Comparative Analysis of the Profitability of Major Value-added Activities Along the Pineapple Value Chain in Ghana

Kwaku Boakye[1,2,3], Iddrisu Salifu[4,5], Hayford Danso[2] & Yu-Feng Lee[2]

[1] New Mexico Department of Transportation, State of New Mexico, Santa Fe, United States

[2] Department of Economics, Applied Statistics and Int'l Business, College of Business, New Mexico State University, United States

[3] Department of Agricultural Economics and Extension, School of Agriculture, College of Agriculture and Natural Science, University of Cape Coast, Cape Coast, Ghana

[4] Depart of Applied Economics, School of Economics, University of Cape Coast, Cape Coast, Ghana

[5] Centre for Coastal Management-Africa Centre of Excellence in Coastal Resilience, Department of Fisheries and Aquatic Sciences, University of Cape Coast, Cape Coast, Ghana

Correspondence: Kwaku Boakye, Department of Agricultural Economics and Extension, Private Mail Bag, University Post Office, UCC, Cape Coast, Ghana. E-mail: kwaku.boakye@stu.ucc.edu.gh

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Abstract

This study aimed to analyze the profitability of sampled pineapple farmers, processors, and marketers in Ghana, which will help to assess how these actors optimize available resources to generate profits and achieve production efficiency. A cross-sectional descriptive survey design was used with interview schedules as the data collection instruments. The sample size was 320, 66, and 169, pineapple farmers, processors, and marketers respectively. The study found that pineapple production and processing were profitable, but marketing was not. The results showed a significant difference in the profit share of the group actors, highlighting that the profit share of each actor along the pineapple value chain is different. The results also showed that income, capital, and planting materials were the main determinants of farmers' profits. On the other hand, capital, pineapples, and packaging materials were the predictors of processors' profits. While transport, revenue, and loading and unloading costs predicted the marketer's profit. Based on these findings, the study recommended that NGOs and other partner agencies promote the pineapple industry in various ways to reduce poverty by providing credit facilities to actors to increase their productivity, profitability, and sustainability.

Keywords: comparative analysis, profitability, gross margin analysis, value-added activities, pineapple value chain

1. Introduction

Agriculture continues to play a crucial role in the economies of developing countries, particularly in sub-Saharan Africa where it serves as the primary means of supporting livelihoods. In Ghana, the service sector is growing significantly, although its agricultural sector remains foundational, contributing 19% of the country's GDP and employing 34% of its workforce (GSS 2019; Omari et al. 2020). Various studies have highlighted the importance of the agricultural sector in Ghanaian households (Danso-Abbeam Baiyegunhi 2020; Ferreira et al. 2022; Mensah 2019). Especially, worth noting is smallholder farmers play a vital role in generating overall employment and promoting income equality, which is crucial for economic development as previous studies (Abdul-Rahaman & Abdulai, 2020; Anang & Apedo, 2023; Waarts et al., 2021) have asserted.

Horticultures significantly contribute to GDP, foreign exchange reserves, and food security, accounting for 86% of total agricultural earnings (Akrong et al., 2021; Ghana Export Promotion Authority, 2017). The horticultural sector helps advance Sustainable Development Goals 1 and 2 by creating employment opportunities and generating income for small-scale farmers nationwide (Akrong et al. 2021; Asem 2018). Pineapple is Ghana's leading horticultural produce, with high production volume and export value (Annor-Frempong, 2023; Asem, 2018; Hanyabui et al., 2024). The Central Region of Ghana is well known for pineapple production, which serves as a significant source of income and food security for rural households, while a sustainable commercial pineapple value chain system is

crucial to yield, income, and livelihoods (Annor-Frempong, 2023).

Nonetheless, anecdotal evidence from previous studies (Annor-Frempong, 2023; Boakye, 2020) has demonstrated that pineapple production faces different challenges. Gates emphasized that "empowering smallholders is an effective strategy to combat hunger and poverty", where innovation is advocated as the primary means of increasing farm productivity and household income. Although this approach may not be effective in diverse geographical areas facing varying resource availabilities, one size may not fit all. In the face of resource misallocation, ineffective production may jeopardize profitability, particularly in small-scale farming.

In a market economy, production prioritizes efficient resource utilization and value chain development to optimize product value through various activities (Hoque et al., 2019; Rahman et al. 2021). Fundamentally, market economies are guided by profit maximization, whereby the quantity produced and sold in value is adjusted to match marginal revenue. As in equilibrium, agricultural production matching its marginal cost can be evaluated by integrated primary stakeholders, including farmers, producers, processors, marketers, and other supporting service providers, who collaborate to achieve a competitive advantage and create fair value for the product.

In Ghana, all key players in the pineapple value chain system, including farmers, processors, and marketers, make rational decisions to maximize profits as a priority or minimize costs (Asante-Poku, 2016). Thus, understanding the market potential of major value-added activities in pineapple farming has become substantial. The major value-added activities in creating pineapple value are essential for economic growth and development, contributing to the growth of the Ghanaian economy. In particular, many farmers view their involvement in the pineapple value chain as unpaid labor rather than formal employment, which has implications for sustainable management strategies and accurate statistical reporting. Profitability metrics are crucial indicators of efficiency.

Profitability alone cannot guarantee efficiency; it is a critical assessment for evaluating performance and standard of living. It is crucial to comprehensively analyze profit margins and marketing expenditures throughout the pineapple value chain. Unfortunately, many studies on resource efficiency and sustainability have overlooked the importance of profitability analysis of all value-added activities along the pineapple value chain in Ghana. Most research focused on farming, harvesting, marketing, and processing, aimed at enhancing only farmers' yield and profitability without adequately exploring the case of processors and marketers, including those in packaging.

This is a critical research gap that highlights the importance of the current study. Analysis of profitability for sampled pineapple farmers, processors, and marketers in the Central Region of Ghana will help determine how these actors optimize available resources for profit generation and the degree of enhanced production efficiency. In addition, this study may serve as a roadmap for creating valuable policy insights to increase productivity and profitability, particularly for smallholder pineapple farmers in the Central Region of Ghana.

2. Literature Review

2.1 Overview of Pineapple Production in Ghana

Pineapple is a fruit that is widely grown and consumed in many tropical and subtropical countries owing to its high nutritional value and unique taste. Previous studies have shown that pineapple is rich in vitamin C, Mn, and Br and can be used in a variety of dishes, beverages, desserts, and processed products (Ali et al., 2020; Dhar et al., 2023; Gumber et al., 2024; Lobo & Siddiq, 2017; Wijesooriya, 2021). Consequently, pineapple production has attracted the attention of several researchers. In 2020, global pineapple production reached approximately 28.4 million metric tons, with Costa Rica, Brazil, the Philippines, Thailand, and Indonesia as the top five producers (Das et al., 2023; Firatoiu et al., 2021). Meanwhile, global pineapple consumption was around 27.4 million metric tons, with China, India, the United States, Brazil, and Nigeria as the top five consumers (Firatoiu et al., 2021). In 2020, approximately 2.6 million metric tons of pineapple was exported, with Costa Rica, the Philippines, the Netherlands, Belgium, and Ecuador being the top five exporters (Firatoiu et al., 2021). The United States, China, the Netherlands, Spain, and France are the top five importers, with approximately 2.7 million metric tons of imported pineapple (Firatoiu et al., 2021). In general, pineapple production enhancement is a value chain development, which can be divided into four main stages: production, processing, distribution, and consumption (Wijesooriya, 2021).

