Journal of Nuts

Journal homepage: sanad.iau.ir/journal/ijnrs

ORIGINAL ARTICLE

Price Movement Influences the Major Coconut Products Production in Fiji

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K E Y W O R D S

Coconut;
Copra;
Fiji;
Price fluctuations;
Multiplicative model

A B S T R A C T

The major coconut products produced in Fiji are copra and coconut oil. As a consequence, coconut oil is the only product now exported, and price fluctuations have a substantial impact. This study examines the changes in copra and coconut oil prices for Fiji from 2009 to 2019. The present study used secondary data for analysis. Copra pricing information was gathered from Fiji Copra Millers, and coconut oil price information was gathered from the website for palm oil analytics' crude coconut oil price. The price changes for trend, cyclical, seasonal, and irregular fluctuations were computed using a multiplicative model. Both the price of copra and the price of coconut oil displayed poor connections, R^2= 0.39 and R^2= 0.18, respectively, despite the years' considerable price volatility. The price of copra and coconut oil fluctuated significantly throughout the year and in distinctly diverse ways. Seasonality and erratic price fluctuations were particularly pronounced for coconut oil, which directly affected the price of copra and discouraged farmers from investing in coconut plants, lowering productivity, production, and copra supply.

Introduction

Global agricultural value chains have been more intertwined over the past few decades as a consequence of technological advancements, reduced transportation costs, and market liberalization (Degain & Maurer, 2016). Due to this and rising worldwide demand for exotic goods like coconuts, many emerging nations now have the chance to join global agrifood chains (Trienekens & Willems, 2007). The demand for coconut products on the global market has risen recently. Nowadays, coconuts are being turned into more and more high-end, specialized products that need for more complex processing and innovations across the entire global value chain. In the past, coconut oil was the main produce and trading commodity. More than 40 coconut-related goods are currently produced and distributed on a global scale, and the number is growing (Herath *et al*., 2022).

The "tree of life" is a term that has been applied frequently to coconut palms. They serve as a source of raw materials in addition to being essential to the traditional way of life in the islands of the Pacific (Lin, 2021). Coconut palms are essential for smallholders in

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Received: 9 September 2022; Received in revised form: 10 May 2023; Accepted: 11 July 2023
DOI: 10.22034/jon.2023.1967369.1195

the countries of the Pacific because they provide food, revenue, and materials for buildings, weaving, and watercraft (Foale & Harries, 2011). Coconuts if used properly have the potential to produce substantial economic returns because all portions of the coconut fruit and tree can be used to produce both edible and inedible goods (Devi & Ghatani, 2022). For example coconut water is one of the most effective plant growth regulators in *in vitro* propagation, due to its high concentrations of glucose and fructose, various minerals, amino acids, and fatty acids (Ebrahimzadeh *et al*., 2023). Coconut palms are a natural feature of Fiji. One of the primary agricultural products is coconuts, namely copra (dried coconut flesh from which oil is extracted), while crude coconut oil is one of the primary export commodities (Moreno *et al*., 2020). Fiji's agriculture industry, which accounts for 44% of the labor force and 13.5% of the nation's gross domestic product (GDP), is very important to the country's economy (Burke & Leigh, 2010). Unfortunately, due to the lack of significant value-adding industries in Fiji, coconuts are primarily regarded as raw materials. Due to their dependence on and vulnerability to global market pricing, farmers in Fiji face greater uncertainty over their possibilities for a living (FAO, 2013).

In Fiji during 1873, when the islands were given to Queen Victoria of England and was established as a colony under the monarchy, the Fijian coconut industry was established. The coconut plantations started to develop the year after. Copra was Fiji's main export by 1877 (Silsoe, 1963). In Fiji, coconut palms occupy about 23% of the arable land (FAO, 2008). Fiji's coconut industry, a portion of the agricultural sector, makes an economic contribution through foreign exchange. The Fijian coconut industry generated $5 million in domestic export earnings from manufactured crude coconut oil in the year 2020 (FBOS, 2021). Coconut oil is exported to a few large processing companies, especially in Malaysia and other Asian Pacific nations, for refinement into refined oil, which is subsequently used in a variety of food and cosmetic applications (Piper, 2019). There are two significant local producers of coconut oil in Fiji, namely Punjas Ocean Soaps, founded in 1967, and Fiji Copra Millers, founded in 1985 (FAO, 2013). Fiji Copra Millers also produces coconut meal, a by-product of copra that is sold locally and primarily used in the dairy industry. For the past three years, the company has also produced virgin coconut oil, a premium coconut oil with numerous health advantages that is made from fresh raw copra that has been shelled in the factory (Singh *et al*., 2010). Recently, the business expanded to include the production of cooking oil and the distribution of coconut oil to national soap producers. Punjas Ocean Soaps manufactures a range of soap-based goods for cleaning and personal care that contain refined coconut oil.

