Price Elasticity Study and Comparison between Agricultural and Fishery Products

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Abstract. Amid an economic downturn, a complex and volatile domestic and international environment, and pressure on economic growth, the development of the agricultural and aquatic products industry has been hampered in many ways. Against this background, it is important to further analyze and understand the nature and characteristics of price elasticity and demand influencing factors of different agricultural and aquatic products to maintain the normal operation of their industries. In this paper, linear regression and price elasticity of demand formulae are used as the two most important methods. Linear regression is used for the derivation of the demand function and the analysis of the factors influencing the demand. The price elasticity of demand formula is used to calculate the price elasticity of different agricultural and fishery products and subsequent analyses. It was found that the differences in price elasticity and quantity demanded for agricultural and fishery products have different implications for firms, consumers, and farmers. The price elasticity of agricultural products is generally higher than that of aquatic products, and according to the different price elasticity characteristics, firms can adjust their business strategies, consumers can estimate and optimize their expenditures, and farmers can plan their production and planting. At the same time, because the demand for products is affected by price, season, and precipitation, different groups can give different feedback on the same products according to the season and precipitation.

Keywords: demand price elasticity, factors affecting product demand.

1. Introduction

After experiencing a series of challenges such as the COVID-19 pandemic, supply chain disruptions, and geopolitical tensions, the global economy is gradually recovering, but it is still not optimistic. In China, although the Chinese government has taken several measures to stabilize economic growth, including infrastructure investment and stimulating consumption, economic growth is still under pressure due to the complex and changing domestic and international environment. Under this economic situation, the development of the agricultural and aquatic products industry has to face many difficulties: the decline in consumer purchasing power and changes in domestic and foreign demand; rising transportation costs, logistics delays, and increased international trade barriers, which affect the industry's supply chain efficiency; accelerated integration within the industry; and rising product prices.

Agricultural and fishery products are essential nutrients for human health and play a vital role in sustaining livelihoods. Understanding the price elasticity of agricultural and fish products in different dimensions is thus important for market managers, farmers, consumers, and policymakers to make informed decisions to ensure market stability and food security. Price elasticities measuring demand response to price changes vary considerably across agricultural and fishery products or seasons for the same agriculture or fisheries due to seasonality, consumer preferences, and supply chain dynamics. This study thus plays a potentially instructive role in firms' pricing strategies and government policy decisions. By identifying the different elasticities of these product categories, firms can optimize their pricing strategies to maximize revenues, while policymakers can design more effective agricultural and aquaculture support measures.

Price elasticity is not a new concept in economics, and extensive research exists on the price elasticity of various commodities, but there is a significant gap in the literature on the price elasticity of agricultural and fishery products in the local market compared to existing research on other types of commodities. After an extensive search and reading of existing articles, the paper found that

previous studies have focused on staple crops or a wide range of agricultural commodities and that there is a relative lack of research on the price elasticity of agricultural and fishery products. This gap highlights the significance of focused research on the price elasticity of agricultural and fishery products to provide actionable insights to stakeholders such as markets, farmers, and consumers.

The study hypothesizes that the price elasticity of demand for agricultural products (e.g., vegetables, poultry, etc.) is high, while the price elasticity of demand for aquatic products (e.g., fish, shrimp, etc.) is low. This assumption is based on the premise that agricultural products are more subject to seasonal variations and have higher substitutability. In contrast, aquatic products tend to have fewer direct substitutes and are regarded as an important source of nutrition. Specifically, the research attempts to explore how consumers' purchasing behavior changes when the prices of these two types of products change. To test this query, the paper will compile the selling price and trading volume of selected types of agricultural or aquatic products in 2023 for two companies engaged in marketing agricultural products and aquatic products, respectively. The data will be abstracted through linear regression to produce a function that matches the trend in demand. At the same time, the demand function will be used to calculate the price elasticity of the same product under the influence of different factors. In addition to this, the comparison of price elasticities of demand, supply, and substitution for agricultural and aquatic products will also be carried out. These analyses will help the government, firms, and consumers to understand the extent to which price changes affect the demand for various products [1].