Different stakeholders, such as farmers, input suppliers, processors, traders, wholesalers, and retailers, perform various functions at each stage and add value to the final product, each of which receives a share of its price until it is paid by the consumer. Ghana is a leading producer and exporter of pineapple in Africa with an annual production of approximately 678,000 tons (Williams et al., 2017). Pineapple production in Ghana is mainly dominant in the Greater Accra, Central, Eastern, and Volta regions, where smallholder farmers and a few large-scale farms cultivate different varieties of pineapple, including Smooth Cayenne, MD2, and Sugarloaf (Osei & Aluah, 2021). Pineapple

production in Ghana involves various factors and activities that transform raw materials into final products for consumers.

However, the industry faces challenges, such as the threat of stakeholders' low productivity and poor quality, high post-harvest losses, low-value addition, high transaction costs and risks, and weak value chain governance and linkages (Osei & Aluah, 2021; Williams et al., 2017). Value distribution across the pineapple value chain may not always be fair or effective because of factors such as uneven bargaining power, information asymmetry, and imperfect market structure. For example, from 2009 to 2018 (per available data), gross production continued to increase year by year, but export performance was not at par with production (Ofori-Appiah et al., 2022). This potentially impacts the profitability and competitiveness of the sector, which, in turn, affects the income and livelihoods of farmers and other stakeholders.

Previous research suggests that comparative profitability analysis can be a useful method for addressing challenges in agricultural value chains and fostering connections between key stakeholders involved in value-added activities and sustainable markets (Boakye, 2020; Kleemann, 2016; Ngcongo, 2021). This evidence underscores the significance of comparing the profitability of key value-added activities in the pineapple chain. A comparative analysis of profitability among the major stakeholders in Ghana can yield valuable insights into the factors affecting the pineapple value chain and provide recommendations for improving its performance and sustainability. Ultimately, addressing the challenges and opportunities associated with pineapples would contribute to food security, income generation, and rural development.

2.2 Value Chain and Value-added Concept

The concept of a value chain comprises two main components: the supply chain, which represents the interconnected stages of production or value-adding processes, and the creation of value, which enhances the value of goods or services throughout these processes (Kaplinsky et al., 2002). These two components work together to form a comprehensive value chain (Kumari et al. 2021; Obinna et al. 2020). According to the Global Value Chain Initiative (GVCI), a value chain refers to the network of activities and participants involved in enhancing the flow of goods and services from production to the final consumer (GVCI, 2007).

Similarly, the World Bank (2010) defines a value chain as the entire process of adding value to a product or service from sourcing raw materials to reaching the end user. Research has highlighted the significance of value chains, which provide a comprehensive analysis of the activities necessary to deliver a product from its point of origin to the end of consumption (Kumari et al., 2021; Obinna et al., 2020; Sahoo, 2010). The pineapple value chain exemplifies a typical agricultural commodity value chain that involves various participants and activities such as input procurement, production, processing, and marketing.

Accordingly, each of these activities incrementally contributes to the product's value, and each stage participant earns stage revenue. The pineapple production value chain starts with farm inputs such as seeds, fertilizers, and agrochemicals provided by suppliers, research and developmental entities, and governmental agricultural financial services (Kolavalli, 2019; Kolavalli et al., 2020). The farmer segment is responsible for cultivating pineapples by using these inputs. The processing phase involves the production of liquid and solid wastes containing fermentable sugars and other nutrients (Kolavalli, 2019; Kolavalli et al., 2020), whereas the trade segment handles the marketing of pineapples to end users (Kolavalli, 2019; Kolavalli et al., 2020). This study focuses solely on the role of farmers, processors, and marketers in the value chain.

On the other hand, the concept of value added refers to a firm's value enhancement resulting from pricing strategies, cost structure, and collaborative efforts with other entities involved in value creation (Donovan, 2011). A value chain breaks down business functions into strategically significant activities that enhance product and service utilities within a business or industry. As a product moves through the marketing system, its value increases, as do the costs involved (Sarangi et al., 2019). The proportion of retail prices earned by different market participants reflects the value they contribute to a product (Dorta & Sogi, 2017). Marketing plays a critical role in facilitating the production and distribution of agricultural value chains as its importance in their development is widely recognized.

In general, value-added and value chain concepts are interrelated. Value-added describes a micro process that focuses on value creation between different stages of production, whereas the value chain is a macro system summarizing the collective integration of the production process.

2.3 Indicators for Measuring Profitability

Profitability is a measure of a company's ability to generate profit from sales, assets, and investments (Das et al., 2023). According to Egyir (2007), it can be evaluated using various methods, such as partial budgeting of net profits, gross margin costing, and assessing marginal return or payback period rates. This study mainly used market margins using the gross margin function to assess profitability. Marketing margins represent the difference in prices between products at various stages of production and consumption (Crawford 1997; Pretolani et al. 2014). Both producers and consumers are interested in understanding marketing margins and their fluctuations.

Marketing costs refer to the expenses incurred during the marketing process such as transportation, packaging, and storage (Obinna et al., 2020; Crawford, 1997). These costs, along with the profits earned by each of the major actors in the value-added along the chain, contribute to marketing margins (Obinna et al., 2020; Crawford, 1997). Gross margin refers to a company's gross income minus the variable costs required to generate this income, where the variable costs are expenses directly related to the size of the company. However, it is crucial to differentiate between gross margins and profits. Unlike profit, the gross margin excludes overhead or fixed costs such as depreciation, interest payments, utilities, insurance, or mortgage expenses.

The gross margin, which represents the difference between total revenue and total variable cost, is an essential metric for evaluating marketing costs and returns. The analysis of gross margin entails evaluating costs and returns in marketing, where gross margin (GM) signifies the money accessible to address fixed-cost expenditures while still yielding profit (Downey & Troche, 1991). This metric is calculated as gross margin (GM) = total revenue (TR)-total variable cost (TVC). To determine the net profit, the total fixed costs (TFC) were subtracted from the gross margin (GM).

Additionally, the benefit-cost ratio, which measures the profitability of a venture by comparing the total benefit to the total cost, is a useful metric. To meet the growing demand for pineapple in Ghana and other international markets, it is crucial to increase its production quantity and quality through value chain assessment. In this study, the gross margin matrix was used to evaluate the profitability of the major actors in value-added activities along the pineapple chain in the Central Region of Ghana, including farmers, processors, and marketers.

2.4 Theoretical Framework Underpinning This Study

This study is guided by social exchange theory, as introduced by Homans (1958), to explore the profitability of actors in the pineapple value chain. Social exchange theory describes the dynamics of relationships in terms of value exchange, in which individuals assess the costs and benefits of their connections and terminate them if the costs outweigh the benefits. This theory also emphasizes mutual exchange, in which individuals feel compelled to reciprocate significant benefits received from others. This theory identifies four key elements: cost, reward, equity, and distributive justice. Costs and rewards imply that social behavior involves exchanges in which individuals seek valued rewards but must sacrifice something of value as a cost. Equity and distributive justice come into play when individuals perceive unfairness in the distribution of rewards, relative to the costs incurred. This study aims to understand the dynamics and profitability of interactions among farmers, processors, and marketers in the pineapple value chain by examining the principles of the social exchange theory.

