiency of beef farmers. Kibona et al. (2023) revealed otherwise, emphasizing that access to market information is vital to the growth of local beef because it generates the required demand (profitable market access) and provides remunerative pricing. Membership in traders' association (-1.332) is significant and negatively related to profit inefficiency of beef traders. This result implies that retailers who are members of marketing associations have lower profit inefficiency. When retailers join such associations, they can gain information about prices and market trends, which enhance their profit efficiency. However, Jimoh et al. (2023) found no significant effect of association membership of beef farms in Nigeria.

Distribution of the levels of profit efficiency

The study further compared the mean value and levels of profit inefficiency between the four major markets in Tamale. The mean profit efficiency of beef traders was 68%. This finding implies that the beef traders are 32% inefficient in their operations. However, traders in central market had highest mean profit efficiency (71.0%), followed by those in Kukuo market (6.9%), Aboabo market (67%), and Lamashegu market (65.3%). The results also show that most of the beef traders exhibited profit efficiency of 61-70%. However, 30% of beef traders in Kukuo market had profit efficiency of 71-80%.

Table 5: Distribution of levels of profit efficiency

Levels	Central market (%)	Aboabo market (%)	Lamashegu market (%)	Kukuo market (%)	All Traders (%)
Up to 0.10	2.5	5.0	2.5	0.0	2.5
0.11-0.20	5.0	5.0	5.0	7.5	5.6
0.21-0.30	0.0	0.0	5.0	0.0	1.3
0.31-0.40	2.5	5.0	5.0	7.5	5.0
0.41-0.50	12.5	7.5	12.5	12.5	11.3
0.51-0.60	20.0	2.5	7.5	10.0	10.0
0.61-0.70	25.0	32.0	25	22.0	26.0
0.71-0.80	20.0	17.5	12.5	7.5	14.4
0.81-0.90	7.5	20.0	19.0	30.0	19.1
0.91-1.00	5.0	5.5	6.0	3.0	4.9
Mean profit efficiency	0.71 (0.29)	0.670 (0.31)	0.653 (0.28)	0.699 (0.27)	0.68 (0.29)

Source: Author's construct, 2023

Challenges faced by beef traders in Tamale

The survey identified five major challenges faced by the beef traders in Tamale. The majority of beef traders had problems of inadequate capital, which was linked to

their inability to access formal source of credit. About 25% of the beef traders reported inadequate cold storage facilities as their major challenge in their business. Furthermore, 10% of them indicated inadequate supply of cattle as their major challenge in business. These respondents complained that they were usually forced to pay high rates to store their products in the cold room or else dispose of them at give-away prices if spoilage was suspected. Nine percent of the traders revealed no meat van as a problem and 7% cited regular power outages as their major challenge in the beef retailer business.