In the experiment, the essay also analyzed the factors affecting the demand for the product. The essay assumed that price, season, precipitation, and weather are the variables affecting the quantity demanded, collected the information, and based on this, carried out calculations to analyze the statistical significance and positive and negative correlations of the different factors. This study of the factors influencing the demand for agricultural and aquatic products can help companies optimize their marketing strategies and supply chain management, help consumers make informed consumption decisions, and help farmers improve production efficiency, enhance market responsiveness, achieve sustainable development, and ultimately contribute to the healthy development of the market as a whole.

In the current economic situation, studying the price elasticity of agricultural and aquatic products and the factors affecting their demand can help understand market dynamics and provide a key decision-making basis for policymakers, producers, and sellers. It can optimize pricing strategies, improve supply chain management, assist government policymaking, cope with market uncertainties, promote sustainable development, and forecast and plan.

2. Literature Review

Today’s research on the price elasticities of agricultural and aquatic products is quite extensive, but there are still gaps in understanding the comparative price elasticities of agricultural and aquatic products.

Andreyeva, Long, and Brownell systematically review reductions and increases in the prices of subsidized fruits and vegetables, as well as taxes on sugar-sweetened beverages and snack foods, and analyze existing research on the impact of prices and pricing strategies on consumer food choices. The conclusion is drawn that price changes significantly affect food consumption patterns, with subsidies on healthy foods such as fruits and vegetables typically increasing their consumption and taxes on unhealthy foods decreasing it [1].

Omezzine et al. used a case study approach to analyze the price elasticity of demand for various types of fresh fish commodities, using empirical data on market sales and pricing information to measure the impact of price changes on consumer demand for different types of fresh fish. The study found that price elasticities varied across fish types, with high-value fish having lower price elasticities than low-value fish [2].

Previous studies have typically focused on a single category without directly comparing the two, limiting a comprehensive understanding of consumer behavior in these two important food groups.

In addition, to gain a more accurate and deeper understanding of the price elasticity of demand, ideas from Price Elasticity of Demand are shown in the essay, from which the paper obtained a comprehensive overview of the theoretical and practical applications of price elasticity of demand, including the factors influencing it as well as examples of its application [3]. Also, the essay obtained an introduction to price elasticity of demand from Yashkina Oksana's paper [4].

For the second part of the empirical study, the research was inspired by the article Factors Affecting the Demand of Organic Food Products: An Empirical Study by Anand M. K., Gowda V. R et al. in the Journal of Food Products Marketing. The study analyzed multiple factors affecting the demand for organic food products using linear regression models. The study used a linear regression model to analyze multiple factors affecting the demand for organic food products. The study investigated the effects of price, income, education level, and health awareness on the demand for organic food products by collecting data on consumers' purchasing behaviors [5-7].

Moreover, the article obtained a methodology for determining the degree of influence of factors on demand and related concepts from About the Licenses - Creative Commons.

The systematic review method of Andreyeva, Long, and Brownell guides data collection and market analysis in this paper: by collecting price and demand data of agricultural and aquatic products, the paper analyzes how price changes affect the demand for these products [8-9]. The research of Omezzine et al. is reflected in this article in the specific empirical analysis and the comparison of price elasticity of different product types. The research of Price Elasticity of Demand and Yashkina Oksana provides basic support for the selection of appropriate econometric models and theoretical analysis frameworks, which helps this article to achieve the combination of theory and practice. The methods of Anand M. K. and Gowda V. R et al. help this paper to establish and analyze the multi-factor linear regression model that affects the demand for agricultural and aquatic products. The case analysis method of Omezzine et al. provides ideas for determining the demand characteristics and influencing factors of products. The theoretical framework of Price Elasticity of Demand and Yashkina Oksana can help understand and expand the model to more comprehensively capture the complex dynamics of demand. Meanwhile, most of these articles focus on the in-depth analysis of a specific product, and there are defects in the analysis and comparison of the two major categories of macro-agricultural products and aquatic products. This deficiency also provides a research idea for this article. The articles by Hongwei Lu et al. and Jens-Peter Loy et al. served as a basis of judgment to corroborate the findings of this paper and prompted the articles to reflect on the errors that occurred in the experiments, adding to the reliability of this study.