3. Methodology

Three districts (Abura-Asebu-Kwamankese, Komenda-Edina-Eguafo-Abirem, and Ekumfi) in the Central Region of Ghana were selected for this study. The sample frame comprised smallholder pineapple farmers, processors, and marketers from the three districts. The sampling frame for the pineapple farmers included 15 farmers from the Abura-Asebu-Kwamankese district, 875 farmers from the Komenda-Edina-Eguafo-Abirem district, and 1051 from the Ekumfi district, according to the Department of Agriculture (2018). Furthermore, because the sample frame for processors and marketers is not known, we used the snowball technique to obtain as many processors and marketers as possible to obtain the sampling frame in the study area. The sample frame obtained for the processors comprised 10 processors from the Abura-Asebu-Kwamankese district, 25 processors from the Komenda-Edina-Eguafo-Abirem district, and 45 processors from the Ekumfi district. The sampling frame for the marketers also included 55 pineapple marketers from the Abura-Asebu-Kwamankese district, 152 from the Komenda-Edina-Eguafo-Abirem district, and 93 pineapples from the Ekumfi district.

Krejcie and Morgan (1970) used the sample size determination technique for a given population by Krejcie and Morgan (1970) was used to delineate the sample size for the study based on the sample frame(s). In total, 320 smallholder pineapple farmers, 66 pineapple processors, and 169 pineapple marketers were used. Because of uncertainty and limitations in obtaining survey respondents, Marc et al. (2005) recommended allocating 10% of the

sample to address non-responses and errors that may occur during the data collection process. Before collecting data, an ethical clearance was sought from the academic committee, the University of Cape Coast Institutional Review Board (IRD), and the Department of Agriculture. Further, consent from the participants was included boldly on the instruments and was verbally communicated to them making them understand that their participation in the study was voluntary and could choose to withdraw from participating in the study at any point before being interviewed. Although stated on the instrument, verbal consent was sought from the respondents because most of the respondents could not read or write. This was approved by the University of Cape Coast IRB, Department of Agricultural Economics and Extension as well as the Department of Agriculture in the selected districts.

4. Estimation Technique for Profitability

4.1 Gross Margin (GM)

The gross margin indicates how much profit a firm makes after paying off the cost of goods sold. It is a measure of the efficiency of a firm's efficiency using its variable inputs and labor during the production process.

$$\text{Gross Margin (GM)} = \text{Revenue} - \text{Cost of goods sold} \quad (1)$$

4.2 The Profit Function

The profit function focuses on business applications. The primary purpose of a business is to sell a product or service to make a profit, which is the revenue a company receives for selling a product or service, less the cost of creating it. The profit function expressed in the equation is composed of two primary parts: revenue function and cost function. If x represents the number of units sold, then these two functions are expressed as follows:

$$R(x) = \text{the revenue function} \quad (2)$$

$$C(x_i) = \text{Cost function.} \quad (3)$$

Therefore, the profit function equation can be specified as follows:

$$P(x_i) = R(x) - C(xi) \quad (4)$$

The input is the domain of the function and the output is the range of the function. The domain is usually represented by variable x as the independent variable. Each value used for the independent variable produces an output value unique to the independent variable. In other words, each input had only one output. The output, or range, of a function is represented by variable y.

This study employed the Cobb-Douglas function to estimate the actors' profit function. According to Tao et al. (2024), the Cobb-Douglas function can be specified as

$$Y = AL^{\beta}K^{1-\beta} \quad (5)$$

Where A factor productivity, L is the labor input, K is the capital input β and $1-\beta$ are the elasticities, as it measures the responsiveness of output to changes in the concentrations of either labor or capital used in manufacturing (Tao et al., 2024). Applying the model to the estimation of the profit function of farmers in this study, the model is specified as

$$\prod a \sim f(R, L, K, A, P) \quad (6)$$

where π is the profit of the farmer, R is the revenue from farm activity, L is the cost of labor, K is the cost of capital, A is the cost of agrochemicals used in farming, and P is the cost of planting materials (suckers) used at the farm.

The profit function for the processor is also specified as:

$$\prod_b \sim f(R, L, K, F, P) \quad (7)$$

where π is the profit of the processor, R is the revenue from the pineapple processing activity, L is the cost of labor, K is the cost of capital, F is the cost of pineapple fruits used in processed products, and P is the cost of packaging the processed pineapple.

For the marketers, the profit function was specified: $\prod_c$

$$\prod_c \sim f(R, T, L, P, S) \quad (8)$$

where π is the profit of the marketer, R is the revenue from the pineapple marketing activity, T is transportation, L is the cost of labor, P is the cost of packaging, and S is the cost of storing the processed fruits. The variables used in all the models were expressed in natural logs for log-linearity.

5. Results and Discussion

This study explores the profitability of major actors' activities in the pineapple value chain. The results of the profitability analysis are presented in Tables 1–11.

Table 1. Gross Margin Analysis for Pineapple Farmers

Gross Margin	Frequency	Percent
0 & below	2	.6
0.1 – 10000	121	37
10001 – 20000	138	42.2
20001 – 30000	22	6.7
30001 & above	44	13.5
Total	327	100

Source: Field survey, Boakye (2019); mean = 15,631.; SD = 9543.1

The gross margin analysis in Table 1 shows that the pineapple farmers in the study area produce an average of 14781 pineapples per acre of pineapple farm and receive an average gross profit of GH¢15,631. The results also revealed that most 138 (42.2%) of the farmers received a profit between GH¢10,001 and GH¢20,000 per acre of pineapple farm whereas only 2 (.6%) are unable to break even and hence make losses.

It can therefore be concluded that pineapple farming business in Ghana is most likely profitable with an average profit of GH¢15,631 per acre. The findings agree with those of Balogun et al. (2018), who found that the pineapple business is profitable and gives more returns to the farmer than the original investment made for purchased inputs.

A study by Baruwa (2013) on the profitability and constraints of pineapple production in Osun State, Nigeria, used a multistage sampling technique to select 50 respondents through purposive and random selection and found that the gross margin and net profits in Naira (Nigerian currency) were N182,725 and N162,045, respectively, concluding pineapple profitability in the region. This result also supports the findings of Kowornu et al. (2013) on certified organic pineapple producers in the Central and Eastern Regions of Ghana over five (5) years period it using the net present value (NPV) and the internal rate of returns (IRR) approaches, where cash flows were discounted to their present values, revealing that the NPVs were positive, indicating that the production of certified organic pineapple in both regions was financially viable. This was further confirmed by the estimated IRRs in both regions, which were higher than the cost of capital and, hence, financially prudent.

Furthermore, a study on organic pineapple production in Ghana for smallholder farmers showed that organic production is more profitable for smallholders than conventional production, and farmers collect a fair share of the price premium at the retail level (Oduro-Yeboah et al., 2017).

Table 2. Gross Margin Analysis for Pineapple Processors

Gross Margin	Frequency	Percent
0 & below	22	32.4
0.1 - 10000	-	-
10001 – 20000	7	10.3
20001 – 30000	17	25
30001 – 40000	5	7.4
40001 & above	17	25
Total	68	100

Source: Field survey, Boakye (2019); mean = 15,681.3; SD = 36,559.7

The results in Table 2 revealed that the pineapple processor after processing on average 14,781 pineapple fruits receives an average profit of GH¢15,681.3. The study further found that 22 of 68 pineapple processors either operated at the break-even point or were making losses. This notwithstanding, 46 out of the 68 pineapple processors were making profits of at least GH¢10,001 after they had processed an average of 14,781 pineapple fruits. According to the processors, losses were incurred owing to the use of poor-quality raw materials and the higher costs involved in transporting them.

