

Analysis of Marketing Efficiency of Cattle for Enhancing Food Security in North-East Nigeria

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ABSTRACT

This study analysed the Marketing Efficiency of Cattle for Enhancing Food Security in North-East Nigeria. Purposive and simple random sampling method were adopted to select 495 respondents, to form the sample size. The Primary data for the study was collected through a cross-sectional survey of cattle marketers with the aid of well-structured questionnaire. The study employed stochastic frontier model to analyse the data collected. The Stochastic frontier analysis revealed that despite decline in efficiency, inputs such as capital (0.210), water (0.277), and cattle feeds (0.337), significantly increased efficiency, while experience in cattle marketing (-0.013) reduced inefficiency in the cattle marketing. The study therefore, recommend a concerted effort to establish robust frameworks, integrate cutting-edge technologies to facilitate a collective approach to addressing the complex challenges faced by cattle marketers, and fortify the adaptive capacity of the livestock sector to external shocks and enhance food security in North-East Nigeria.

Keywords: Cattle, Food security, In-efficiency, Marketing, Stochastic frontier

INTRODUCTION

Background of the Study

In Nigeria livestock sub-sector is an essential and integral component of its agriculture. It plays an important role in the economic and food security of the country. In the second quarter of 2023, the contribution of livestock production to Nigeria's GDP experienced an increase of 2.3% compared to the same period of the previous year. Agriculture contributes significant part of the country's GDP. It is a key activity for the country's economy after oil. By its population and capacity for animal production, with 25% of livestock herds in the sub-region, Nigeria is by far the leading livestock producer in central and West Africa. The country's cattle herds are estimated at over 16 million, head, far ahead of Niger (8.7 million), Mali (8.2 million), and Chad (7 million), the share of Sahel countries is significant, however, representing over 50% of the total cattle herds. Cattle raising in Nigeria is largely supplemented by short-cycle livestock operations estimated at 33.8 million head of sheep and 175 million poultry birds. The larger proportion of livestock population, about 90 % of the country's cattle population and 70% of the sheep and goat population, is concentrated in the northern region of the country. On the other hand, poultry is distributed across Nigeria with greater concentration in the southwest and southeast Nigeria (Anonymous, 2017).

The process of performing market research, selling products and services to customers and promoting them via advertising to further enhance sales is term as Marketing. Marketing efficiency is often used in evaluating the performance of the marketing process. Efficiency is a measure of performance of a system, it may be marketing or production performance. Marketing efficiency is measured by the input-output ratio, hence an efficient market

is obtained when the ratio value of the input throughout the system is maximized. The value of marketing efficiency ranges from zero (0) to infinity and less than 100% efficiency shows that the market is efficient while over 100% efficiency shows excess profit (Olukosi and Isito, 1990). According to Sessim et al. (2022), when assessing the technical and financial outcomes of various beef cattle production systems, advantageous marketing of cows and calves in native pastures (CCNP) was found to be the most financially efficient method when considering the gross margin per kilogram (GM/kg) (US\$ 0.93). When compared to the four units' combined average of US\$0.54, IAS had the lowest total production expenditures per kg (22.5%) and the highest GM/kg value (US\$0.74). Each autonomous unit was demonstrated to be capable of raising GM/kg (37%), GM/ha (3.8%), and using calves in a rearing-fattening unit for future sale. As a result, the integration of beef production systems increases company gross margins, providing rural entrepreneurs with a profitable advantage through non-opportunistic commercialization. The imperative to enhance efficiency within the livestock industry and the broader agricultural sector is paramount, given its pivotal role in addressing global challenges such as food security, economic development, and environmental sustainability. The significance of the livestock industry extends beyond conventional agricultural practices; it serves as a linchpin in the transformation toward sustainable agri-food systems, actively contributing to the regeneration of soils and the restoration of degraded landscapes (Zizhong et al., 2023).

Marketing efficiency is a crucial aspect of evaluating the effectiveness of agricultural systems, and various methods have been employed to quantify and analyse this efficiency. In a broader sense, marketing efficiency is often gauged by the ratio of input to output, with an increase in this ratio signifying improved efficiency and conversely, a decrease indicating diminished efficiency (Adanacioğlu, 2014). Among the numerous methodologies used to measure marketing efficiency, examining marketing margins has proven to be a common and insightful approach (Rupindo, 2009). One prevalent metric utilized to assess marketing efficiency is the profit-to-cost ratio, which delves into the relationship between the benefits gained and the costs incurred within a marketing system (Adefemi, 2014). A positive ratio signifies a proficient and effective marketing system, particularly when evenly distributed across all marketing institutions. This approach provides a view of the economic dynamics within the marketing ecosystem, shedding light on the balance between profitability and costs.