Despite the industry's potential, there have been numerous issues with coconuts that have hurt both the agriculture and coconut production sectors throughout the years. The decline in copra production in the Pacific, according to Anon (2011) and McGregor & Sheehy (2017), was caused by price changes, which was a significant factor in farmers' lack of interest and reinvestment in maintaining copra supply for oil production. This is because coconut has a high production cost due to raising seedlings, managing land area, managing, harvesting nuts, and processing copra. The majority of coconut plantations have been abandoned due to the low local copra price, resulting in an excessive number of senile trees that are harming coconut productivity, production, and farm size as farmers switch to more lucrative agricultural crops.

Various studies have been conducted worldwide on different aspects of the coconut industry using different analysis methods (Reeja, 2011; Reeja, 2012). For example, Babu *et al.* (2009) used the classic time series analysis to try and separate the secular trend, seasonal, cyclical, and irregular components in the price of

coconut, copra, and coconut oil in India. Their research was based on monthly price data from 1976–1977 through 2004–2005. Similarly, Preethi *et al*. (2019) estimated the variations in price due to trend, cyclical, seasonal, and irregular fluctuations in the major markets of Kerala for two periods, Period I (from 1980-01 to 1995-96) and Period II (from 1996-97 to 2015-2016). Hence, in order to understand how price affects the production of copra and coconut oil in Fiji, this paper will analyze price movement for copra and coconut oil using the time series method. Each component of the time series, including trend, seasonality, cyclicity, and irregularity, will be investigated separately by removing it from the standard model in order to provide a clear understanding of why price movement occurs and to suggest ways the Fijian coconut industry can be strengthened.

Materials and Methods

The present study used secondary data as it is ideal when analyzing time series because it requires a large amount of data from previous months and years. Monthly recordings of the data were collected from 2009 to 2019. Data for prices for copra was retrieved from the records of Fiji Copra Millers (2021). The prices for coconut oil were compiled from the Palm Oil Analytics (2021) website, which provides information on the price of crude coconut oil.

Analysis of price movement

The standard classical time series techniques were used to analyze the price movement of coconut (Croxton & Cowden, 1955; Spiegel *et al*., 1992). The time series data on coconut prices in potential markets were divided into numerous components using a multiplicative model for analysis, comprising trend, seasonal, cyclical, and irregular variations. The source for the multiplicative model is set up as follows:

$$Y(t) = T \times S \times C \times I \quad (1)$$

Where, Y(t) is referred as the value of a variable at time t; T represents the secular trend; S is the seasonal variation; C denotes the cyclical variation and I refers to the irregular variations.

Estimation of trend value

A trend is the data's overall propensity to increase or decrease over an extended period of time. By fitting pertinent trend equations, the long-term trend in copra and coconut oil pricing was evaluated. Models of the following types were attempted:

$$\text{Linear trend: } Y = bx + a \quad (2)$$

$$\text{Power trend: } Y = ax^b \quad (3)$$

$$\text{Exponential trend: } Y = ae^{bx} \quad (4)$$

$$\text{Polynomial trend: } Y = b_6 x^6 + \ldots + b_2 x^2 + b_1 x + a \quad (5)$$

$$\text{Logarithmic trend: } Y = a * \ln(x) + b \quad (6)$$

Estimation of seasonal variation

Rhythmic elements that operate consistently and predictably over the course of a year are what produce seasonal changes in a time series. After removing the influence of other factors including trend, cyclical variation, and irregular variation, seasonal indices were constructed using the simple moving average method to obtain a statistical analysis of the seasonal changes in the time series.

Estimation of cyclical variation

Cyclical variations in a time series with a period longer than a year are oscillatory movements. The cyclical fluctuations in the price of copra and coconut oil in Fiji were examined using the multiplicative model of time series. In order to estimate cyclic fluctuations, procedures were used.

Trend component removal

Each of the original values is divided by the matching trend values, and the result is expressed as a percentage, eliminating the influence of the trend component from the time series data.

$$\text{In other words, } \frac{T \times S \times C \times I}{T} = S \times C \times I \qquad (7)$$

Therefore, the data includes irregular, cyclical, and seasonal components.