The findings confirmed the assertion made in a study by Asante & Kuwornu (2014), who sought to compare the profitability of pineapple-mango blend juice and pineapple fruit juice in Ghana. The study identified that pineapple juice processing has a Benefit-Cost Ratio (BCR) of 1.03, which means that the processing of pineapple juice is profitable. The value of the NPV (GH¢11,728.0) and IRR (23%) further confirmed that pineapple juice processing is profitable due to positive NPV and IRR greater than the discounted factor (21%).

Table 3. Gross Margin Analysis for Pineapple Marketers

Gross Margin	Frequency	Percent
0 & below	109	62.3
0.1 – 10000	36	20.6
10001 – 20000	19	10.9
20001 – 30000	5	2.9
50001 & above	6	3.4
Total	175	100

Source: Field survey, Boakye (2019); mean = -134.3; SD = 8,218.8

The results of the gross margin analysis of pineapple marketers are presented in Table 3. The results show that more than half 62.3% of the marketers are either breaking even or making losses. 20.6% received between GH¢1 and GH¢10,000 and less than 20 % of the marketers received a profit of GH¢10,001 or above. On average, the pineapple marketer sells 14,781 pineapples and loss of GH¢134.3.

The study concludes that the pineapple marketing business is not profitable, especially when marketing fresh fruits. This is not surprising because the study found fruit perishability, poor pricing of pineapple, and unfavorable weather conditions to be the major constraints facing pineapple marketers. The findings agreed with those of a study by Das et al. (2016), who found that pineapple production is remunerative, but the marketing of pineapple in Ghana is done wrongly, which lowers the marketers' share of profits.

On the contrary, a study by Abbey (2005) on the Profitability and Risk Analysis of Ghana's Pineapple Marketing (exports) indicated that the production and marketing of pineapple is a profitable business, particularly for marketers and exporters who buy from out-growers and therefore do not bear the risks involved in farming pineapple.

5.1 Test for Normality

The following analysis summarizes the results of test for normality.

Table 4. Shapiro-Wilk Normality Test for the Profit Share of the Major Actors along the Pineapple Value Chain

Actors	Statistic	df	P – Value
Farmers	.896	327	.000
Processors	.753	68	.000
Marketers	.768	175	.000

Source: Field survey, Boakye (2019)

The Shapiro-Wilk test is a formal test for normality. The test was performed based on the null hypothesis that the

data would be normal. For given data to be normal, the p-values are expected to be larger than .05 (Acquah, 2013). On this premise, it can be concluded that the data on the profit share of the actors do not follow the normal distribution assumption, and hence, cannot be used for any parametric test. Therefore, instead of using the Analysis of Variance (ANOVA) technique to compare the actors' share of profits, the Kruskal-Wallis test was used.

According to Acquah (2013), the Shapiro-Wilk test can be used with normal Q-Q plots and histograms. The normal Q-Q plots and histograms for the test are presented in the appendices (see Appendices – Figures A1 – A6).

5.2 Difference in the Share of Profit Among the Major Actors Along the Pineapple Value Chain

The expectation from this hypothesis is to examine the differences in the profit share of the actors. The results of this analysis are presented below:

Table 5. Kruskal-Wallis test to Compare the profit share of the Major Actors along the Pineapple Value Chain

Actors	N	Median (%)	Mean Rank
Farmers	327	87.5	329.65
Processors	68	77.1	337.05
Marketers	175	4.4	182.97
Test Statistics			
Kruskal Wallis H.	100.283		
Df	2		
P – Value	.000		

Source: Field survey, Boakye (2019)

The results in Table 5 show that there is a significant difference in the profit shares of the actors (farmers, $n = 327$; processors, $n = 68$; marketers, $n = 175$), Kruskal-Wallis H (2, $n = 570$) = 100.28, $p < .05$. The farmers had a higher median score of 87.5% than the processors and the marketers, who recorded 77.1% and 4.4%, respectively.

5.3 Post-hoc Tests and Effect Size

Since the study obtained a statistically significant difference for the Kruskal-Wallis test, there is a need to know which of the actors are statistically different from one another. To determine this, the Mann-Whitney *U* test was performed between groups. However, to control for type 1 errors, it was necessary to apply the Bonferroni adjustment to the alpha values because each actor was cross-compared with one another (farmers with processors, farmers with marketers, and processors with marketers).

The Bonferroni adjustment involves dividing the alpha level of .05 by the number of tests to be conducted and using the revised alpha level as the criteria for determining the significance (Pallant, 2005). This means a stricter alpha level of .05/3 = .017. Because the effect size statistic is not given, the z-statistic is used to compute the approximate value of *r*.

$$r = \frac{z}{\sqrt{N}} \tag{9}$$

where N denotes the total number of cases. The study employed Cohen's (1988) criteria of 0.1 = small effect, 0.3 = medium effect, and 0.5 = large effect.

Table 6. Mann-Whitney U Test to Compare the Profit Share of Farmers and Processors

Actors	N	Median (%)	Mean Rank
Farmers	327	87.5	196.36
Processors	68	77.1	205.9
Test Statistics			
Mann-Whitney U.	10580.5		
Z	-.650		
R	.03		
P – Value	.516		

Source: Field survey, Boakye (2019)

The cross-examination results in Table 6 show that there is no significant difference in the profit share of farmers and processors. The study had U = 10580.5, z = -.650, r = .03 and p = .516. An r of .03 indicates that there is a small effect on the difference, although it is not significant. The farmers recorded a larger median of 87.5%, whereas the processors recorded a smaller median of 77.1%.

Table 7. Mann-Whitney U Test to Compare the Profit Share of Farmers and Marketers

Actors	N	Median (%)	Mean Rank
Farmers	327	87.5	297.29
Marketers	175	4.4	165.93
Test Statistics			
Mann-Whitney U.	13638		
Z	-9.834		
R	.44		
P – Value	.000		

Source: Field survey, Boakye (2019)

From Table 7, The Mann-Whitney U test reveals that there is a statistically significant difference in the profit share of farmers and marketers with U = 13,638, z = -9.834, r = 0.44, and p = .000. Meanwhile, indicating a fairly large difference, the farmers were known to have a larger median (87.5%) than the processors (4.4%).

Table 8. Mann-Whitney U Test to Compare the Profit Share of Processors and Marketers

Actors	N	Median (%)	Mean Rank
Processors	68	77.1	165.04
Marketers	175	4.4	105.04
Test Statistics			
Mann-Whitney U.	2982		
Z	-6.034		
R	.39		
P – Value	.000		

Source: Field survey, Boakye (2019)

The results in Table 8 indicate that there is a significant difference in the profit share of processors and marketers with U = 2982, z = -6.034, r = .39, and p = .000. According to Cohen (1988), the magnitude of the difference was large (r = .39). From the results, the processors had a greater median profit of 77.1% compared to that of the marketers 4.4%.

The study revealed a statistically significant difference in the profit shares of the main actors (farmers, processors, and marketers) along the pineapple value chain. There was a need to determine which of the actors' profits differed using the Mann-Whitney U test. The test revealed that the profit of marketers was significantly different from that of farmers and processors. This finding contradicts Kumi (2017), who identified farmers and marketers as the main actors in the tomato value chain. It further showed that the activities of these actors are profitable, but marketers (distributors, wholesalers, and retailers) receive a greater share of the profit. He further indicated that among the marketers, the retailer of the fresh tomato earned the highest profit of GHS 4.50 for every 5 kg of fresh tomatoes sold.