Problem Statement

One key avenue for improving efficiency in the livestock industry lies in the adoption of livestock solutions that have demonstrated success in enhancing eco-efficiency and productivity. Notably, improved forages and innovative grazing management strategies, as evidenced by case studies presented by Alem (2023), showcase the potential for positive environmental and economic outcomes. These solutions not only contribute to increased productivity but also align with sustainable practices that are critical for the long-term health of agricultural ecosystems. However, the realization of enhanced efficiency in the livestock industry is contingent upon addressing various challenges. Kennady et al. (2023) emphasize the need for improved institutional mechanisms, scientific and technological support, and resilience within the industry and its supply chain. Overcoming these challenges requires a concerted effort to establish robust frameworks, integrate cutting-edge technologies, and fortify the adaptive capacity of the livestock sector to external shocks.

No doubt in North east Nigeria some of the limiting factors in livestock marketing, policy planning and development analysis are the non-availability of reliable and accessible information on the cattle prices at different markets, distribution as well as market forces of demand and supply. These scenario became more pronounce lately as a result of farmer harder conflict, insurgency, as well as Boko Haram attack on herdsmen and cattle markets. "Therefore, the Analysis of Marketing Efficiency of Cattle for Enhancing Food Security in North-east Nigeria" is call for.

LITERATURE REVIEW

Conceptual Clarifications

The pivotal role of cattle marketing in Nigeria, emphasizing its multifaceted contributions to the economic, social, and cultural dimensions of the individuals engaged in cattle rearing and marketing. The significance of

cattle marketing extends beyond mere economic transactions, encompassing broader societal and cultural implications (Ismail, 2008). From an economic perspective, further recognises cattle marketing as a complex function influenced by various factors. Among these factors, transportation, pricing and financing, risk management, and the strategic practice of keeping cattle for future marketing play integral roles. The transportation infrastructure, pricing mechanisms, financial considerations, and risk mitigation strategies collectively contribute to shaping the dynamics of cattle marketing in Nigeria. Cattle marketing is deeply embedded in the fabric of communities, influencing livelihoods and fostering social connections. The economic transactions associated with cattle marketing have ripple effects that extend to various layers of society, contributing to the socio-economic well-being of individuals and communities engaged in this activity. Culturally, cattle hold symbolic value in many Nigerian communities, and their marketing is intertwined with traditional practices and cultural norms. The act of rearing and marketing cattle is often deeply rooted in cultural traditions, making it more than just an economic activity-it becomes a cultural practice that reflects the heritage and identity of the people involved (Mubi et al. 2013; Mafimisebi, 2012).

Theoretical Review

The estimate of the technical efficiency of the cattle feedlot system in Adamawa State, Nigeria, by Gabdo et al. (2020) uses data envelope analysis (DEA), free disposal hull (FDH), order-m, order- α , and bootstrap. The objective is to test the mean difference hypotheses across the estimators and rank the efficiency estimates based on the TE estimates from the five estimators in descending order. Furthermore, the feedlot system's independent variables were rated according to their contribution to overall cost. The original cost of the animal, feed, water, labour, depreciation, medications, and salt lick costs are rated 1st, 2nd, 3rd, 4th, 5th, 6th and 7th, respectively, in terms of their percentage to the total cost, according to the results, Akouegnonhou et al. (2023) aimed to assess the efficiency of beef cattle markets in the Republic of Benin. Among different marketing channels that were identified in the selected beef cattle markets: Channel I, II, III, IV, and V. Channel I appears to be the most efficient in both markets with a marketing efficiency of 2.57 in self-managed beef cattle markets and 1.23 in traditional beef cattle markets. The average marketing efficiencies are 1.25 and 0.97 in self-managed beef cattle markets and traditional beef cattle markets, respectively.

Optimizing animal productivity within resource constraints is a central tenet of sustainable livestock production, as highlighted by Brithe et al. (2023). This involves striking a balance between maximizing output and minimizing resource inputs, a critical consideration for both economic viability and environmental stewardship. Equally vital is the necessity to ensure that livestock production practices align with societal and consumer preferences, underscoring the importance of social acceptance and ethical considerations in the pursuit of efficiency.

Policies play a fundamental role in steering the course of the livestock industry, and initiatives encouraging innovation and investment in new technologies are instrumental in driving economic competitiveness, emission reduction, and increased productivity (Bumbiere et al., 2023).

Acharya's modified method is another valuable tool employed to ascertain marketing efficiency. Gangwar et al. (2010) utilized this method to evaluate the marketing efficiency of broilers in Delhi, India, exemplifying its applicability in diverse agricultural contexts. Similarly, Adanacioğlu (2014) employed Acharya's modified method to assess the efficiency of both direct and indirect marketing channels employed by farmers in İzmir, Türkiye, showcasing its versatility in analysing different marketing strategies.