3. Method

This paper selected two companies on the official website of the Kunming Agriculture and Rural Affairs Bureau and summarized their daily reference prices in 2023. The research took half of the days from each month and plotted the price and transaction volume of several specific products on that day. Through the statistical procedure of linear regression, the value of the dependent variable, demand y, is calculated from the independent variable, price x, which in turn creates a model that can be used to measure the association between the two variables [6].

3.1. Agricultural product

This model is the quantity demanded function required in this study, which is consistent with the function graph shown in Figure 1:

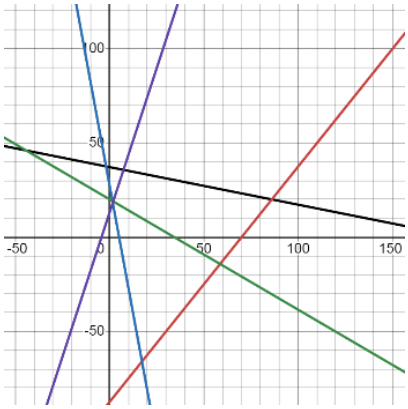

Fig. 1 Demand functions for five agricultural products

Pork y=-0.19933x+37.15893 (1)

Beef y=1.248208x-87.4598 (2)

Pumpkin y=-5.43329x+27.48226 (3)

Tomato y=-0.58549x+20.08496 (4)

Potato y=3.062668x+12.96615 (5)

Having the quantity demanded function, the research further carried out the calculation of the price elasticity of demand. The price elasticity of demand in terms of mathematical analysis is determined by the following formula [4]:

$$Ep(Q) = P\frac{Q'(P)}{Q(P)} \tag{6}$$

$$Pork\ Ep(Q) = -\frac{0.19933x}{0.19933x + 37.15893} \tag{7}$$

$$Beef\ Ep(Q) = \frac{1.248208x}{1.248208x - 87.4598} \tag{8}$$

$$Pumpkin\ Ep(Q) = -\frac{5.43329x}{5.43329x + 27.48226} \tag{9}$$

$$Tomato\ Ep(Q) = -\frac{0.58549x}{0.58549x + 20.08496} \tag{10}$$

$$Tomato\ Ep(Q) = \frac{3.062668x}{3.062668x + 12.96615} \tag{11}$$

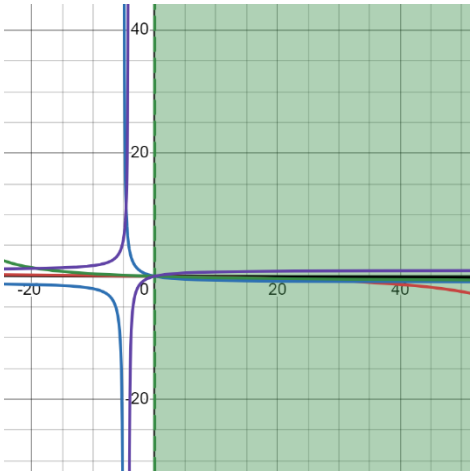

Fig. 2 Price elasticity functions of demand for five agricultural products

The black, red, blue, green, and purple in Figure 2 are the price elasticity functions for pork, beef, squash, tomatoes, and potatoes.

As most products have a price elasticity near 1.0, this measure is often used as a general guideline. Products with a price elasticity greater than -1 are termed "elastic," while those with elasticities less negative than -1 are considered "inelastic." Essential goods with few substitutes usually exhibit lower elasticities [3]. With such judgment criteria, the paper randomly selected a day's price x to substitute into the corresponding elasticity formula for each agricultural product:

Table 1 Daily agricultural product prices

Types of agricultural products	Average selling price for the day
Pork	18
Beef	82.5
Pumpkin	3.25
Tomato	4.25
Potato	2.65

Plug the data in Table 1 into the formula.