A study by Das et al., (2016) on the marketing systems and value addition of pineapple found farmers, processors, and marketers as the major actors along the pineapple value chain. The study also found that the activities of these actors were profitable, but the marketer received the greatest portion of chain profit.

Owusu-Adjei et al. (2017) conducted a study on the value chain of groundnuts in Ghana. Through mapping, value chain actors were identified as primary producers (farmers), distributors, processors, and output retailers. Costs and returns estimates indicate that for every liter of groundnut oil and kilogram of paste produced along the oil and paste chain, respectively, the farmer benefits most when he or she sells groundnut in a shelled form. This is followed by the distributor, retailer of the processed output, and processor. On the other hand, when the farmer sells groundnut in an unshelled form, the distributor benefits most from both the oil and the paste chain, with a 51% increase in profit.

Table 9. Cobb-Douglas Function to Estimate the Effect of Inputs on Gross Profit of Pineapple Farmers

Variable	Coefficients	Std. Err.	t	P-Value
Constants	-1.499	.445	-3.369	.001
Revenue	1.815	.062	29.237	.000
Cost of labor	-.098	.059	-1.651	.100
Cost of agro-chemicals	-.094	.105	-.904	.367
Capital	-.161	.049	-3.263	.001
Cost of planting materials	-.268	.061	-4.385	.000
Model Summary				
R-Square	.75			
F-Stats	196.4			
P-Value (F-Stats)	.000			

Source: Field survey, Boakye (2019)

The results in Table 9 reveal that the entire model was statistically significant with an f-statistic of 196.4 and P = 0.000. As shown in the t-tests, except for the cost of labor and cost of agrochemicals, all other independent variables (revenue, capital, and cost of planting materials) significantly influence the dependent variable (profit). Meanwhile, Table 9 shows an r-square value of .75, which indicates that about 75% of the variations in the profit received by the pineapple farmers are explained by variations in revenue, cost of labor, cost of agrochemicals, capital, and cost of planting materials.

In sum, the revenue received from the pineapple farm is statistically significant, with a coefficient of 1.815 and *t* of 29.237. This indicates that a one-percentage change (e.g., increase) in the revenue from the farm will most likely change the profit received by the farmer by 1.82 cedis (increase) in the same direction.

The coefficient of -0.161 and *t* = -3.263 for farming capital were statistically significant at the 0.05 significance level. Specifically, a one-percentage change (e.g., increase) in the capital employed causes profit to change by .16 pesewas (decrease) in the opposite direction. The results further suggest that the cost of planting materials (suckers)

used at the farms negatively influences the amount of profit received by the farmer. That is, a one-percentage increase in the amount of planting materials used will decrease the farmer's profit by 0.27 pesewas.

From the results in Table 9, we conclude that farm revenue, capital inputs, and planting materials (suckers) influence farmers' profits. The empirical results confirm the findings of Onoja et al. (2012), who assessed the profitability of cocoa farms in Nigeria's largest cocoa-producing state. The results showed that cocoa production was profitable, with a mean profit of US$10,342.93. The determinants were labor, capital, seedling planting, and household size.

However, the finding disagreed with Olujenyo (2008), who identified that farming was profitable with gross margins and net returns of N2,637.80 and N2,141.00 respectively. The study further revealed that farm operations were in stage 2 of production, with an RTS of .62. The results further showed that age, education, labor, and cost of non-labor inputs were positively related to profit, whereas farm size and years of experience had negative impacts. However, only labor input has a significant influence on profit.

Table 10 shows that the entire model was statistically significant, with F = 6.003 and p = .000. As indicated in the t-tests, except for the revenue received by the pineapple processor and the cost of labor employed, the profit is influenced by the capital, cost of pineapple fruits used, and cost of packaging materials used. The results also revealed that the r-square was .33, with a poor 'goodness of fit,' which implies about 33% of the variations in the processor profit is caused by variations in revenue, cost of labor, capital, cost of pineapple fruits, and cost of packaging materials.

From the results in Table 10, it was found that revenue and labor cost had no significant effect on profit, although revenue was positively related to profit. Capital was also found to positively influence profit, with a coefficient of .616 and t = 2.427. This indicates that a one-percentage increase in the amount of capital inputs employed will increase profit by .62 pesewas.

Table 10. Cobb-Douglas Function to Estimate the Effect of Inputs on Gross Profit of Pineapple processors

Variable	Coefficient	Std. Err.	t	P-Value
Constant	2.826	.560	5.048	.000
Revenue	.266	.195	1.362	.178
Cost of labour	-.268	.219	-1.225	.225
Capital	.616	.254	2.427	.018
Cost of pineapple fruits	.531	.185	2.864	.006
Cost of Packaging materials	-.434	.161	-2.699	.009
Model Summary				
R-Square	.33			
F-Stats	6.003			
P-Value (F-Stats)	.000			

Source: Field survey, Boakye (2019)

Furthermore, the cost of pineapple fruit influences the processor's profit. Thus, the cost of fruits significantly and positively influences profit, with a coefficient of .531 and t of 2.864. The results also showed that the cost of packaging materials significantly influenced profits. Thus, a percentage change in the cost of packaging materials will cause a profit to change by .43 in the opposite direction.

Therefore, the study concluded that the profitability of the pineapple processor is influenced by capital, cost of pineapple fruits (raw materials), and cost of packaging materials. The findings agreed with the conclusions of a study by Adekanye et al., (2013) who researched "gari" processing determinants among female processors in Kwara State, Nigeria, and found that age and capital were the major determinants of profit in the research area.

Similarly, Ehinmowo et al. (2015) revealed that the cassava processing business was profitable. The outcome of the regression model stated that the variables that determined profitability in the study area were education, years of experience, access to extension facilities, family size, price of raw materials, and types of cassava bought.

Table 11. Cobb-Douglas Function to Estimate the Effect of Inputs on Gross Profit of Pineapple Marketers

Variable	Coefficient	Std. Err.	t	P-Value
Constant	.167	.185	.903	.368
Revenue	.809	.049	16.571	.000
Transportation	-.294	.083	-3.538	.001
Cost of loading and off-loading	-.205	.098	-2.078	.039
Cost of packaging	.165	.143	1.150	.252
Cost of storage	.026	.081	.319	.750
Model Summary				
R-Square	.70			
F-Stats	79.216			
P-Value (F-Stats)	.000			

Source: Field survey, Boakye (2019)

The results in Table 11 reveal that the entire model is statistically significant, with F= 79.216 and p = .000. This shows that the pineapple marketer's profit, in general, is significantly affected by the income earned, cost of transportation, cost of loading, and off-loading, but not by the cost of storage and packaging. The results also reveal that the r-square was .70, in fair 'goodness of fit,' which implies about 70% of the variations in the marketer profit are caused by variations in revenue, cost of transportation, cost of loading and off-loading, cost of packaging and cost of storage.

The results in Table 11 show that the cost of packaging and storage had no significant impact on profit, although both had a positive relationship with profit. In addition, revenue was found to positively influence profit, with a coefficient of .809 and t = 16.571. This indicates that a one-percentage increase in revenue will increase profit by .81 pesewas.