The utility of Acharya's modified method extends to various agricultural value chains, as demonstrated by Sirak, and Derek, (2015), who used this approach to estimate the marketing efficiency of the beef cattle value chain in the Longido and Monduli districts in Tanzania. Erdoğan et al. (2016) also harnessed this method to identify the marketing efficiency of apple production in the Senirkent district of the Isparta province in Türkiye. This consistency in methodology allows for cross-context comparisons and facilitates a standardized assessment of marketing efficiency across diverse agricultural sectors.

METHODOLOGY

Description of the Study Area

Adamawa State is located at the North eastern part of Nigeria. It lies between latitude 7° and 11° North of the equator and between longitude 11° and 14° east of the Greenwich meridian. It shares boundaries with Taraba State in the Southwest; Gombe state in the Northwest and Borno State in the North. The State has an international boundary with the Cameroun Republic along its Eastern border. It covers a land area of about 38.74km^2 with a current projected population of about 3.2 million people according to 2006 National Census figure using the annual estimated population growth rate of 2.41 percent (Adebayo et al., 2021).

However, Taraba State had a population of about 2,300,736 people as at 2006 (NPC 2006). It has 16 Local Government Areas and one Special Development Area. It is divided into three Senatorial Districts: North, South and Central. It lies between latitudes $6^{\circ} 30'N$ and $8^{\circ} 30'N$ of the Equator and between longitudes 9° and 12° E of the Greenwich Meridian with a land mass of $54,426\text{ km}^2$ (Oruonye and Bashir, 2011). Taraba State shares boundaries with Bauchi and Gombe States in the North, Adamawa State in the East and Republic of Cameroun in the South and Nasarawa and Benue States in the South-West as indicated in figure one below (Figure1). It has a tropical wet and dry season, well drained alluvial soils and characterized by both savannah and temperate vegetation. Its dry season lasts for a minimum of five months (November to March) while the wet season spans early March to late November in the south and early April to November in the North. The mean annual rainfall ranges from 1000 mm in the northern part to over 1800 mm in the extreme southern part and Mambila area (Oruonye and Bashir, 2011).

Borno state is located on latitude $10^{\circ} 05'$ to $13^{\circ} 55'N$ and longitude $11^{\circ} 45'$ to $14^{\circ} 45'E$ it is bounded in northeast by Lake Chad, north by republic of Chad. West by Yobe state, south by Gombe and Adamawa state and east by republic of Cameroon. it has its capital in Maiduguri and it made up of 27 local government areas. The climate is characterized by two distinct seasons dry and wet the wet season last a period of four months (June – September), while the dry season covers the month of October to may. Precipitation is quite low with a mean annual rainfall of 630mm. temperature are generally high throughout the year with the annual average of $26^{\circ}C$. The Harmattan wins however exercised a moderating effect on temperature between November to February. Main annual sun shine hours are high in Borno state (10hrs) while the mean annual humidity is low (20-40%).

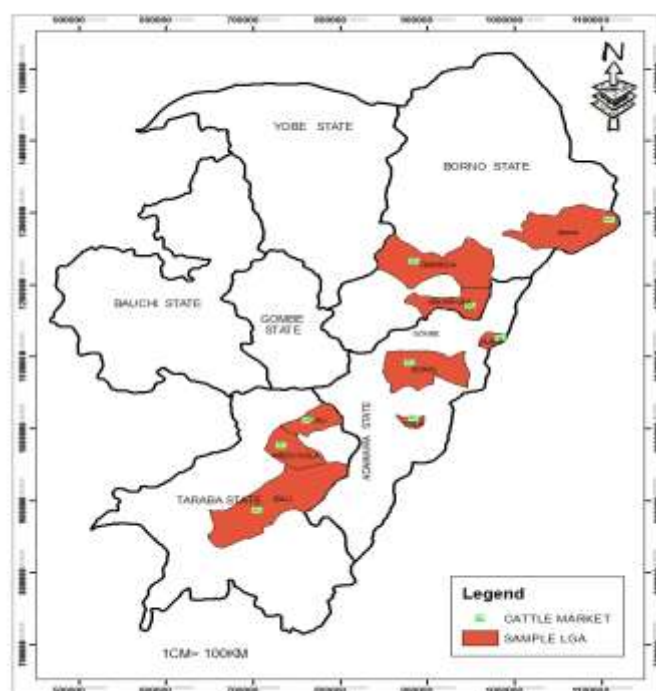


Figure 1: Map of Nigeria indicating Study Area

Sampling Techniques

This study used purposive and simple random sampling approach. The sampling process consist of five distinct stages, each serving a specific purpose and contributing to the overall robustness of the research. Stage i, involved the purposive selection of three states, namely Adamawa, Borno, and Taraba, within the North-East region. The rationale for this choice is rooted in the presence of the most prominent cattle markets in these areas, making them suitable for an in-depth investigation of efficiency of the marketers. Stage ii, involved the selection of three local governments from each of the aforementioned states.