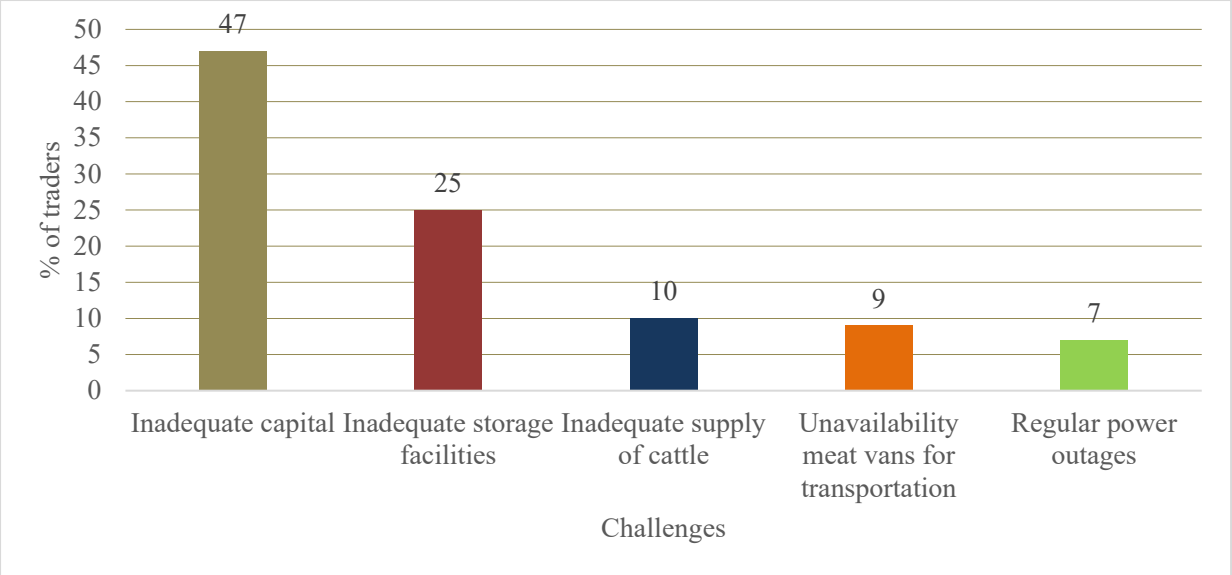

Figure 2: Challenges faced by beef traders in Tamale
Source: Author's construct, 2023

CONCLUSIONS

The study was conducted to examine the determinants of profit and profit efficiency of beef traders in Tamale, Ghana. The study applied a Cobb-Douglas stochastic frontier analysis to primary data from a random sample of 160 beef traders. The study found that cost of packaging, transportation cost, and storage played an important role in profit of beef traders. However, traders had a mean profit efficiency of 0.683, indicating that beef traders were 68.3% profit efficient. Moreover, the study identified the central market as the most profitable location for beef marketing, attributable to its strategic positioning to attract busier and affluent customers. The study highlights the significance of market selection and location strategy in maximizing profitability within the beef trading industry. Furthermore, age, education, household size, ownership of cold storage facility, access to marketing information, and membership in traders' associations were identified as the significant sources of profit (in-) efficiency among beef traders. The study concludes that the beef trading business in Tamale is profitable, but traders' profit efficiency needs to be improved. Furthermore, several challenges confronting traders in Tamale need to be mitigated. The most prevalent challenge reported by traders was inadequate capital, linked to difficulties in accessing formal credit. Additionally, concerns regarding inadequate cold storage facilities, limited supply of cattle, lack of meat vans, and regular power outages were identified as significant hurdles hampering the operations of beef traders. The study recommends that the establishment of marketing associations could play a pivotal

role in alleviating the inefficiencies in beef marketing. Furthermore, educational programmes could help improve the profit efficiency of beef traders. Beef traders should also be trained with better cost minimizing packaging options that would maximize their profit. The study also observes that measures such as providing cold storage infrastructure could significantly alleviate the challenges faced by beef traders in Tamale. Moreover, policies should moderate the transportation charges for beef traders in order to reduce their marketing cost and increase their profit.

References

Adzitey, F., Mireku, D. and Huda, N., (2018). Assessment of selected heavy metal concentration in fresh and grilled beef-A case study in East Legon, Ghana. *International Journal of One Health*, 4, 40-44.

Aidoo, R., Nimoh, F., Andivi Bakang, J. E., Ohene-Yankyera, K., Cudjoe Fialor, S., Mensah, J. O. and Abaidoo, R. C., (2012). Estimation of margins and efficiency in the Ghanaian yam marketing chain. *Asian Journal of Agriculture and Rural Development*, 2(2), 226-234.

Aigner, D., Lovell, C. K. and Schmidt, P., (1977). Formulation and estimation of stochastic frontier production function models. *Journal of Econometrics,* 6(1), 21-37.

Ali, M. and Flinn, J.C., (1989). Profit efficiency among Basmati rice producers in Pakistan Punjab. *American Journal of Agricultural Economics*, 71(2), 303-310.

Amankwah, K., Klerkx, L., Oosting, S.J., Sakyi-Dawson, O., Van der Zijpp, A. J. and Millar, D., (2012). Diagnosing constraints to market participation of small ruminant producers in northern Ghana: An innovation systems analysis. NJAS-Wageningen *Journal of Life Sciences*, 60, 37-47.