Seasonal effect removal

The trend-eliminated data for each month is multiplied by 100 after being divided by the relevant seasonal index.

$$\frac{S \times C \times I}{S} = C \times I \qquad (8)$$

Irregular components removal

Eliminating irregular variation is quite challenging since it is so entangled with cyclical movements. It is necessary to use short period moving averages to smooth the data in order to clearly identify cyclic oscillations.

Irregular variation estimation

Unpredictable or irregular fluctuation in a time series is that which is not taken into consideration while estimating seasonal, cyclical, and secular variation. These variations are completely arbitrary, chaotic, and unpredictable, and they happen as a result of a variety of unusual conditions that are out of human control. By dividing the cyclical- irregular indices by the cyclical indices, irregular indices are obtained.

$$\text{Symbolically, } \frac{C \times I}{C} = I \qquad (9)$$

Results

The comprehensive trend analysis conducted independently for copra and coconut oil aimed to understand their long-term price progression. Various functional forms were employed to describe the underlying trend, with the model exhibiting the highest R^2 value being selected as the best fit. The research findings revealed that a power function best represented the copra prices in Fijian dollars over the analyzed period, while a linear function adequately captured the coconut oil prices in US dollars (Figs. 1 & 2). In the long run, copra prices exhibited a consistent upward trend, whereas coconut oil prices displayed a declining trend, with both trends demonstrating variable correlations. These results emphasize the significance of comprehending long-term trends and their implications for the pricing dynamics of copra and coconut oil. They underscore the need for effective market analysis and strategic approaches to address the challenges faced by the industry.

The seasonal price changes for copra and coconut oil during the specified time period were summarized in Table 1. It was observed that copra prices reached their peak in June and hit their lowest point in November. The buoyant phase, characterized by higher prices, was identified from March to July, while the depressed phase, characterized by lower prices, was observed from August to February. In contrast, coconut oil prices exhibited a distinct seasonal pattern (Fig. 3). The highest prices were recorded in December, while the lowest prices occurred in September. The buoyant phase extended from November to April, while the depression phase persisted from May to October (Table 1).

To analyze the cyclical price fluctuations in copra and coconut oil, the cyclical-irregular data was obtained by averaging the data after removing the trend and seasonal variations from the original dataset. The cyclical variations of copra and coconut oil in the Fiji market were depicted in Figure 4 for different time

periods. It was noted that until 2018, the cyclical movements of copra and coconut oil prices closely resembled each other, displaying significant variations (Fig. 4). Both coconut products exhibited prominent cyclical fluctuations spanning one to three cycles. Furthermore, the prices of copra and coconut oil exhibited unpredictability over time, as illustrated in Figure 5. Fluctuations in both prices demonstrated high levels of irregular variations, with variations differing between the two products (Fig. 5). The projected outlook suggests that prices for copra and coconut oil will continue to experience significant and irregular fluctuations.