The criterion for this selection was based on cattle marketing activities within these local governments. Stage iii, involved the purposive selection of three specific cattle markets within each selected local government. This selection was guided by observable factors, primarily the visible capacities of cattle inflows and outflows from these markets. The last stage, iv employed simple random sampling technique to select the respondents in proportion to the total population of cattle marketers in each market. The data was obtained from government tax collectors' records.

Sampling Frame and Sample Size

From Table 1 in Adamawa State: Yola South, Song and Mubi South local governments were selected, with their respective cattle markets, Ngurore, Song cattle market and Tike International cattle market. The Table detailed the population of cattle marketers in each of these markets, which is 560 in Ngurore, 470 in Song and 750 in Mubi South. A 10% sample of the population was taken from each market, resulting in a total sample size of 178 individuals from Adamawa State. For Borno State, the local governments of Askira Uba, Chibok, and Maiduguri were considered, and the respective cattle markets, Askira Uba, Chibok, and Maiduguri cattle markets, were assessed. The Table display the population of cattle marketers in each of these markets, which includes 558 in Askira Uba, 510 in Chibok, and 580 in Maiduguri. A 10% sample was extracted from each market, resulting in a total sample size of 165 individuals from Borno State.

The final state, Taraba, was presented with the local governments of Gashaka, Eware, and Sardauna, and their respective cattle markets, Gashaka, Eware, and Nguroje cattle markets. The table outlines the population of cattle marketers in each market, with 541 in Gashaka, 515 in Eware, and 464 in Sardauna. Similarly, a 10% sample was chosen from each of these markets, resulting in a total sample size of 152 respondents from Taraba State.

Table 1: Sampling Frame and Sample Size

State	Local Government	Cattle markets	Population of cattle marketers	Sample (10% of the population)	Total sample
Adamawa	Yola South	Ngurore	560	56	
	Song	Song cattle market	470	47	
	Mubi South	Tike Int'l cattle Market	750	75	
			1,780	178	178
Borno	Askira Uba	Askira Uba cattle market	558	56	
	Chibok	Chibok cattle market	510	51	
	Maiduguri	Maiduguri cattle market	580	58	
			1,648	165	165
Taraba	Gashaka	Karamti cattle market	541	54	
	Eware	Eware cattle market	515	52	

	Sardauna	Nguroje cattle market	464	46	
			1,520	152	152
			4,948		495

Source: Designed by the Author based on pilot information from each of the markets.

Method of Data Collection

The primary data related to marketing efficiency of the cattle marketers was collected via structured questionnaire. The method of data collection was carefully structured to gather the necessary information for the research. This method was used to ensure the systematic and standardized acquisition of data from the study respondents.

Stochastic Frontier Analysis (SFA) Model:

The efficiency of cattle marketers for enhancing food security is a critical aspect of this study. To analyse this, the specialized method of stochastic frontier analysis was employed. This method differentiates between observed outcomes and the maximum achievable outcomes, making it a valuable tool for measuring efficiency in the presence of random factors, technical inefficiencies, and external challenges. By utilizing stochastic frontier analysis, the researcher will estimate the efficiency of individual cattle marketers and identify the factors contributing to deviations from optimal performance. This approach allowed the study to gain valuable insights into the efficiency dynamics within the cattle marketing sector. In line with previous empirical studies such as Ogbanje (2015) and Adebayo et al. (2018), this study specified the stochastic frontier model in the form of Cobb-Douglas (log-log) functional form as shown in equation (II).

$$\text{Log(KGCS)}_i = \varphi_0 + \varphi_1 \text{Log(K)}_i + \varphi_2 \text{Log(L)}_i + \varphi_3 \text{Log(W)}_i + \varphi_4 \text{Log(F)}_i + \varphi_5 \text{Log(T)}_i + \varphi_6 \text{Log(M)}_i + (v_i - \mu_i) \text{ --- (II)}$$

Where:

KGCS = Kilogram of Cattle Sold

K = Capital (measured as the total amount of money invested in purchasing cattle for marketing)

L = Labour (measured as the hours of labour employed per month)

W = Water (measured as the litres of water used by the cattle per month)

F = Feeds (kilogram of cattle feeds used per month)

T = Transportation cost incurred per month (NGN)

M = Medical cost per month (NGN)

$(v_i - \mu_i)$ = composite errors

Log = Natural logarithm

i = Individual cattle marketers

φ_0 = Constant

$\varphi_1, \varphi_2, \varphi_3, \varphi_4, \varphi_5$, and φ_6 = the coefficients of the respective variables to be estimated.