Annan, R. A., Apprey, C., Oppong, N. K., Petty-Agamatey, V., Mensah, L. and Thow, A. M., (2018). Public awareness and perception of Ghana's restrictive policy on fatty meat, as well as preference and consumption of meat products among Ghanaian adults living in the Kumasi Metropolis. BMC nutrition, 4, pp.1-8.

Asogwa, B. C. and Okwoche, V. A. (2012). Marketing of Agricultural Produce among Rural Farm Households in Nigeria: The Case of Sorghum Marketing in Benue State. *International Journal of Business and Social Science*, 3(13), 269-277.

Bageant, E. R., & Barrett, C. B. (2017). Are there gender differences in demand for index-based livestock insurance? *The Journal of Development Studies,* 53(6), 932-952.

Bahta, S. and Baker, D., (2015). Determinants of profit efficiency among smallholder beef producers in Botswana. *International Food and Agribusiness Management Review*, 18(3), 107-130.

Baker O. P. (1983). Basic Marketing Studies. Manchester, UK: Denner Publishers. Cited in Adekanye T.O., (ed.) (1988) Readings in Agriculture Marketing (Adekanye T.O., ed.), Lagos, Nigeria: Longman (Nigeria) Ltd.

Barnard, C. S and Nix, J. S, (1979). Farm Management and Control: 2nd Edition, Press Syndicate of the University of Cambridge, New York.

Bettencourt, E. M. V., Tilman, M., Henriques, P. D. D. S., Narciso, V. and Carvalho, M. L. D. S., (2013). The economic and sociocultural role of livestock in the wellbeing of rural communities of Timor-Leste. SOBER - Sociedade Brasileira de Economia, Administração e Sociologia Rural, Belém - PA, 21 a 24 de julho de 2013, 1-20.

Balogun, O. L., Ogunsina, I. J., Ayo-Bello, T. A. and Afodu, O. J. (2018). Effect of social capital on productivity of cassava farmers in Ogun State, Nigeria. Journal of Agricultural Sciences Belgrade, 63(1), 99-112

Cramer, G. L. and Jensen, C. W., (1982). Agricultural Economics and Agribusiness. 2nd ed. 465pp.

Dastagiri, M. B., Chand, R., Immanuelraj, T. K., Hanumanthaiah, C. V., Paramsivam, P., Sidhu, R. S., Sudha, M., Mandal, S., Singh, B., Chand, K. and Kumar, B. G., (2013). Indian vegetables: production trends, marketing efficiency and export competitiveness. *American Journal of Agriculture and Forestry*, 1(1), 1-11.

Dede, A. (1972). Ghanaian Favourite Dishes. Anowno Educational Publications, Accra.

Devendra, C. and Thomas, D., (2002). Crop–animal systems in Asia: importance of livestock and characterisation of agro-ecological zones. *Agricultural systems, 71(1-2), 5-15.*

Dziwornu, R. K. and Sarpong, D. B., (2014). Application of the stochastic profit frontier model to estimate economic efficiency in small-scale broiler production in the Greater Accra region of Ghana. *Review of Agricultural and Applied Economics* (RAAE), 17(2), 10-16.

Eyasmin, F. and Ghosh, B. C., (2024). Analyzing the determinants of beef cattle commercialization and Its market inefficiency: A case study of Pabna district, Bangladesh. *Plos one*, 19(3), p.e0300034.

Eze, C. C., (2007). Marketing margin and determinants of profit of beef marketing in Southeast Nigeria. *Tropical Science*, 47(2), 89-95.

FAO (2022). Livestock, engine for economic growth and sustainability: Framing role of livestock - a multi problem solving solution. Food and Agriculture Organisation of the United Nations. Rome, 2022.

Ghana Statistical Service (GSS), (2014). Population and Housing Census, District analytical report, Tamale Metropolis.

Haggblade, S., (2011). Modernizing African agribusiness: reflections for the future. *Journal of Agribusiness in Developing and Emerging Economies*, 1(1), 10-30.

Herrero, M., Havlik, P., McIntire, J., Palazzo, A. and Valin, H., (2014). African Livestock Futures: Realizing the potential of livestock for food security, poverty reduction and the environment in Sub-Saharan Africa. Office of the

Special Representative of the UN Secretary General for Food Security and Nutrition and the United Nations System Influenza Coordination (UNSIC), Geneva, Switzerland, 118 p.