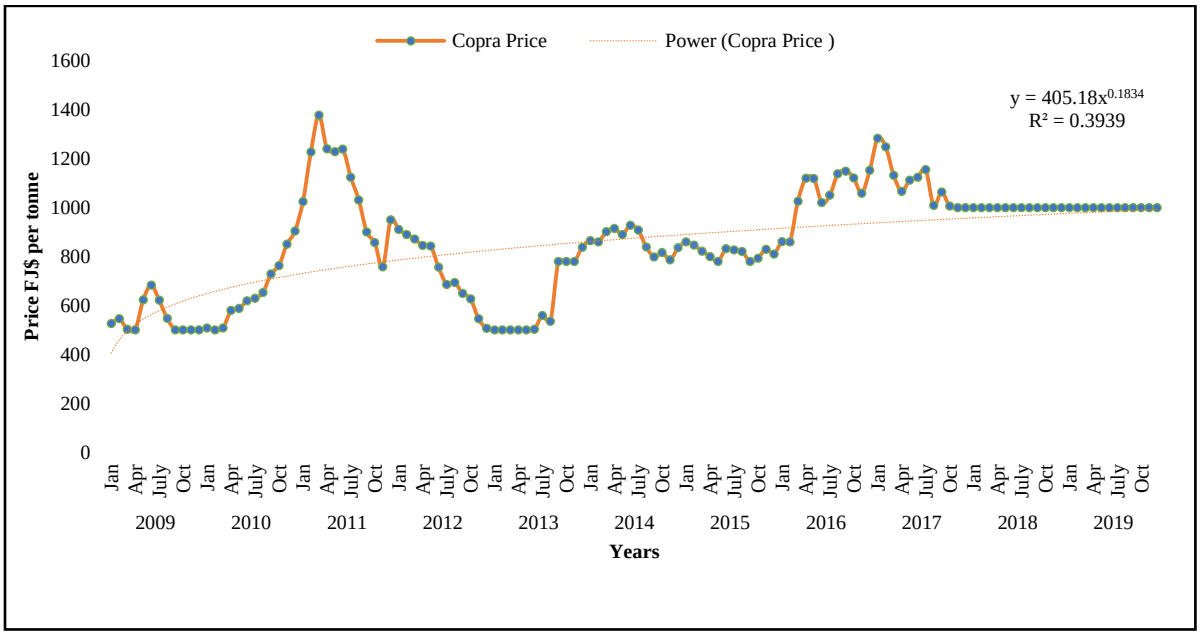

Fig. 1. Trend in copra prices in Fijian dollars per tonne for Fiji from the year 2009 to 2019.

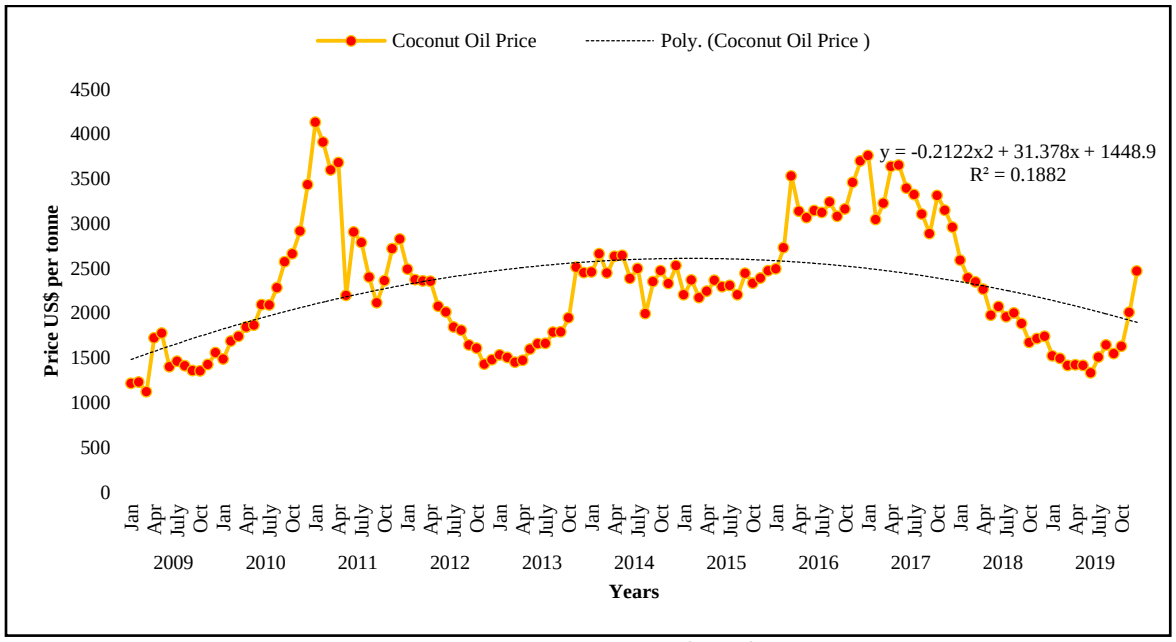

Fig. 2. Trend in coconut oil prices in US dollars per tonne for Fiji from the year 2009 to 2019.

Table 1. Seasonal indices for average price of copra and coconut oil in Fiji.

Seasonal Indices		
Months	**Average copra price (FJ$)**	**Average coconut oil price (US$)**
Jan	98.76	103.56
Feb	100.22	101.69
Mar	101.97	102
Apr	101.18	105.59
May	102.4	96.26
Jun	102.64	97.71
July	101.12	97.78
Aug	98.02	94.12
Sept	98.89	93.14
Oct	97.98	97.2
Nov	96.35	102.27
Dec	100.46	108.63