A Priori Expectations

The coefficients $\varphi_1, \varphi_2, \varphi_3, \varphi_4, \varphi_5$, and φ_6 are expected to have positive and statistically significant signs. This is because the study theoretically expects that capital investment of the cattle marketer, labour hours employed, water provided to the cattle, feeding of cattle, transportation and medicals should increase the efficiency of cattle marketing as well as enhance food security in Northeast Nigeria.

The inefficiency model (u) for the stochastic frontier can be defined as in equation 3.

$$U = \vartheta_0 + \vartheta_1 h_{1i} + \vartheta_2 h_{2i} + \vartheta_3 h_{3i} + \vartheta_4 h_{4i} + \vartheta_5 h_{5i} + (v_i - \mu_i) \text{ --- (III)}$$

Where:

h_1 = age of the cattle marketer in years

h_2 = Years of education of the cattle marketer

h_3 = Years of cattle marketing experience
 h_4 = Household size of the cattle marketer
 h_5 = Membership of cattle marketers' association
 θ_0 = constant
 $\theta_1, \theta_2, \theta_3, \theta_4$ and θ_5 = coefficients of the respective variables

A priori Expectations

$\theta_1, \theta_2, \theta_3, \theta_4$ and θ_5 are expected to have negative signs and be statistically significant. This is due to the theoretical expectation that age, education, experience, household size and being a member of cattle marketers' association are likely to reduce inefficiency of cattle marketers.

RESULTS AND DISCUSSION

Efficiency of Cattle Marketers in the Northeast During Cash Crunch Period

The Table 2 presents the results of a Stochastic Frontier Analysis (SFA) examining the efficiency of cattle marketers in the Northeast during the challenging period of the cash crunch era. This analysis provides valuable insights into the production factors (frontier) and inefficiency factors (μ) affecting the performance of cattle marketers. The dependent variable is the output which is measured by the log of the amount of cattle (in kilograms) sold by cattle marketers during the cash crunch period. The log transformation of the quantity of cattle sold is a common practice in econometric analysis. It offers several advantages, such as normalizing the distribution of the variable and allowing for a linear relationship between the independent and dependent variables. In this context, it assesses the efficiency of cattle marketers in terms of their sales performance during a challenging economic period, the cash crunch period.

The coefficient estimates for the independent variables in the table indicate how each factor influences the quantity of cattle sold, which, in turn, reflects the efficiency of cattle marketers in generating sales. The statistical significance and magnitude of these coefficients provide insights into the impact of various factors on the marketing efficiency of cattle marketers during the cash crunch period.

Frontier (Production Factors)

The constant term in the analysis, represented by a coefficient of -1.839 and a highly significant p-value of 0.000, plays a crucial role in the interpretation of the efficiency of cattle marketers during the cash crunch period. The constant serves as the baseline or intercept in the model, and it provides a reference point for understanding the efficiency level of cattle marketers when all other factors are at their reference values. In other words, it represents the starting point or initial efficiency level in the absence of any specific input or factor under consideration. The negative coefficient indicates that, without any input or adjustment, the baseline efficiency level is below zero. This might seem counterintuitive, but it's important to remember that this value is relative to the other factors in the model. The significance of the coefficient (p-value of 0.000) underscores the importance of considering this baseline when evaluating the impact of other factors on efficiency.

In practical terms, the constant helps provide a baseline comparison for assessing how various factors, such as capital, labour, water, feeds, transport costs, and medicine, affect the efficiency of cattle marketers. It allows for a reference point to gauge the magnitude and direction of change in efficiency as these factors vary. Understanding the baseline efficiency level is essential for policymakers, researchers, and stakeholders who aim to improve the efficiency and economic outcomes of cattle marketing businesses. By considering the constant term alongside the other coefficients, they can gain insights into the relative importance of different inputs and how adjustments can lead to enhanced efficiency during challenging economic periods.

Capital: The coefficient of 0.210 with a highly significant p-value of 0.000 for the variable "Log of Capital" reveals a vital relationship between financial resources and the efficiency of cattle marketers during the cash crunch period. The log transformation of capital, which quantifies the financial resources available to cattle marketers, provides a critical insight into how financial stability impacts their operations. The positive coefficient

indicates that an increase in the logarithm of capital is associated with improved efficiency. In practical terms, this means that cattle marketers with greater financial resources tend to be more efficient in selling cattle during the cash crunch period. This result is in harmony with Zizhong et al. (2023) who stated that finance have more influence on the profit level in cattle marketing. This result has important implications for their ability to navigate challenging economic conditions. The statistical significance of this finding features the robustness of the relationship. It suggests that the effect of capital on efficiency is not merely due to chance but is a reliable and meaningful pattern in the data. In other words, the positive impact of financial resources on efficiency is a consistent and substantial one.