Table 2 The price elasticity of demand of 5 agricultural products

Types of agricultural products	Price elasticity of demand	
Pork	-0.088	Extremely inelastic
Beef	6.636	High elasticity
Pumpkin	-0.391	Inelastic
Tomato	-0.110	Inelastic
Potato	0.384	low elasticity

Price elasticity is of great significance in economics. It reflects the degree to which consumers react to price changes. Specifically, price elasticity refers to the sensitivity of demand to price changes when other conditions remain unchanged. For goods with greater elasticity, price increases will lead to a decrease in demand, while for goods with less elasticity, price increases may increase demand. In addition, the positive and negative values of price elasticity also represent different economic meanings. The price elasticity of demand is usually negative, that is, when the price rises, the demand decreases; when the price falls, the demand increases. The positive price elasticity of demand often occurs in Geffen goods and conspicuous goods, which means that when the price rises, the demand also increases.

As shown in Table 2, beef is a highly elastic product, while the demand for pork, pumpkin, and tomato is less sensitive to price changes and is inelastic. Potatoes are in-between but on the inelastic side. It can be seen that except for beef, the remaining agricultural products are not sensitive to price changes.

3.2. Aquatic product

The essay made a table of prices and demand for three aquatic products of an aquaculture company for the year 2023 and obtained the following data by following the same analysis as for the agricultural products mentioned above:

The demand function obtained from linear regression is:

$$\text{Cutlassfish } y=8.769771x+60.01226 \tag{12}$$

$$\text{Rainbow trout } y=-3.51526x+62.29341 \tag{13}$$

$$\text{Turbot } y=-7.27821x+61.37032 \tag{14}$$

$$Cutlassfish\ Ep(Q)=\frac{8.769771x}{8.769771x+60.01226} \tag{15}$$

$$Rainbow\ trout\ Ep(Q) = -\frac{3.51526x}{3.51526x + 62.29341} \tag{16}$$

$$Turbot\ Ep(Q) = -\frac{7.27821x}{7.27821x + 61.37032} \tag{17}$$

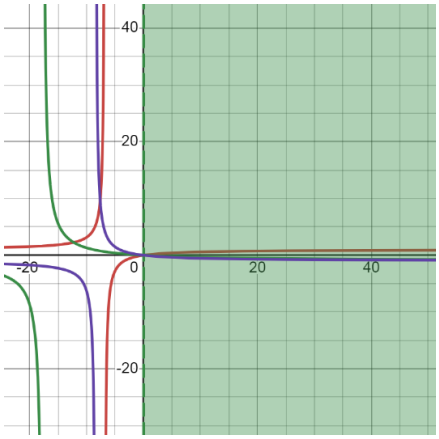

Fig. 3 Price elasticity functions of demand for three aquatic products

The red, green, and purple bars in Figure 3 are the price elasticity functions for striped bass, rainbow trout, and turbot

Table 3 Daily agricultural product prices

Types of aquatic products	Average selling price for the day
Cutlassfish	0.2
Rainbow trout	0.2
Turbot	0.3

Table 4 The price elasticity of demand of 5 agricultural products

Types of aquatic products	Price elasticity of demand	
Cutlassfish	0.028	Extremely inelastic
Rainbow trout	-0.011	Relatively inelastic
Turbot	-0.034	Inelastic

According to table 3, the price elasticity of demand for striped bass is very low, close to zero, indicating that changes in its price have almost no effect on the quantity demanded, which means that the demand for striped bass is very inelastic. The price elasticity of demand for rainbow trout is negative and very small in absolute value, indicating that the effect of price change on the quantity demanded is also very weak and the demand is relatively inelastic.

The price elasticity of demand for turbot is also negative, and although the absolute value is slightly larger than that of rainbow trout, it is still small, so the response of demand for turbot to price changes is also relatively weak, and demand is inelastic (Table 4).

Based on the data analysis fish products in general show much lower price elasticity, especially striped bass, rainbow trout, and turbot, whose demand is almost unresponsive to price changes. In contrast, while there are some products in agricultural products with inelastic demand, such as pork and tomatoes, there are also highly elastic products like beef. Thus, the price elasticity of fish is generally lower than that of agricultural products. The article ‘Demand for fishery products in Brazil’ mentions that due to the low availability of close substitutes and the perception of fishery products as a specialty or luxury item, fishery products tend to have lower price elasticity compared to other food groups, such as agricultural products [8]. Such a statement serves as evidence to support the conclusion of this paper that the price elasticity of fishery products tends to be lower than that of agricultural products.