Furthermore, the cost of transportation significantly influences the marketer's profit. Thus, the cost of transportation negatively influences profit, with a coefficient of -.294 and t of -3.538. The results also showed that the cost of loading and off-loading of fruits significantly influenced profit. Thus, a one-percentage change in the cost of loading and off-loading of the fruits will cause the profit to change by .21 pesewas in the opposite direction.

The empirical study revealed that revenue, cost of transportation, and cost of loading and off-loading significantly influence the marketer's profit. This result is consistent with the finding of Arowolo et al. (2016), who discovered that the marketing of cocoa beans in the study area is a lucrative venture with a gross margin of $137,719.27 (US$ 885.51) per month and a marketing margin of N40,600 (US$ 261.94). It also disclosed that transportation costs, communication costs, quantity of cocoa traded, and credit union affiliation are the major determinants of the profit margin accruing to the cocoa bean marketer.

Wongnaa et al. (2014) revealed that wholesaler in tomato production had a margin that was 99.7 percent larger than that of retailers with a 75.4 percent margin. Labor cost, purchase price, transport cost, and selling price are determinants of profit for marketers, as confirmed by the findings of this study.

6. Conclusions

In this study, we examine the profitability of major value-added activities in the pineapple value chain in Ghana using primary data collected from pineapple farmers, processors, and marketers. We conclude that pineapple production and processing are profitable ventures in Ghana, which is consistent with several previous studies showing a higher return on investment (Balogun et al., 2018; Baruwa, 2013; Kuwornu et al., 2013; Oduro-Yeboah et al., 2017). However, the marketing of fresh pineapple fruits is not profitable, primarily because of factors such as fruit perishability, poor pricing, and unfavorable weather conditions, which contradicts Kumi (2007) and Das et al. (2006). The study also highlights the significant differences in profit shares among the major actors–farmers, processors, and marketers–along the pineapple value chain. In sum, the empirical findings provide valuable insights into the profitability dynamics of the pineapple value chain in Ghana, offer recommendations to improve the industry's performance, and contribute to economic development and poverty reduction.

The study emphasized the importance of addressing the challenges faced by pineapple marketers, which include improving transportation facilities, enhancing packaging methods, and implementing better pricing strategies. Thus, by investing in better transportation systems, such as roads and logistics, transportation costs can potentially be reduced, thereby enhancing marketers' efficiency and profitability. Additionally, the study recommends promoting the pineapple industry through various initiatives, including providing financial credit and access to actors along the value chain to enhance their productivity, profitability, and sustainability.

Another important finding of this analysis is the enhancement of packaging methods and materials for pineapple processing. Exploring and adopting cost-effective packaging solutions that maintain product quality and extend the shelf life of fresh pineapple may significantly impact processor profitability. Targeted training for the efficiency of the value chain, including finance, packaging, marketing, and operations, will have a long but positive impact on the profitability of all actors.

Additionally, enhancing the capacity of value-chain stakeholders in product pricing strategies tailored to market demand, cost-effectiveness operations, competition, and product damage reduction are essential to ensure profitability in the industry. Moreover, policies directed at providing patient and innovative capital (financial access) to the industry can enhance productivity, profitability, and sustainability, particularly for smallholder farmers.

6.1 Recommendation and Policy Implications

Pineapple farmers can optimize resource use and increase their marginal productivity by adopting efficient farming practices. These include proper land preparation, effective planting techniques, appropriate fertilizer application, and comprehensive pest management. Utilizing water-efficient irrigation methods tailored to pineapple cultivation is also crucial. Exploring high-yielding pineapple varieties suitable for local climate and soil conditions and engaging in crop rotation and intercropping can maintain soil fertility and reduce pest and disease issues. Additionally, farmers should consider value-added activities, such as processing, to increase profitability by investing in small-scale units to produce pineapple juice, jams, canned products, or dried slices. Acquiring training in food processing, packaging, and quality control and forming partnerships with processors can ensure a consistent supply of high-quality pineapples.

Collaborating with other value chain actors can significantly improve market access and bargaining power. Joining farmer cooperatives or producer organizations helps in collectively marketing produce and negotiating better prices. Establishing direct linkages with retailers, exporters, and processors can eliminate intermediaries and capture a higher share of profits. Participation in agricultural fairs, exhibitions, and trade shows can provide opportunities to showcase products and connect with potential buyers. Farmers should seek continuous training and capacity-building opportunities from government agencies, NGOs, or research institutions to enhance their skills in farming techniques, value addition, and marketing strategies. Diversifying income sources by integrating activities such as livestock rearing or growing other cash crops and exploring agritourism or farm-stay experiences can also provide additional revenue streams. Adopting sustainable practices such as soil conservation, organic fertilization, and renewable energy use can ensure long-term farm viability and environmental health.

We also recommend that policymakers support the pineapple industry and focus on infrastructure development and financial accessibility. Investing in rural roads, bridges, and transportation networks will facilitate the efficient movement of pineapples from farms to markets, reduce post-harvest losses, and improve market access. Establishing cold storage facilities and collection centers in key pineapple-growing regions will help extend the shelf life of produce and minimize spoilage. Providing incentives or subsidies for the private sector to modernize transportation fleets and cold chain infrastructure can further enhance the supply chain. Facilitating access to credit and financial services for smallholder pineapple farmers is crucial. Policymakers should collaborate with financial institutions to develop tailored credit products and loan schemes, with reasonable interest rates and repayment terms. Implementing credit guarantee schemes or risk-sharing mechanisms can encourage lending to smallholder farmers and promoting farmer cooperatives can improve access to credit by pooling resources and collateral.

Moreover, it is essential to implement fair market practices and support efficient farming and value addition through extension services and training programmes. Establishing regulatory frameworks to ensure transparency in pricing and prevent exploitative practices will help ensure equitable profit distribution among value-chain actors. Enforcing quality standards and grading systems for pineapples will enable fair pricing based on the product quality. Strengthening agricultural extension services and establishing demonstration farms can showcase best practices in pineapple cultivation and value addition. Encouraging research and development by allocating funds and fostering public-private partnerships will address industry-specific challenges and drive innovation. Promoting export markets through trade agreements, quality certification systems, and incentives for exporters boosts international trade.

Creating an enabling environment for private sector participation by streamlining bureaucratic processes and offering tax incentives will attract investment in processing facilities, storage, and transportation, thus further enhancing the value chain.

Development partners play a crucial role in value chain development. Development partners, including NGOs and agencies, can support the pineapple value chain through collaborations and targeted initiatives. Partnering with governmental bodies, agricultural departments, and local authorities ensures that programs are aligned with national priorities and local needs. Engaging with community leaders, farmer organizations, and other stakeholders is essential for understanding the specific challenges and opportunities within the pineapple industry. Joint initiatives that focus on access to finance, technology transfer, capacity building, and market linkages can address key issues and promote overall value chain growth. Partners must collaborate to fund research on the pineapple value chain in Ghana.

Providing financial assistance tailored to the needs of pineapple farmers and small-scale processors is crucial to enhance productivity and profitability. Development partners can offer microcredit or financing schemes with favorable terms and facilitate the creation of village savings and loan associations to improve access to credit. Innovative financing models such as value chain finance or contract farming can link credit access with market opportunities. Knowledge transfer and capacity-building programs are vital, with training in good agricultural practices, post-harvest handling, value addition, and business management skills conducted through farmer field schools and demonstration plots. Educational materials in local languages and exposure visits can further enhance students' learning. Supporting research and development in areas such as pest management, climate-resilient varieties, and post-harvest technologies and promoting sustainable practices can drive long-term improvements. Advocating favorable policies and an enabling environment and ensuring inclusive value chain development, particularly for women and youth, will foster a more equitable and prosperous pineapple industry.