This result highlights the critical role of financial stability in the cattle marketing business during economic challenges. Cattle marketers with access to capital are better equipped to cover essential costs, respond to market fluctuations, and seize opportunities, ultimately contributing to their efficiency in selling cattle. Therefore, strategies that enhance financial stability, such as access to credit or financial support mechanisms, can be instrumental in helping cattle marketers maintain their efficiency during cash crunch periods.

Water: The variable Log Litre of Water has a coefficient of 0.277 and a highly significant p-value of 0.000. This result suggests that the logarithm of the litres of water used by cattle marketers during the cash crunch period has a positive and substantial impact on their efficiency. The positive coefficient indicates that a percentage increase in water usage is associated with improved efficiency in selling cattle. In practical terms, this means that cattle marketers who have better access to water resources tend to be more efficient in their operations during the cash crunch period. The statistical significance of this relationship underscores its reliability and robustness.

Access to water resources is crucial for maintaining the health and well-being of cattle. Adequate water supply is essential for cattle to thrive and remain in good condition, which directly affects their market value. This finding highlights the importance of water availability for the efficiency of cattle marketers, particularly during challenging economic periods. Efforts to support cattle marketers during cash crunch periods should consider strategies to ensure reliable access to water resources. This may involve investments in water infrastructure, improved water management practices, and measures to address water scarcity issues. By addressing the water needs of cattle, policymakers and stakeholders can contribute to the overall efficiency and profitability of cattle marketing businesses in the Northeast region.

Feeds: The variable Log Kg of Feeds has a coefficient of 0.337 and a highly significant p-value of 0.000, indicating that the kilograms of cattle feeds used by cattle marketers during the cash crunch period have a positive and substantial impact on their efficiency. The positive coefficient suggests that an increase in the cattle feed usage is associated with improved efficiency in cattle marketing operations. In practical terms, this means that cattle marketers who have better access to and utilization of cattle feeds tend to be more efficient in their activities during challenging economic periods like the cash crunch period. The highly significant p-value underscores the statistical reliability of this relationship. It highlights the critical role of cattle feeds in enhancing the efficiency of cattle marketers, which, in turn, positively influences their economic performance. Cattle feed is a fundamental resource for maintaining the health and productivity of cattle, directly impacting their market value.

Efforts to support cattle marketers should prioritize strategies to ensure reliable access to high-quality cattle feeds. This may involve promoting efficient feed management practices, supporting the availability of affordable and nutritious cattle feed options, and offering guidance on optimizing feed usage. By addressing the cattle feed needs of cattle marketers, stakeholders can play a crucial role in enhancing the overall efficiency and profitability of cattle marketing businesses in the Northeast region during challenging economic periods.

Transport Cost: The variable "Log Transport Cost" has a coefficient of 0.090 and a significant p-value of 0.002. This result indicates that transport costs incurred by cattle marketers during the cash crunch period positively affect their efficiency. The positive coefficient suggests that an increase in the logarithm of transport costs is associated with improved efficiency in cattle marketing operations. In practical terms, this means that cattle marketers who invest in efficient transportation, even though it incurs costs, tend to be more efficient in their activities during challenging economic periods like the cash crunch period.

The significant p-value highlights the statistical significance of this relationship, highlighting the importance of transportation in enhancing the efficiency of cattle marketers. Efficient transportation plays a vital role in ensuring that cattle can be moved to markets or buyers in a timely and cost-effective manner. It can help reduce losses, enhance market access, and optimize the use of resources.

Efforts to support cattle marketers should consider strategies to improve transportation infrastructure and logistics. This may involve investments in better roads, vehicles, and transportation management practices. By addressing transportation challenges, stakeholders can contribute to the overall efficiency and profitability of cattle marketing businesses in the Northeast region, even during challenging economic periods.

Medicine: The variable "Log of Gram of Medicine" has a coefficient of 0.129 and a significant p-value of 0.000. This result indicates that medicine used by cattle marketers during the cash crunch period has a positive effect on their efficiency. The positive coefficient suggests that an increase in the grams of medicine is associated with improved efficiency in cattle marketing operations. In practical terms, this means that cattle marketers who have access to and make effective use of medicine for cattle health management tend to be more efficient in their activities during challenging economic periods like the cash crunch period.

The significant p-value underscores the statistical reliability of this relationship, emphasizing the crucial role of medicine in enhancing the efficiency of cattle marketers. Access to appropriate medicines and their proper administration are vital for maintaining the health and productivity of cattle, which directly affects their market value. Efforts to support cattle marketers should prioritize strategies to ensure reliable access to quality medicines and promote effective health management practices for cattle. This may involve training, guidance on disease prevention, and access to veterinary care.