Jimoh, S. O., Baruwa, O. I. and Kolapo, A., (2023). Analysis of profit efficiency of smallholder beef cattle farms in South-West Nigeria. *Cogent Economics & Finance*, 11(1), 2181786.

Kibona, C. A., Kironyi, L. and Zhang, Y., (2023). Profit Efficiency and its Determinants among Traditional Beef Cattle Farmers in the Meatu District of Simiyu Region, Tanzania. *Asian Journal of Agricultural Extension, Economics & Sociology,* 41(10), 525-548.

Kumbhakar, S. C., (1989). Economic performance of US Class 1 railroads: a stochastic frontier approach. *Applied Economics,* 21(11), 1433-1446.

Mahaboubil-Haq, M. and Adzitey, F., (2016). Meat production and consumption in the Wa Municipality of Ghana. *International Food Research Journal*, 23(3), 1338-1342.

Marandure, T., Mapiye, C., Makombe, G., Nengovhela, B., Strydom, P., Muchenje, V. and Dzama, K., (2016). Beef traders' and consumers' perceptions on the development of a natural pasture-fed beef brand by smallholder cattle producers in South Africa. *African Journal of Range & Forage Science*, 33(3), 207-214.

Mair, L. P. (2018). East Africa. In Survey of African Marriage and Family Life (pp. 46-72). Routledge.

MOFA (2007). Food and Agriculture Sector Development Policy (FASDEP II). Accra: Ghana, pp. 23-43.

Nastasijevic, I., Lazic, I. B., & Petrovic, Z. (2019). Precision livestock farming in the context of meat safety assurance system. In IOP Conference Series: Earth and Environmental Science (Vol. 333, No. 1, p. 012014). IOP Publishing.

Ojogho, O., Erhabor, P. O., Emokaro, C. O. and Ahmadu, J., (2012). Marketing margin and price transmission analysis for beef in Benin metropolis. *International Journal of Agricultural Economics and Rural Development*, 5(1), 63-73.

Osondu, C. K., Ijioma, J. C., Anyiro, C. O. and Obike, K., (2014). Economic analysis of pig production in Abia State, Nigeria. *International Journal of Applied Research and Technology*, 3(3), 3-10.

Owusu-Sekyere, E., Owusu, V. and Jordaan, H., (2014). Consumer preferences and willingness to pay for beef food safety assurance labels in the Kumasi Metropolis and Sunyani Municipality of Ghana. Food Control, 46, 152-159.

Sidhu, R. S., Sidhu, M. S. and Singh, J. M., (2011). Marketing efficiency of green peas under different supply chains in Punjab. *Agricultural Economics Research Review*, 24(2), 267-274.

Timmer, C. P., (2017). Food security, structural transformation, markets

and government policy. *Asia & the Pacific Policy Studies*, 4(1), 4-19.

Tiri, G. D., Ekpa, D. and Akinyemi, M., (2015). Empirical assessment of factors affecting marketing efficiency: A focus on sweet orange markets in kano metropolis, Nigeria. *International Journal of Innovative Agriculture & Biology Research*, 3(2), 1-9.

Ukwuaba, I. C., Agbo, F. U. and Adeosun, K. P., (2018). Socio-economic and institutional determinants of watermelon marketing in Enugu State Nigeria. *Journal of Agricultural Extension,* 22(3), 161-173.

Upton, M., (2004). The role of livestock in economic development and poverty reduction. FAO A Living from Livestock. PPLPI Working Paper No. 10. file:///C:/Users/cobbi002/Downloads/wp040010.pdf

Vaskó, Á., Vida, I., Vasa, L. and Adzitey, F., (2024). Correction: Opportunities within the meat supply chain in Africa—The case of beef production in Northern Ghana. *PLOS ONE*, 19(2), e0298803. doi: 10.1371/journal.pone.0298803.

World Population Review. (2024). Tamale Population 2024. https://worldpopulatioprofitefficiencyview.com/world-cities/tamale-population