We also recommend that further research is essential to conduct in-depth studies on market dynamics, pricing strategies, and value distribution across post-harvest technologies and to promote sustainable practices within the pineapple value chain. Understanding the factors that influence market prices, mechanisms of price formation, and value distribution among supply chain actors can help identify inefficiencies and ensure fair compensation for smallholder farmers. Additionally, examining market demand, consumer preferences, and emerging trends can provide insights for farmers and processors to adapt their practices and maximize their profits.

Further research should explore innovative processing techniques and value-addition methods to enhance profitability and reduce post-harvest losses. Investigating new technologies and methods for processing pineapples into various products, such as juices, dried fruit, and canned goods, can create new revenue streams for farmers and processors. Assessing the feasibility and scalability of these techniques in different contexts is crucial for their successful implementation. Studying the role of cooperatives and collective marketing strategies in strengthening the bargaining power of smallholder farmers can inform policies and programs that support cooperative models. Finally, assessing the environmental and social impacts of pineapple production is vital for identifying sustainable practices that minimize the negative effects on ecosystems and communities. Research should explore methods for reducing chemical inputs, conserving water, promoting biodiversity, and examining labor conditions and community well-being to ensure holistic sustainability in the pineapple industry.

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Authors' contributions

Conceptualization: K.B. and I.S.; Literature review: I.S. and K.B.; methodology: K.B. and Y.-F. L; Formal analysis: K.B. I.S. and H.D.; Resources: K.B. and Y.-F.L.; writing – original draft preparation: K.B., I.S., H.D., and Y.-F. L; writing, review, and editing: K.B., I.S., H.D., and Y.-F.L.

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Competing interests

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Appendices

Normality Test for the profit share of the major actors along the pineapple value chain