Mu (Inefficiency Factors)

In this context, inefficiency refers to the degree to which cattle marketers may fall short of their maximum potential in terms of output (i.e., the amount of cattle sold) given the inputs and resources available to them. The constant term in the inefficiency model serves as the baseline or reference point for the analysis of inefficiency factors. It represents the level of inefficiency when all other independent variables in the model are at their reference values or held constant. In this specific model, the constant term does not significantly impact inefficiency, as indicated by a p-value of 0.518.

Table 2: Stochastic Frontier Result of the Efficiency of Cattle Marketers During Cash Crunch Period

Output (log of kg of cattle sold)	Coefficient	Standard Error	z-statistic	P-value
Frontier (Production Factors)				
Log of capital	0.210***	0.039	5.350	0.000
Log labour hour	0.004	0.012	0.350	0.729
Log litre of water	0.277***	0.052	5.320	0.000
Log kg of feeds	0.337***	0.057	5.900	0.000
Log transport cost	0.090***	0.029	3.120	0.002
Log of gram of medicine	0.129***	0.037	3.490	0.000
constant	-1.839***	0.307	-5.990	0.000
Mu (Inefficiency factors)				
Average age of cattle marketer	0.003	0.003	1.090	0.276
Years of Education	-0.001	0.002	-0.620	0.537
Years of Business/marketing Experience	-0.013*	0.007	-1.910	0.056
Constant	0.046	0.071	0.650	0.518
Usigma Constant	-12.039**	5.024	-2.400	0.017
Vsigma Constant	-2.628***	0.065	-40.280	0.000
sigma u	0.002	0.006	0.400	0.691
sigma_v	0.269***	0.009	30.650	0.000

lambda	0.009	0.011	0.850	0.393
Number of observations	470	Wald chi2(6)	15202.52	
Log likelihood	-49.3938	Prob > chi2	0.0000	

Source: Field Survey, 2023. Note that Stoc. frontier normal/tnormal model was estimated.

A p-value of 0.518 means that the constant term is not statistically significant in explaining variations in inefficiency among cattle marketers during the cash crunch period. In other words, the constant term does not provide meaningful information or contribute significantly to the understanding of inefficiency in this context. The lack of statistical significance for the constant term suggests that other variables, such as capital, labor, water resources, feeds, transport costs, and medicine, play a more substantial role in influencing inefficiency among cattle marketers during the cash crunch period. This is in line with Gabdo et al. (2017) who stated that inappropriate scale of production and managerial problems as the causes of inefficiency in the cattle feedlot. These variables are the key determinants of efficiency in this model, and their coefficients and significance levels provide more valuable insights into the factors affecting inefficiency in cattle marketing. While the constant term itself may not be significant, it is essential in statistical modelling as a reference point and in constructing the overall model equation. Its role is to account for any constant or unexplained factors contributing to inefficiency that are not captured by the explicit independent variables in the model. However, in this specific analysis, the constant term does not appear to significantly contribute to the explanation of inefficiency among cattle marketers during the cash crunch period.

Average Age: The average age of cattle marketers is considered as a potential factor that could affect their efficiency. However, the coefficient associated with the average age of cattle marketers, which is 0.003, and the non-significant p-value of 0.276 suggest that the age of cattle marketers does not have a statistically significant impact on their inefficiency during the cash crunch period. This result appears to be contrary to the findings of Restiyana, et al. (2023) who revealed that average age significantly reduces inefficiency of cattle marketers and farmers.

The non-significant p-value of 0.276 indicates that the relationship between the age of cattle marketers and inefficiency is not strong enough to draw statistically significant conclusions. In other words, the data does not provide compelling evidence that the age of cattle marketers plays a significant role in determining their inefficiency. This result suggests that, during the cash crunch period, other factors, such as access to resources, education, and experience, may have a more substantial influence on the efficiency of cattle marketers. Age, while an important demographic factor, does not emerge as a strong determinant of inefficiency in this specific context.

Years of Education: The number of years of education received by cattle marketers is considered as a potential factor that could affect their efficiency. However, the coefficient associated with years of education, which is - 0.001, and the non-significant p-value of 0.537 indicate that years of education do not have a statistically significant impact on the inefficiency of cattle marketers during the cash crunch period.

The non-significant p-value of 0.537 suggests that there is no strong statistical evidence to support the idea that the number of years of education significantly influences the inefficiency of cattle marketers. In other words, the data does not provide compelling evidence that the level of education plays a significant role in determining their inefficiency during the cash crunch period. This result indicates that, within the context of the cash crunch period, years of education, while important for overall human capital development, do not appear to be a significant determinant of inefficiency in this specific economic context.