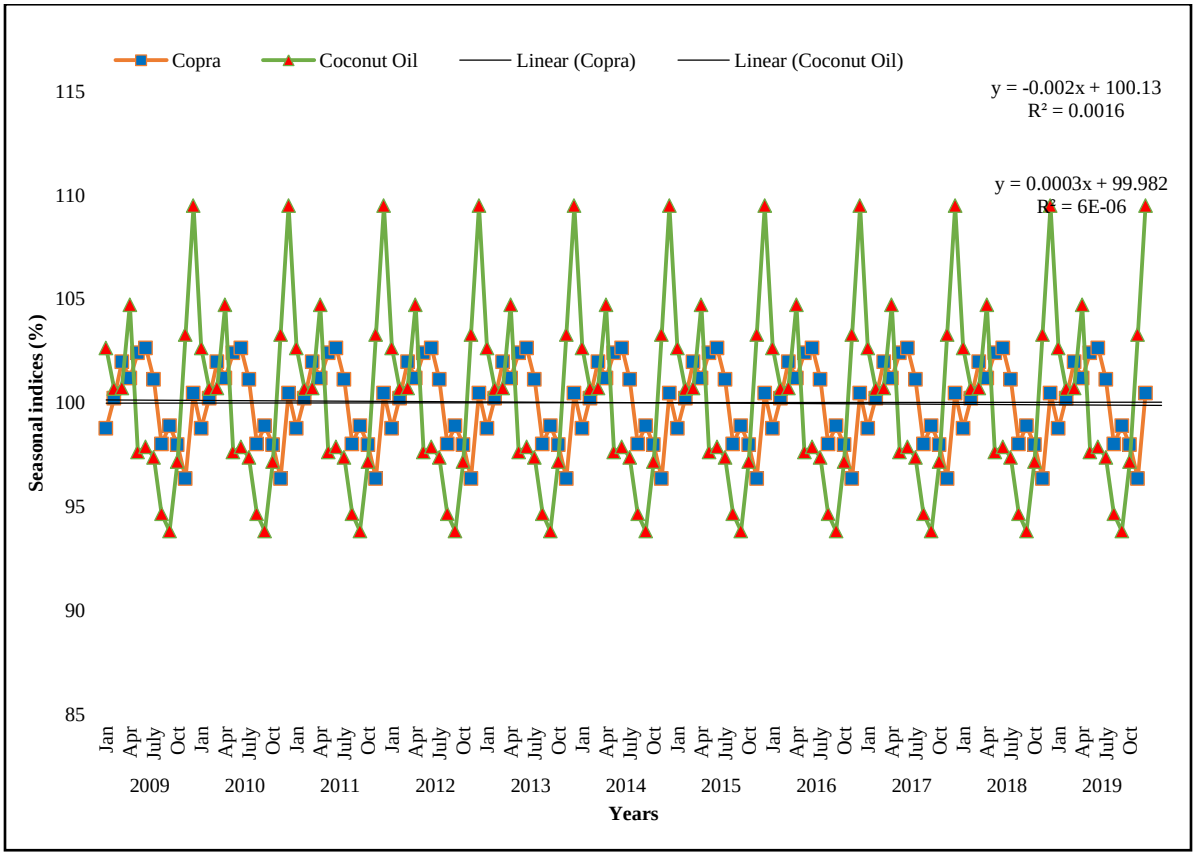

Fig. 3. Seasonal variations in the prices of copra and coconut oil in Fiji from the year 2009 to 2019.