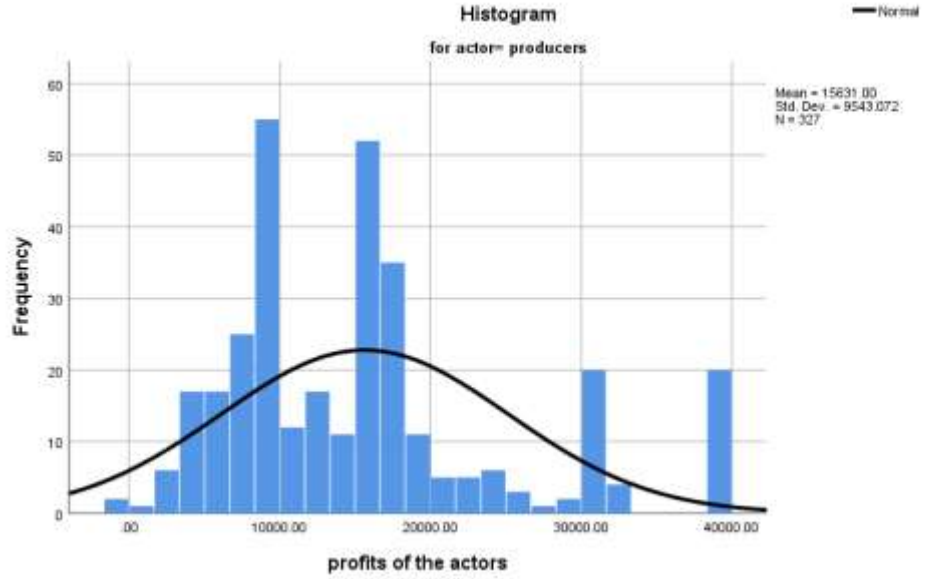

Figure A1. Histogram for Producers

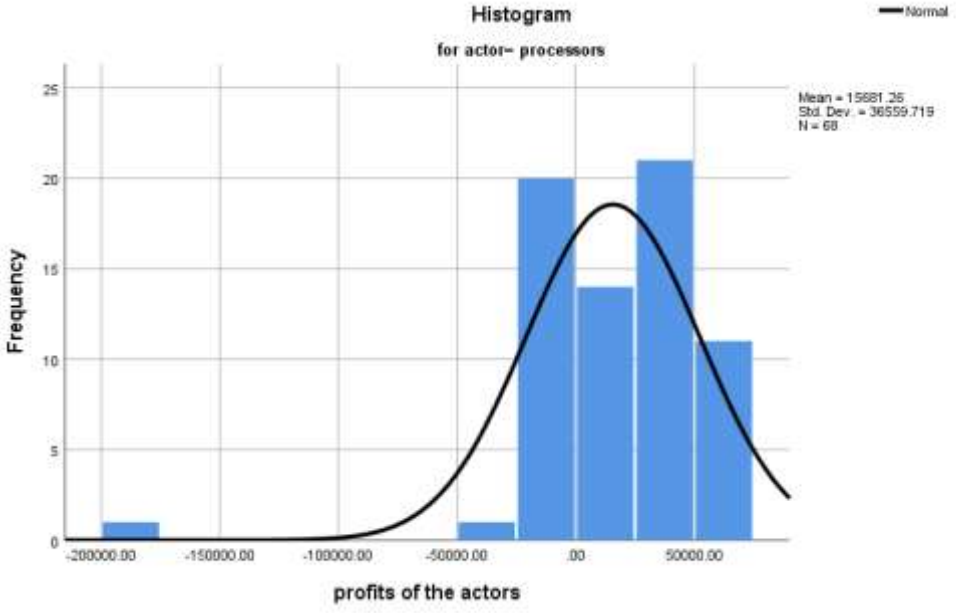

Figure A2. Histogram for Processors

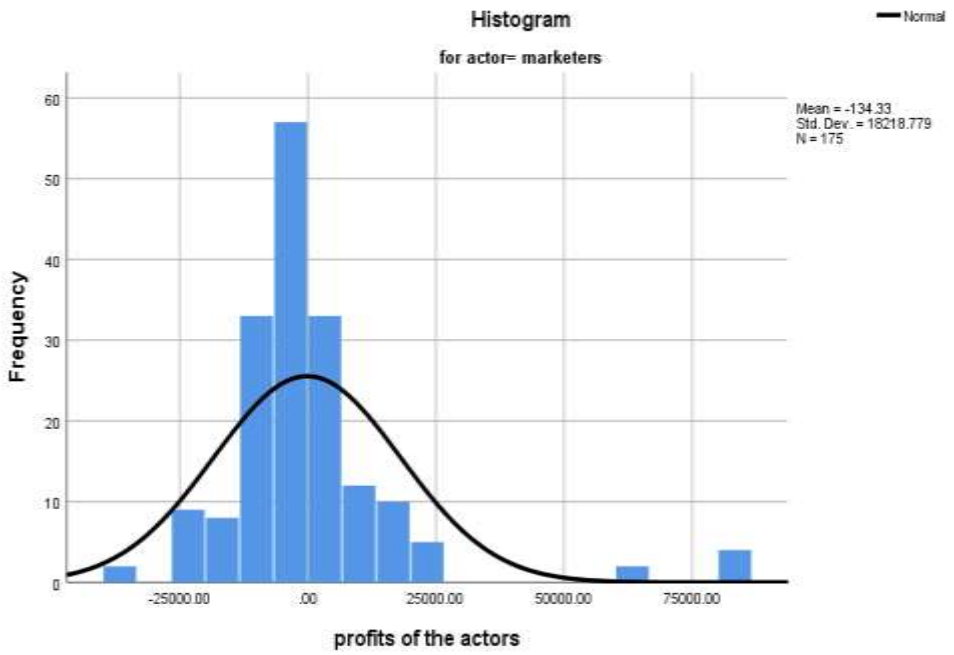

Figure A3. Histogram for Marketers

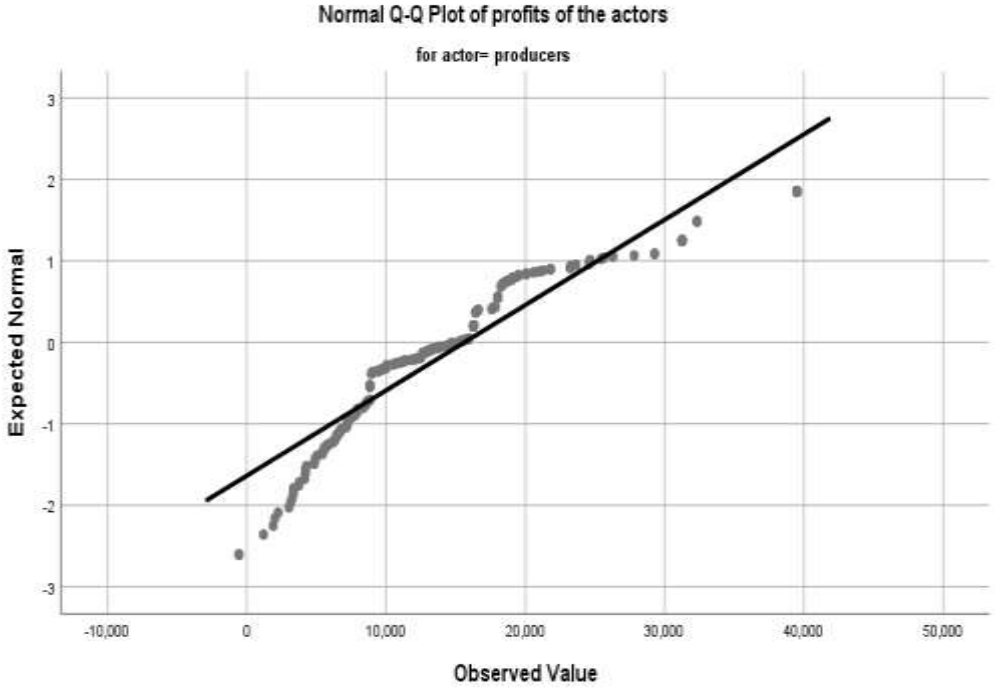

Figure A4. Normal Q-Q Plot for the producers

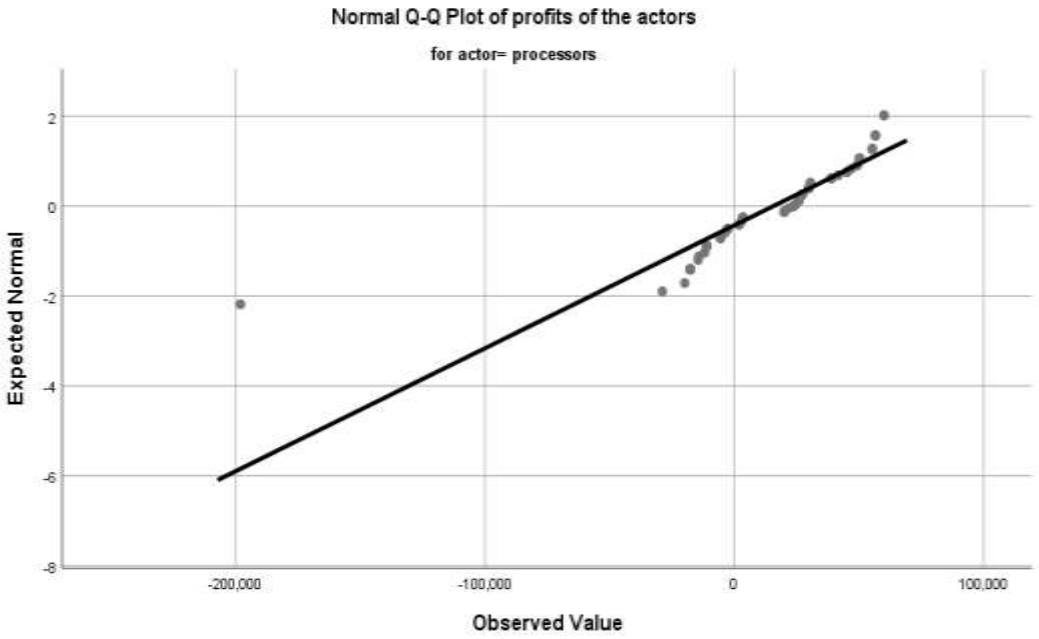

Figure A5. Normal Q-Q Plot for the Processors

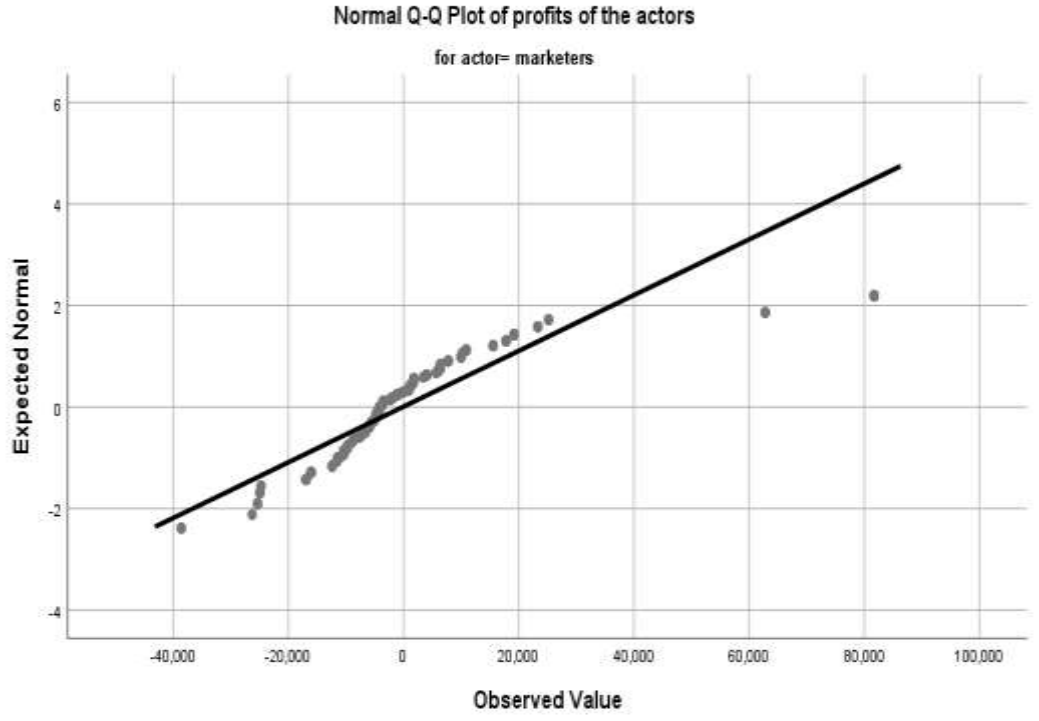

Figure A6. Normal Q-Q Plot for the Marketers