It is important to recognize that education remains a crucial factor for various aspects of individual and societal development. While it may not be a significant driver of efficiency in this particular analysis, it still has broader implications for the livelihoods and well-being of cattle marketers and their communities. However, for the specific context of operational efficiency during the cash crunch period, other factors seem to play a more prominent role.

Years of Business/Marketing Experience: The coefficient of -0.013 associated with years of business or marketing experience, along with a p-value of 0.056, suggests that years of experience in the cattle marketing business have a weakly significant negative impact on inefficiency. In other words, there is some evidence to indicate that as cattle marketers gain more experience in their business or marketing activities, they tend to become slightly more efficient during the cash crunch period. The weakly significant negative coefficient implies that with each additional year of experience, cattle marketers may reduce their level of inefficiency. This suggests that seasoned cattle marketers, who have a better understanding of the market dynamics, customer preferences, and operational challenges, tend to handle their business operations with a slightly higher degree of efficiency. While the p-value of 0.056 does not reach the conventional significance level of 0.05, it indicates that there is some level of statistical evidence to support the idea that experience contributes to efficiency.

However, the evidence is not strong enough to conclude with high confidence that years of experience play a substantial role in reducing inefficiency during the cash crunch period. Years of experience is just one of many potential determinants of efficiency, and the analysis suggests that its impact, while present, may be relatively modest in this context. Overall, the findings imply that cattle marketers with more experience may have a slight advantage in terms of operational efficiency during challenging economic periods, but this advantage is not strongly significant according to the statistical test results.

Unobservable Factors (Usigma and Vsigma)

Usigma Constant: With a coefficient of -12.039 and a significant p-value of 0.017, Usigma represents one of the components of the inefficiency structure. It indicates that unobservable factors contribute to the inefficiency of cattle marketers. The negative coefficient suggests that these unobservable factors tend to reduce inefficiency.

Vsigma Constant: Vsigma, represented by a coefficient of -2.628 and a highly significant p-value of 0.000, signifies another component of the inefficiency structure. It suggests that observable factors, which can be controlled or influenced, have a substantial impact on reducing inefficiency.

Sigma_u: The coefficient of 0.002 with a non-significant p-value of 0.691 represents the variability in unobservable factors contributing to inefficiency. While the coefficient is non-significant, it indicates that there is minimal variation in unobservable factors affecting inefficiency.

Sigma_v: The coefficient of 0.269 with a highly significant p-value of 0.000 suggests a significant level of variation in observable factors influencing inefficiency. This implies that there is considerable scope to address and control observable factors that contribute to inefficiency.

Impact of Inefficiency on Model's Efficiency

Lambda: The coefficient of Lambda, which is 0.009, with a non-significant p-value of 0.393, provides insights into the impact of inefficiency on the overall stochastic frontier efficiency in the context of cattle marketing during the cash crunch period. Although the coefficient is not statistically significant, its value suggests that inefficiency does not have a substantial or statistically significant effect on the overall stochastic frontier efficiency. In this context, the stochastic frontier model attempts to separate observed output into two components: the productive (efficient) component captured by the frontier and the inefficiency component that accounts for deviations from the frontier. The Lambda coefficient reflects the degree to which inefficiency influences the overall stochastic frontier efficiency.

With a non-significant p-value of 0.393, the analysis indicates that the inefficiency factor, represented by Lambda, is not statistically significant. This suggests that inefficiency, which may arise from various unobservable or random factors, does not significantly affect the overall stochastic frontier efficiency for cattle marketers during the cash crunch period.

The lack of statistical significance for Lambda implies that the deviations from the frontier caused by inefficiency do not substantially impact the overall efficiency of cattle marketing operations. While inefficiency may exist to some extent, it does not pose a significant obstacle to achieving a high level of overall efficiency in the industry during the cash crunch period. Other factors, such as capital, labor, water resources, feeds, transport costs, and medicine, seem to play a more dominant role in influencing efficiency, as indicated by their significant coefficients in the model.

Summary and Recommendations

The efficiency of cattle marketers during the cash crunch period in North-east Nigeria was analysed, where significant evidence of declining efficiency was observed. However, inputs such as capital, labour, water, cattle feeds, transportation cost and medications were found to significantly increase the efficiency of cattle marketers during the period of the cash crunch. Similarly, years of cattle marketing experience was found to significantly reduce inefficiency of the cattle marketers during the cash crunch period.

RECOMMENDATIONS

- a) Effective government regulation and oversight are necessary to ensure fair pricing practices, maintain product quality standards, and address issues related to counterfeit credit alerts in the cattle marketing sector. This oversight should be conducted transparently and consistently.
- b) Establishing platforms for knowledge exchange and networking can facilitate a collective approach to addressing the complex challenges faced by cattle marketers in Northeast Nigeria.

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