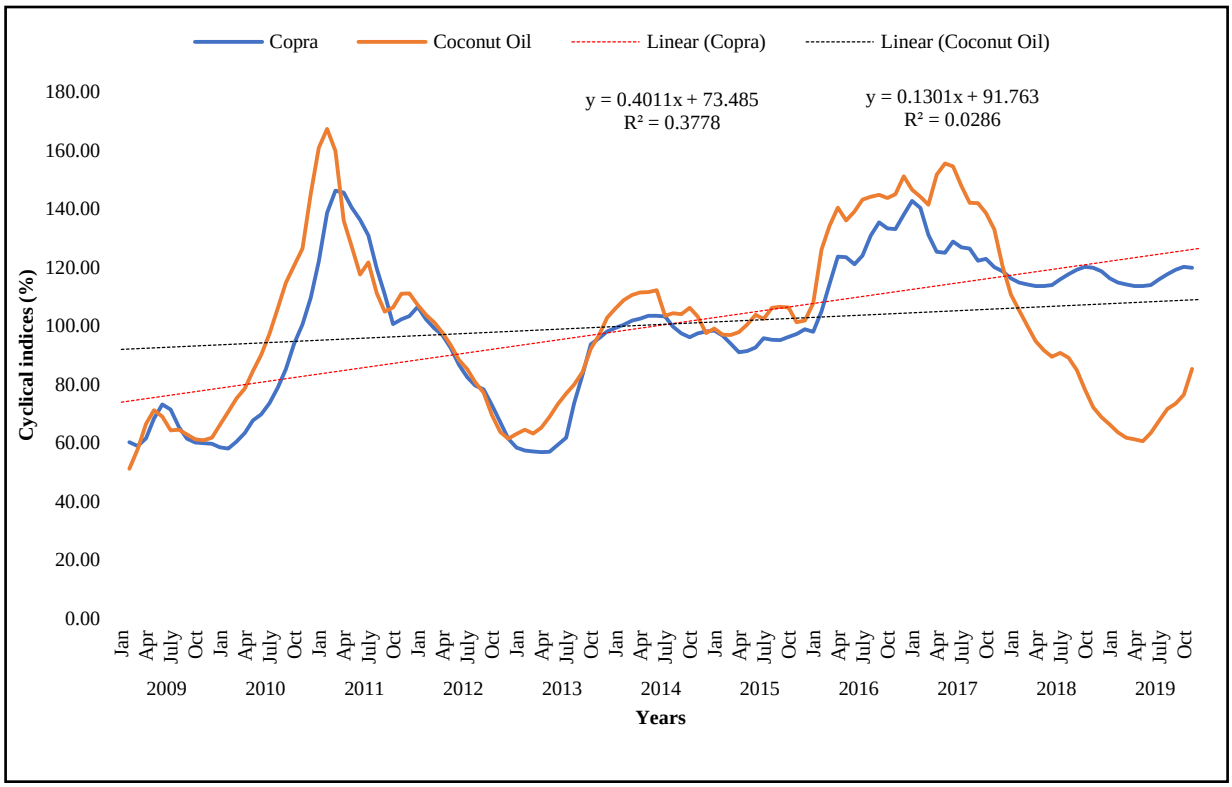

Fig. 4. Cyclical variations in the prices of copra and coconut oil in Fiji from the year 2009 to 2019.

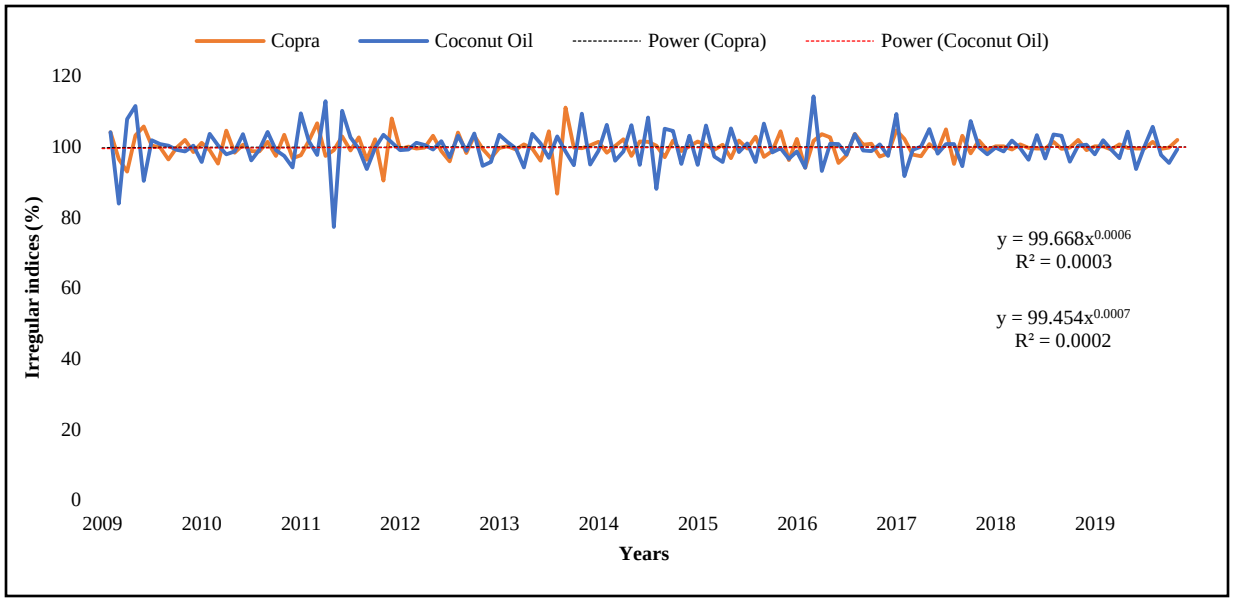

Fig. 5. Irregular variation in prices of copra and coconut oil in Fiji from 2009 to 2019.