3.3. Factors Affecting Product Demand

After examining the price elasticity of agricultural and fishery products in general, the study further explores the factors influencing the quantity demanded of the products. The paper chose to use potatoes as an example for their study. Based on the existing data on demand and selling price, they further collected data such as monthly precipitation and monthly mean temperature for Yunnan for the year 2023 from authoritative websites such as Weather and Climate and Climate Data, and incorporated seasons as dummy variables into the study. The following table was obtained through linear regression (Table 5):

Table 5 Regression results

	Coefficients	Standard error	t Stat	P-value	Lower 95%	Upper 95%
Constant	13.291	1.844	7.206	0.000	9.657	16.926
Price	2.141	0.409	5.226	0.000	1.334	2.949
Winter	2.345	0.571	4.106	0.000	1.220	3.471
Spring	-2.440	0.437	-5.584	0.000	-3.301	-1.579
Summer	-2.140	0.567	-3.771	0.000	-3.259	-1.022
Rainfall(mm)	0.018	0.007	2.671	0.008	0.005	0.032
Temperature	0.058	0.101	0.575	0.566	-0.142	0.258

Because a p-value greater than 0.05 indicates that statistical significance is not significant, the paper retained variables with $p < 0.05$ to make the estimates of the parameters statistically significant to ensure that there is an association between the variables [7]. Since the P-value for temperature is more than 0. 100, the function of the demand for dropping this variable can be expressed as:

$$Quantity\ demanded = 13.291 + 2.142 * Price + 2.345 * Winter - 2.440 * Spring - 2.140 * Summer + 0.019 * Rainfall \quad (18)$$

Based on the linear regression results it can be found that price, season, and precipitation can affect the demand for potatoes. In this case, for every unit increase in price, the quantity demanded increases by 2.142 units. Since the coefficient is positive, it means that the quantity demanded increases with the price increase. During the winter season, the quantity demanded increases by 2.345 units which has a positive effect on the quantity demanded. In spring, the quantity demanded decreased by 2.440 units, which hurt the quantity demanded. In summer, the quantity demanded decreases by 2.140 units, which hurts the quantity demanded. For every unit increase in precipitation, the demand increases by 0.019 units, which shows that the amount of precipitation has a slight positive effect on the demand.

In the two studies The Fluctuation Characteristics and Periodic Patterns of Potato Prices in China and Potato Prices as Affected by Demand and Yearly Production: A German Perspective, the article also analyzed the factors affecting potato demand [8-10]. The results of the two studies are generally consistent with this article, and they also explored the impact of price, season, precipitation, and temperature on demand. The latter article points out that in the cold months (autumn and winter), potatoes are the staple food of many traditional European dishes, and potato consumption tends to be higher; in the warm months (spring and summer), as consumers turn to lighter foods, potato demand will decline [9]. This is completely consistent with the results of this article that autumn and winter are positively correlated with demand, and spring and summer are negatively correlated. However, from the analysis results of this article, the effect of temperature on potato demand is very small and has no statistical value, but it is analyzed in detail as an important influencing factor in The Fluctuation Characteristics and Periodic Patterns of Potato Prices in China. Such differences may be mainly due to the following reasons: the model in this article has included seasonal dummy variables. Since temperature changes are essentially related to seasons, seasonal variables may explain changes that could otherwise be attributed to temperature; the data used in the research comes from companies in Kunming, Yunnan, where the climate is relatively mild throughout the year and temperature

fluctuations may not be enough to have a significant impact on demand; potatoes are generally regarded as a staple food in Yunnan, and demand is relatively stable at different temperatures.

4. Result

Price elasticity calculations and regression analyses for agricultural and aquatic products can be used as a guide for businesses, consumers, and farmers, respectively.