Discussion

A trend represents a persistent and discernible pattern in data that demonstrates a consistent upward or downward movement over an extended period. It is indicative of a long-term tendency for the values to consistently increase or decrease without significant deviations or random fluctuations. Trends provide valuable insights into the underlying behavior and direction of the data, allowing for the identification of

broader patterns and making informed predictions about future outcomes (Goldthorpe & Mills, 2008). The present study showed that copra prices showed a consistent upward trend over the long term, indicating an increase in value. On the other hand, coconut oil prices exhibited a downward trend, indicating a decrease in value. The observed consistent upward trend in copra prices over the analyzed period highlights the potential increase in value over the long run. This trend suggests a positive outlook for copra producers, indicating factors such as growing demand or scarcity of supply in the market. On the other hand, the declining trend in coconut oil prices implies a decrease in value, which can pose challenges for coconut oil producers. Understanding these long-term trends is crucial for market participants to make informed decisions regarding production, pricing, and investment strategies. Moreover, the variable correlations observed in both trends indicate that the relationship between copra prices and coconut oil prices fluctuates over time. This suggests that various factors, such as changes in global supply and demand dynamics, competition from alternative oil crops, and other market forces, influence the pricing dynamics of copra and coconut oil. These findings highlight the need for effective market analysis to identify the key drivers behind these variable correlations and adapt strategies accordingly. The aforementioned findings are consistent with those of Babu *et al*. (2009) and Preethi *et al*. (2019), who noted higher price changes in coconuts in the markets of Kerala, India. The prices of coconut oil in the market can affect the supply of copra and its price (Das *et al*., 2022). Since the Fijian producers export ~ 90% of their coconut oil, hence the local price of copra is based on the price of coconut oil in the international market. Competition from other oil crops, low market demand for oil for biofuel, and low global copra and coconut oil supply to international markets may have caused the price of coconut oil to be weakly correlated over the time, which in turn affected the price of copra in Fiji (McGregor & Sheehy, 2017). Due to factors such as the ongoing high number of senile trees, the vulnerability of coconut plantations to natural disasters, and the destructive effects of exotic pests like the coconut rhinoceros beetle, the demand for coconut oil has increased globally and notably in the Asia-Pacific (McGregor & Sheehy, 2017).

The consistent and periodic changes in a time series over the course of a year are known as seasonal variations (Ollech, 2021). The observed seasonal patterns in copra and coconut oil prices provide valuable insights into the dynamics of these markets. The discussion of these patterns and their potential reasons can shed light on the factors influencing price fluctuations and assist market participants in making informed decisions. For copra prices, the peak in June and the lowest point in November indicate a consistent seasonal cycle. This pattern can be attributed to various factors. Firstly, it is important to consider the harvest season for coconuts. Coconuts typically take a few months to mature, and the peak in copra prices in June suggests a higher supply during this period. As a result, increased availability leads to lower prices in the market. Conversely, the lowest prices in November correspond to a reduced supply, likely due to a lower harvest volume during that time. This seasonal fluctuation in supply and demand dynamics influences copra prices. The buoyant phase for copra, characterized by higher prices from March to July, can be explained by factors such as increased demand or limited supply during that period. It is possible that there is a surge in demand for copra during certain months, leading to a price increase. This could be influenced by factors like the seasonality of industries relying on copra, such as the production of coconut-based products or seasonal variations in consumer preferences. Additionally, factors such as changes in export demand or shifts in global market dynamics could contribute to the buoyant

phase. Similarly, the depressed phase for copra, with lower prices observed from August to February, may be influenced by factors such as decreased demand or an abundance of supply. During this period, there might be lower consumption or reduced export demand for copra, leading to a surplus in the market and subsequently causing prices to decrease. Seasonal variations in consumer behavior or shifts in global market demand could contribute to the depressed phase. In contrast, coconut oil prices exhibit a distinct seasonal pattern, with the highest prices in December and the lowest prices in September. The reasons behind this seasonal variation in coconut oil prices can be analyzed from various perspectives. Firstly, it is crucial to consider the global demand for coconut oil during different periods. Seasonal variations in consumer preferences, such as increased consumption during the holiday season, can drive up the demand for coconut oil and subsequently push prices higher in December. On the other hand, the lowest prices in September could be influenced by factors such as reduced consumption or lower export demand during that period. Additionally, factors like the availability of alternative oils in the market or changes in the global supply of coconut oil can impact seasonal price variations. The main factor influencing price variations is seasonality in the production of agricultural commodities (Boughton *et al*., 2021). The above findings are in accordance with those of Babu & Sebastian (1996), Babu *et al*. (2009), and Indraji (2016), who reported high price fluctuations in coconuts between 1990-01 and 2015-16. The primary driver of changes in copra prices was revealed to be fluctuation in the price of coconut oil on a global scale (Rethinam, 2019). Despite the fact that coconuts are a perennial crop and are produced all year long. It is revealed that the price behavior may be due to the differences in harvesting patterns of coconut (Preethi *et al*., 2019). The US being the world's greatest producer and exporter of oil, the price of oil on the international market is set in US dollars (Lizardo & Mollick, 2010). The demand for US dollars as well as other elements like inflation rates, trade imbalances, and political stability affect how much the dollar fluctuates in value. If all other conditions remain constant, the price of oil tends to decrease as the US dollar gains; conversely, the price of oil tends to rise when the US currency weakens. Prices for coconut oil are greatly influenced by different oil markets and large production countries suppliers. The price of oil rises when market demand for coconut oil does, while price of oil tends to fall when market demand falls (Gaskell, 2015). When competing with other alternatives, larger producer coconut oil providers set the price of coconut oil.