Firms: Firms can use knowledge of price elasticity to maximize revenue when developing pricing and promotional strategies. For price elasticity considerations, for highly elastic products like beef, sales, and total revenue can be significantly increased through price reductions, while for less elastic products like pork, pumpkin, and tomatoes, price changes have less impact on sales, and firms can maintain or fine-tune their prices to maximize profits. In the case of fish products, due to their low price elasticity of demand, firms can obtain a stable revenue stream even if they are relatively free to adjust prices. Considering the perspective of factors affecting demand, enterprises may consider attracting consumers through discounts or promotions during low seasons, such as spring and summer, and increasing stocks to meet demand in winter.

Consumers: Consumers can use price elasticity information to make more informed purchasing decisions. Consumers can choose alternatives to save money for highly elastic products with high price volatility, such as beef. On the contrary, due to the low price elasticity of demand for fish products, consumers do not need to adjust their consumption plans significantly in the face of changes in fish prices, thus contributing to budget stability. For agricultural products, understanding the price elasticity of different products can help consumers selectively purchase more cost-effective alternatives during periods of price volatility. In addition, consumers can analyze the characteristics of the same product in different seasons based on the factors affecting the quantity demanded, for example, it may be fresher in winter and more affordable in spring and summer

Farmers: Farmers can optimize their production and planting plans by knowing the price elasticities of different agricultural and fish products. For fish products with low demand elasticity, farmers can stabilize production and reduce production risks and income fluctuations. For highly elastic products, such as beef, farmers should consider the risk of market fluctuations and protect their income by developing more detailed market research and risk management strategies. Considering the multiple influences on demand, and depending on seasonal changes in demand, farmers can increase planting and harvesting before winter, plant crops with relatively stable demand diversify planting strategies in spring and summer to cope with reduced demand, and use precipitation forecasts to adjust planting strategies.

By analyzing the price elasticity of different products and the factors affecting the quantity demanded, businesses, consumers, and farmers can maximize the benefits. These data can help different groups of people achieve the goal of reducing unnecessary costs and maximizing returns.

5. Conclusion

The first part of the research highlights significant differences in the price elasticity of agricultural and fishery products, which provides some reference value for various stakeholders. The study shows that compared to agricultural products, fishery products in general show lower price elasticity, with demand being almost unresponsive to price changes, while agricultural products have a combination of inelastic and highly elastic products in terms of demand.

For companies, understanding product elasticity can help in strategic pricing and inventory management, and in making targeted adjustments to optimize revenues. For example, they can reduce prices to boost sales of highly elastic products, while maintaining stable prices for less elastic products to generate stable revenues.

Consumers can make informed purchasing decisions based on product elasticity. Consumers can look for substitutes when prices of highly elastic agricultural products increase, while stable demand for fish products ensures budget predictability.

Farmers can optimize production strategies by focusing on inelastic products for stable returns and carefully managing highly elastic products to reduce risk. Meanwhile, real-time elasticity data to guide planting and harvesting decisions can align supply with market dynamics.

Overall, this study highlights the importance of price elasticity analysis in developing market strategies, consumer behavior, and agricultural planning, contributing to a more efficient and resilient food supply and marketing chain.

The second part of the study uses the example of potatoes and focuses on analyzing the degree of influence of different factors on demand through linear regression. The magnitude of the p-value was compared to 0.05 to determine whether the factors were statistically significant. The positivity and negativity of the coefficient are then used to determine whether the variable brings about a positive or negative effect.

Enterprises set more reasonable pricing strategies by analyzing the influencing factors, launching promotions or new products at the right time, optimizing market strategies, and thus increasing market share and maximizing profits. Meanwhile, optimizing inventory management reduces inventory costs and wastage, and prevents over-production or under-supply.

Consumers, inferring changes in market demand based on the factors influencing demand, can make more informed purchasing decisions and enjoy more cost-effective, high-quality products.

The benefits to farmers of understanding the factors influencing demand are reflected in the fact that they can increase productivity and reduce waste; help them to be in a favorable position in price negotiations with enterprises or intermediaries to ensure a reasonable income; and adjust the cropping structure to help ecological balance and sustainable agricultural development.

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