The analysis of cyclical price fluctuations in copra and coconut oil provides valuable insights into the dynamic nature of these markets. By extracting the cyclical-irregular data, which represents the remaining variations after removing the trend and seasonal components, a clearer picture of the cyclical patterns emerges. Cyclical variations are oscillatory movements in a longer-than-a-year time series (Dhekale *et al*., 2019). The cyclical movements of both copra and coconut oil prices closely mirrored each other, exhibiting significant variations. This suggests a strong correlation and shared cyclical behavior between the two products during that period. Both copra and coconut oil prices exhibit prominent cyclical fluctuations spanning one to three cycles. This indicates that these markets are subject to cyclical forces that influence their pricing dynamics over time. These cycles can be driven by various factors, such as changes in global supply and demand, economic conditions, or specific industry-related events. Both prices exhibit high levels of irregular variations, indicating significant fluctuations that are not easily explained by known factors or predictable patterns. The irregular variations may stem from various external factors such as changes in market conditions, geopolitical events, natural disasters, or

unexpected shifts in consumer demand. The projected outlook suggests that copra and coconut oil prices will continue to experience significant and irregular fluctuations. This indicates the need for market participants to remain vigilant and responsive to changing market conditions. Effective risk management strategies, such as hedging against price volatility or diversifying product portfolios, may be crucial for industry stakeholders to navigate these uncertain price dynamics successfully.The prices of coconut products fluctuated erratically due to numerous irregular and non-recurring circumstances that were out of human control. Prices for coconuts were predicted to fluctuate greatly because they are a principal produce with a limited shelf life and a bulky appearance (Yang *et al*., 2018; Shana, 2019). Also, because coconut is a crop grown by small farmers, the producer sells it right away at the going rate (Nghiem *et al*., 2020).

Conclusions

Given that coconut is a permanent crop that demands a significant investment in comparison to seasonal and annual crops, price stability is crucial in encouraging farmers to engage in coconut cultivation. The frequent fluctuations in international coconut oil prices, which have impacted copra pricing and reduced copra output because most farmers have lost interest and have shifted to growing other lucrative crops to recoup their costs and make a profit, have been one of the most troubling aspects of Fiji's coconut industry over the past ten years. Long-term trends have not been evident in the price variations of coconut oil around the world. The price of copra was more significantly impacted by the seasonality and irregular price fluctuations of coconut oil, the price of which is influenced by changes in the US dollar's value, market demand, and suppliers from major producer nations. As a result, recommendations have been made to stabilize the price of coconut oil and copra as part of the global effort to improve the coconut industry. This can be done if the Fijian government and the coconut industry place more emphasis on maximizing farmer revenue, minimizing farmer cost of input, and developing alternative sources of income for farmers, as well as increasing the profits of the coconut industry through infrastructure development, expanding markets, and reducing costs. Future research in Fiji should therefore concentrate on enhancing the value chain of the Fijian coconut industry, which includes farmers, different uses and processing techniques for coconut palms, product diversification and development, and market study taking into account coconut having a long gestation period, low coconut production, high number of senile palms, coconut vulnerability to natural disasters, and increasing exotic pest the coconut rhinoceros beetle.

Acknowledgements

The authors would like to acknowledge the support from Fiji National University (FNU), Australian Centre for International Agricultural Research (ACIAR), Fiji Copra Millers Ltd and Palm Oil Analytics for providing accessible data.

Conflict of interests

The authors declare that there is no conflict of interest.

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